Integrated Pest Management
Collaborative Research Support Program

Technical Workplan

2012–2013

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IPM CRSP | Integrated Pest Management
Collaborative Research Support Program

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

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Dominican Republic: IDIAF

Guatemala: Universidad del Valle de Guatemala and AGROEXPERTOS

Objective 1: Generate and transfer effective farmer-friendly IPM packages in vegetables and Andean fruits

Description: Research on IPM packages is at different stages across the LAC region. While the Ecuador and Honduras sites are fairly well along, having identified key pests and diseases and promising solutions, work in Guatemala is less well advanced. In the former two countries, we are moving toward refinement of IPM packages. These packages are at various stages depending on the crop. In the latter, we are continuing research toward identification of an IPM package for tomatoes, peppers and potatoes.

We will continue to develop alternative strategies for Andean fruits in Ecuador, as well as pests on a variety of solanaceous crops in Ecuador and Central America.

Activity 1: Conduct crop- and pest-specific research

Status: Continuing

US Scientists involved: Alwang, Norton (VT), Backman, Gugino (Penn State), Weller, Foster (Purdue), Brown (U of AZ), Tolin (VT)

Description: In Ecuador and Honduras, many experiments were initiated in prior years and will be carried over into the current year. In Guatemala, we are ending and summarizing pest surveys. We are also establishing field trials for promising technologies and important pests of tomato, peppers and potatoes. These trials will be supported by Virginia Tech, Purdue and Penn State scientists. In all countries, we are collecting information on costs (input prices and quantities) and benefits (output prices and crop yields) of promising practices in field-level trials and this information will be used in impact assessment.

Progress to date: Trials have been set up on farmer fields in Ecuador (Andean fruits, maize and beans, and potatoes) and Honduras (peppers, tomatoes, potatoes, sweet potato, eggplant, bittermelon, with the latter being a "model" crop to evaluate combinations of biofumigant mustards, nematode-resistant cowpeas and solarization). In Guatemala, we will establish new plots using a randomized block design, based on the results and evaluations of the demonstration plots from the prior year in Salamá and in Sololá. Plots will have tomato, pepper and potato in Sololá and only tomato and pepper in Salamá. Three plots or replications will be managed using standard grower practices and another three replications with an IPM approach. In addition, treatments will be established with individual IPM practices (selected based on their promise) to evaluate individual components of the IPM package.

<u>Ecuador.</u> Several trials for pest and diseases of naranjilla have been established. Means have been identified for managing *Fusarium oxysporum,* nematodes (*Meloidogyne incognita*), late blight (*Phytophthora infestans*), anthracnose (*Colletotrichum acutatun*), bacterial canker (*Clavibacter michiganensis*) and naranjilla fruit borer (*Neoleuocinodes elegantalis*). In the case of the latter, IPM techniques include selective spraying of low toxicity pesticides, local application of such pesticides to the flower and small fruits, and removal of affected fruits from the fields. Minor adjustments to the IPM package are needed and wide-spread validation is being conducted. Tree tomato and blackberry research is ongoing. The main pest problems are: anthracnose (*Colletotrichum* sp), late blight (*Phytophthora infestans*) and various leaf insect pests (tree tomato); and botrytis (*Botrytis cinérea*), mildew (*Peronosphora* sp) and scarab larvae in the plant's root system (blackberry). IPM packages for potato pests, developed and tested in earlier phases of the CRSP are

being adapted to new environmental conditions in Guaranda, Ecuador. Key potato pests include: late blight (*Phytophthora infestans*), White Worm (*Premnotypes vorax),* Central American Tuber Moth (*Tecia solanivora*) and the potato cyst nematode (*Globodera pallida*).

The Ecuador site has made considerable gains in developing pest resistant cultivars, particularly on Andean fruits, such as naranjilla, tree tomato, and intercropping plants such as blackberry. Data have been collected on the identification of pathogens and races and/or subspecies. Extensive breeding for resistance has occurred in naranjilla for *Fusarium oxysporum* and root knot nematode (*Meloidogyne incognita*). Some of the best lines have advanced to the F6 generation with good inheritance of other market sensitive characteristics. These advanced lines typically have single gene (vertical) resistance and are now almost ready for field evaluation. A poty virus and *Clavibacter* bacteria (cause of bacterial canker) are also causing significant problems in naranjilla, tomato, and potato and require additional research inputs from our collaborators. Still another threat is the ability of *Phytophthora infestans* the causal agent of late blight to cause significant crop loss on virtually all of these solanaceous fruits. A survey of the genotypes or clonal lineages would greatly improve the IPM packages presently being developed allowing them to be more tailored for specific genotypes present.

Guatemala. Through the use of surveys, we have identified the primary diseases that should be emphasized in the three regions (the highlands, principally in Sololá, the southern coast, principally Escuintla and Santa Lucía Cotzumalguapa and Salamá; Progreso and Zacapa). For solanaceaus crops, these principally are viruses (begomoviruses, potyviruses, tospoviruses and Torrado virus and tobamoviruses on tomato). With virus vectors we have determined that we should emphasize control of whiteflies (*B. tabaci* and *T. vaporariorum*), cycadellids, thrips and aphids. Priority bacterial pathogens include *R. solanacearum* (bacterial wilt)*, C. michiganensis michiganensis* (bacterial canker) and *Candidatus Liberibacter solanacearum* (zebra chip), vectored by a psyllid.

In the case of fungal diseases, we concentrate on *Fusarium* spp. and *Phytophthora infestans*. With nematodes, the focus will be on *Pratylenchus* spp. and *Meloidogyne* spp. In the first year, we also saw the need for implementing programs that include biological control or other ways of control and prevention that reduce reliance on chemicals. Growers are having very difficult time with pests and applying substantial quantities of chemicals. The economics and environmental/human health impacts of production under such circumstances are highly suspect. New pests and diseases are more problematic (such as zebra chip of potato and infection of tomato by *Liberibacter*, *Clavibacter michiganensis* subsp. *michiganensis* and others).

Producers need alternative safe technologies to address these problems while reducing reliance on chemicals.

Expected outputs: Pest complexes fully identified and IPM technology packages tested.

Task 1: (Guatemala) Disease surveys

Status: finalizing.

Scientists involved: Brown (AZ), Tolin (VT), Arevalo and Palmieri (Guatemala). *Progress to date:* completed field work. Will finalize analysis in current year.

Description: plants and vectors have been sampled for tomato, potato, pepper and hosts close to crops. We have collected information on the following vectors: Psyllids, whiteflies, aphids and thrips. These have been tested for associated pathogens. Also soil samples and root samples have been collected and we are analyzing them for the presence of nematodes and mycorrhiza. We are focusing on the identification of pathogenic viruses, bacteria, fungi and nematodes associated with the selected crops. This year we decided to focus on two regions: Sololá and Salamá.

Task 2: (Guatemala) Experiment-station and farmer field research activities

Status: Continuing. *Scientists involved:* Tolin (VT), Brown (AZ), Backman and Gugino (Penn State), Palmieri and Arevalo (Guatemala).

Description: In Guatemala, we will establish new plots using a randomized block design, based on the results and evaluations of the demonstration plots from the prior year in Salamá and in Sololá. Plots will have tomato, pepper and potato in Sololá and only tomato and pepper in Salamá. Three plots or replications will be managed using standard grower practices and another three replications with an IPM approach; currently we are evaluating a number of IPM practices, and will select the most promising for inclusion in subsequent trials (see below). In addition, treatments will be established with individual IPM practices (selected based on their promise) to evaluate individual components of the IPM package These will be set-up as a split plot or multi-factorial design so that individual and combinations of practices could be evaluated in one experiment. The trials need to be established in locations where there is significant pest pressure and presence of diseases, or be in a location where the pathogen can be inoculated in order to determine the efficacy of the proposed tactics.

For the IPM treatment we will evaluate: the use of biological emulsions, the use of sunflowers to encourager *Orius*, and discourage thrips and whiteflies, use of *Trichoderma* and/or *Bacillus subtilis* and some options of biological controls for nematodes. We will evaluate the use of Ruda (*Ruta graveolens*) and *Tagetes* as trap plants in the highlands and Salamá and the use of sorghum as a barrier in Salamá. In the highlands we will evaluate corn as an insect barrier. We are also establishing treatment plots with a similar design to test individual components of the IPM package.

We will also evaluate macrotunnels and screen enclosures compared to plantations without cover. We will use identical cultivars of tomato, pepper and potatoes. In these experiments we will conduct periodic monitoring of diseases, insects and arthropods and if possible of natural enemies especially against psyllids in the highland where *Paratrioza*, the vector of zebra chip, is present. Yellow sticky traps (4/field) will be used to determine psyllid and whitefly catches/dispersal times for IPM management/insecticide use when psyllids are dispersing (farmers currently spray throughout the growing season).

To estimate the percent infectivity in dispersing psyllid populations, psyllids will be removed from sticky traps and transferred to vials containing 95% ethanol and assayed in the laboratory by DNA hybridization using a *Liberibacter*-specific probe (with PCR validation using DNA isolated from selected samples) or Real Time PCR. Percent infection in each study field will be estimated by counting symptomatic plants in sectors. Selected symptomatic leaf samples will be collected to verify that plants called positive are infected. Spray technologies to target insecticides (nozzles) have to be evaluated to improve coverage for better psyllid control. Yellow sticky traps will be used to monitor psyllid infestation and samples will be collected to verify infection in plants considered symptomatic. Also we will check for natural enemies of the psyllid making captures and identifying potential biological control that could be used in subsequent trials.

Disease and pest evaluations will be conducted before planting of the crop, the second just before flowering, the third when fruit is present and the last after the crop ends. The reason of evaluating before the planting is because growers do not remove weeds and some plants of the crop to be planted may grow in the field or near the field and can harbor pathogens. We will focus on following diseases: *Candidatus Liberibacter solanacearum* (causal agent of Zebra chip in potato and affects tomato); *Ralstonia solanacearum* (causal agent of bacterial wilt of tomato and potato); some oomycetes and fungi, principally *Phytophthora infestans* in tomato and potato, *Phytohphthora capsici* in pepper, *Rhizoctonia* spp. and *Fusarium* spp.; nematodes, principally *Meloidogyne* spp., *Pratylenchus* spp. and *Helicotylenchus* spp. and the

principal viruses (begomoviruses, potyviruses, tospoviruses and viruses transmitted by mechanical means such as TMV or PVX in the two regions). If suspicious symptoms appear, other viruses will be evaluated. Collections of possible vectors will be made and monitored for associated pathogens.

All cost data will be collected and yields will be measured at harvest.

Task 3: (Ecuador) Continue to refine and validate naranjilla pest management techniques in Ecuador

Status: continuing.

Scientists involved: Ochoa, Gallegos, Poveda, Asaquibay (INIAP–DNPV); Martínez (INIAP-PF); Barrera, Escudero (INIAP-RRNN); Backman, Gugino (Penn State University); Miller (Ohio State University).

Description: Work in Bola de Oro in Bolívar Province, Tandapi in Pichincha, and Puyo in Pastaza to continue to validate our naranjilla IPM package. As noted, the key pests and diseases are *Fusarium* wilt, nematodes, late blight, anthracnose, leaf wilts and fruit borers. To control the first two problems, we graft common naranjilla (*S. quitoense*) on a resistant rootstock (*S. hirtum*)*;* for late blight control, we have tested appropriate fungicide applications (see table). These validation trials will examine biological and economic optimality of the packages and their components.

We will also study control of bacteria *Clavibacter michiganensis* subsp *michiganensis*. We will use isolates taken from different regions of Ecuador where the disease is present or suspected in order to characterize the bacteria. These activities will be conducted with Dr. Miller; detailed identification will occur in her laboratory (IPVD-Global theme).

Expected outputs: Completed validation of a technology package for farmers in the three areas; use of validation parcels for training of farmers; trainings will be coordinated with local governmental and non-governmental organizations. Determination of the suitability and resistance to *F. oxysporum* and *P. infestans* in the following crosses: *S. quitoense* (naranjilla) with *S. vestissimun*, *S. hiporodium*, *S. felinum* and *S. hirtum*. Scientific and technical publications.

Pest and practice prioritization matrix for naranjilla, Ecuador

		Decreasing promise		
	Pest problem	**IPM Practice**		
Decreasing severity	*Fusarium* and nematodes	Grafting onto resistant rootstock of *S. hirtum*	Seed sanitation, use of clean agricultural tools. Use of *trichoderma* and bacillus	
	Late blight	Foliar application of fungicides metalaxyl, cymoxanil or azoxistrobina following observation of first symptoms; rotation of protecting applications such as captan and copper hydroxide	Rotation of protectant fungicides with those with a base of phosphates and systemic products. Use of bacillus and trichoderma.	Field sanitation
	Anthracnose	Timed application of systemic fungicides (with rotations): triadimiefon, difeconazole, copper hydroxide and azoxistrobina; and protectants: captan and copper hydroxide and chlorothalonil.	Reduction and elimination of infected fruits; cut and remove old plants	Field sanitation
	Fruit borer	Application to flowers and small fruits (< 2 cm diameter): Cyfutrin, Triflumuron and Spinosad	Collection and elimination of fallen fruits.	
	Bacterial canker	Sanitary seeds	Monitoring in fields; removal of infected plants	Application of oxytetracycline in greenhouses and adult plants at appearance of symptoms

Task 4: (Ecuador) Development of IPM components for tree tomato IPM package

Status: continuing.

Scientists involved: Ochoa, Gallegos (INIAP–DNPV); Martínez (INIAP PF); Barrera, Escudero, Cruz (INIAP-RRNN); Backman, (Penn State University).

Description: The most important diseases for tree tomato are: anthracnose (*Colletotrichum acutatum*), late blight (*Phytophthora infestans*) and nematodes (*Meloidogyne incognita*). Anthracnose is the most important because of its wide geographic distribution and the magnitude of losses it causes (Sánchez *et al.*, 1996). Late blight is also widely distributed, but is most problematic in humid areas with temperatures between 10 and 24 °C.

Current year activities: (i) evaluation of giant tree tomato grafted into *Solanum auriculatum* and *Nicotiana glauca* with resistance to *M. incognita*, and validation of management practices for late blight and anthracnose using previously developed strategies. (ii) study the genetic resistance to *P. infestans* and *C. acutatum* of segregate of *Solanum betaceum* (tree tomato) with *Solanum uniloba*. This activity will be conducted in a greenhouse and validated in farmer fields. (iii) Study the productivity and resistance to P. *infestans* and *C. acutatum* of segregates of S*olanum betaceum* with *Solanum uniloba* in comparison with the yellow giant variety grafted into *Solanum auriculatum* and *Nicotiana glauca* in Bola de Oro-Chillanes. (iv) further testing uses of bio-rational controls for insect (B.t, insect pathogens, etc.) and disease management (*Bacillus* sp., *Trichoderma* spp., etc.).

Expected outputs: Validation of the management of the grafted variety and its ability to resist the main diseases of the crop. Training of farmers in appropriate management practices. Information on genetic resistance to *P. infestans* and *C. acutatum* with the segregates described. This will result in better long-term control through genetic resistance. Scientific and technical publications are also expected.

Task 5: (Ecuador) Development of IPM components for blackberry IPM package

Status: continuing

Scientists involved: Ochoa, Gallegos, Asaquibay (INIAP–DNPV); Martínez (INIAP PF); Barrera, Escudero (INIAP-RRNN); Backman (Penn State)

Description: The principal production problems for blackberry are botrytis (*Botrytis cinérea*), mildew (*Peronospora* sp), soil-borne fungi and beetles attacking the root system. INIAP and the IPM CRSP have developed a number of promising practices to address these production problems. These include: improved plant nutrition, strategic rotation of pesticides, plant sanitation, use of entomopathogenic nematodes *Steinernema* sp and *Heterorhabditis* sp, to control larvae of coleópteros. These practices need to be validated and combined into a package.

Current year activities: In Chillanes, Bolívar Province, and Ambato, Tunguarahua Province, we will continue to use a research plot to evaluate various management

practices. We will used three treatments: sanitary management (M1)--organic management (M2) and farmer practices (M3). We will also evaluate the following: Factor B (Use of *Trichoderma* for plant wilts)-- (B1with *Trichoderma* drench applications and B2 without *Trichoderma*). As a result, the treatments will be as follows: T1: A1B1: Sanitary management with *Trichoderma*; T2: A1B2: Sanitary management w/o *Trichoderma*; T3: A2B1: Organic with *Trichoderma*; T4: A2B2: Organic management w/o *Trichoderma* and T0 (farmer's practices).

Expected outputs: An effective IPM package for control of main blackberry pests and diseases. Use of experimental fields as demonstration plots suitable for training farmers and representatives from governmental and non-governmental organizations. Scientific and technical publications.

Task 6: (Ecuador) Development of package for management of pests and diseases of potatoes *(Solanum tuberosum*)

Status: Continuing (joint activity with SANREM CRSP).

Scientists involved: Gallegos, Ochoa, Tello, Asaquibay (INIAP–DNPV); Barrera, Escudero (INIAP- RRNN); Backman, Gugino (Penn State University).

Description: Potato is an extremely important crop for farmers in Ecuador's highlands; it is the principal source of dietary energy and a major income generator. The principal diseases are late blight (*Phytophthora infestans*) and rizocnoniosis (*Rhizoctonia solani*), The principal insect pests are white worm (*Premnotypes vorax),* the Andean potato weevil (*Tecia solanivora*). The IPM CRSP worked with INIAP for many years in development of an IPM package for control of these problems with a geographic focus on Carchi, in northern Ecuador, a major potato-producing area. Our current focus is to adapt this package to conditions in Bolivar province. This study will be implemented in Ato Guanujo-Bolívar and Cutuglahua-Pichincha. We will establish experimental parcels with random block treatments and three repetitions. These will be established on farmer fields: these parcels will also be used to train farmer in IPM practices.

Expected outputs: An integrated IPM package suitable for potatoes in other regions of Ecuador. Trained capacity of governmental and non-governmental organizations for IPM outreach.

Task 7: (Ecuador) Identification of biological controls for the naranjilla fruit borer (*Neoleucinodes* elegantalis)

Status: new

Scientists involved: Patricio Gallegos, César Asaquibay, José Ochoa, Katherine Orbe (INIAP-DNRG); Aníbal Martínez (INIAP Programa de Fruticultura); Víctor Barrera, Luis Escudero (INIAP-Programa RRNN); R. Muniappan (Virginia Tech)

Description: the fruit borer is the principal insect pest in naranjilla cultivation, due to its high incidence, which can reach up to 80% without adequate controls. Excessive use of pesticides by naranjilla producers means that IPM approaches are needed. These will reduce the use of dangerous or unnecessary pesticides and possibly lower input costs. The IPM CRSP has designed an IPM package for naranjilla, and recommendations are available for use of less toxic pesticides, more targeted application to flowers and small fruits, and removal of affected fruits. Even these controls, however, can be associated with pesticide residues and biological controls of the pest should be identified. Control of the insect through the introduction of a virus is a promising approach. Application of localized solutions can lower costs of control substantially.

Current year activities: We will begin by identifying natural enemies of the fruit borer in naranjilla-producing areas and expand the list of antagonistic viral strains (we currently have two identified). We will multiply these strains in laboratory conditions and conduct trials in laboratories and farmer fields. Field work will take place in Amazon and other naranjilla growing areas.

Progress to date: We have two available virus strains. We know how to multiply these strains. We have also obtained, through prior CRSP research, the biological cycles of *N. elegantalis*, and have produced two publications on control of the pest.

Expected outputs: Information on potential use of biological agents for the control of the pest. Lower cost of pest control, improved fruit quality, and higher net returns to producers. Consumers will benefit from fewer pesticide residues. Potential exists for formation of a national industry for this type of biological control agents.

Task 8: (Ecuador) Characterization and development of management principles of viral diseases in tree tomato, melon and water melon in Ecuador

Description: See Task 1.1.3 and Task 3.1.5 from the Plant Virus Disease global theme. These crops were added following discussions between the Ecuador team and the virus global theme.

Task 9: (Honduras and Guatemala) Detection of virus-like pathogens of Solanaceous crops Honduras and Guatemala

Status: Continuing.

Scientists involved: Brown (AZ), Palmieri (UDV Guatemala), several at FHIA (Honduras). Also see PVD-GT Task 1:2.2

Description: Ca. Liberibacter solanacearum-specific PCR (testing different primers for detection in plants and psyllids).

Progress to date: In order to estimate the percent infectivity in dispersing psyllid populations, psyllids are being captured in yellow sticky trap cards, then they are removed from the cards and transferred to vials containing 95% ethanol, and are assayed in the laboratory by DNA hybridization using a *Liberibacter*-specific probe (with PCR validation using DNA isolated from selected samples) or Real Time PCR. Percent infection in each study field is being estimated by counting symptomatic plants in sectors. Selected symptomatic leaf samples are collected to verify that plants called positive are infected.

Expected outputs: Tools for identification and design of management practices.

Task 10: (Honduras) Developing/optimizing the diagnostics and integration of management for the sweet potato viruses in Honduras

Note: This is an activity in which the work is done in the laboratory of Dr. Brown and FHIA only provides the raw samples.. Also see PVD-GT Tasks 1.2.1, 1.3.1d.

Status: Continuing.

Scientists involved: Brown (AZ), several at FHIA (Honduras).

Description: Molecular and bioassay development is needed to detect the predominant viruses in sweet potato. Additional approaches (dsRNA isolation) may be needed to discover previously undetected viruses, or those that cannot be identified using diagnostics for the 'known' viruses.

Progress to date: The AZ lab has received some but not all the necessary positive controls. Additional contacts have been made to obtain the outstanding RNA viruses. A literature search was conducted to learn of the current status on sweet potato viruses and identify those most commonly associated with sweet potato. A database search for all available viral sequences has been completed. Diagnostic RT-PCR primers will be designed to detect three of the most important RNA viruses and optimized using positive controls. PCR primers for begomovirus detection (general) are now available along with positive controls. Symptomatic sweet potato samples will be collected in Honduras and Guatemala. Grafting methods to indicator plants will be optimized.

Expected outputs: Molecular and bioassays will be employed to determine incidence and distribution of viruses infecting sweet potato in Honduras and Guatemala and for epidemiological studies, including detection in planting material and materials already planted. Assays also will ultimately be used for identifying 'putative' clean material for tissue culture passage and clean up and for follow up screening of sweet potato seed stock produced from tissue culture clean up.

Task 11: (Honduras) Management of the complex Zebra-chip disease-psyllid of potato and like diseases of other Solanaceous crops

Status: Continuing.

Scientists involved: H.R. Espinoza (FHIA), R. Foster and S. Weller (Purdue), J. Brown (AZ). Also see PVD-GT Task 3:1.5.

Description: In the last decade a pathological problem has gradually arisen in Honduras that currently is responsible for yield losses of up to 90% in some of the potato cropping areas. The problem, named locally "Papa rayada' ("Striped potato"), was identified in 2009 as the same disease known in North America as "Zebra chip", caused by the fastidious bacteria *Candidatus* Liberibacter psyllaurous/solanacearum. For the disease to occur the bacteria have to be transmitted to healthy plants by a vector, the Potato psyllid *(Bactericera cockerelli).* Literature shows the control of this complex relies on combating the vector. In addition, it has been reported elsewhere that tomato and pepper are hosts of the complex, as well as some weeds. Some activities will be as follows:

1) Continuation of studies on the population dynamics of the psyllid vector *B. cockerelli.* FHIA. We will continue pest monitoring in defined potato fields of the main potato growing areas, as well as recording catches in some 20 yellow traps deployed the year before in strategic sites along the main roads that interconnect the La Esperanza region. This will be complemented with prospection and diagnostic work on other plant species (Solanaceous crops and weeds) to ascertain their role in the dynamics of the complex.
2) Particular activities will be to continue evaluating, in separate trials, insecticidal chemicals of different modes of action (these are sprisomesifen, spirotetramat, pymetrozine, abamectin, thiametoxam and imidacloprid), spraying techniques to improve foliar coverage of the insecticide for better psyllid control, and use of the entomopathogen Metarhizium anisopliae for control of the psyllid. Variety trials are planned for the fall 2012 season. Plots will be established and monitored in fall-winter 2012.
3) At least one plot will be established in a grower's field to validate and demonstrate a package of practices identified as key elements for the integrated

management of the complex. An example of a package is use of neonicotonoids at planting, yellow traps for monitoring insect arrival, improved foliar insecticide spraying techniques, sanitation practices (rouging, volunteers and crop remains destruction), etc.

4) *Progress to date:* The results of samples are currently being analyzed, along with data from monitoring being carried out in grower fields. Evidence from last year shows that occurrence of the complex in the main potato growing areas of Honduras has decreased markedly. The scientists on the project feel that climate conditions in the past year, especially the rain and relatively high temperatures, were not favorable for the growth of the complex. One potato variety trial using certified seed was completed at La Esperanza in collaboration with seed producers (local and importers). These trials showed that there are differences in varietal susceptibility to the disease. A bulletin was published based on literature review and local results, covering the biology and management of the psyllid.

Expected outputs: Generation of knowledge on the behavior of *B. cockerelli* and occurrence of Papa rayada under local conditions. We will produce information required to support recommendations on chemical control, variety use, cultural and biological alternatives to chemical control, management of alternative hosts and other management practices. This information will be transferred to growers and field extension workers leading to improved management of the problem.

Task 12: (Honduras) Management of the Late blight disease on potatoes

Status: Continuing

Scientists involved: J. Mauricio Rivera C. (FHIA). R. Foster and S. Weller (Purdue).

Description: The late blight disease of Solanaceous crops (caused by *Phytophthora infestans*) is regarded locally as the most important disease of potato. In the absence of resistant potato cultivars the control of this disease has relied heavily on application of fungicides via foliar spraying. The most common fungicides utilized are i) preventative wide spectrum products of contact mode of action, based mostly on the active ingredients chlorothalonil and manzozeb, and ii) a group of site-specific products of systemic/translaminar mode of action with curative effect, i.e. mefenoxam, propamocarb, cymoxanil, etc. Of the latter group mefenoxam has been and continues to be the most widely used, although, it has been reported elsewhere, that continued use of mefenoxam (or products of like mode of action) has led to the loss of its effectiveness due to selection for resistance in *Phytophthora infestans*. Sites with the two known mating types of the organism have increased frequency and speed of development of mefenoxam-resistant strains compared to sites where

only one mating type occurs. It is evident that under the current technological conditions of the crop in Honduras, if the two mating types occur, there is a higher risk of crop losses due to Late blight. In fact, there are already reports of failure of mefenoxam to control Late blight.

Current activities: We will publish a pictorial guide to assist small growers in decision-making (timing and product selection) for spraying chemicals for late blight control using temperature and rain patterns as guidelines. A second run will be carried out of a varietal trial evaluating resistance to blight in commercial and newly introduced varieties.

Progress to date: Attempts in 2010-11 started with an undergraduate intern from Universidad Nacional de Agricultura (UNA) and in 2011-2012 continued by Dr. J. Melgar failed to isolate the organism to perform tests for sensitivity to mefenoxam and to determine the sexual status of the pathogen. As a result, this line of work will be stopped. The review of literature on late blight control was completed. A first run of a trial was conducted to evaluate the resistance to blight in commercial and also newly introduced varieties.

Expected outputs: A pictorial guide to be used for decision-taking on when and what to spray for chemical control of late blight. Transfer to growers and field extension workers of information leading to improved management of the problem. Reduction in crop losses due to improved control.

Task 13: (Honduras) Management of bacterial leaf and fruit spots of tomatoes and peppers

Status: Continuing

Scientists involved: J. Mauricio Rivera C. (FHIA) and S. Weller (Purdue).

Description: In order to provide the local market with a steady supply of tomatoes and peppers, producers must grow these crops throughout the year. During the rainy period (June thru October), these crops are field-grown under environmental conditions highly favorable for bacterial and fungal leaf and fruit diseases, forcing growers to make a higher investment in chemicals. Based on historical records generated from specimens analyzed at FHIA's plant pest diagnostic clinic and also field observations by FHIA's scientists, it has been found that the field extension workers and growers have been misdiagnosing field symptoms of two different bacterial diseases and one fungal disease, namely: Bacterial speck, Bacterial spot, and Septoria leaf spot (caused by *Pseudomonas syringae* pv. *tomato*, *Xanthomonas campestris* pv. *vesicatoria*, and *Septoria licopersici*, respectively). This confusion has led to application of inadequate chemical control measures and resulted in heavy

losses to some growers because control applied for one disease is not necessarily appropriate for the actual cause of the symptoms. Our approach is to provide extension workers and growers with information leading to correct identification of leaf problems and appropriate management practices for these key leaf diseases so application of the right control measures can be made.

Current year activities: The only activities this year will be finalizing and publication of a field guide for recognition and management of leaf diseases along with training and technology transfer to growers and field extension workers of information leading to improved management of the problem.

Expected outputs: An illustrated disease recognition guide presenting the distinctive features of the diseases and measures for their appropriate control. Reduction in crop losses due to the negative effect of disease misdiagnosis.

Task 14: (Honduras) Management of the root-knot nematode, *Meloidogyne* spp on solanaceous and other key crops

Status: Continuing

Scientists involved: F. J. Díaz, D. Perla and J. Mauricio Rivera C. (FHIA), R. Foster (Purdue) and J. Brown (AZ).

Description: In Honduras, root-knot nematodes are a major problem, especially in Solanaceous crops. Their management in Honduras is based on application of synthetic chemicals with either nematicidal or nematostatic effects. This option is usually not cost-effective for smallholders and has the added drawback that synthetic chemicals used for nematode control are highly toxic. Grafting of scions onto resistant *(Solanum* spp.) rootstocks has been successful in controlling root-knot nematodes. Some specific crop rotations have been found to have a positive effect in controlling nematodes, including Meloidogyne. At FHIA, we tested rotations of presumably resistant lines of cowpea *(Vigna unguiculata),* in comparison to local rotation crops (landraces of cowpea and Sorghum) and application of chemicals. Two separate experiments showed that some accessions were associated with significant reduction of root-knot populations in the soil prior to the follow-up commercial crop. However, in the literature it has documented that the efficacy of use of crop rotations for control of root-knot depends on the crop and species of the root-knot nematode; thus, the efficacy of a particular rotation can be limited depending on the local species of root-knot.

Current year activities: Some activities will continue or be complete from those initiated in 2011-12, as follows:

1) Completion and publication of growers' guides for recognition and management of root knot nematode in vegetable crops.
2) Finalize, in the Comayagua Valley, evaluation of the Caliente Brand Mustard cvs. NEMAT/199 and NEMAT to evaluate effects as a rotation crop and as a bio fumigant.
3) Establish at least one validation and demonstration plot for integrated management of pests in a grower's field. Emphasis in root knot nematode management will involve using nematode-resistant cowpea lines in tomato or export oriental vegetables in the Comayagua Valley.
4) Establishment of a seed production plot of the best two performing Cowpea lines at FHIA's research station in the Comayagua valley.
5) Transfer to growers and field extension workers of information leading to improved management of nematodes and use of cowpea.

Progress to date: Preparation of a guide for recognition and integrated management of the root knot nematode is underway. A draft has been prepared on the specific use of solarization as management tool for root knot nematode. A model root knot-susceptible crop *Momordica*, is being tested for levels of nematodes in grower's fields, when following rotations of nematode-resistant cowpeas and bio fumigant mustards (solarized and non-solarized) versus a chemical nematicidal treatment. A cowpea rotation was shown in previous tests to be the best performing treatment followed by use of bio fumigant mustards.

Expected outputs: Dissemination of knowledge on recognition and management of root knot nematodes under local conditions. Reduction of losses due to root knot nematode on Solanaceous and other vegetable crops.

Task 15: (Honduras) Integrated management of Bacterial wilt in Solanaceous crops

Status: Continuing

Scientists involved: Francisco Javier Díaz and J. Mauricio Rivera C. (FHIA). R. Foster and S. Weller (Purdue) and J. Brown (AZ).

Description: Bacterial wilt (caused by *Ralston/a solanacearum)* has become an important cause of death of plants of tomato, pepper, eggplant and occasionally potato. Common disease management is based on preventive measures aimed to avoid ingress of the pathogen into the fields and into plants. Recently, grafting of scions onto resistant eggplant (*Solanum melongena)* rootstocks has been successful in Asia as an effective means of controlling bacterial wilt on tomato and eggplants. Likewise, soil biofumigation with brassica residues, alone or combined with solarization has been reported to reduce occurrence and damage of bacterial wilt.

Current year activities: Some activities will continue or be completed or are new from those initiated in previous years as follows:

1) At least one plot will be established at a grower's field to validate and demonstrate a package of practices identified locally and/or in the literature as key elements for the integrated management of pests of tomato and eggplant, with emphasis in the bacterial wilt.
2) Conduct a field evaluation of grafting of tomatoes and eggplants as a means to control the disease, using rootstocks introduced from AVRDC-Taiwan in 2011. These have not been screed, but all are AVRDC-recommended as rootstocks.
3) Transfer to growers and field extension workers information leading to improved management of the problem.

Progress to date: Based on the existing literature on bacterial wilt and local experience, a grower's guide for recognition and integrated management of bacterial wilt disease was published. A trial was conducted to evaluate the effect of bacterial wilt incidence on eggplants cultivated on soil treated with solarization and solarization + biofumigation using cabbage leaves (3 kg/m'). Grafting was not included in this trial. Seeds of four eggplant lines (from AVRDC-Taiwan) resistant to bacterial wilt were introduced and evaluated as rootstocks for commercial varieties of tomato and eggplant.

Expected outputs: Dissemination of knowledge on recognition and management of bacterial wilt under local conditions. Reduction of losses due to bacterial wilt on Solanaceous and other vegetable crops.

Task 16: (Honduras) Integrated management of viruses of sweet potato

Status: continuing.

Scientists involved: F. J. Díaz, J. and Mauricio Rivera C. (FHIA). R. Foster (Purdue) and J. Brown (AZ).

Description: FINTRAC, the main agency providing technical assistance to vegetable growers in Honduras has identified sweet potato as one of the most profitable and promising export crops. They have developed a crop management package, validated it and promoted sweet potato cultivation. However, after several years they reported that severe limitations to sweet potato cultivation are virus diseases that result in low productivity of export quality roots. FHIA initiated actions in this phase of the IPM CRSP with the goal of identifying which diseases prevail locally and, if possible, to promote production of virus-free propagative material. This activity is joint with the Global Theme on Insect Transmitted Viruses (Tasks 1.2.1, 1.3.1d).

Current year activities: Continue activities initiated in 2011-12: (i) Collection and analyses of plant specimens to identify prevalent viruses. (ii) Completion and publication of a fact sheet describing the identity and management appropriate for the locally prevalent virus diseases of sweet potato.

Progress to date: Collection and analysis of samples for virus identification was carried out with the analyses performed mostly at AGDIA (Elkhart, IN, USA) and at the UAZ (as part of the collaborative activities linking with the Global Theme on Insect Transmitted Viruses), and at FHIA using the NCM kit developed by CIP. An introduction was made from CIP/Peru of seed of *ipomoea setosa* ("Campanilla"), which can be utilized as rootstock for grafting scions of desired commercial varieties of sweet potato. This grafting would allow a determination of whether grafted plants are free of virus diseases (the rootstock works as an indicator plant, inducing the scion to express symptoms in positive cases). The only purpose of grafting is to bioassay for virus detection. This is a CIP-developed bioassay by which, when certain Potyvirus are asymptomatically present in the commercial sweetpotato, their presence can be detected due to the fact that the grafting induces in the top (the scion of commercial sweet potato) an increase in the titer of the target virus and, consequently, better symptom expression and detection (otherwise it might go undetected). What we will get is just yes or not expression of the Potyvirus present in the scion part of the grafted plant.

Expected outputs: A publication presenting a national profile of virus diseases identified and management strategies and transfer of this information to growers and field extension workers. Reduction in field crop losses due to the negative effect of viruses in sweet potato.

Task 17: (Honduras) Management of purple nut sedge (*Cyperus rotundus*) in horticultural crops in Honduras

Status: New (was planned for last year but not established).

Scientists involved: F. J. Díaz (FHIA) and S. Weller (Purdue).

Description: Purple nutsedge is among the most difficult weed in the world to control and its management can become very expensive. In the Comayagua Valley of Honduras nutsedges have become a serious problem, adding to the crop production costs (hand removal) and loss of yield. There has been no research performed locally to manage this problem and practices used to control purple nutsedge are not based on sound studies relating cost to benefit of various management approaches.

Current year activities: Initiate control studies evaluating several alternatives for control of purple nutsedge that have shown effectiveness elsewhere in the world. The

experiment will involve comparing treatments, in a heavily nutsedge infested area of the FHIA Research Farm in Comayagua, consisting of: control-no treatment; clear plastic soil solarization; clear plastic soil solarization that is insulated each day to maintain a longer period of high soil temperature; and three separate herbicide treatments - 1) soil-applied sulfentrazone; soil and foliar applied (to emerged nutsedge) halosulfuron and foliar-applied (to emerged nutsedge) glyphosate. Data collected will include: 1) number of nutsedge tubers in the soil prior to the start of the experiment; 2) level of emerged nutsedge plants at 2, 4 and 6 weeks after treatment applications; 3) numbers of viable nutsedge tubers remaining in the soil at 6 weeks post-treatment. Viable nutsedge tubers will be determined in each plot at soil depths of 7.6, 15.24 and 23 cm soil depths. At the conclusion of the experiment, the most effective treatments will be rated for ability to eliminate or greatly reduce viable tubers in the soil. The experiment will be repeated.

Expected outputs: Identification of environmentally friendly practices leading to successful control of the purple nutsedge along with biorational treatments (solarization) that reduce or eliminate the need for herbicide treatment. Results will allow development of IPM practices recommendations for purple nutsedge control in vegetable crops and result in transfer to growers and field extension workers of updated information leading to improved management of purple nutsedge along with the reduction in weed management costs and increase in crop yield. A referred publication will be prepared based on experimental results.

Task 18: (Honduras) Management of thrips and mites in eggplants and other horticultural crops

Status: Continuing

Scientists involved: H. R. Espinoza and F. J. Díaz (FHIA), R. Foster (Purdue).

Description: Thrips and mites are important pests attacking different vegetable crops in Honduras. Bittermelon, *Luffa* spp. and other cucurbits are hosts of thrips and mites and the sunflower diversification practice also should be valid for these crops. The damage they cause to foliage results in yield reduction and in the case of crops in which the fruit is attacked, like eggplants, damage to the surface of the fruit which renders them unacceptable for market. This kind of damage is particularly critical in crops for the export markets, such as different types of eggplants exported from Honduras to the American market. Traditionally, management of these insects has relied solely on application of insecticides. The use of insecticides poses a high risk for resistance in the insect populations.

Current year activities: Completion of and analyses of data from current field trial monitoring eggplant fields inter-planted with sunflower as a refuge/substrate for the

beneficial *Orius* sp. Training and technology transfer activities to disseminate information on the results of the research. Establishment in a grower's field of a validation and demonstration plot.

Progress to date: In 2012 a third repeat of this trial was completed, in which interplanting of sunflower plants with eggplant was evaluated for effects on reducing cosmetic damage provoked by mites on the skin of eggplant fruits. Results are consistent over all experiments where plots diversified with sunflower interplants and without application of any insecticides, had higher populations of *Orius,* lower populations of mites and thrips, reduced incidence of damaged fruits and higher export quality yield than insecticide-treated plots.

Expected outputs: Identification and dissemination of environmentally friendly practices leading to successful control of mites and thrips in eggplant production. Reduction in the use of pesticides for mites and thrips control. Transfer of updated information to growers and field extension workers leading to improved management of the problems. Reduction in field crop losses due to mites and thrips.

Activity 2: Identify results from other countries and regions that can be evaluated and incorporated into country-specific packages.

Status: Continuing

US Scientists involved: Alwang, Norton (VT), Backman, Gugino (Penn State), Weller, Foster (Purdue), Brown (AZ)

Description: Through scientist interactions as IPM CRSP and other meetings, and through literature, opportunities for sharing promising technologies are being identified. The regional project will support activities to evaluate and adapt promising technologies.

Progress to date: Several opportunities have been identified for moving technologies between countries in the LAC region. For example, IPM controls for potato pests have been identified and tested during prior phases of the CRSP in Ecuador; these controls are being considered for use in Honduras. Another example is sharing of the Bacterial wilt management publication for Solanaceous and other keys crops from Honduras. Most of the technology sharing takes place during annual meetings of the LAC group, but others such as grafting and use of trichoderma are brought in from other CRSP regions.

Expected outputs: Technologies shared across region and adapted for use in the region from other CRSP regions.

Task 1: Continue to identify opportunities for sharing technologies across countries and regions within countries. Identify opportunities from other IPM CRSP regions.

Task 2: Adaptation and development of an IPM package for potato pests in Ecuador

Status: continuing.

Scientists involved: Ochoa, Gallegos, Manangón, Asaquibay (INIAP–DNPV); Barrera, Escudero (INIAP-Programa RRNN); Backman, Gugino (Penn State).

Description: technologies exist for the control of all major potato pests and diseases (developed under the prior CRSP for potato pests and diseases in the northern Ecuador province Carchi). This task will involve validation and adaptation for conditions specific to Guaranda where the IPM CRSP is now focusing its research activities. Two outreach publications will be produced.

Task 3: Identify bio-rational controls for pests that have the potential for establishment of local industries

Status: continuing.

Scientists involved: Alwang (VT), Backman (PSU), Barrera (INIAP-Ecuador), Weller (Purdue), Rueda (Honduras-Zamorano).

Description: the global IPM CRSP and the LAC regional project has identified and tested a number of bio-rational controls (e.g. controls for fungal diseases using *Trichoderma* spp. and *Bacillus* spp.). We would use these isolates as know bioactive isolates, and determine their potential for pest control in fruits and vegetables. In many regions of the world, such control technologies have led to indigenous industries for production of the bio-rational (especially South Asia). Opportunities will be explored for development of small-scale industries, beginning with *Rhizobium* production in Ecuador. Other opportunities will be explored as they arise. Previous research in cycle three identified several *Bacillus* species that showed excellent potential for biological control of diseases.

Task 4: Cross-reference our biological controls for pests to identify potential for use in other regions. Continue to identify successes in local production of bio-rationals. Example: solarization for purple nutsedge control.

Activity 3: Continue to coordinate activities with global themes

Description: Regional project allocates $10,000 annually to each of the four global themes with presence in LAC. Project scientists interact with global theme scientists to ensure that global themes are contributing to regional project objectives.

Status: Continuing

US Scientists involved: Alwang, Norton, Tolin, Christie (VT), Miller (Ohio State) Brown (AZ)

Host-country scientists: Valenzuela (Zamonano, Honduras), Arevalo and Palmieri (Guatemala), Ochoa (Ecuador)

Progress to date: Significant accomplishments have been attained in coordinating with the global themes. All four global themes had representation at the annual meeting (June in Guatemala). The impact assessment global theme is currently analyzing baseline data from Ecuador and Guatemala, and conducting a detailed impact study in Ecuador. Yordana Valenzuela is coordinating the gender network. The IPDN and virus global themes have active research and training programs in the LAC region, with the virus global theme expected to expand its activities into Ecuador this year.

Expected outputs: Impact and gender studies completed, IPDN established and functioning in LAC, technologies for virus diseases developed and integrated into IPM packages.

Task 1: Analysis of baseline survey for Ecuador

Status: continuing.

Scientists involved: Norton, Alwang (VT), Barrera (INIAP). *Description:* during past year, the impact assessment global theme together with partners in Ecuador completed a baseline survey. These data are currently being analyzed for gender-differentiated responses to key questions about decision making and control of resources.

Expected output: MS thesis and draft of a journal article.

Task 2: Analysis of baseline survey for Guatemala

Status: continuing.

Scientists involved: Norton (VT), and Palmieri (UVG).

Description: during past year, the impact assessment global theme together with partners in Guatemala completed a baseline survey. These data are currently being analyzed.

Expected output: baseline data report.

Task 3: Study of impacts of IPM research and outreach in potatoes in Carchi, Ecuador

Status: continuing.

Scientists involved: Norton, Alwang (VT), and Barrera (INIAP).

Description: during past year, a survey was undertaken to examine the persistence over time of use of IPM practices in potatoes. During 1998 through 2004, the IPM CRSP worked with INIAP and potato producers in Carchi, Ecuador to identify and test IPM packages for potato pests and diseases. These packages have been evaluated, but an ex-post assessment of impacts was never conducted. During the past year, we collected a sample of 400 producers in the region. These data are currently being digitized and cleaned. They will be thoroughly analyzed in the coming year.

Expected output: MS thesis and draft journal article.

Task 4: Gender and the use of IPM practices in the production of Aloe Vera in La Esperanza

Status: New.

Scientists involved: Valenzuela and Alwang.

Description: Participatory assessments will be undertaken to understand the productive challenges faced by women in this important (local) product.

Expected outputs: Undergraduate thesis (Zamorano), report.

Task 5: Coordinate virus work with virus global theme

Status: Continuing.

Scientists involved: Brown (AZ), Tolin (VT).

Description: coordination is being done on a regular basis. In current year, virus global theme work will begin in Ecuador (with J. Ochoa—INIAP).

Objective 2: Analyze and disseminate IPM information for enhanced profitability of targeted products through planning, pre-planting operations, pest management and value enhancement during production, processing and marketing

Activity 1: Analysis and validation of proposed IPM packages.

Task 1: Validation of IPM package for naranjilla

Status: Continuing.

Scientists involved: Barrera, Ochoa, Gallegos, and Martínez (INIAP); Alwang and Norton (VT).

Description: A new naranjilla variety, produced as a part of the prior phase of the IPM CRSP, was released in August 2009 by INIAP in Ecuador. This variety, a graft of a common naranjilla on a fusarium-resistant rootstock, is being commercialized by two private firms. Anecdotal evidence shows widespread adoption, but evidence also exists of disease problems associated with the variety. Analysis of the spread and impact of the variety is needed to validate its use in other regions of Ecuador. *Progress to date:* A comprehensive survey of naranjilla producers was undertaken and analyzed under the prior phase of the IPM CRSP (Barrera). This information serves as a baseline prior to introduction of the new technology. *Expected outputs:* draft publication.

Task 2: Validation of IPM packages for tomatoes and peppers (Honduras). Validation will include evaluation of the cost-effectiveness of each of the components of the package.

Scientists involved: Alwang, Norton (VT), Rivera (FHIA), Valenzuela (Zamorano).

Description: Data on costs of production under various IPM scenarios will be collected during field work; these data will be compiled into budgets and costs of production, net returns and other indicators will be computed. We will evaluate cost-effectiveness of each of the components of the package.

Task 3: Continue to collect information on costs of each IPM package.

Objective 3: Become a regional center of excellence by building human capacity, generating IPM knowledge, and promoting adoption of IPM packages

Activity 1: Continue with short-term training priorities.

Task 1: Conduct at least 3 formal short-term trainings of regional project staff (Purdue internships, bio-control training at Penn State, and impact training in VT, weed science training in Honduras, Guatemala).

Task 2: As a part of an organizing committee led by Zamorano, to contribute to celebration in Honduras of the 13th Regional Congress on IPM, with an audience made up with participants from the Central America-Caribbean region, speakers from the collaborating American Universities and other institutions from Honduras involved in the project.

Task 3: Offer training on IPM to field extension workers, growers and staff of agrichemical companies in at least 10 training events in Honduras.

Scientists involved: FHIA staff.

Task 4: Enroll one to three outstanding undergraduate students from Honduras' Universidad Nacional de Agricultura (UNA, Catacamas, Olancho) as summer intern at Purdue University under the supervision of Drs. R. Foster and S. Weller (depending on funding availability). Explore the possibility of expanding this internship opportunity to Honduran students studying at Earth University in Costa Rica with Dr. Jose Melgar.

Task 5: Gender training

Scientists involved: Valenzuela, Christie.

Description: One short-term training about *trichoderma and sábila (aloe vera)* and gender issues targeted at women in La Esperanza Honduras will be held. A second gender workshop will be held in Guatemala.

Activity 2: Design comprehensive long-term training plan for regional project

Description: this is a hold-over activity from project's first year. We have a prioritized long-term training program in place.

Task 1: Continue to work with graduate and undergraduate students. We currently have 7 students at US universities who are finishing their graduate degrees with IPM CRSP funding. In all countries, undergraduate researchers will be employed as funds permit and promising students are identified.

Activity 3: Identify opportunities for intra-regional learning and transfer of packages between countries

Task 1: Working group has been established to identify these opportunities. Group will report to full project during annual meeting.

Objective 4: Develop strong linkages between the regional IPM project and global themes and with the Hort CRSP in Honduras and interactions with in-country USAID Missions to foster quicker development and use of effective IPM packages.

Description: Discussions have been initiated to design training and collaborative research programs for remainder of project between IPM CRSP and Fintrac and other organizations working in our target crops in Honduras on their ACCESO project. Discussion has been initiated with Beth Mitcham of the Hort CRSP and Steve Weller and Judy Brown of the IPM CRSP to compliment the IPM CRSP activities in Honduras with those of the Hort CRSP where possible and to include the USAID Mission in these discussions.

Task 1: Management of diseases caused by virus, viroids, fastidious bacteria and the like.

Country: Honduras.

Status: Continuing.

Scientists involved: H. R. Espinoza, J. M. Rivera C. and F. Javier Díaz (FHIA); J. Brown (AZ), S. Tolin (VT) and R. Foster (Purdue).

Progress to date: Training on the recognition, management and proper collection of samples for diagnostic work was provided to extension officers of the USAID-funded project ACCESO. It was identified a very promising candidate to attend to graduate school at U. Arizona to pursue a MSc in Plant Pathology, but unfortunately he declined the scholarship due personal financial limitations. A candidate from Guatemala has been identified and is in the process of applying.

Expected outputs: Dissemination of information on the identity of viruses and on environmentally friendly practices leading to successful control of their diseases. Reduction in pesticide use for vector control. Transfer to growers and field extension workers of updated information leading to improved management of the problems. Reduction in field crop losses.

See description above. Linkages have been created and are currently quite strong. We have active participation by LAC regional project participants on the global themes. These include the following. Impact assessment: Alwang and Norton (VA Tech), Barrera (INIAP-Ecuador), Gender: Alwang (VA Tech), Barrera (INIAP), Valenzuela (Zamorano—Honduras). IPDN: Palmieri and Arevalo (Guatemala). Virus: Tolin (VT), Brown (AZ), Palmieri (UDV-Guatemala), Rivera (FHIA-Honduras), Ochoa (INIAP).

In current year, these linkages will be continued by: engaging in jointly sponsored research (see above) and participation in the LAC annual meeting (2013 in Ecuador).

Graduate Students and Post-Doctoral Research Associates:

1. Name: Sally Brady

Sex: Female

Nationality: US

Discipline: Agricultural Economics

Site/*Country:* Ecuador

Degree: MS

Start date: July 2012

Completion date: July 2013

IPM CRSP funds: 100%

Advisor/PI: Jeffrey Alwang

Thesis topic: Gendered responses to agricultural management tasks and pest control

University: Virginia Tech

2. Name: Hillary Kessler Cheeseman

Sex: Female

Nationality: U.S.

Discipline: Plant Pathology/Microbial Ecology

Site/*Country:* Ecuador

Degree: Ph.D.

Start date: Aug. 15, 2010

Completion date: Dec. 30, 2015

IPM CRSP funds: 20% (Approx. $5K/yr)

Advisor/PI: P.A. Backman & Beth Gugino (Co-advisors)

Thesis topic: Alternative management strategies for vegetables

University: Penn State University

3. Name: Emily E. Pfeufer

Sex: Female

Nationality: US

Discipline: Plant Pathology

Site/*Country:* Ecuador

Degree: Ph.D.

Start date: Aug. 2010

Completion date: Dec. 2015

IPM CRSP funds: 30% (approx. $8K/yr)

Advisor/PI: Beth K. Gugino

Thesis topic: Interactions of Bacterial Pathogens with biocontrol agents in Onion

University: Penn State University

4. Name: Anna Testen

Sex: Female

Nationality: US

Discipline: Plant Pathology

Site/*Country:* Ecuador

Degree: M.S.

Start date: Aug. 2010

Completion date: Dec. 2012

IPM CRSP funds: 25% $8k/yr.

Advisor/PI: P. A. Backman/ Beth K. Gugino (co-Advisors)

Thesis topic: Biological control of plant diseases

University: Penn State University

5. Vanessa Carrion

Sex: Female

Nationality: Ecuador

Degree: M.S.

Discipline: Agricultural Economics

Start date: August 2011

Completion date: August 2013

IPM CRSP funds: 100% (shared with impact global theme)

Thesis topic: Impacts of IPM technologies for potato producers in Carchi, Ecuador

University: Virginia Tech

6. David Perla

Sex: Male

Nationality: Honduras

Degree: MS

Discipline: Entomology (nematodes)

Start date: January 2012

Completion date: August 2013

IPM CRSP fund: 60%

Thesis topic: Control of nematodes

University: Purdue

Short-Term Training planned:

Workshops and Field days: Ecuador, Guatemala and Honduras. Workshops will cover various topics, depending on needs.

Internship at Purdue University for UG students from Honduras with exploring possibility of expanding this to Honduran students studying at Earth University in Costa Rica with Dr. Jose Melgar.

Annual meeting: Ecuador

Others: Individual short term training for person from host countries in US.

Publications planned:

Graduate theses: 3

Research articles: 6

Books and book chapters: 1

Extension articles: 4

Posters: 6

Bulletins: 2

Regional IPM CRSP program for East Africa: Kenya, Tanzania and Uganda

PI: Dr. Mark Erbaugh, Ohio State University

Objective 1: Continue building a regional model of collaborative IPM research, training and knowledge dissemination.

Activity 1: Facilitate and expedite project administrative activities.

Task 1: Maintain and update subcontracts and expedite financial flows.

Activity 2: Strengthen the regional collaborative IPM research and development model.

Task 1: Plan and implement 6th meeting of RTC in the region; Improve RP/EA website portal

URL – http:/www.aaec.vt.edu/ipmcrspuganda/IPMCRSPEA/

Activity 3: Improve IPM research and technology transfer in the region.

Task 1: Approve research work plans for Year 4 that focus on IPM package development; integrate technology transfer strategies including farmer training programs into work plan; and integrate linkages between research and extension into work plan activities.

Activity 4: Ensure integration of Global Theme Programs into the regional program.

Task 1: Integrate prioritized GTP activities into Year 4 work plan.

Activity 5: Strengthen regional capacity for performance monitoring.

Task 1: Implement integrated plan for performance monitoring including the use and compilation of Activity Reporting Forms.

Activity 6: Build IPM human resource capacity in the region through advanced degree training.

Task 1: Implement training plans for each country;

Activity 7: Support presentation and publication of research results.

Tasks: *Scientists involved* and students present at RTC meetings; Review manuscripts at RTC meetings.

Objective 2: Implement a participatory and ecologically-based IPM research program focused on developing IPM packages that address priority pest constraints of selected, marketed horticultural crops in the region.

Activity 1: Develop IPM packages that address priority pests of tomato (Uganda)

Task 1: Assessing Transfer of IPM Technologies to Tomato Farming Communities

Scientists involved: J. Karungi, J. Bonabana-Wabbi, M. Mangheni, S. Kyamanywa; Z. Muwanga, G. Biso, P. Sseruwagi, M. Kleinhenz, M. Erbaugh, D. Taylor, and J. Kovach (conducted with Impact Assessment GT).

Description: Following the dissemination of the IPM package through two FFS's a study will be implemented to assess the extent of IPM technology adoption by participating farmers and nearby non-participating farmers. Location: Mukono and Wakiso districts, Central Uganda; farmer or NGO group identified: Balikyewunya Farmers group and Namulonge Horticultural farmers' Association. Priority Pests: Bacterial wilt (*Ralstonia solanacearum*), Late blight (*Phytophthora infestans*). IPM strategies to be disseminated: The IPM package developed during previous season includes use of soil sterilization for seedling protection, tolerant varieties (MT-56 and 2 varieties from AVRDC), raised beds, mulching, staking and grafting as strategies to reduce incidence and severity of bacterial wilt and late blight of tomato.

Current research Status: The IPM package was transferred to growing communities through two FFS in Wakiso and Mukono districts. Wakiso FFS had 20 members (18 men: 2 women) whereas the Mukono one had15 members (8 men: 7 women).

Expected outputs: Assessment of tomato IPM technology adoption; increased awareness by farmers of benefits of tomato IPM; increased yields and reduced use of pesticides.

Task 2: Complete Registration and Release of Tomato Variety MT56 to the Ugandan Farming Community

Scientists involved: P. Rubaihayo, S. Kyamanywa; J. Karungi, J. Bonabana-Wabbi, D. Asiimwe (RIP); M. Kleinhenz, S. Miller & M. Erbaugh

Description: The process was interrupted last year by the passing-away of the graduate student who was working on this activity. Since then his results have been retrieved, compiled and submitted. The varietal release committee has asked for some additional paperwork that is being compiled. Location: Makerere University Faculty of Agriculture. Priority pests to be addressed: Bacterial wilt (by *Ralstonia solanaceurum*). IPM strategies to be tested: Resistant/tolerant variety for management of Bacterial wilt of tomato.

Current research Status: The variety MT56 was screened alongside popular tomato varieties in 6 agro-ecological zones in Uganda for tolerance to bacterial wilt and yield stability. The performance of the variety was found to be very high confirming results from multi-season on-station and on-farm studies. This data has been documented and submitted to Varietal Release Committee for clearance for registration of the variety in Uganda.

Expected outputs: Approved registration and release of MT56 in Uganda by the end of 2012.

Task 3: Develop and Promote Techniques for Management of Boll Worm, Spider Mites and Leaf-Mining Flies on Tomato

Scientists involved: M. Otim; S. Kyamanywa, Z. Muwanga (MSc. student), Matt Kleinhenz, J. Kovach, I. Tumwesigye (BSc. Student)

Description: Field work and data collection completed; data analysis and thesis write-up on-going. Priority pests to be addressed: Boll worm (*Helicoverpa spp*), leaf miners (*Liriomyza spp*), spider mites (*Tetranychus spp*). IPM objectives/strategies to be tested: Mulching and well-timed pesticide applications to reduce pesticide applications from 12-24 per season to 2-3 for the management of key pests and diseases of tomato. Location: on-farm – Luwero district. Farmer or NGO group identified – Mr. Kawoya, Wabikokoma village

Current research Status: The final season of trials to assess the effect of timing of pesticide applications and mulching on incidence and severity of key pests and diseases and natural enemies of these key pests, of tomato was completed on-farm in Luwero district.

Expected outputs: Reduced pesticide usage on tomato for effective pest management and increased profitability. Completion of two degree programs and a manuscript prepared.

Task 4: Effect of row covers, rouging and living physical barriers in the management of insect-transmitted viruses of tomato

Scientists involved: P. Sseruwagi, J. Karungi, M. Ochwo-Ssemakula, S. Kyamanywa, Matt Kleinhenz, J. Kovach, MSc student Herbert Jurua.

Description: On-station trials have been implemented to assess the effect of utilizing cultural practices including variety, planting date; rouging, crop isolation using a living barrier (maize), and differential screening of tomato plants with insect-proof row covers on insect vectors' population dynamics and virus infection. Priority pests to be addressed: insect vectors (aphids, thrips, whiteflies); CMV, TYLCV, TSWV. IPM strategies to be tested: row covers, living physical barriers and rouging for management of insect vectors and viruses on tomato. Location: On station, MUARIK

Current research Status: Activity with student funded by RUFORUM.

Expected outputs: Evaluation of IPM practices for managing tomato viruses.

Task 5: Effect of plastic mulch and soil fertility amendments on incidence and severity of the insect vectors and viral diseases of tomato in Uganda

Scientists involved: J. Karungi, S. Kyamanywa, M. Ochwo-Ssemakula, P. Sseruwagi, Matt Kleinhenz, J. Kovach, M. Erbaugh

Status: Three consecutive seasons of the research evaluating the effect plastic mulch, cattle manure, straw mulch, coffee husks on incidence and severity of insect vectors and viral infections, and on yield of tomato have been completed.

Description: Field work and data collection completed; data analysis and thesis write up on-going. Location: On-station; MUARIK. Priority pests to be addressed: Insect vectors (aphids, thrips, whiteflies) and viral diseases of tomato. IPM objectives/strategies to be tested: Cultural practices including use of plastic mulch and soil fertility management for pest management and yield increase.

Expected outputs: Completed student projects on the effectiveness of plastic mulch and soil fertility amendments in management of insect vectors and virus diseases on tomato established.

Activity 2: Develop IPM packages that address priority pests of tomato (Kenya)

Task 1: Tomato grafting trials

Scientists involved: Waiganjo M; Kambo,C; Kuria, S; C; Njeru C; Mbaka J; Amata, R; Erbaugh, M. Miller, S. Kyamanywa, S.; Kleinhenz, M..Kovach, J. Charity Gathambiri; S. Wepukhulu

Status: On-farm

Description: Location: on-farm trials – Kirinyaga; farmers –Simon & Kangai Tisa tomato farmers group. Priority Pests: Tomato diseases (*Ralstonia solanacearum* and yellow leaf curl virus), arthropod pests (thrips, Thripidae; whiteflies, *Bemisia tabaci*; Mites, *Tetranychus sp*; leafminers, *Liriomyza trifoli*, aphids, *Aphis gossypii*; jassids and bollworms, *Helicoverpa armigera*. IPM Strategy to be tested: Carry out grafting trials on-station (KARI-Thika) and on-farm Kirinyaga on different grafting methods and fine tune compatibility of different rootstocks with the commercial varieties.

Bacterial wilt caused by *Ralstonia solanacearum* continues to pose major challenge on tomato production in Kirinyaga County. Grafting susceptible varieties onto resistant ones is an effective approach to control the disease and has been shown to improve the tomato plant vigour. This technology has been employed successfully in various countries. 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 and grafting among resource poor small holder is prevalent.

Three on-farm trials using one bacterial wilt tolerant line (MT56) rootstock grafted with commercial varieties using wedge grafting have shown promising results (Waiganjo et al., 2010). However, more wilt resistant rootstocks (TKA 193-31, wild cherry tomato and *Solanum incanum*) and methods of grafting have been employed in other countries including Vietnam (slice grafting). The objectives of these trials are: to test new rootstocks for tolerance to soil-borne pests using commercialized high tunnel adapted scions; to test different methods of tomato grafting. The current grafting technology is time consuming with a percentage take ranging from 50-80% slice grafting is reportedly less time consuming and has been adopted by farmers in Vietnam. The different grafting method (slice grafting) is expected to result in higher percentage take of grafts with less labour time. This will hopefully lead to increased technology adoption.

Expected outputs: An efficient grafting method and soil solarization that is suited to smallholder farmers developed. At least two papers published in refereed journals.

Task 2: Tomato farmer training under high tunnel production systems

Scientists involved: Waiganjo MM, Kinyua Z, Amata, Otipa, M, R; Erbaugh, M., Miller, S., Seruwangi, P, Kambo, C; Njeru, C; Charity Gathambiri, Gitonga, J.

Status: On-going

Description: Tomato production is limited in the region by a plethora of pests and diseases. The most important tomato pest problems in the region are bacterial wilt (*Ralstonia solanacearum*), late blight (*Phytophthora infestans*), bollworm (*Helicoverpa armigera*) and thrips (*Thrips tabaci* and *Frankliniella* sp). Bacterial wilt is a serious problem in high tunnels and several management options are being tested including grafting, solarization and use of biopesticides (*Trichoderma* spp.). Technologies to manage bollworm and thrips include cultural such as insect proof netting, weeding methods and use of bio-pesticides (*Bacillus thurungiensis*, neem derivatives).

Small scale growers and extension staff knowledge of pest identification and management strategies are limited. The objectives of this activity are to: assess pest knowledge of the farmers and extension staff of tomato pests and their management; carry out tomato IPM training at KARI-Thika and improve their knowledge. Location: Training will take place at KARI-Thika. Priority Pests: Major arthropod and disease pests of tomato (Mites, whiteflies, leaf miners, bollwarms, thrips, bacterial wilt, *Phytophthora* blights, bacterial spots, blossom end rot etc) to be addressed. Tasks and/or IPM strategies to be tested: Diagnostics and environmentally acceptable need based pest management with special reference to high tunnel.

Expected outputs: Knowledgeable high tunnel tomato growers. Increased tomato yields and food safety from those using IPM practices and at least 6 handouts on different topics developed and circulated to 20 smallholder high tunnel tomato growers.

Task 3: Use of Bio-pesticides and Soil amendments to control bacterial wilt, *Ralstonia solanacearum*

Scientists involved: Sylvia K, G. Tusiime, Waiganjo M, M. Wepukhulu, S; Erbaugh, S. Miller, S. Kyamanywa

Status: Laboratory and on-station

Description: Grafting has provided satisfactory control of bacterial wilt but the technology has its challenges in terms of skilled labour, cost and rootstock availability. More options in an integrated approach would provide sustainable management of the pest. Biopesticides and legume soil amendments have tested effective against *Fusarium* wilt in passion fruit and is currently undergoing efficacy trials towards registration against root knot nematodes in French beans. *Trichoderma* sp. have however not been tested against bacterial wilt in tomato and the trials will provide useful information on its effect against tomato bacterial wilt which is a major constraint in tomato production in the region. The trials have been initiated in year three and will coincide with the second year studies of an MSc student.

Priority Pests: Bacterial wilt, (*Ralstonia solanacearum);*Soil-borne diseases *(Fusarium spp, Phytophthora spp.,* nematodes*).* IPM objectives or strategies to be tested/disseminated: Management of a serious tomato bacterial disease, *Ralstonia solanacearum* using safe environmentally friendly bio-pesticides and legumes soil amendments to control the soil borne disease. Location: Makerere University (Laboratory/screen house trials)

Expected outputs: Known bio-pesticide for the control of bacterial wilt and other soil-borne diseases in tomato, one MSc.thesis and at least one scientific publication.

Activity 3: Develop IPM packages that address priority pests of tomato (Tanzania)

Task 1: Impact of management practices on postharvest physiology and shelf life

Scientists involved: A.P. Maerere and H. Mtui (PhD student registered at SUA); Collaborating Co-PI from USA: M. Bennett, S. Miller

Status: Completed

Description: Field trials were established using two widely grown varieties Tanya (determinate) and Tengeru 97 (indeterminate). Their yield potential, susceptibility to specific pests, perishability and other characteristics have been documented to examine advantages. Disease incidence and severity was scored using standard procedures. Fruits with symptoms will be collected for pathogen identification. On farm demonstration of the effect of different pest management (Farmer practice, IPM and pesticide spray based on manufacturers recommendations) on tomato shelf-life. Tomato fruits were collected from farmers' fields (with known spray records) in

the target areas for comparison. (i) Hot water and chlorine treatment of fruit produced under IPM technologies (seed treatment + reduced sprays + mulch)

Tasks and/or IPM strategies to be tested: This activity focuses only on reducing post-harvest losses and includes pre-harvest practices that improve fruit quality and shelf life. The components are: Seed treatment (with hot water, 2% Sodium hypochlorite and Ridomil 68WP) to reduce seed borne and nursery diseases, mulching, staking and pesticide use when needed as determined by pest scouting and a comparison of varieties aimed at exploiting genotypic adaptability. Location: On station (field and laboratory) and on farm. Farmer group/NGO identified: Peco and Misegese farmer groups in Mvomero district.

Priority pests: Disease pathogens: Fruit rot pathogens, early and late blights; Insects [leaf miner (*Liriomyza* sp.), aphids (*Aphis spp*), thrips (*Frankinnela occidentalis*) and bollworm (*Helicoverpa armigera*) and root knot nematodes (*Melodogyne spp*.]; Weeds [Nutsedge (*Cyperus rotundus*I*,* pigweeds *(Amaranthus spp}*, wandering Jew tropical spiderwort (*Commelina benghalensis) and* Mexican poppy *(Argemone mexicana)].*

Expected output: One PhD thesis, four scientific publications and a technical manual.

Task 2: Evaluation of the performance of tomato varieties and pests problems under high tunnels compared to open-field production.

Scientists involved: A.P. Maerere, K.P. Sibuga, E.R. Mgembe, M.W. Mwatawala, D. Mamiro. Collaborating Co-PI from USA: M.J. Erbaugh, and from Kenya M, Waiganjo

Status: On station

Description: Use of high tunnels for tomato production is a new to Tanzania and through this activity the practice will be introduced. A high tunnel will be built on station to modify environmental conditions and evaluate impact on incidence of pests and diseases on selected indeterminate and determinate tomato varieties. Performance of the varieties and the incidence and severity of pests in different seasons will be assessed. Open field plots will also be established adjacent to the tunnel for comparative evaluation. The purpose of the comparison is to examine the advantages/disadvantages of the high tunnel system and the potential for off-season production.

Priority pests: Disease pathogens: Fruit rot pathogens (to be identified), early blight (*Alternaria solani*) and late blight (*Phytophthora infestans*), insects [leaf miner (*Liriomyza* sp.), aphids (*Aphis* spp), thrips (*Frankliniella occidentalis*) and bollworm (*Helicoverpa armigera*); Mites (*Tetranychus* sp). Tasks and/or IPM strategies to be tested: Use high tunnel to modify environmental conditions. Location: SUA.

Expected outputs: Facilitate pest management and hence continuous production of higher and better quality yield in relatively small area regardless of weather changes. Evaluation of high tunnel production with open-field production; and high tunnel system introduced and adapted to local conditions. Technical manuals and scientific publication produced.

Task 3: Disseminate recommended IPM packages

Scientists involved: A.P. Maerere, K.P. Sibuga, E.R. Mgembe, M.W. Mwatawala, D. Mamiro, C. Msuya-Bengesi, K.K. Mwajombe; Collaborating Co-PI from USA : J. Kovach and M. Erbaugh

Status: Scaling out

Description: On-station and on farm demonstrations plots will be established and used to train farmers on recommended IPM packages and for tomato. The IPM packages will consist of varieties, mulching, seed treatment, plant training techniques, stale seedbed, use of high tunnels, pest scouting, minimized and timely pesticide application, use of soil amendments (compost, farmyard organic matter) and recommended cultural and postharvest practices. On farm demonstrations will be conducted at Mlali and Mateteni (Mvomero district) and Kingolwira village (Morogoro Rural district) where demand has recently been expressed. Leaflets will be prepared, produced and distributed during the training sessions and follow-up visits.

Priority pests: Diseases [Leaf spot (*Septoria lycopersi*) late blight (*Alternaria solani*), tomato yellow leaf curl and root knot nematode (*Melodogyn*e spp.); Insects [leaf miner (*Liriomyza* sp.), aphids (*Aphis spp*), thrips (*Frankinnela occidentalis*) and bollworm (*Helicoverpa armigera*); Mites (*Tetranychus* sp); Weeds [Nutsedge (*Cyperus rotundus*I*, pigweeds (Amaranthus spp}*, Wondering jew (*Commelina benghalensis)* and Mexican poppy *(Argemone mexicana)]*]). Tasks and/or IPM strategies to be tested: Conduct training to farmers, extension agents and traders to expose them to recommended IPM packages. Location: Mvomero and Morogoro Rural districts (3 villages). Farmer or NGO group: Juhudi Farmers, Twiyambe and a group to be formed at Kingolwira village.

Expected output: Recommended IPM packages applied by farmers in the project site and the application scaled out. Technical manuals and scientific publications produced.

Task 4: Assessment of farmers' adoption, impact and gender integration of IPM packages

Scientists involved: A.P. Maerere, Msuya-Bengesi, K.K. Mwajombe, K.P. Sibuga, E.R. Mgembe, M.W. Mwatawala, D. Mamiro, M. Mangheni, J. Bonabana-Wabbi, S. Kyamanywa; Collaborating Co-PI from USA: J. Kovach and M. Erbaugh

Status: On-station

Description: Project participating and nonparticipating farmers will be monitored during field visits to be conducted twice a month. For comparison, equal samples of farmers who have and who have not participated in the project will be monitored for application of IPM packages in their own farms. Information on farmers' knowledge of IPM practices/packages will be collected, while partial budgets for farmer practices versus IPM packages will be analyzed to provide basis for impact assessment.

Priority pests: Tomato insect pests, diseases and weeds already identified in the project areas. Tasks and/or IPM strategies to be tested: Assess extent of adoption, impact and, in cooperation with Gender GT, integrate the IPM packages in project sites. Location: On-farm. Farmer or NGO group: Juhudi Farmers, Twiyambe and a group to be formed at Kingolwira village.

Activity 4: Develop IPM packages that address priority pests of passion fruit (Uganda)

Task 1: Establishing efficacy of grafting, nutrition amendment and use of *Trichoderma* spp in the management of collar rot disease of passion fruit.

Scientists involved: P. Sseruwagi, M. Ochwo-Ssemakula, J. Tumwiine, G. Tusiime, R. Amata, S. Nyanzi, S. Miller, and S. Tolin.

Status: Passion fruit germplasm was collected from growing areas of western, central and eastern Uganda and assembled at NaCRRI. KPF4 rootstocks were acquired from Kenya. The Fusarium pathogen (*Fusarium solani*) was isolated and cultured; and is being used to screen germplasm in the screen house to select tolerant lines to be used as rootstocks in field trials.

Description: Tolerant passion fruit lines (locally or externally obtained) will be used as root stocks for popular commercial types in Uganda and evaluated in field trials against collar rot (*Fusarium solani*) and passion fruit wilt (*Fusarium oxysporum*). The tolerant lines will be used as rootstocks in field trials in addition to use of *Trichoderma spp* and mulching as soil amendments as an IPM strategy against *Fusarium spp*. Priority pests: Collar rot, *Fusarium* wilt of passion fruit. IPM

strategies to be tested: Grafting, resistant germplasm, and *Trichoderma* spp. as a soil fertility amendment. Location of trial: On-station (MUARIK).

Expected outputs: IPM package for management of Fusarium wilt of passion fruit developed.

Task 2: Identify Environmentally-Friendly Options for Managing Vectors of Viral Diseases of Passion Fruit

Scientists involved: M. Otim, M. Ochwo-Ssemakula, P. Sseruwagi, R. Atukunda (MSc. student), G. Tusiime, J. Kovach

Status: Aphid samples were collected during the baseline survey of the Central Region. Plant samples including passion fruit leaves, crops & weeds showing virus like symptoms (mosaic, woodiness, chlorosis, deformation, rugosity, mottling) found growing within vicinity of passion fruit plants were collected during the survey. These samples are now ready for identification and analysis for viruses.

Description: Aphid and weed samples collected from farmers' fields will be identified at Makerere University. Laboratory analysis of collected weed samples by PCR and RT-PCR will then follow at NARL- Kawanda to confirm/reject them as alternate hosts of the passion fruit viruses (potyviruses).The field study will aim to manipulate the host-seeking behavior of the aphids, the key vectors of passion fruit viruses and reducing the virus source so as to protect passion fruit crops. Removal of weeds from cropping areas minimizes potential sources of viral inoculum by reducing the available alternate hosts for the vector. Mulch repels alighting aphids and influences the landing behavior of aphids hence minimizing chances of aphids a landing on plants. A trial will be set up at NaCRRI to assess the effect of straw mulch; reflective plastic mulch; clean weeding; and a non-weeded control will be implemented for two seasons. Priority pests: Aphids (*Aphis gossypi, Myzus persicae*) and viral diseases of passion fruit. IPM strategies to be tested: Cultural practices utilizing different types of mulch; and weeding. Location of trial: On-station (NACRRI)

Expected output: Knowledge of the alternative hosts of passionfruit vectors and viruses present in farmers' fields and farmer-friendly virus management strategies developed.

Activity 5: Develop IPM packages that address priority pests of passion fruit (Kenya)

Task 1: Activity title: Validate virus detection procedures and establish clean virus-free passion fruit mother block seedling nursery at KARI Thika and farmer-operated nursery in Uasin Gishu County.

Scientists involved: Miriam Otipa; Ruth Amata; Waiganjo M; Simon Wepukhulu; Sally Miller; F. Qu. Priority Pests: Passion fruit woodiness virus complex (Poty viruses)

Status: on-station KARI Thika

Description: Validation of virus detection tools that will enable proper virus diagnosis and facilitate proper management was done in Year 3 of the project at KARI-KABETE. Two primer pairs will be used to screen/clean passion fruit plants in the two nurseries to establish clean planting materials. The plan is to establish clean nurseries where farmers can go get clean planting materials. To maintain high quality of seedlings in these nurseries, regular virus indexing will be carried out and corrective measures put in place. Five nursery operators will be trained in simple hygienic standard to ensure continued quality of seedlings is adhered to in the screened nurseries. IPM strategy being tested: Establishment of clean passion fruit nursery in Thika and farmer-operated nursery in Uasin Gishu county using primers for passion fruit woodiness. Location: Thika and Uasin Gishu. Farmer or NGO group identified: Two farms have been identified and 3 CBOs.

Task 2: Activity title: Farmer/extension training on passion fruit diseases and their management (in collaboration with IPDN)

Scientists involved; Ruth Amata; Miriam Otipa; Waiganjo Monica; Simon Wepukulu, Zachary Kinyua; Sally Miller; Mark Erbaugh.

Description: Passion fruit diseases pose a major constraint to passion fruit production in the East African region. Growers' pest identification and management capacity is limited. This activity will involve training of selected Passion fruit farmers (20 members) and their frontline extension staff in Uasin Gishu County. Priority Pests: Fusarium wilt (Fus*arium oxysporum* fsp. passiflorae), Collar rot *Fusarium solani,* Dieback disease complex *(Fusarium spp* and *Phytophthora spp.).*Passion fruit woodiness virus complex (PWV) and arthropod pests (Mites, *Polyphagotarsonemus ,* Mealybugs, *Pseudococcus sp*; Aphids, *Aphis gossypii*, and thrips, Thripidae). IPM strategy being tested: Continue training farmers and extension agents on the management of passion fruit pest and diseases in Uasin Gichu County. The components include, use of pest and disease free grafted passion

fruit seedlings (fusarium tolerant KPF-lines) produced under insect proof screenhouse confirmed through virus indexing; use of *Trichoderma* spp. bio-pesticides and need-based foliar sprays of fungicides for the management of fungal diseases (*Fusarium* spp, *Phytophthora* spp and *Alternalia passiflora*); control of arthropod pests (mites, thrips, mealybug) through cultural methods (mulching); and need-based application of Bio-pesticides (*Metarhizium anisopliae*). Location: Uasin Gishu. Farmer or NGO group: Passion fruit Farmers in Uasin Gishu Kenya

Task 3: Activity title: Farmer participatory validation of technologies for the management of passion fruit fungal diseases.

Scientists involved: Ruth Amata; Miriam Otipa; Waiganjo M; Juster Gitonga; Simon Wepukulu, Sally Miller; Mark Erbaugh.

Status: On-farm

Description: Trials on two biocontrol agents and a Copper based fungicide (Copper oxychloride/Kocide) will be implemented at Juja farm and Uasin Gichu district. Data collection and analysis of the Juja trial will be completed and learnt lessons used to implement the trials at Uasin Gishu county in year IV. One site will be selected in Uasin Gishu county for this trial and also used as a training site for extension agents and growers. Priority Pests: *Fusarium* wilt (*F. oxysporum* fsp. *passiflorae*), Dieback disease complex (*Fusarium* spp. and *Phytophthora* spp.) and brown spot disease (*Alternaria pasiflorae*). IPM strategy being tested: *Trichoderma harzianum* and *T. asperellum* and copper based fungicides in the management of passion fruit fungal diseases. Location: Juja Farm and Uasin Gishu counties. Farmer or NGO group identified: Juja Farmers group

Activity 6: Develop IPM packages that address priority pests of coffee (Uganda)

Task 1: Transfer of IPM Technologies for Management of Priority Insect Pests and Diseases

Scientists involved: Kyamanywa S, Kucel P., J. Bonabana-Wabbi, M. Mangheni, R. Ochago and Kagezi G., Erbaugh, J.M., Kovach J.

Status: Dissemination of IPM management package that includes fertilizer application (CAN), Organic manure and bean intercrop against root mealy bugs; and stem wrapping and Stem smoothing against the white stem borer management has been running using one modified FFS (one year cycle) in Sironko district. Dissemination materials have been produced and distributed through the FFS.

Description: The FFS will continue running until the one-year cycle is finished. Thereafter, adoption studies will commence to see the level of adoption of the different IPM components. Priority pests: Coffee Stem borer (*Monochamus leuconatus Pascoe*), coffee root mealy bug (*Planococcus ireneus*, De Lotto), Common coffee mealybug (*Planococcus kenyae*, Le Pelley) and coffee berry borer (*Hypothenemus hampei*). IPM strategies to be tested: Use of fertilizer application (CAN), Organic manure and bean inter-crop for control of root mealy-bugs, and stem wrapping, and stem smoothening for control of stem borers. Location of FFS: Sironko district. Farmer/NGO group: Kibowa United Coffee Farmers Field School (Buwasa sub-county).

Expected outputs: Assessment of coffee technology adoption; increased awareness by farmers of the benefits of IPM technologies; increased coffee yields and manuscript prepared.

Task 2: Establish the Action Thresholds for Key Priority Pests of Coffee

Scientists involved: Kyamanywa S., Kucel, P, C. Ssemwogerere, J. Karungi, J. Kovach

Status: On-station trials (repeated) to establish the relationships between insect pests' infestations and coffee yield were implemented under natural infestation. Analysis of the data will yield action thresholds (AT) and economic injury levels (EIL).

Description: The experiment to establish the relationships between insect pests' infestations and coffee yield will be repeated under a controlled environment and will thereafter be validated on-farm. Priority pests: Coffee root mealy bug (*Planococcus ireneus* De Lotto), common coffee mealybug (*Planococcus kenyae* Le Pelley), Coffee Stem borer (*Monochamus leuconatus*), Antestia bug (*Antestiopsis* spp), coffee lace bugs (*Habrochila* spp), the coffee berry borer (*Hypothenemus hampei* Ferr), leaf miners (*Leucoptera* spp) and coffee scales. IPM strategies: Developing a decision tool to guide usage of interventions in insect pest management of coffee. Location: On station - Sironko district. Farmer/NGO group: Bugusege coffee Farmer Association group, Sironko district

Task 3: Use of Community Based Phyto-sanitary Interventions and Innovative Approaches for Management of the Coffee Twig Borer

Scientists involved: Kucel P, Kagezi G, Kyamanywa S; J., Kovach

Status: Phytosanitary measures as a technology to manage BCTB was disseminated to three farmers groups that have been transformed into FFS in the districts of Mukono and Nakaseke. Also, on-farm evaluations (3) of the phytosanitary

interventions as a strategy to manage BCTB were done; and search for alternate hosts of BCTB have been initiated.

Description: The FFS on community-based phytosanitary interventions including pruning, stumping, burning of infested coffee plant parts and alternate host plants will run until the end of the crop cycle after which adoption studies will be executed. Full-fledged evaluation of efficacy of BROCARP traps in reducing BCTB damage will be implemented. Further testing for efficacy of *Beauveria bassiana* and *Metarhizium anisopliae* against BCTB will also be implemented. Priority pests: Black coffee twig borer (BCTB, *Xylosandrus compactus* Eichoff) on coffee. Location: Ntenjeru and Nakanyonyi sub-counties in Mukono District, and Nakaseke sub-county in Nakaseke district. Farmer/NGO group: Twekembe coffee farmers group (Ntenjeru, Mukono); Kyagalanyi coffee farmers group (Nakanyonyi, Mukono); Kezimbira coffee farmers group (Nakaseke).

Expected outputs: Data has been collected and manuscript will be prepared.

Activity 7: Develop IPM packages that address priority pests of coffee (Tanzania)

Task 1: Conduct on-station field trial to study effect of existing shade and open-grown coffee on key pests

Scientists involved: J.M. Teri, F. Magina, A.P. Maerere, K.P. Sibuga, D. Mamiro, M.W. Mwatawala
Status: On station
Description: Continue pest monitoring: insects (white coffee stem borer, coffee berry borer, and antestia bugs), diseases (coffee berry disease, leaf rust) and weeds (star grass, couch grass and wandering jew) to assess the effects of shade on incidence and infestation levels. The behaviour of key coffee pests under natural shade and open field conditions will be assessed in respect to damage (infestation) level, impacts on yield and quality of coffee. Evaluation will be conducted in existing plantations with tree shade and purposefully established plantations intercropped with banana at various plant spacing. Priority pests: Insects: Coffee berry borer (*Hypothenemus hampei*), white coffee stem borer (*Monochamus leuconotus*), Antestia (*Antestiopsis* spp.), Diseases: Coffee Berry Disease (*Colletotrichum coffeanum/kahawae*), leaf rust (*Hemileia vastatrix*), Weeds: Star grass (*Cynodon dactylon*), Couch grass (*Digitaria* spp), Wondering jew (*Commelina* spp). IPM strategies to be tested: Assess the effect of shade on insect pests, diseases and weeds. Location: TaCRI- Lyamungu.
Expected output: Recommended intercrop spacing established. At least two scientific publications and one technical manual produced.

Task 2: Activity title: Coffee berry borer management using traps and parasitoids

Scientists involved: J.M. Teri, F. Magina, A.P. Maerere, K.P. Sibuga, D. Mamiro, M.W. Mwatawala; Collaborating Co-PI from USA: J. Kovach

Status: On station and on farm (release of parasitoids)

Description: On station field trials (i) continue with rearing parasitoid for Arabica coffee and their release in the field (ii) initiate rearing of parasitoids for Robusta coffee (iii) evaluate the efficacy of locally made traps (alcohols, methylated spirit and juices, red coloured materials) and pheromones in trapping coffee berry borer in Arabica and Robusta coffee. Release of parasitoids will be followed by monitoring and evaluation of their establishment and their effect on the Coffee Berry Borer incidence and infestation levels. Priority pests: Insect: Coffee berry borer (*Hypothenemus hampei*). IPM strategies to be tested: Evaluate the efficacy of locally made traps, pheromones and parasitoids. Three potential parasitoids have been identified including *Cephalonomia stephanoderis and Prorops nasuta.* They were isolated last year from local farms and identified by ICIPE. Pheromone traps have been acquired and will be tested this year. Location: TaCRI stations at Lyamungu, Mbimba and Lushoto (for Arabica coffee) and at Maruku (for Robusta coffee). Farmer or NGO group identified: Undugu farmer group at Kombo village

Expected output: Efficacy of traps and parasitoids established. One PhD thesis, at least two scientific publications and one technical manual produced.

Activity 8: Develop IPM packages that address priority pests of onions (Kenya)

Task 1: Development of action thresholds for onion infesting thrips

Scientists involved: Waiganjo M; Amata, R; Wepukhulu, S; Sylvia K; Gitonga, J; M. Erbaugh, S. Miller, D. Taylor, Maerere, J. Kovach

Status: The study will be carried out on-station at KARI-Thika and later in farmer's fields; On-Station trials initiated at KARI Thika

Description: On-station trials will be carried out to determine the most cost effective option for thrips management. Onion thrips, *Thrips tabaci* are among the most important onion production constraints in Kenya. To promote need based pesticide application, action thresholds based on the onion growth stages which could be easily applied at the farm level will be assessed. Environmentally friendly bio-pesticide (*Metarhizium anisopliae*) will be used at different frequencies during the onion growth period and the most economically beneficial option determined. Priority Pests: Thrips, *Thrips tabaci, Frankliniella occidentalis.* IPM strategies to be tested:

Conduct on-station and on-farm trials to test cost effective IPM options for onions. Location: Kirinyaga. Farmer or NGO group identified – Kirinyaga Farmers

Expected outputs: Known action thresholds for management of thrips in onion.

Task 2: Evaluation of onion accessions on bulb quality, yield and biotic stress and pest tolerance

Scientists involved: Waiganjo M; Amata, R; Wepukhulu, S; Sylvia K; Gitonga, J; M. Erbaugh, S. Miller and Mtui Hosea Ruth Amata; Miriam Otipa; Waiganjo Monicah; Juster Gitonga; Simon Wepukulu, Zachary Kinyua; Sally Miller; Mark Erbaugh.

Status: The study will be carried out on-farm

Description: A plant's ability to resist insect attack is an important in-built protection that has often been utilized in crop management. Some onion cultivars have been reported to resist infestation by *T. tabaci* (Brar et al., 1993; Lewis, 1997). Morphological and anatomical characteristics which help to hold thrips populations to a minimum include, shape of leaves and glossiness of foliage. Cultivars with a relatively wide angle of leaf emergence were found to hold smaller thrips populations than those with a smaller angle of leaf emergence (Fournier et al., 1995). Protection from pesticides, natural enemies and adverse abiotic conditions were suggested as mechanisms of such resistance (Fournier et al., 1995). White onions have also been reported to be less susceptible to onion thrips attack than the red onions (Pawar et al., 1987). Onions with glossy foliage were found to be less susceptible to onion thrips infestation probably due to the chemistry of their leaf waxes (Molenaar, 1984). However, these genotypes have been reported to be extremely susceptible to purple blotch, Alternaria porri (Ellis) and downy mildew, Peronospora destructor (Berk). Selected cultivars that are ecologically adapted to the target area will be evaluated for yield performance and tolerance to onion thrips, foliar and postharvest diseases. Priority Pests: Thrips, Thrips tabaci and Frankliniella occidentalis; Downy mildew, Peronospora destructor and Purple blotch, Alternalia porri, onion neck rot, Botrytis spp, Bacterial soft rot, Erwinia caratovora, white rot, Sclerotium cepivorum and Fusarium bulb rot, Fusarium spp. and basal rots, F. oxysporium f. sp. cepae. IPM strategy being tested: Evaluate varieties for tolerance to major onion pests and diseases and assess bulb yield and qualities. Location: Kirinyaga. Farmer or NGO group identified – Kirinyaga Farmers

Expected outputs: Onion varieties with susceptibility/tolerance to thrips known and possibly avoided/adopted.

Activity 9: Develop IPM packages that address priority pests of onions (Tanzania)

Task 1: Evaluate weed management options

Scientists involved: Maerere, A.P; Sibuga, K.P; Mwatawala, M.W; Msuya-Bengesi, C.P; Mgembe, E.R; Mamiro, D.P; Mwajombe, K.K., Mtui D.; Collaborating Co-PI: USA: D. Laron, Erbaugh, M

Status: On-station and on farm

Description: Field trials to evaluate cultural weed management options will be conducted on station and on farm during the rainy and dry seasons. Management options to be evaluated will include: mulching, stale bed technique, stale bed technique + locally sourced post-emergent herbicide (GALIGAN™ – Oxyfluorfen) and weeding frequency. Major weeds will be identified and quantified before and after imposing weed management treatments. Onion yields will be assessed along with bulb quality variables. Insect pests and diseases will be controlled by using standard procedures. Priority pests: Weeds: Mexican poppy (*Argemone mexicana*), pigweeds (*Amaranthus* spp.), star grass (*Cynodon* spp), black jack (*Bidens pilosa*) nut sedges (*Cyperus* spp.). IPM strategies to be tested: Evaluate weed management options. Location: on-farm: Malolo B and Chabi villages in Kilosa district and Msosa in Kilolo district. Farmer/NGO group identified: Upendo group (Malolo B), Tetema group (Chabi village) and Tupendane group (Msosa village).

Expected outputs: Best weed management options identified.

Task 2: Evaluate insect pests and disease management options

Scientists involved: Maerere, A.P; Mamiro, D.P; Sibuga, K.P; Mwatawala, M.W; Msuya-Bengesi, C.P; Mgembe, E.R; Mwajombe, K.K., Mtui, D.; Collaborating Co-PI: USA: D. Laron; Erbaugh, M.

Status: On-station and on-farm

Description: Field on-farm trials will be conducted to evaluate different insect pests and disease management options. Management options to be evaluated will be; mulching, varieties, time of planting, trap and repellant plants (Trap plants: Yellow and orange Marigold (*Tagetes sp.)* for thrips; Repellent plants: Spiderplant (*Cleome gynandra*), sunhemp (*Crotalaria ochroleuca*) for thrips). Major insect pest and disease incidences, type of damage and onion yields will be assessed. Effectiveness of each pests and disease management option will be compared. Priority pests: Insect pests: Onion thrips (*Thrips tabaci*), Onion grub (*Phyllophaga* spp), onion powdery mildew disease (*Leveillula taurica)* onion purple blotch disease (*Alternaria porri*) and onion neck rot disease (*Botryitis* spp.). IPM strategies to be tested: Evaluate insect pest and disease management options. Location: on-farm: Malolo B village (Kilosa district) and Msosa (Kilolo Districts). Farmer or NGO group identified: Budget:

Upendo group (Malolo B), Tetema group (Chabi village) and Tupendane group (Msosa village) and the Water users associations in Malolo B and Msosa villages.

Expected output: Efficient weed management practices identified and recommended to farmers, One MSc. dissertation, at least two scientific publications and one technical manual produced.

Task 3: Conduct variety evaluation and fertilizers application

Scientists involved: Maerere, A.P; Mgembe, E.R; Sibuga, K.P, Mwatawala, M.W; Msuya-Bengesi, C.P; Mamiro, D.P; Mwajombe, K; Mtui, D.; Collaborating Co-PI: from USA: Laron, D; Erbaugh, M

Status: On farm

Description: Locally available onion varieties (Mang'ola Red, Red Creole, Red Bombay and Khaki (Texas Grano) will be evaluated on farm to identify types that are resistant or tolerant to priority insect pests and diseases. Desirable quality and yield characteristics will be evaluated. Use of different types (Urea, CAN, NPK and DAP) and rates of fertilizers will be evaluated to assess direct/indirect effect on plant health and tolerance to pests. Priority pests: Insect pests: Onion thrips (*Thrips tabaci*), Onion grub (*Phyllophaga* spp), onion powdery mildew disease (*Leveillula taurica)* onion purple blotch disease (*Alternaria porri*) and onion neck rot disease (*Botryitis* spp.). IPM strategies to be tested: Evaluate variety performance, fertilizer types and rates of application. Location on-farm: Malolo B village (Kilosa District). Farmer or NGO group identified: Upendo group and the Water Users Association (at Malolo B village).

Expected output: Adapted varieties of desirable quality identified and recommended fertilizer application rates established. One MSc. dissertation and at least two scientific publication and one manual produced.

Activity 10: Develop IPM packages that address priority pests of scotch bonnet peppers (Uganda)

Task 1: Exploiting Host Plant Resistance to Manage Hot Pepper Root Rot/Wilt Disease in Mubuku Irrigation and Settlement Scheme

Scientists involved: Geoffrey Tusiime; Karungi J., Bonabana J., Kyamanywa S., Sally Miller

Status: 60 of the lines from crosses between *C. chinense* PI159234 x Habanero F3 lines obtained from Cornell University were raised and planted in Mubuku Irrigation Scheme and evaluated for wilt resistance. None of the adapted lines succumbed to root rot and wilt (*Phytophtho*ra) disease. 50 were multiplied at the Makerere University Research Institute, Kabanyolo (MUARIK). First level screening of the improved hot pepper lines using additional parameters was completed.

Description: A final level screening of the improved hot pepper lines is planned after which, superior ones in terms of resistance, fruit type and yield will be evaluated by farmers. Priority pests to be addressed: Phytophthora root and wilt disease (*Phytophthora capsici*). IPM objectives or Strategies to be disseminated: Continue screening of hot pepper germplasm for resistance to root rot/wilt disease in Uganda. Location: MUARIK, Mubuku Irrigation and Settlement Scheme, Kasese (On-farm). Farmer or NGO group identified: Abasaija Kweyamba Mubuku Farming Co-operative Society Limited. (AKMFCS Ltd.).

Expected outputs: Resistance of selected hot pepper lines to *Phytophthora* validated

Task 2: Establishing the Effect of Soil Water Amount on Hot Pepper Wilt Incidence and Severity in Mubuku Irrigation Scheme

Scientists involved: Geoffrey Tusiime; Karungi J., Bonabana J., Kyamanywa S., Sally Miller

Status: Data from season I of this trial was analyzed and the preliminary results indicated that the highest incidence of the disease was the shallow farmer practice ridging; and ridge size had no significant effect on yield parameters. Also, the less frequent the irrigation the lower the incidence of the wilt; however reduced frequency of irrigation had a negative effect on yield parameters. The repeat trial that was planned for 2012 was affected by flooding.

Description: Different ridge sizes and frequency of irrigation were studied to determine the optimum in reducing infection. Three ridge sizes: Farmer practice , 18cm and 30cm high; and three irrigation frequencies: after 2 days, after 4 days, and after 8 days were tested. This study is being repeated to confirm results of season I.

Priority pests: *Phytophthora* root and wilt disease (*Phytophthora capsici).* IPM Objective/Strategy to be addressed: i) determine optimum ridge size for managing pepper root rot/wilt disease. ii) Determine optimum irrigation frequency to manage pepper root rot/wilt disease. Location of trial: On-farm - Mubuku Irrigation and Settlement Scheme. Farmer or NGO Group identified: Abasaija Kweyamba Mubuku Farming Co-operative Society Limited. (AKMFCS Ltd.)

Expected outputs: Management of irrigation water in reduction of incidence of *Phytophthora* wilt established.

Task 3: Developing a System for Small-Holder Virus-Free Seed Production in Uganda

Scientists involved: Geoffrey Tusiime; P. Sseruwagi, Mukasa S. B., Karungi J., Bonabana J., Kyamanywa S., Munyazikwiye D; Sally Miller

Status: Hot pepper seedlings were grown in the tunnel production system and the seed harvested to be used in subsequent trials.

Description: The 'virus-free' seedlings will be taken to the field on-farm to study the re-infection rate so as to generate appropriate recommendations for farmers. Priority pests: Seed and vector-transmitted pepper viruses, specifically, TMV, PVMV, PMMV, and ToMV. IPM strategy to be addressed: Evaluate a low tunnel production system for producing virus free hot pepper seed. Location of trial: On-farm - Mubuku Irrigation and Settlement Scheme. Farmer or NGO Group identified: Abasaija Kweyamba Mubuku Farming Co-operative Society Limited. (AKMFCS Ltd.)

Expected outputs: Small-holder virus-free seed production system verified.

Global Themes for East Africa

Impact Assessment Global Theme

Task 1: Impact of Tomato IPM technologies on Farming Communities in Mukono and Wakiso Districts

Scientists involved: J. Bonabana-Wabbi, G.W. Norton, D.B. Taylor, M. Mangheni, J. Karungi, S. Kyamanywa, Z. Muwanga, G. Bisso, P. Sseruwagi, M. Klienhenz, J. Kovach, M. Erbaugh

Status: As per Activity 1 on tomato in Uganda, biological trials have been completed and technologies disseminated to farmers. The Uganda IPM CRSP site developed many of the original tomato IPM strategies (resistant variety, mulching, staking,

reduced spray schedule), validated them and disseminated them to groups of growers in Wakiso and Mukono districts.

Description: Data will be obtained from participants of the IPM tomato technology groups in Mukono and Wakiso districts in Central Uganda. The data will include values and volumes of the following key areas: Acreage, yields, incomes, prices, costs of planting materials, costs of inputs in the adoption of tomato IPM technologies, costs of developing the technologies, adoption rate of the technologies and yield and area changes attributable to tomato IPM adoption. Economic surplus modeling will be used to determine economic gains. Priority Pests: Bacterial wilt (*Ralstonia solanacearum*) and Late blight (*Phytophthora infestan*s). IPM *Objective:* To determine the economic impact of disseminated tomato IPM technologies.

Expected output: Manuscript

Task 2: Analysis of Socio-economic Survey Data for Onion in Kenya and Tanzania

Scientists involved: J. Bonabana-Wabbi, D.B. Taylor, M. Erbaugh, M. Mangheni, S. Kyamanywa, M. Waiganjo, J. Gitonga, M. Menza, A. Maerere, C. Msuya-Bengesi

Status: Biological research began in 2010 and baseline data was collected. Need to analyse data further

Description: The previously collected data will be analyzed using multivariate analytical methods to determine factors affecting adoption of IPM technologies on Onions. Logistic regression will be used to obtain estimates for individual technologies, while for multiple adoption; cumulative logit regression will be used. Priority Pest: to be determined. IPM *Objective:* To determine factors that affect the adoption of IPM technologies in Kenya and Tanzania.

Expected outputs: Manuscript

Task 3: Economic Analysis of Hot Pepper in Uganda

Scientists involved: J. Bonabana-Wabbi, D.B. Taylor, M. Erbaugh, M. Mangheni, S. Kyamanywa

Status: Biological research has established varying incidences and severity of phytophthora root and wilt disease at different ridge heights, ridge sizes and irrigation frequencies. Hot pepper farmers grow hot pepper at varying height, sizes and irrigation frequencies. Subsequently the severity and incidence of disease varies.

Description: The Hot Pepper IPM technologies developed by the biological scientists include planting hot-pepper on raised ground (ridging) and irrigation of Hot Pepper.

The extent of adoption will be measured as the proportion of the area under each practice. An index of hot pepper technology adoption will be computed as the dependent variable and regressed against farmer characteristics, agronomic characteristics and other socio-economic characteristics to obtain the determinants of intensity of adoption. Priority pest: *Phytophthora infestans* (wilt). *Objective:* Complete analysis and write-up of the hot pepper baseline survey, conduct partial budget analysis and estimate the economic impact of the Hot pepper research

Expected outputs: A manuscript on determinants and intensity of Hot Pepper IPM technology adoption in S. W. Uganda

Gender Knowledge Global Theme

Task 1: Monitoring gender equity using the 'Women Participation checklist' and targeting women in IPM research (Kenya, Uganda, and Tanzania)

Scientists involved: M. Mangheni, J.Gitonga, C.Msuya, M. Waiganjo, A. Maerere, J. Karungi, M. Erbaugh, M.E. Christie

Description: The gender focal persons in the three countries collect data on barriers to women's participation and share it with scientists. Scientists use the findings to target women. GGT Regional coordinator will compile data and experiences for dissemination in the annual report and other channels. Crop(s): Tomato, passion fruit, coffee, onion, scotch bonnet.

Expected output: Report on experiences with targeting women in IPM research projects

Task 2: Capacity building (Kenya, Uganda, and Tanzania)

Scientists involved: M.Mangheni, R. Miiro, J.Gitonga, C.Msuya,J. Bonabana-Wabbi, M. Waiganjo, A. Maerere, J. Karungi, M. Erbaugh, M.E. Christie

Description: i) Sensitization on use of the 'Women Participation checklist' for gender focal persons for Tanzania and Kenya (this will be done through online communication; (ii) Supervision of the student Robert Ochago, MSc Agric. extension to analyze data and write a thesis on 'Gender-based constraints and opportunities in coffee production in Sironko district, Uganda: implications for IPM control of coffee stem borer. Crop(s): Tomato, passion fruit, coffee, onion, scotch bonnet

Expected output: MSc thesis and graduate

Task 3: Research (Kenya, Uganda and Tanzania)

Scientists involved: M. Mangheni, J. Bonabana-Wabbi, M. Waiganjo, A. Maerere, J. Karungi, M. Erbaugh, M.E. Christie

Description: Publication of articles from coffee study and impact assessment studies. Crop(s): Tomato, passion fruit, coffee, onion, scotch bonnet

Expected output: At least two journal articles

Plant Virus Global Theme

Task 1: Develop, test and train stakeholders on use of membrane-based ELISA for indexing passion fruit plants for new strains of passion fruit viruses (Kenya, Tanzania, and Uganda)

Scientists involved: Sseruwagi, P., Ochwo-Ssemakula, M., Opita, M.J., Kyamanywa, S., Maerere, A., Erbaugh, M., and Sue Tolin

Description: Antibodies will be made against the capsid proteins of passion fruit virus strains in East Africa. A membrane-based ELISA assay will be developed for the new passion fruit virus isolates using the antibodies. Training will be conducted for nursery operators/seedling stock providers on use of ELISA assays for virus screening. Target group: scientists/technicians and nursery/seedling stock producers

Task 2: Conduct comprehensive epidemiological and molecular characterisation studies to better understand the complexes of tomato infecting virus diseases and associated viruses (Kenya, Tanzania, and Uganda)

Scientists involved: Sseruwagi, P., Ochwo-Ssemakula, M., Opita, M.J., Kyamanywa, S., Maerere, A., Erbaugh, M., and Sue

Description: Conduct field surveys in Kenya, Tanzania and Uganda to score for tomato virus disease incidence, symptom severity and insect vector (aphid, whitefly and thrips) populations on tomato and other plants in and around the tomato fields. Fresh virus symptomatic leaf isolates will be collected together with insects found on tomato and other plants (with virus-like symptoms), and viruses identified using molecular tools. Insects will also be identified morphologically using published keys and also using molecular tools targeting the mitochondria DNA. Target group: Scientists, extension workers and farmers

Task 3: Develop and evaluate IPM options that target insect vector control for pepper and tomato virus diseases (Uganda)

Scientists involved: Sseruwagi, P., Ochwo-Ssemakula, M., Opita, M.J., Karungi, J., Kyamanywa, S., Maerere, A., Erbaugh, M., and Sue Tolin

Description: Field trials will be conducted to evaluate cultural IPM practices that target insect vector control to manage pepper and tomato virus diseases in smallholder farmers' fields. The cultural practices to be evaluated should be accessible, affordable and user friendly. Target group: scientists and farmers

IPDN Global Theme

Task 1: Developing diagnostic and management fact sheets and posters on prioritized diseases of tomato, passion fruit and onion in East Africa (Kenya, Uganda, and Tanzania)

Scientists involved: Kinyua, Z.M., R.L. Amata, M.J. Otipa, P. Sseruwaji, M. Ochwo-Ssemakula, G. Tusiime, D. Mamiro, J. Karungi, S. Miller, M. Erbaugh, F. Beed, D.W. Miano, G.M. Kariuki, M. Mangheni

Status: a) On-going; b) To be executed through email and telephone communications and refined through focus group discussions.

Description: Several diseases affect the production of tomatoes, passion fruit and onions in the Kenya, Uganda and Tanzania. At the farm level, lack of knowledge on early recognition of the diseases and poor understanding on the causes and mode of spread of the diseases greatly limits the application of both preventative and management strategies. Therefore, farmers and extension staff require quick guide reference materials to aid in recognition and management of the diseases. This activity will be geared towards the development, pre-testing, refinement and dissemination of fact sheets for already prioritized diseases of tomatoes, passion fruit and onions. This will involve the application of literature searches, on-farm observations and information collation, consolidation of information and pictorials and pre-testing of refined fact sheets. Thereafter, strategies of disseminating the reference materials to farmers and agricultural extension workers will be devised. Farmer or NGO group identified: Literature searches (grey & published) and visits/interviews with a selection of farmer groups and extension agents in East Africa. Priority pests to be addressed: Fungal, bacterial, viral and nematode diseases. IPM Strategies to be tested/disseminated: Standard reference materials (fact sheets and posters) for recognition and management of major diseases affecting tomatoes, passion fruit and onions.

Expected outputs: By the end of Year 4 (September 30, 2013), selected fact sheets and posters on recognition and management of priority diseases available.

Task 2: Training and backstopping farmers and extension staff on diagnosis and management of priority diseases of tomato and passion fruit (joint training with E.A. Regional Project) (Kenya, with backstopping in Uganda and Tanzania)

Scientists involved: Kinyua, Z.M., R.L. Amata, M.J. Otipa, S. Miller, M. Waiganjo, S. Miller and M. Erbaugh.

Status: a) New; b) To be undertaken through pre-arranged training sessions.

Description: Farmers and agricultural extension staff identified during field visits and trial establishment by the regional project team will be trained on the diagnosis of the main diseases affecting tomato and passion fruit in their localities. This will take the form of on-farm sessions and a joint workshop to systematically train them on the steps in diagnosis and management of the diseases. The tasks will be coupled with analysis of diseased samples obtained from farm sites hosting the regional project trials. Priority pests to be addressed: Fungal, bacterial, viral and nematode diseases. IPM Strategies to be tested/disseminated: Recognition and management options for various diseases affecting tomatoes and passion fruit. Location: i) A joint training workshop at KARI Thika and on-farm sessions in Kirinyaga; ii) KARI NARL Kabete for laboratory analysis of project samples. Farmer or NGO group identified: Farmers and extension staff to be identified during field assessments.

Expected outputs: By the end of Year 3 (September 30, 2012) a) Farmers and extension staff in project areas trained; b) Samples from the Regional Project sites analyzed for diseases; c) Diagnostic laboratories in Kenya, Uganda and Tanzania backstopped.

Task 3: Testing and fine-tuning selected standard operating procedures (SOPs) for passion fruit, tomato and onion in East Africa (Kenya, Uganda and Tanzania)

Scientists involved: Kinyua, Z.M, R.L. Amata, M.J. Otipa, P. Sseruwaji, M. Ochwo-Ssemakula, D. Mamiro, J. Karungi, S. Miller, M. Erbaugh and F. Beed.

Status: a) on-going; b) To be executed through a training workshop involving both field sampling and laboratory sessions.

Description: Timeliness and accurateness of diagnosis of diseases are critical considerations for effective disease management strategies. However, these two components are hardly satisfied in most of the diagnostic establishments in the East African region. Therefore, provision of guided standard procedures of diagnosing plant diseases would help in bridging the existing gaps, thereby enhancing diagnostics services that feed directly into disease management strategies. Standard

operating procedures (SOPs) developed on the basis of information collated on the diagnostic techniques/tools available for major tomato, passion fruit and/or onion diseases will be utilized in training sessions to assess their practicability and effectiveness in guiding disease management decisions. The training sessions will also serve as fora for identification of knowledge gaps and improvements required on the SOPs. Priority pests to be addressed: Fungal, bacterial, viral and nematode diseases. IPM Strategies to be tested/disseminated: Standard procedures for diagnosis of major diseases affecting tomatoes, passion fruit and onions. Farmer or NGO group identified: A selection of established laboratories with operations involving disease diagnostics in East Africa.

Expected outputs: By the end of Year 4 (September 30, 2013), focused capacity of diagnosing critical, economically important diseases.

Task 4: Training of plant doctors/extension workers on diagnosis of insect pests and disease of key horticultural crops (budgeted under Uganda Regional Programme and in collaboration with Uganda Ministry of Agriculture) (Uganda)

Scientists involved: M. Ochwo-Ssemakula, J. Karungi, S. Kyamanywa, H. Talwana, S.B. Mukasa, J. Okee, J. Kovach, S. Miller, M. Erbaugh

Status: New activity

Description: Systematic training of extension workers and plant doctors from individual districts in diagnosis and management of key insect pests and diseases of key horticultural crops in Uganda. Develop extension tools such as disease photo sheets and factsheets to facilitate diagnostics in Uganda. Conduct plant clinic days (Department of Agricultural Production, Makerere University) as an outreach program. IPM objectives/strategies to be tested: Correct pest and disease diagnosis.

Expected outputs: Improved and quick diagnosis of pest problems of key horticultural crops in individual districts in Uganda.

West Africa Regional Consortium for IPM Excellence

Development of comprehensive IPM packages for key vegetable crops in West Africa: Building upon and extending previous IPM-CRSP research

PI: **Dr. Douglas G. Pfeiffer**, Virginia Tech

Co-Investigators/Advisors and Institution Affiliation:

Robert Gilbertson, University of California, Davis

George Mbata, Fort Valley State University

Sally Miller, Ohio State University

Carlyle Brewster, Virginia Tech

Patricia Hipkins, Virginia Tech

Donald E. Mullins, Virginia Tech

Jim Westwood, Virginia Tech

Institutional Collaboration:

DPV – Senegal

ISRA – Senegal

CSIR-CRI – Ghana

Brief description of the project: Vegetables are a critical source of nutrition and an important cash crop in West Africa. However, vegetable crop production in West Africa is subject to numerous constraints, including losses due to arthropod pests, diseases and weeds; lack of up-to-date technology and varieties; and misuse and lack of availability of pesticides. Previous IPM-CRSP research has made progress in addressing a number of these constraints, including pesticide safety training and residue analysis; identification and management of whitefly-transmitted viruses and identification of key weed species. Here, we propose to build upon and extend these results to develop comprehensive IPM packages for three major vegetable crops (cabbage, potato and tomato) in two West African countries (Ghana and Senegal). (Mali was previously an active partner in this regional project, but funding and activities there have been curtailed because of a recent coup.) These packages will cover all aspects of production from seed selection to harvest. In the development of these packages, our team will build upon our extensive experience in vegetable crop production in West Africa, and our collective expertise in IPM and the related sub-disciplines (entomology, plant pathology and weed science). We will develop and

implement these packages through a strong collaborative effort with our host country partners and focus our efforts on improving the livelihoods of farmers and their families in rural agricultural households. In cases where new efforts are proposed (cabbage and potato), surveys will be conducted in parallel with development of the IPM packages to help identify the key pests and to understand the specific crop production system(s) used. We will categorize pesticides currently used on these crops and assess whether they are being used according to current recommendations and whether they are being applied safely. Depending on the outcome of these surveys we may need to recommend new pesticides or emphasize farmer training for safe use of pesticides. This latter point builds on an existing strength of our project. Based on our previous experience, we expect to have special emphasis on a number of other problems including whiteflies and whitefly-transmitted viruses (tomato), bacterial wilt disease (potato and tomato), potato tuber moth (potato), diamondback moth (cabbage) and the role of weeds as reservoirs for viruses and arthropod pests (all three crops). In the research on bacterial wilt and plant viruses, we will work closely with the International Plant Diagnostic Laboratory and the International Plant Virus Disease Network Global Theme. We also expect to greatly improve the overall diagnostic capacities of both countries. In order to document the impact of the IPM packages, we will compare farmers using the IPM package and those that do not. This will be carried out in collaboration with the Impact Assessment Global Theme. Female farmers have a unique role in production of these vegetable crops, often different from the male role. Consequently we will collaborate with the Coordination of Gender Knowledge and Application Global Theme project, in order that our IPM packages will have maximum impact with women farmers. Finally, we will disseminate the information generated in this project through various venues, so that it has the maximum opportunity to reach farmers and others involved in vegetable crop production. In this way we believe this work proposed will have maximum impact on the health and wellbeing of vegetable farmers and consumers in West Africa.

Objective 1: Develop and implement an IPM package for tomato in Ghana and Senegal

Activity 1a: Select plants of the open pollinated OPGP varieties for production of seed

Countries: Senegal and Ghana

Status: Complete in Ghana, Continuing in Senegal.

Scientists involved: Bob Gilbertson/UC-Davis; Michael Osei/CSIR-CRI; Moussa Noussourou/IER and Samba Diao and Papa Dembe Kane/ISRA

Description: The varieties OPGP 1 and 5 were evaluated in Mali as part of the year 1 IPM plots and will be evaluated in Ghana and Senegal in 2011-2012 as part of the year 1 IPM plots. Based upon the results in Mali, both varieties appear to be tropically adapted, virus-resistant/tolerant and able to produce good yields. Moreover, as open-pollinated varieties they serve as a means to provide farmers with seeds of an improved variety in the absence of a means to provide seeds of the preferred hybrid varieties. Therefore, we will select vigorous disease-free plants of the varieties OPGP 1 and 5, collect the fruits and harvest the seeds. These seeds will be use in future IPM plots (and possibly other situations) and hopefully eventually released to growers along with recommendations on how to collect seeds.

Progress to date: Complete in Ghana, Continuing in Senegal

Expected outputs: Plants of OPGP 1 and 5 will be selected for seed multiplication and seeds produced.

Task 1: The vigorous disease-free plants of OPGP 1 and 5 will be selected in Ghana and Senegal and seed produced from these plants.

Activity 1b: Sampling & identification of whitefly natural enemies in the cropping systems in Senegal and Ghana

Country: Complete in Ghana

Status: Continuing

Scientists involved: Carlyle Brewster/VT; Brandford Mochiah and Michael Osei/CSIR-CRI

Description: The sweetpotato whitefly, *Bemisia tabaci*, is a major insect pest and vector in agricultural cropping system, has been linked to the transmission of over 100 plant viruses, including viruses in tomato. Management of vector-borne diseases such as those caused by whitefly-transmitted viruses can be achieved by several means including a reduction in vector density and life expectancy, limiting contact between the vector and host plants, or by reducing the rate of infection of the virus. Whitefly management tactics, therefore, are organized around three key activities: Sampling, Effective Chemical Use, and Avoidance. Sampling is central to the development of IPM programs and is the key to the understanding, implementation, and refinement of all management strategies. As such, over the past few years, we have conducted area-wide spatiotemporal sampling of whitefly population in cropping systems in Senegal and Mali. In addition, because *Bemisia tabaci* is a

species complex consisting of 13 or more biotypes, we have also collected, and continue to collect, samples for identification of the biotypes in each of the countries of the study.

In Year 4 of the project we will continue our emphasis to the third key activity for whitefly management, i.e., Avoidance. Specifically, we will focus on one of the components of Avoidance, which is Natural Enemy Conservation (NEC). For NEC, we will conduct surveys to first identify potential natural enemies of the whitefly (predators and parasitoids) in both countries. Because assessment of parasitoids is much easier than that of predators (which may require the use of immunologically-based gut assays – ELISA methods), parasitoids will be the group of interest in Year 4.

Progress to date: Complete in Ghana, Continuing in Senegal

Expected outputs: An inventory of whitefly parasitoids with *Eretmocerus* spp. and *Encarsi* spp. as the main candidates

Task 1: Survey and identify whitefly parasitoids — Collect whitefly red-eye pupae and examine them for parasitism. Also, deploy yellow stick cards in or near vegetable fields to capture parasitoids.

Country: Senegal

Status: Continuing

Scientists involved: Carlyle Brewster/VT; Kemo Badji/DPV

Description: Same as above.

Progress to date: Same plan as outlined for Ghana provided above, except a second task will be performed in Senegal as part of Ph.D dissertation research to be performed by Kemo Badji (DPV)

Expected outputs An inventory of whitefly parasitoids with *Eretmocerus* spp. and *Encarsi* spp. as the main candidates, and an understanding of the within-field spatiotemporal dynamics of whiteflies and parasitoids.

Task 1: Survey and identify whitefly parasitoids — Collect whitefly red-eye pupae and examine them for parasitism. Also, deploy yellow stick cards in or near vegetable fields to capture parasitoids.

Task 2: Spatiotemporal dynamics and parasitism by whitefly parasitoids— Set up replicated unsprayed field plots (10 m x 10 m) of tomato or eggplant. Conduct non-destructive spatial sampling of whiteflies and parasitized pupae across several dates. Collect samples of parasitized pupae for parasitoid identification. Analyze

data to determine the parasitoid species complex, and level and spatiotemporal pattern of whitefly parasitism with each plot.

Activity 1c: Develop management strategies for *Ralstonia* bacterial wilt of tomato

Country: Senegal

Status: Continuing

Scientists involved: Bob Gilbertson/UC-Davis; Sally Miller/OSU; Papa Diedhiou/Univ. aston-Berger; Papa Demba Kane/ISRA

Description: Evaluate tomato and other *Solanum* species for resistance to *Ralstonia solanacearum* as part of the development of an IPM program to address this emerging disease

Progress to date: Continuing

Expected outputs: Resistant tomato varieties and rootstocks will be identified and confirmed under local farm conditions; an IPM strategy for this disease will be formulated

Task 1: Isolate *Ralstonia solanacearum* from multiple (up to 10) fields in the major tomato-growing regions of Senegal where bacterial wilt is a problem.

Task 2: Screen tomato varieties knows to be resistant on *Ralstonia*

Task 3: Screen tomato varieties and *Solanum* spp. collected under Task 2 against *R. solanacearum* strains from each region in pot studies

Task 4: Develop an IPM program for tomato production in areas of northern Senegal where bacterial wilt is a problem.

Task 5: Prepare an informational flyer on bacterial wilt disease and it's management for tomato growers and associated personnel for northern Senegal.

Task 6: Train women's group on grafting techniques as a micro-enerprise in Dagana area and also as technicians

Activity 1d: Assess the feasibility of using tomato grafting technology for management of bacterial wilt of tomato in Senegal

Country: Senegal

Status: New

Scientists involved: Bob Gilbertson/UC-Davis; Sally Miller/OSU; Papa Diedhiou/Univ. Gaston-Berger; Papa Demba Kane/ISRA

Description: Establish methodology for tomato grafting for resistance to bacterial wilt.

Progress to date: New

Expected outputs: Grafting technology established at ISRA and Univ. Gaston Berger.

Task 1: Build necessary facilities (simple graft healing chambers) in St. Louis, Dakar (CDH) and Dagana (for women's group)

Task 2: Test previously identified *R. solanacearum* tomato varieties and other *Solanum* spp., including wild *Solanum* spp., for graft compatibility with popular local tomato varieties.

Activity 1e: Plan for technology transfer and short-term training

Country: Ghana

Status: Planning

Scientists involved: Don Mullins & Pat Hipkins/VT; Michael Osei/CSIR-CRI

Description: Identify information content growers need to know in order to follow production package protocols and recommendations

Progress to date: Ongoing

Expected outputs: Targeted training to support production package adoption and effective implementation

Task 1: Work with scientists developing IPM tomato packages to identify training needs; plan training as appropriate

Country: Senegal

Status: Planning

Scientists involved: Don Mullins & Pat Hipkins/VT; DPV +ISRA-CDH

Description: Identify information content growers need to know in order to follow production package protocols and recommendations

Progress to date: Ongoing

Expected outputs: Targeted training to support production package adoption and effective implementation

Task 1: Work with scientists developing IPM tomato packages to identify training needs; plan training as appropriate

Activity 1f: Develop an IPM package for rainy season tomato production

Country: Ghana

Status: Continuing

Scientists involved: Sally Miller/OSU; Bob Gilbertson/UC-Davis; Eric Cornelius, Univ. Ghana-Legon; Rodney Owosu-Darko, Univ. Ghana Biotechnology Centre

Description: Develop tactics for the management of bacterial spot in tomato

Progress to date: Continuing

Expected outputs: An IPM program for rainy season tomato production will be developed, with emphasis on growing varieties that are tolerant of rains and approaches to manage key foliar diseases, such as bacterial spot and fungal blights (e.g., target spot, early blight and Septoria blight). These approaches will be incorporated into the rainy season tomato IPM package

Task 1: Survey tomato growing areas and identify disease problems; identify the pathogens involved, including the species of *Xanthomonas* causing bacterial spot

Task 2: Test seed sanitation procedures (acid wash, chlorine soak, etc.) eliminate bacteria from seed

Task 3: Test tomato varieties for "tolerance" to bacterial spot and fungal blights and local adaptability

Task 4: Assess the use of inexpensive high tunnel technology for seedling and plant production during the rainy season.

Activity 1g: Produce a tomato production guide for West Africa

Countries: Ghana and Senegal

Status: Continuing

Scientists involved: Bob Gilbertson/UC-Davis; Michael Osei/CSIR-CRI; Samba Diao and Papa Demba Kane/ISRA

Description: Based upon our knowledge of tomato diseases and production through our research efforts to date, we have generated a draft of a tomato production guide for West Africa. The current draft is fairly detailed and would be appropriate for academics, extension personnel and certain producers. For smallholder farmers, it may be necessary to produce a smaller-scale manual.

Progress to date: A draft tomato production manual has been generated.

Expected outputs: The current draft will be refined, translated into French and local languages and a shortened version for shareholder farmers generated.

Task 1: Complete current version of the tomato production manual, translate to French and prepare a strategy for publication. Work on developing shorter version for shareholder farmers.

Activity 1h: Determine distribution and incidence of *Tuta absoluta* in Senegal and Ghana

Countries: Ghana and Senegal

Status: New

Scientists involved: Bob Gilbertson/UC-Davis; Brandford Mochiah/Ghana-CRI; Dienaba Sall/ISRA

Description: Tuta absoluta has continued its spread across North Afirca, and we have now detected it in Senegal. We need to know more about its occurrence in West African tomato production areas. Traps will be placed in Saint Louis, a center for tomato production, in the Nyias region, and in Dakar, and in tomato-producing areas of Ghana.

Progress to date: New

Expected outputs: A knowledge of distribution and incidence of this major tomato pest

Activity 1i: Determine efficacy of selective insecticides for *Tuta absoluta* in Senegal and Ghana

Countries: Ghana and Senegal

Status: New

Scientists involved: Bob Gilbertson/UC-Davis; Brandford Mochiah/Ghana-CRI; Dienaba Sall/ISRA

Description: Tuta absoluta has been confirmed in Senegal, and we need to determine way in which to address this pest within our tomato IPM package. Insecticides will be evaluated which are low in toxicity to human applicators, after begin addressed in PERSUAP. Indoxacarb, spinosad and a pyrethroid will be compared with botanical insecticides.

Progress to date: New

Expected outputs: Control methods suitable for producers in Senegal and Ghana

Activity 1j: Determine background parasitization levels for *Tuta absoluta* in Senegal and Ghana

Countries: Ghana and Senegal

Status: New

Scientists involved: Bob Gilbertson/UC-Davis; Brandford Mochiah/Ghana-CRI; Dienaba Sall/ISRA

Description: Tuta absoluta has been confirmed in Senegal, and we need to determine ways in which to address this pest within our tomato IPM package. Populations of parasitoids attacking *Tuta* will be surveyed by collecting host insects from the field and rearing.

Progress to date: New

Expected outputs: Control methods suitable for producers in Senegal and Ghana

Activity 1k: Sampling, identification and management of tomato viruses in Ghana, with particular attention on *Cucumber mosaic virus* (CMV) and *Tobacco mosaic virus* (TMV)

Country: Ghana

Status: Continuing

Scientists involved: Bob Gilbertson/UC-Davis; Michael Osei/CSIR-CRI/Eric Cornelius/University of Ghana

Description: It is well-established that viruses and virus-like diseases are a constraint on tomato production in Ghana, and our initial surveys have supported this notion. However, the results of our surveys have indicated that, in addition to whitefly-transmitted begomoviruses, there are a number of other viruses and virus-like agents that maybe important in Ghana. These include the RNA viruses CMV (aphid-transmitted) and TMV (mechanically transmitted). In addition, there is some evidence that potyviruses and viroids also may be involved in some of the disease symptoms observed in the field. Thus, we will continue to survey for viruses and virus-like agents in the IPM and non-IPM tomato plots. Samples will be collected of the predominant virus symptoms and tested using methods already developed for begomoviruses, RNA viruses and virioids through IPM-CRSP efforts.

Progress to date: We have confirmed that begomoviruses are an important constraint on tomato production in Ghana, but also that there is a high incidence of CMV and TMV in some fields. In addition, we have preliminary results that a potyvirus and viroid also may associated with virus-like symptoms in the field.

Expected outputs: A better understanding of the relative importance of viruses and virus-like agents affecting tomatoes in Ghana, development of diagnostic tools for these viruses and virus-like agents and development of disease management strategies that can be used for these diseases

Objective 2: Develop and implement IPM strategies for diseases and arthropod pests of potatoes in Senegal

Activity 2a: Implementation of the potato IPM packages in Senegal

Country: Senegal

Status: ongoing

Scientists involved: Sally Miller/OSU, Bob Gilbertson/UC-Davis; Lamine Senghor, DPV and Papa Demba Kane and Emile Coly/ISRA-CDH

Description: Continued development and implementation of potato IPM packages

Progress to date: Continuing

Expected outputs: The first potato IPM packages will be implemented

Task 1: Work with potato growers to implement the first IPM packages

Activity 2b: Continue to conduct surveys in each location for potato production practices, yields and disease and pest problems

Country: Senegal

Status: Ongoing

Scientists involved: Sally Miller/OSU & Bob Gilbertson/UC-Davis; Lamine Senghor, DPV, and Papa Demba Kane and Emile Coly/ISRA-CDH

Description: Continue to survey potato growers to gain an understanding of potato production practices, yields and disease and pest problems

Progress to date: A preliminary survey of potato production in Central Senegal was conducted in March 2011

Expected outputs: A better understanding of relative importance of potato pests and diseases will be achieved

Task 1: Conduct expanded surveys for potato pests and diseases in potato-growing regions of Senegal

Activity 2c: Have farmers participating in the IPM program complete surveys

Country: Senegal

Status: Ongoing

Scientists involved: Sally Miller/OSU, Bob Gilbertson/UC-Davis; Lamine Senghor, DPV, and Emile Coly/ISRA-CDH

Description: Have farmers participating in the IPM project complete surveys

Progress to date: Farmers willing to participate in the project have been identified

Expected outputs: Farmers that will participate in the project will begin to fill out surveys

Task 1: Have participating farmers fill out surveys

Activity 2d: Continue to train pathologists from Senegal in the use of diagnostic tools for the identification of the strains of *Ralstonia* and *Erwinia*

Country: Senegal

Status: Continuing

Scientists involved: Sally Miller/OSU & Bob Gilbertson/UC-Davis; Papa Demba Kane and Emile Coly/ISRA-CDH

Description: Training of selected plant pathologists will be continued in the use of diagnostic tools for these bacterial pathogens of potato

Progress to date: The training of Mohameth Kane in bacteriology is underway; this will be completed

Expected outputs: An individual well-trained in practical bacteriology will be available in Senegal, and could assist in diagnosis and research on bacterial wilt and soft rot diseases and conduct additional training

Task 1: Clarify working relationsfor Mohameth Kane at SAED, who is conducting research on bacterial wilt and soft rot diseases and improving diagnostic capabilities for plant pathogenic bacteria in Senegal, with other IPM CRSP scientists

Task 2: Continue training efforts with other individuals, such as Lamine Senghor of DPV, to improve capacity in Senegal

Activity 2e: Initiate efforts to evaluate new potato varieties in Senegal

Country: Senegal

Status: New

Scientists involved: Sally Miller/OSU & Bob Gilbertson/UC-Davis; Lamine Senghor, DPV, and Papa Demba Kane and Emile Coly/ISRA-CDH

Description: We will collaborate with the U.S. Potato Board and private potato seed producers in the U.S. in an effort to have seed pieces of promising varieties screened in West Africa

Progress to date: New

Expected outputs: Trials of new potato varieties will be established in key potato-growing areas of Senegal

Task 1: Select varieties to be tested, arrange for shipment and establish variety trial plots

Activity 2f: Expand the monitoring of PTM populations & determine the parasitoids associated with PTM

Country: Senegal

Status: On going

Scientists involved: George Mbata/FVSU; Emile Coly/ISRA; Dienaba Sall Sy/ISRA; Kemo Badji/DPV

Progress to date: : Trap data from experimental plots sited in Notto Guouye Diama, and Kayar, towns that are about 30 miles north of Dakar, indicate that potato tubermoth males were caught between February 12, 2011 and May 7, 2011; and between January 27 and July 7, 2012. Moths per trap averaged between 0.5 and 1.1 for 2011, while averaging between 6.17 and 34.33 in 2012. The tuber moth exhibited high incidence between the months February and April in 2011, while there was high incidence of the moth throughout the cropping season in 2012 (January through June). The biweekly trapping data showed between 6 and 34 folds more PTM in 2012 compared to 2011. In 2012, after potatoes were harvested the moths were still being trapped in previously cultivated plots. The source of the tubermoth was abandoned potato tubers in previously cultivated plots as was revealed laboratory experiments. In addition, tubermoths were monitored in stores housing bags of potatoes in the Notto. The number of moths caught per trap ranged between 1.0 and 7.8. There is incontrovertible evidence of tubermoth activities during cultivation and storage of harvested potatoes.

Description: In Senegal, potatoes are considered to be one of the most economically important vegetable crops and are becoming more important because their high nutritional value, a high value cash crop, and a potential export crop for Senegalese farmers. Infestation by the potato tubermoth, *Phthorimaea operculella* Zeller, is a major problem limiting both yield and storage potatoes. In Senegal, local potato production has decreased considerably for 17,044 metric tons in 1992 to 2006 level of 6,649 metric tons, while importation of table potatoes has increased from 3,394 metric tons in 1995 to 51,814 metric tons in 2006. The decrease in potato cultivation in Senegal is in most part due to the potato tubermoth. Traps baited with PTM lures were used in monitoring PTM populations. This provided information on the incidence of PTM, and demonstrated that all phenological stages of potato are susceptible to the moth. In addition, it was shown that tubers abandoned in the plots contribute to the reservoir of the tuber moth. Experiments in 2012-2013 cycle will focus on the developing an IPM package for the management of the moth populations. **Logical progression of this project will be to search for tools for the control of the tubermoth**.

Expected outputs: Develop IPM tools for management of populations of PTM in the farm and in storage; establish the identity of parasitoids associated with the tubermoth

Task 1: Cultural Control: Effect of mixed cropping and trap crops on PTM populations: The biweekly monitoring of the tubermoth populations using pheromone baited traps will in addition focus on investigating the effect of mixed cropping on PTM population densities and damages on potato. We will evaluate populations of tubermoth in different types of potato plots viz: Plots with potato crop only, plots with potato crop and other crops such as cassava, tomato, etc. This experiment will help us understand how mixed cropping affects populations of the tubermoth. We can also advise the farmers on what crops to cultivate with potatoes to reduce the incidence and abundance of the tubermoth.

Task 2: Cultural Control: Investigate crop rotation on incidence and abundance of PTM: Incidence of the tubermoth is to be compared in plots cultivated every year and those that are fallowed for 2 -3 years. PTM in both plots will be monitored as usual with PTM lures and traps.

Task 3: The possible of using baited traps around potato plots to draw away PTM on the incidence and crop losses to PTM will also be investigated. If cost will be an obstacle potato tissue extracts could be invested in the lab for attractiveness to the tubermoth, and if effective could be used as lures instead of synthetic lures.

Task 4: Determine parasitoids associated with tubermoth in Senegal: Infested tubers, flowers or floral parts of potato will be incubated in the laboratory in cages. Emergent parasitoids will be collected and reared on the hosts' eggs, larvae, pupae or adult, whichever stage of PTM is the apparent host for the development of the parasitoids. If the parasitoids can be identified and mass-reared, they can be used for inundated release in potato stores.

Task 5: Controlling PTM in stores with ***Trichogramma***: Trapping experiments have demonstrated that PTM are carried into storage along with harvested potatoes, and moths emerge from infested tubers. Release of Trichogramma in the stores will be investigated to see if this can reduce infestation by tubermoths in storage

Activity 2g: Plan for technology transfer and short-term training

Country: Senegal

Status: Planning

Scientists involved: Don Mullins & Pat Hipkins/VT; Mody Gaye/DPV +ISRA-CDH

Description: Identify information content growers need to know in order to follow production package protocols and recommendations

Progress to date: Ongoing

Expected outputs: Targeted training to support production package adoption and effective implementation

Task 1: Work with scientists developing IPM potato packages to identify training needs; plan training as appropriate

Objective 3: Develop and implement an IPM package for cabbage in Ghana and Senegal

Activity 3a: Establish pheromone trapping grid for determination of species presence and phenology

Country: Senegal

Status: Continuing

Scientists involved: Doug Pfeiffer/VT; Dienaba Sall/ISRA

Description: A group of 3-5 traps per species, depending of farm size, will be established for diamondback moth and *Spodoptera littoralis*. Traps will be serviced weekly by CRSP scientists in Senegal.

Progress to date: Almost complete

Expected outputs: A clear understanding of phenology of flight activity will be allowed for the two most important lepidopteran pests of cabbage.

Task 1: A grid of pheromone traps for diamondback moth and *Spodoptera littoralis* will be maintained in the 10 Senegal research farms, serviced weekly, to determine patterns of phenology. In addition, traps will be monitored in 5-10 farms not a part of our research, to serve as controls.

Country: Ghana

Status: New

Scientists involved: Doug Pfeiffer/VT; Brandford Mochiah, Michael Osei/CRI

Description: A grip of 3-5 traps per species, depending of farm size, will be established for diamondback moth and *Spodoptera littoralis*. Traps will be serviced weekly by CRSP scientists in Senegal.

Progress to date: New

Expected outputs: A clear understanding of phenology of flight activity will be allowed for the two most important lepidopteran pests of cabbage.

Task 1: A grid of pheromone traps for diamondback moth and *Spodoptera littoralis* will be maintained in the 10 Senegal research farms, serviced weekly, to determine patterns of phenology. In addition, traps will be monitored in 5-10 farms not a part of our research, to serve as controls.

Activity 3b: Conduct routine field scouting to make collections of lepidopteran larvae and natural enemies for identification.

Country: Senegal

Status: Continuing

Scientists involved: Doug Pfeiffer/VT; Dienaba Sall/ISRA

Description: Larvae feeding on cabbage in the field will be collected during weekly visits, and placed into ethanol for taxonomic evaluation.

Progress to date: Initial larvae have been collected.

Expected outputs: A proper systematic foundation will be in place to design modern control approaches, some of which are species-specific.

Task 1: At each research site in Senegal, 100 cabbage plants will be examined visually for injury by lepidopteran larvae; larvae will be preserved in ethanol for identification.

Expected outputs: A clear understanding of phenology of flight activity will be allowed for the two most important lepidopteran pests of cabbage.

Task 1: A grid of pheromone traps for diamondback moth and *Spodoptera littoralis* will be maintained in the 10 Senegal research farms, serviced weekly, to determine patterns of phenology. In addition, traps will be monitored in 5-10 farms not a part of our research, to serve as controls.

Country: Ghana

Status: New

Scientists involved: Doug Pfeiffer/VT; Brandford Mochiah, Michael Osei/CRI

Description: Larvae feeding on cabbage in the field will be collected during weekly visits, and placed into ethanol for taxonomic evaluation.

Progress to date: New

Expected outputs: A proper systematic foundation will be in place to design modern control approaches, some of which are species-specific.

Task 1: At each research site in Ghana, 100 cabbage plants will be examined visually for injury by lepidopteran larvae; larvae will be preserved in ethanol for identification.

Expected outputs: A clear understanding of phenology of flight activity will be allowed for the two most important lepidopteran pests of cabbage.

Task 2: A grid of pheromone traps for diamondback moth and *Spodoptera littoralis* will be maintained in the 10 Ghana research farms, serviced weekly, to determine patterns of phenology. In addition, traps will be monitored in 5-10 farms not a part of our research, to serve as controls.

Activity 3c: Conduct small-scale field trials to determine efficacy of selective insecticides

Country: Ghana

Status: New

Scientists involved: Doug Pfeiffer & Pat Hipkins/VT; Brandford Mochiah, Michael Osei/CRI

Description: This activity will include relative comparisons of low-risk insecticides for management of the key lepidopteran species. These will include, but not be limited to, botanical and other bioinsecticides. *Beauveria bassiana* will be included in 2012-2013.

Progress to date: Continuing

Expected outputs: Chemical control is often required because to date biological control has been insufficient. We aim to provide data to support chemical control using appropriate safe materials, of differing modes of action, to manage development of insecticide resistance, a common problem with diamondback moth.

Task 1: Complete PERSUAP in Ghana to assure pesticide safety.

Task 2: At each research in Ghana, small scale field trials will be carried out to compare relative efficacy of several selective insecticides and bioinsecticides against lepidopteran cabbage pests.

Country: Senegal

Status: Plan pesticide use patterns

Scientists involved: Doug Pfeiffer & Pat Hipkins/VT; Kemo Badji/DPV + ISRA-CDH

Description: This activity will include relative comparisons of low-risk insecticides for management of the key lepidopteran species. These will include, but not be limited to, botanical and other bioinsecticides. *Beauveria bassiana* will be included in 2011-2012.

Progress to date: Continuing

Expected outputs: Chemical control is often required because to date biological control has been insufficient. We aim to provide data to support chemical control using appropriate safe materials, of differing modes of action, to manage development of insecticide resistance, a common problem with diamondback moth.

Task 1: Complete PERSUAP in Senegal to assure pesticide safety.

Task 2: At each research site in Senegal, a small scale field trial will be carried out to compare relative efficacy of several selective insecticides and bioinsecticides against lepidoptera pests of cabbage.

Activity 3d: Evaluate intercropping with tomato as a control for diamondback moth in cabbage.

Country: Senegal

Status: Continuing

Scientists involved: Doug Pfeiffer/VT; Dienaba Sall/ISRA/CDH + DPV + CERES-Locustox

Description: Larvae and pupae of diamondback moth and *Spodoptera littoralis* will be collected in the field, and reared individually in containers. Parasitoids that emerge will be preserved and identified taxonomically.

Progress to date: This work started in 2011.

Expected outputs: Parasitoids that successfully control pests are often locally adapted. It will be helpful to identify those that are present in our trial areas, in order to develop other means to foster their presence.

Task 1: In five of the research sites in Senegal, plots will be established and maintained with alternating rows of tomato and cabbage; population levels and injury by diamondback moth will be evaluated weekly.

Activity 3e: Plan for technology transfer and short-term training

Country: Senegal

Status: Planning

Scientists involved: Don Mullins & Pat Hipkins/VT; Mody Gaye/DPV + Papa Demba Kane/ISRA-CDH

Description: Identify information content growers need to know in order to follow production package protocols and recommendations

Progress to date: Ongoing

Expected outputs: Targeted training to support production package adoption and effective implementation

Task 1: Work with scientists developing IPM cabbage packages to identify training needs; plan training as appropriate

Country: Ghana

Status: Planning

Scientists involved: Don Mullins & Pat Hipkins/VT; Michael Osei, Brandford Mochiah/Ghana CRI

Description: Identify information content growers need to know in order to follow production package protocols and recommendations

Progress to date: Ongoing

Expected outputs: Targeted training to support production package adoption and effective implementation

Task 1: Work with scientists developing IPM cabbage packages to identify training needs; plan training as appropriate

Collaboration with Global Theme Projects:

Specifics regarding the Global Themes projects are not available, since communication with the host country units is incomplete. Once the work plan activities are confirmed, we will develop the Global theme projects with the host country units.

Virus GT = Plant Viral Disease Global Theme

Diag GT = International Pest Diagnostic Network Global Theme

Imp A GT = Impact Assessment Global Theme

Gend GT = Integration of Gender Knowledge and its Application Global Theme

Graduate Students and Post Doctoral Research Associates:

Name: Kemo Badji

Sex: Male

Nationality: Senegal

Discipline: Entomology

Site/*Country:* Senegal

Degree: Ph.D.

Start date: September 2010

Completion date: September 2013

IPM CRSP funds: 100%

Advisor/PI: C. C. Brewster

Thesis topic: Spatiotemporal Dynamics and Management of Whiteflies in Vegetable Cropping Systems in Senegal, West Africa

University: University of Bamako

Name: Potential student to be determined

Sex:

Nationality: Ghana

Discipline: Plant Pathology

Site/*Country:* Ghana

Degree: Masters of Science

Start date: To be determined

Completion date: December 2012??

Advisor/PI: R. Gilbertson

Thesis topic: This student will work on a project involving rainy season tomato production in Ghana that will be a combination of pathogen identification, germ plasm screening and fungicide efficacy assessment

University: University of Ghana

Short-Term training planned

Workshops: Plant Pest Diagnosis for tomato, potato & cabbage (Location: IER-Sotuba for scientists from Ghana & Senegal)

Publications planned:

Research articles: 2 ?

Extension articles 4

Posters 5

Bulletins 2

South Asia Regional Program

PIs: Dr. Ed Rajotte, Penn State University

Dr. George Norton, Virginia Tech

Dr. Doug Pfeiffer, Virginia Tech (India)

The South Asia Region consists of India, Bangladesh and Nepal. Our main thrust has been to develop and test full-season IPM packages for each crop that addressed all pest issues including arthropods, diseases, nematodes and weeds to provide economical, environmentally benign and safe approaches to managing pests. These packages are supported by problem specification activities such as grower and pest surveys, component, discipline-based research and evaluation activities that measure economic and social impacts. While each country develops a workplan based on local needs, every effort is made to coordinate activities among the countries. This is accomplished by holding annual regional planning meetings in each country on a rotational basis and ensuring that representatives from each country are present at the annual meeting. In addition, scientists from each country have the opportunity to travel to other countries for special training, workshops and other functions. As a result several technologies developed in one or the other of these countries has been transferred and adapted to another country. These technologies include root grafting, fruit fly pheromone mass trapping, *Trichoderma* and *Pseudomonas* soil amendments, etc. Opportunities for expansion of IPMCRSP activities in the region are possible since Bangladesh and Nepal have been named Feed the Future countries. It is most likely that mission-based Associate Awards will allow us to expand our programs in Nepal and Bangladesh in the coming year.

Bangladesh Site

In Bangladesh we primarily collaborate with the Bangladesh Agricultural Research Institute (since 1998). Our outreach partners include several major non-governmental organizations that support thousands of village-level trainers. It is likely that a new Associate Award in the coming year will expand the technology transfer activities beyond our historical research/demonstration sites to other vegetable growing regions in the country.

Activity 1: Demonstration of integrated management packages for different insect pests and diseases of country bean

Objective: To develop & disseminate IPM (bio-rational and bio-agents based) packages for efficient and sustainable management of different major pests of country bean.

Justification: Generally more than one pest attacks a crop. In country bean, there is a pod borer complex comprising, *Maruca vitrata* and *Helicoverpa armigera*, aphids are the major insect pests, whereas nematodes, anthracnose, soil borne pathogens are the major constraints for its production. So, development of IPM packages against one pest is not sufficient. Vegetable farmers are generally reluctant to use any IPM packages against one pest as other major pests can damage the crops economically. So, to grow chemical pesticide-free vegetables bio-rational and bio-agent based IPM components of all major pests should be developed.

Treatments:

T1= IPM package I

1. Hand picking of the infested flowers and pods at every alternate day + Sequential release of *Trichogramma* sp. and *Bracon* sp. for lepidopterous borer pests + Spraying of detergent water against aphids + Spraying of bio-pesticide Spinosad at 20 days interval from flowering (for summer beans only) + application of *Trichoderma* against nematodes and soil-borne pathogens.

T2= IPM package II

Hand picking of the infested flowers and pods at every alternate day + Sequential release of *Trichogramma* and *Bracon* for lepidopterous borer pests + Spraying of HNPV & MNPV + Spraying of detergent mixed water against aphids + application of *Trichoderma* against nematodes and soil borne pathogens

T3= Farmers' practice

Components	Target pest	T1	T2	Tc farmers
hand picking infested flowers/pods	*H. armigera* *M. vitrata*	X	X	
Trichogramma & *Bracon*	*H. armigera* *M. vitrata*	X	X	
Spinosad	*H. armigera* *M. vitrata*	X		
HNPV &MNPV	*H. armigera* *M. vitrata*		X	
detergent water	aphids	X	X	
Trichoderma	nematodes, soil pathogens			
Chemical pesticides	?			X

Activity 2: Development and demonstration of integrated management packages for different insect pests and diseases of cucurbit crops (bitter gourd, sweet gourd, ash gourd, teasel gourd)

Objective: To develop & disseminate IPM (bio-rational and bio-agents based) packages for efficient and sustainable management of different major pests of cucurbit crops (bitter gourd, sweet gourd, ash gourd, teasel gourd etc.).

Justification: From the previous studies it has been observed that sex pheromone based integrated management can efficiently control fruit fly, *Bactrocera cucurbitae* in cucurbit crops but in spite of fruit flies there are also infestation of epilachna beetle, *Spodoptera* caterpillar and pumpkin caterpillar in cucurbit crops. On the other hand nematodes, soil-borne pathogens are also major constraints for its production. So, integrated management packages should be developed against the major diseases and insect pests of different cucurbit crops.

Procedure/Methods:

Treatments:

T1= IPM package I

Use of cuelure pheromone traps, sequential release of *Trichogramma* sp., and *Bracon hebetor*, application of *Trichoderma* sp. against nematode, soil borne pathogens.

T2= IPM package II

Use of cuelure pheromone traps, mashed sweet gourd trap, sequential release of Trichogramma sp., and *Bracon hebetor*, application of Trichoderma sp. against nematode, soil borne pathogens.

T3= Farmers' practice

Application of chemical pesticide

Component	Target pest	T1	T2	T3 farmer
Cuelure	*B. cucurbitae*	X	X	
Mashed gourd trap			X	
Trichogramma & Bracon	?	X	X	
Trichoderma		X	X	
Chemical pesticides				X

Activity 3: Development of mass rearing techniques of predator lady bird beetle and parasitoid of epilachna beetle *pediobius foveolatus* and evaluate their parasitism efficacy in the greenhouse and field

Objectives: To develop mass rearing techniques of predator lady bird beetle and larval parasitoid of epilachna beetle, *Pediobius foveolatus*; To evaluate the parasitism efficacy of reared predator and parasitoids at the farm level.

Justification: Bio-control agents are one of the key elements for sustainable pest management. But unfortunately due to indiscriminate use of insecticides, prevalence and abundance of different bio-control agents became nil in the vegetable eco-system. So, to fill up the gap inundative release of different efficient bio-control agents are very much essential. For that reason mass rearing techniques of some prominent and effective bio-control agents should be developed and their field parasitism efficacy should also be tested and documented.

Procedure/ Methods: Natural parasitism of epilachna grubs by *P. foveolatus* at non-pesticide, bio-pesticide and chemical pesticide treated fields will be observed. Mass rearing techniques of predator (lady bird beetle) on the *Corcyra* / *Sitotroga* eggs along with fresh soft-bodied insects will be developed in the laboratory. Mass rearing protocol of *P. foveolatus* on its' natural hosts epilachna grubs will be developed.

Efficacy of those mass-reared predators and parasitoids will be tested in the greenhouse and field under micro-plot condition against host insect pests as well as generation freshness and related works will also be carried out.

Investigators: S.N. Alam, F. Khatun, M. Nabi, Entomology Division, BARI, M. Y. Mian, IPM CRSP, Bangladesh, E. G. Rajottee, Penn State University, USA.

Season : Rabi and Kharif 2012-13

Date of initiation: September 2012

Expected output: Effective and economic mass rearing techniques for predators and parasitoids will be developed. Mass-reared bio-control agents will be used in the integrated management packages for major insect pests of vegetables and in that way pesticide-free vegetable cultivation will be ensured.

Locations: Joydebpur, Gazipur

Activity 4: Survey of papaya mealy bug, *paracoccus marginatus* and their parasitoid *acerophagus papayae* on different vegetables and fruits crops especially in the Indo-Bangla border belts

Objective: To record the incidence of papaya mealy bug, *Paracoccus marginatus* and their parasitoid, *Acerophagus papayae* on different vegetables and fruits crops at different locations of the country (especially at the India-Bangladesh border belt).

Justification: Mealybug, *Paracoccus marginatus* Wiliams and Granara de Wilink has recently emerged as a major threat to different crops in many regions of Bangladesh causing serious economic loss. Especially severe infestation of mealybug causes economic losses of papaya and different vegetables, viz. eggplant, okra etc. Cultivation of different fruits and vegetables in many regions of the country greatly hampered due to severe mealy bug infestation. As chemical control of papaya mealybug is very difficult so in many countries biological control with different parasitoids especially with *Acerophagus papayae* were successfully done. So, this study will be undertaken to assess the occurrence and pest status of mealybug in different crops as well as to identify associated parasitoid(s) especially *Acerophagus papayae* with it.

Procedure/ Methods: Crops: Vegetables: brinjal, tomato, bitter gourd, bottle gourd, cucumber, country bean, cole crops, okra.

Fruits: mango, ber, guava, papaya

Data to be recorded: In-sito field inspection at every 15 days interval

Infestation status of papaya mealy bug will be determined from the farmers field at Joydebpur, Jessore, Comilla, Moulovibazar, Rajshahi, Panchagar

Investigators: S.N. Alam, N.K.Dutta, D. Sarker, A. K. M. Z. Rahman, M. Nabi, F. Khatun, Entomology Division, BARI, M. Y. Mian, IPM CRSP, Bangladesh, E. G. Rajotte, Penn State University, USA.

Season : Rabi and Kharif 2012-13

Date of initiation: September 2012

Expected output: The population fluctuation and pest status of papaya mealybug as well as its parasitoid(s) on some selected vegetables and fruits will be documented

Locations: Joydebpur, Jessore, Comilla, Moulovibazar, Rajshahi, Panchagar

Status: 1st year

Activity 5: Management strategies for *Pythium* diseases of summer tomato.

Objective(s): Use of IPM tools for management of *Pythium* disease of summer tomato.

Justification: Tomato is one of the important vegetable crops in Bangladesh. Due to hot and humid weather, summer tomatoes are attacked by various soil-borne diseases. Damping off disease in seed bed nursery and *Pythium* rot after transplanting of seedling into the main field are major constraints for tomato production in summer time. *Pythium* species are fungal-like organisms (Oomycetes), commonly referred to as water molds, which naturally exist in soil and water as saprophytes, feeding on organic matter. However, some species of *Pythium* infection lead to damping off disease in seed nurseries and crown rot (water soaked lesion greet stem and rotten) in plants after transplanting in main fields. In Bangladesh, several *Pythium* species, including *P. aphanidermatum* and *P. ultimum* are known to cause damping off and crown rot in cucumber, pepper and summer tomato. Over watering, poor root aeration, root injury and improper root zone temperatures can weaken the crop and, thus, trigger *Pythium* outbreaks. Single approaches may not be suitable management of this disease. Therefore, integration of cultural, chemical and biological approaches may be considered as mitigation tools for *Pythiu*m disease management of summer tomato.

Name of treatments: Experimental design will be randomized complete blocks with four replications. Treatments will be: i) Soil amendment with Mustard oil extract cake (MOC) @ 600 kg/ha, ii) Soil amendment with Mustard oil extract cake (MOC) @ 300 kg/ha , iii) soil amendment with Mustard oil extract cake (MOC) @300 kg/ha +soil drenching with neem seed carnal extract, iv) Ridomil gold @ 0.2% root dipping + soil drenching, and v) control. Tricho-compost @ 2.5 t/ha will applied in main field to control the other soil borne diseases.

No. of replications: Four replications will be maintained in each of the experiment.

Data to be recorded: Data on seedling mortality, *Pythium, Phytophthora, Fusarium*, *Sclerotium* and *Rhizoctonia* population in soil will be determined. Data on yield and other quality parameter will be recorded.

Name of the scientists: M. S. Nahar, M A Goffar, M. A. Rahman and M. Afroz, Plant Pathology Section, HRC, BARI; M Y Mian, IPM CRSP

US Scientists: Sally A. Miller

Date of initiation: May, 2013

Date of completion: November 2015

Expected output: 1. Information of *Pythium* disease management will available.

Summer tomato production will be increased and farmers will be benefited.

Location: HRC, BARI, Gazipur

Status: New

Activity 6: Formulation and utilization of *Trichoderma harzianum* for production of Tricho-compost and its application for soil borne disease management of vegetable crops.

Objective(s): Find out suitable media for quick mycelium and spore production of *Trichoderma harzianum*.

Examine the shelf life of *T. harzianum* in talc base formulation.

Effectiveness test of talc base *T. harzianum* for bio-conversion of organic waste (Tricho-compost production).

Application of Tricho-compost for fungal, bacteria and nematode disease control.

Tricho-compost production at farmer's level by using Tricho-leachate and its application for vegetable production.

Justification: Economically important horticultural crop plants are attacked by various soil-borne and foliar pathogenic fungi, bacteria and nematodes resulting in billions of dollars in cumulative crop losses. Currently, the most widely used control measure for suppressing these diseases are the use of fungicides. However, problems encountered, such as development of pathogen resistance to fungicides, pollution of food and feeds, health hazards, environmental pollution, etc. Furthermore, soil borne diseases are very difficult and uneconomical to control with chemicals. Considering these limitations biological control is an important approach in this direction. *Trichoderma harzianum* found as an effective bio-agent against several soil borne fungal, bacterial and nematode diseases. However, to ensure the availability of *T. harzianum* among researchers, NGO's, private agency and farmer need a suitable liquid media for mass multiplication of microorganisms within a short time. In addition, to preserve them for long time, need a solid media for maintain the spore alive and retain productivity. Therefore, it is necessary to find out suitable liquid media for spore production and solid media for long time preservation of *T. harzianum*. Use of talc base *T. harzianum* for production of Tricho-compost and its effectiveness test to control soil borne diseases is also necessary. To reduce production cost of Tricho-compost, BARI scientist in associate with NGO person working with farmers and was developed low cost technology for production of Tricho-compost. However, upscale methodology and large scale application, need more research and work with farmers.

Name of treatments: Different liquid media such as molasses yeast media, potato dextrose broth, potato dextrose broth+ yeast extract powder, Richard's solution + yeast extract powder will be tested for mycelial growth and spore production. For preservation in solid media, neem cake, maize bran, talc powder etc. will be used and shelf life will be study. The solid formulation of *T. harzianum* will be used for Tricho-compost production. Tricho-compost @ 2.5 t/ha will be used for its effectiveness test against soil-borne pathogens. Tricho-leachate will be used by the farmer's (women) for production of Tricho-compost.

No. of replications: Four replications will be maintained in each of the experiments.

Data to be recorded: Mycelial and spore production data, spore viability in solid media, data of insect and disease in Tricho-compost applied treatment, data of Tricho-compost production and utilization by the farmers will be recorded.

Name of the scientists: M. S. Nahar, M. A. Rahman and M. Afroz, Plant Pathology Section, HRC, BARI; M. J. Alam, MCC, Bogra; M Y Mian, IPM CRSP

US Scientists: Sally A. Miller

Date of initiation: September 2012

Date of completion: September 2015

Expected output:

Quick and mass multiplication technique of *T. harzianum* will be available.

Talc base media will keep spore viable for long of *T. harzianum* which will be used by the stockholder.

Quick and odorless decomposition technique of organic material will be available.

IPM tools will be available at farmer's level

Application of chemical fertilizer and pesticide will be reduced.

Women involvement, farmer's socioeconomic condition will be up-lifted.

Location: HRC, BARI, Gazipur and Chupi nagor, Shahjanpur, Bogra

Status: On going

Activity 7: Survey and diagnosis of virus diseases of vegetable crops in some districts of Bangladesh

Scientists	**Institution**
A. Muqit	Senior Scientific Officer Plant Pathology Div. BARI, Gazipur
Md. Shamim Akhter	Scientific Officer Plant Pathology Section, FRS, HRC, BARI, Rajshahi
M. Mahfuzur Rahman	Scientific Officer Plant Pathology Section, HRC, BARI, Gazipur
Mafruha Afroz	Scientific Officer Plant Pathology Section, HRC, BARI, Gazipur
MD. Yousuf Mian	IPM CRSP, Bangladesh HRC, BARI, Gazipur
US Scientists : Naidu Rayapati	Washington State University, USA
Sally A. Miller	Ohio State University, USA

Objective (s): i. To diagnose virus diseases occurring on vegetable crops

ii. To assess the prevalence of virus diseases in vegetables

Background information: Vegetables are important dietary constituents. They are rich in vitamins and minerals. They are important for securing nutritional security. A large number of vegetables are grown in Bangladesh. Some of the important vegetables are pumpkin, cucumber, okra, tomato, yard long bean, country bean etc. Some of them are cultivated in summer, some in winter and some are cultivated in both the season. One of the major problems of vegetable production is the occurrence of virus diseases. But virus diseases are not easily diagnosed and characterized. They need to be properly diagnosed and characterized before attempting to devise any management strategy.

Description of the activity: A disease survey will be conducted on different vegetable crops in the research and farmer's field. Samples will be collected from possible virus infection and will be tested in the laboratory for identification through ELISA.

Justification: Large number of vegetables is being cultivated in the country. From field observation it appears that many of them are susceptible to various virus diseases. They cause significant reduction in yield and quality. Therefore, proper diagnosis and adequate survey is essential to design or develop management strategies against them.

Projected output: Prevalence, distribution and severity of virus diseases in vegetable crops will be known.

Location: Farmer's field at Narsingdi, Comilla, Chittagong, Jessore, and Bogra districts of Bangladesh.

Projected Impacts: i. Better understanding of the virus disease situation in vegetable crops. ii. Will help to devise strategies for virus disease management in vegetable crops.

Name of treatments: Not Applicable

No. replication: NA

Data to be recorded: NA

Status: Continuing (4th year)

Priority: 1

Projected start: February 2013

Projected completion: December 2014

Activity 8: IPM package for cucumber production at different location

Scientists	Institution
G. M. A. Halim	Vegetable Section, HRC, BARI
M. S. Nahar	Plant Path. Section, HRC, BARI
M. A. Muqit	Plant Pathology Division, BARI
M. S. Hossain	Entomology Section, HRC, BARI
Md. Yousuf Mian	IPM CRSP

U.S. Scientists: Sally A. Miller

Background: Cucumber (*Cucumis sativus*) is one of the most popular vegetables and salad crops in Bangladesh. Production of cucumber is very low for many reasons. Among them, lack of healthy seedling, insect and diseases are the main constraints for cucumber cultivation. Most of the varieties are susceptible to insect, pest and diseases. Fruit fly, pumpkin beetle, root-knot nematode, cucumber mosaic virus, *Fusarium* wilt and angular leaf spot are the major insect pest and diseases causing huge loses of cucumbers. A single approach may not able to control all the pest and diseases. Therefore, integration of two or more IPM component is necessary for management of insect pest and diseases.

Objectives: To find an effective IPM package for production of healthy cucumber

Description of research activity: Two selected cucumber line, CS0079, CS080 and Baromashi (as check) will be included with three IPM production package and a control in the study following RCBD factorial design with three replications.

Treatments are as follows:

Factor A	Factor B
V1=CS0079,	M1=Tricho-compost@3t/ha+½CD + ½ chemical fertilizer
V2 =CS 0080	M2 =Poultry Refuse @ 3t/ha+½ CD + ½ chemical fertilizer
V3 =Baromashi	M3=MOC @ 300kg/ha+ ½CD +½ chemical fertilizer
	M4 =Control (Only CD) + ½ chemical

fertilizer

Besides, the following technologies will be integrated for effective package development of cucumber production: (1) Seedling production by using Tricho-compost; (2) Seed treatment; (3) Application of Tricho-compost, leachate for soil amendments and (4) Using of *Bracon hebator,* pheromone trap and spraying of neem oil/neem seed water extract for insect pest management.

Projected output (s): Effective IPM package will be developed for cucumber production and farmers will be benefited by growing healthy and quality crops.

Projected Impacts:1) Improved understanding of disease management among the growers; 2) Reduced insect disease incidence of cucumber; 3) Reduced dependency on chemical control and 4) Improved yield and quality of cucumber.

Priority: I

Project start: September 2012 for rabi season planting and February 2013 for kharif season planting

Projected completion: June 2013

Location: (5) Joydebpur, Jessore, Ishurdi, and Jamalpur

Activity 9: Development of IPM package for summer tomato production

Objective(s): To develop IPM package for summer tomato production; and

To disseminate IPM technology at farmers field.

Rationale: During summer season, wilting of tomato is a great threat to tomato production. Only resistant variety is capable to combat this problem but still such variety is not available. As an alternative means, grafting of tomato with wild species and use of Tricho-compost may play an important role to minimize wilt problem exist in tomato production.

Procedure/Methods:

Materials: BARI Hybrid Tomato 4 or 8 (summer variety)

Treatment: 12

Factor A (level 2). i) Grafting with *Solanum sisymbriifolium*; ii) Grafting with BARI Brinjal 8

Factor B (level 2) i) Use of Tricho-compost @ 3kg/40m2; ii) Without Tricho-compost

Design : RCB Factorial

Replication: 3

Plot size: 20 x 2.3m (200 plants per tunnel)

Spacing: Row to row- 60cm and Plant to plant- 40cm

Planting time: Sowing- 1st week of May 20123 (Rootstock sowing March & April)

Planting date: Trans.-1st week of June 2013

Irrigation: As and when necessary

Plant protection: Use of neem seed extract, yellow sticky trap and Tricho-leachate spraying (will be used during seedling raising to crop production)

Fertilizer doses and application methods:

Cow dung10t/ha

Urea 550kg/ha

TSP 450kg/ha

MOP 250kg/ha

Gypsum120kg/ha

Boron: 2kg/ha

Half of the quantity of cow dung, half amount of TSP and entire amount of gypsum and boron will be applied during final land preparation. The remaining half of cow dung and TSP are to be applied during pit preparation before a week of planting. The entire urea and MP are to be applied in 3 equal installments of 15, 35 and 55 days after seedling transplantation

Data to be recorded: i) Days to 50% flowering; ii) Plant height at last harvest; iii) Days required for harvest; iv) No. of fruits /plant; v) Individual fruit weight; vi) Fruit size (length and breadth); vii) TSS%; viii) Number of locules; ix) Shelf life x) Yield/plant; and xi) pest and disease reaction (wilt and virus infection at 45, 60 and 75 DAS).

Investigator: M.A. Goffar, G.M.A.Halim, M. K. Sultan, S. Ahmad and M.Y. Mian

Season: Summer

Date of initation: April 2013

Expected output: Technology of IPM package for summer tomato will be generated and finally, growers will benefit.

Location: Joydebpur and Bogra

Status: New

Priority: 1st

Activity 10: Production package development in pumpkin (*Cucurbita moschata* Duch Ex Poir)

Objectives: i. To ensure potential yield of pumpkin.

ii. To develop sustainable cultivation method of pumpkin

Justification: Pumpkin is widely grown vegetable crop of Bangladesh. It is one of the important sources of ß-carotene content. The tender stem and leaves, and fruits of pumpkin are used as delicious vegetables. Its well-matured fruits have highest storability among all the vegetables (2-4 months). Among others, the production of pumpkin is limited by the important pests. The pests include nematode, fusarium wilt, leaf blight, different viruses (PRSV, CMV and WMV2), red pumpkin beetle and fruit fly. Aphid species (Predominantly *Aphis gossypii* and *Myzus persicae*) are the vectors of pumpkin viruses. BARI released two pumpkin varieties which include BARI Mistikumra-1 and -2. These varieties came from previous activity of IPMCRSP were attributed to resistant to *PRSV* based on the serological test. Currently both varieties exhibit virus-like symptom of CMV, WMV2 and even PRSV. Yield of pumpkin is significantly reduced by the attack of these pests which sometime causes serious sufferings to the farmers. Development of resistant pumpkin varieties against these pests is difficult. Single approach of management of these pests is not helpful to minimize the yield loss of pumpkin. Therefore, our aim is to develop a package of pumpkin production to ensure its potential yield and establish a sustainable cultivation method.

Name of the treatments:

i. *Variety:*

BARI Mistikumra-1

ii. *Nematode and fusarium wilt control*

Tricho-compost will be added @ 2.5 tons per hectare (3/4th in pit as basal and 1/4th as top dress after four weeks of transplanting)

iv. *Leaf blight control*

Tricholeachate will be applied @ 20ml per liter water (at early vegetative, flowering and early fruiting stages).

v. *Control of vectors of virus diseases*

Seeds will be treated with Imivax. Yellow sticky plate will be used in the crop growing field.

vi. *Control of fruit fly*

Sex pheromone and meshed sweet gourd trap will be used.

vii. *Control of red pumpkin beetle*

Hand picking will be followed.

vii. *Controlled cultivation* (*Farmers practice*)

Number of replications: 03

Data to be recorded:

Yield and yield contributing characters of pumpkin; incidence and reaction of wilt, leaf blight and virus symptoms; and per cent red pumpkin beetle, nematode and fruit fly infestation.

Name of the scientists:

M.A.T. Masud (PI) and M.Bz. Talukdar (Vegetable Division, HRC)

M.S. Nahar (Plant Pathology Section, HRC)

N. Kumar Dutta (Entomology Division, BARI)

A.K.M. Habibur Rahman (ARS, Benerpota, Satkhira)

Date of initiation: November, 2012

Date of completion: June, 2014

Expected output: Sustainable cultivation method of pumpkin will be established. Farmers will benefit by applying developed production technology of pumpkin. Potential yield of pumpkin will be ensured for the growers.

Location: Joydebpur (Program will be leaded from this place) and Benerpota, Satkhira.

Status: New

Activity 11: Demonstration of IPM Package of Eggplant

Objective: To adapt and popularize the safe eggplant production technology to the growers

Justification: Eggplant is most popular vegetables in Bangladesh can be grown round the years. BW and FSB two devastating pest might be damaged 70-80% crop. Farmers use enormous amount of pesticides indiscriminately to control the aforesaid

pest, but have often success. Package of production technology have been developed through IPMCRSP during last couple of years and these packages are getting popular day by day, particularly grafting technology. During last two years, *S. sissymbrifolium* rootstock was found susceptible to BW. Therefore, new rootstocks were obtained from AVRDC.

Demonstration of IPM package for eggplant production

T1	Local brinjal variety & Farmers practices
T2	Soil amended with Tricho-compost and use of local cultivar
T3	Use of Tricho-compost + Wilt Resistant variety (BARI Begun 8)+ Pheromone + Braconoids
T4	Use of Tricho-compost + Grafted seedlings (New AVRDC line as stock and farmers variety as scion and AVRDC tube grafting tech) + Pheromone + Braconoids release

Number of farmer: 5 (Each farmer's field will be one replication)

Data to be recorded: % BW, yield and yield contributing characters

Scientists: M. Khled Sultan, M. Nazim Uddin, R. Islam

Date of Initiation: February 2013

Date of Completion: September 2013

Expected output: New stock and grafting method will be tested and popularized

Location: Jordhigi, Tangail

Status: 3rd year

Activity 12: Management of Anthracnose and nematode of Early Country bean by different means

Scientists	Institution
M. A. Rahman	Plant Path. Section, HRC, BARI
M. Mahfuzur Rahamn	Plant Path. Section, HRC, BARI
MS Nahar	Plant Path. Section, HRC, BARI
M.Yousuf Mian	IPM CRSP

U.S. Scientists: Sally A. Miller

Objectives: To identify effective means for controlling anthracnose of Early Country bean in the farmer's field.

Background information: Anthracnose caused by *Colletotrichum lindemuthianum* is considered one of the major constraints for country bean crops in Jessore region. Farmers applying chemicals (insecticide & fungicides) irrationally to control insect and disease is another problem. Resistant among country bean's germplasm against anthracnose and root knot nematode is not available. To reduce pesticide use and produce healthy crops it is important to develop an IPM package for country bean.

Description of package activity: Effective package for controlling country bean crops in Jessore region will be identified, farmers' will be benefited and hence the new IPM activity will be continued as to create global information.

Justification: Farmers are cultivating early country bean with local cultivar mainly which are mostly susceptible to anthracnose. As a result, enormous loss of country bean faced by the farmers every year. On the other hand, Tricho-solution enriched in *Trichoderma harzianum* spores may affect anthracnose in nature. Present research will include *Trichoderma harzianum* suspension, fungicide like carbendazim and suitable insecticide for managing Maruca fruit borer. The farmers practice will be the control treatment.

Treatment: 1) *Trichoderma harzianum* suspension; 2) Carbendazim-Bavistin @0.2%; 3) 4) Tricho-compost; 5) Tracer and 6) Farmers Practice. The field will be arranged 0.1ha per treatment and it will be replicated.

Projected output (s): Knowledge will be improved about effective control measures of anthracnose and nematode in the selected regions of Bangladesh.

Location: **Jessore**

Projected Impacts:1) Improved understanding anthracnose and nematode among the growers; 2) Improved yield and quality of country bean by managing diseases and pests.

Priority: I

Projected start: 2012

Projected completion: 2015

Activity 13: Isolation, identification, preservation and efficacy test for Fluorescent pseudomonas as bio-control agent for disease management and as growth promoter of crops

Scientists	Institution
M. A. Rahman	Plant Path. Section, HRC, BARI
M. Afroz	Plant Path. Section, HRC, BARI
M.Yousuf Mian	IPM CRSP

U.S. Scientists: Sally A. Miller

Objectives: 1) Isolatie, identify, and preserve *Pseudomonas fluorescens*.

2) Complete efficacy test of the bacteria for managing vascular wilt as well as bacterial wilt

Background information: Vascular wilt caused by fungi and bacteria is one of the major constraints for production of many crops in Bangladesh. These pathogens are causing various diseases on different crops and the researchers are taking challenge for increasing crop production. *P. fluorescens* is found posing growth-promoting characters as well as suppressing many diseases of crops at any stage of growth. So, isolation, identification, preservation; and efficacy tests of Fluorescent pseudomonas is important.

Description of package activity: Effective package for controlling vascular diseases will be identified, farmers' will be benefited and hence the new IPM activity will be continued as to create global information.

Justification: Farmers are growing different vegetables with local and hybrid cultivar which getting infected by so many diseases. As a result, enormous loss faced by the farmers every year. The damage of various crops may hinder using Fluorescent pseudomonas as they can enhance resistance of the host and also may act as growth promoter.

Projected output (s): Knowledge will be improved about effective control measures of vascular wilt in the selected regions of Bangladesh.

Location: **Lab. Gazipur**

Projected Impacts:1) Improved understanding about bio-agent Fluorescent pseudomonas will be create among the growers; 2) Improved yield and quality of various crops will be ensured

Priority: I

Projected start: 2012

Projected completion: 2015

Activity 14: Survey and Identification of New Diseases and pests of Various Crops in Bangladesh.

Objective(s): To measure the incidence and to identify the new diseases of various crops

Rationale: Various diseases of field and fruit crops have not been identified regularly in Bangladesh. With the global climate change, different diseases may evolve comprising new races and biovars or new generation resistant to pesticides. It will be helpful to identify the diseases with their pathogenicity to select management strategies.

Materials and methods: Survey and identification of new diseases of various crops like cucurbits, tomato, eggplant, papaya, litchi and Jackfruits will be done in Central, Northern, Southern, Eastern and Western parts of Bangladesh.

Data to be recorded: Incidence of different diseases with their severity and preservation of new diseases

Treatment: Available diseases of a specific crop at locations will be taken as incidence and severity will be measured following standard method and a scale

Investigator(s): M. A. Rahman, M.S. Nahar, N. K. Datta, M. Afroz and M.Y. Mian

Season: Summer & Winter

Expected output: New diseases and their damaging factors will be identified for select management strategies

Location: Narasinhdhi, Bogra-Rangpur, Jessore-Khulna, Chittagong, Pabna-Rajshahi regions of Bangladesh

Status: Third year

Date of initiation: 2011

Date of completion: 2014

Priority: 1st

In addition to this, "Role of women in vegetable cultivation and IPM Technology adoption under the Global Gender Program" will be continued.

Nepal

Primary sites in Nepal include Lalitpur District in the Kathmandu Valley in the Central Region and the Kaski District in the Western Region, encompassing the city of Pokhara and environs. The Nepal Site is the smallest project in the South Asian region. Site activities began in in 2005.

This work plan details the Fourth year's activities under the objectives stated in the full proposal.

Regional Project:

Project Title:	The South Asia Regional IPM CRSP Program, Nepal
Names PI(s):	Dr. Luke A. Colavito
Co PI(s):	B. K. Gyawali

Brief description of the project:

The project is aimed to devise IPM technologies in vegetable crops to reduce crop loss due to pests while minimizing adverse effect on health, environment and bio-diversity.

Nepal is divided into three physiographic regions (high mountains, mid-hills and flat land terai) and five development regions (eastern, central, western, mid-western and far-western). Nepal IPM CRSP has two sites from western development region: Kaski representing mid-hill and Rupandehi for terai), whereas Lalitpur is demo site from central development region representing mid-hill climate. Two commercial crops: tea and coffee grown with separate identity for tea, Illam from the eastern development region with mid-hill climate and for coffee, Palpa from the western development region with mid-hill climate.

Similarly, Nepal IPM CRSP Associate Award focuses two sites in mid-western development region: Surkhet representing mid-hill and Banke for terai.

Objectives

1. To develop effective IPM packages for vegetables produced by limited resource farmers in Nepal;

2. To achieve transfer of vegetable IPM packages on a large scale to limited resource farmers in Nepal; and

3. To strengthen the institutional capacity for vegetable IPM in Nepal so that Nepal can sustain an ability to generate IPM knowledge and promote adoption of IPM packages

Objective 1: IPM package development

Description: Development of effective IPM package for 4 vegetable crops such as tomato, cucurbits, cole crop (cauliflower/cabbage), eggplant and 2 commercial crops such as tea and coffee produced by limited resource farmers.

Activity 1: Tomato IPM package development

Country: Nepal

Status: Continuing

Scientists involved: B. K. Gyawali, Ram Bahadur KC, Ram Devi Timila, Gopal Thapa, Arjun Khanal, Shiva Sanker Bhattarai

Description: Management of major pests (tomato fruit worm, whitefly, leafminer, thrips, tobacco caterpillar, fruit fly, aphids, cutworm, and white grubs) and major diseases (Bacterial wilt, Root Knot Nematode, TYLCV, Tomato spotted wilt, Tobacco mosaic virus, CMV, anthracnose and Sclerotinia rot).

Progress to date: Bio-control agents such as Nuclear Polyhedrosis Virus, Bacillus thuringiensis var. kurstaki, Verticillium lecanii, Beauvaria bassiana and Metarhizium anisoplae, Borer guard, Derisom, Anosom, Margosom to manage insects, and Trichoderm viride, T. harzianum, Pseudomonas fluorescence, Bacillus subtilis, Bio-mycin, Bio-fit and Margo NF to manage diseases. Similarly, eco-friendly IPM tools such as pheromone traps were also used for the management of tomato fruit worm. Evaluation of bio-fertilizers such as nitrogen fixing bacteria, phosphorus solubilizing bacteria, potash mobilizing bacteria and agri VAM performed well.

Major pests include whitefly, Helicoverpa, Spodoptera, leafminer and thrips. Major diseases include bacterial wilt, root knot nematode, tomato yellow leafcurl virus, tomato spotted wilt virus, TMV, CMV and Sclerotinia rot.

Expected outputs: Increase of crop yield and beneficial organisms with minimum or no environmental/health hazards.

Task 1: Technology verification for tomato IPM Package in Terai and Hill ecological regions of Nepal

Task 2: Technology dissemination and scale up for tomato crop IPM package in 80 HH in each of 2 project districts

Task 3: Training of tomato IPM package to technical staffs, service providers, interaction with stake holders, farmer to farmer program in each project districts

Activity 2: Cucurbit IPM package Development

Country: Nepal

Status: Continuing

Scientists involved: B. K. Gyawali, Ram Bahadur KC, Ram Devi Timila, Gopal Thapa, Arjun Khanal, Shiv Shanker Bhattari

Description: Management of major pests (Fruit fly, red pumpkin beetle, white fly, epilachna beetles and aphids) and major diseases (Damping off, cucumber mosaic virus, powdery mildew and downy mildew).

Progress to date: Bio-control agents such as *Verticillium lecanii, Beauvaria bassiana* and *Metarhizium anisoplae*, Borer guard, Derisom, Anosom, Margosom to manage insects, and *Trichoderm viride*, *T. harzianum*, *Pseudomonas fluorescence*, *Bacillus subtilis*, Bio-mycin, Downy care, Powdery care, Bio-fit, and Margo NF to manage diseases. Similarly, eco-friendly IPM tools such as pheromone trap were also used for the management of fruit fly. Evaluation of bio-fertilizers such as nitrogen fixing bacteria, phosphorus solubilizing bacteria, potash mobilizing bacteria and agri VAM performed better.

Expected outputs: Increase in crop yield and beneficial organisms with minimum or no environmental/health hazards.

Task 1: Technology verification for cucurbit IPM package in terai and Hill ecological regions of Nepal

Task 2: Technology dissemination and scale up for cucurbit IPM package in 40 HH in each of 3 project districts

Task 3: Training of cucurbit IPM package to technical staffs, service providers, interaction with stake holders, farmer to farmer program in each project districts

Activity 3: Cole crop (cauliflower/cabbage) IPM package Development

Country: Nepal

Status: Continuing

Scientists involved: B. K. Gyawali, Ram Bahadur KC, Ram Devi Timila, Gopal Thapa, Arjun Khanal, Shiv Shanker Bhattari

Description: Management of major pests (Cabbage butterfly, Diamond back moth, Tobacco caterpillar, Flea beetle, Aphids, cutworm, Red ants, White grubs and Mole crickets) and major diseases (Damping off, Alterneria leaf spot, Sclerotinia rot, Black rot, Downy mildew, Turnip mosaic virus and club root).

Progress to date: Bio-control agents such as Nuclear Polyhedrosis Virus, *Bacillus thuringiensis kurstaki, Verticillium lecanii, Beauvaria bassiana* and *Metarhizium anisoplae*, Borer guard, Derisom, Anosom, Margosom to manage insects, and *Trichoderm viride, T. harzianum, Pseudomonas fluorescence, Bacillus subtilis*, Bio-mycin, Bio-fit and Margo NF to manage diseases. Similarly, eco-friendly IPM tools such as pheromone trap used for the management of Diamondback moth. Evaluation of bio-fertilizers such as nitrogen fixing bacteria, phosphorus solubilizing bacteria, potash mobilizing bacteria and agri VAM performed better.

Expected outputs: Increase in crop yield and beneficial organisms with minimum or no environmental/health hazards.

Task 1: Technology verification for cole crop (cauliflower/cabbage) IPM package in terai and Hill ecological regions of Nepal.

Task 2: Technology dissemination and scale up for Cole crop IPM package in 40 HH in each of 2 project districts.

Task 3: Training of cole crop IPM package to technical staffs, service providers, interaction with stake holders, farmer-to-farmer program in each project districts.

Activity 4: Eggplant (brinjal) IPM package Development

Country: Nepal

Status: Continuing

Scientists involved: B. K. Gyawali, Ram Bahadur KC, Ram Devi Timila, Gopal Thapa, Arjun Khanal, Shiv Shanker Bhattari

Description: Management of major pests (Shoot and fruit borer, Epilachna beetles, thrips, white flies, Aphids, cutworm, and white grubs) and major diseases (damping off, root knot nematode, bacterial wilt, anthracnose and *Sclerotinia* rot).

Progress to date: Bio-control agents such as Nuclear Polyhedrosis Virus, *Bacillus thuringiensis* var. *kurstaki, Verticillium lecanii, Beauvaria bassiana* and *Metarhizium anisoplae*, Borer guard, Derisom, Anosom, Margosom to manage insect pests, and *Trichoderm viride, T. harzianum, Pseudomonas fluorescence, Bacillus subtilis,* Bio-mycin, Bio-fit and Margo NF to manage diseases. Similarly, eco-friendly IPM tools such as pheromone traps used for the management of shoot and fruit borer. Evaluation of bio-fertilizers such as nitrogen fixing bacteria, phosphorus solubilizing bacteria, potash mobilizing bacteria and agri VAM performed better.

Expected outputs: Increase in crop yield and beneficial organisms with minimum or no environmental/health hazards.

Task 1: Technology verification for eggplant (brinjal) IPM package in terai ecological regions of Nepal

Task 2: Technology dissemination of eggplant (brinjal) IPM package in Rupandehi project district

Task 3: Training of eggplant (brinjal) crop IPM package to technical staffs, service providers, interaction with stake holders, farmer to farmer program in each project districts.

Activity 5: Tea crop IPM package Development

Country: Nepal

Status: Continuing

Scientists involved: B. K. Gyawali, S. K. Pradhan

Description: Management of major pests (tea mosquito, red spider mite, red coffee borer, termite and white grubs) and major diseases (blister blight, red rust and canker).

Progress to date: Bio-control agents such as *Verticillium lecanii, Beauvaria bassiana* and *Metarhizium anisoplae*, Borer guard, Derisom, Anosom, Margosom to manage insects, and *Trichoderm viride, T. harzianum, Pseudomonas fluorescence, Bacillus subtilis,* Bio-mycin, Bio-fit and Margo NF to manage different diseases. Evaluation of bio-fertilizers such as nitrogen fixing bacteria, phosphorus solubilizing bacteria, potash mobilizing bacteria and agri VAM performed better.

Expected outputs: Increase in crop yield and beneficial organisms with minimum or no environmental/health hazards.

Task 1: Technology verification for tea crop IPM package in Hill ecological regions of Nepal

Task 2: Technology dissemination of tea crop IPM package in Orothodox tea growing district

Task 3: Training of tea crop IPM package to technical staffs, service providers, interaction with stake holders, farmer to farmer program in each project districts.

Activity 6: Coffee IPM package Development

Country: Nepal

Status: Continuing

Scientists involved: B. K. Gyawali, Kamal Khanal (DCPA)

Description: Management of major pests (coffee white stem borer, red coffee borer, mealybug and scale insects and major diseases (berry blotch, *Cercospora* leaf spot, brown leaf blight and die-back disease).

Progress to date: Bio-control agents such as *Verticillium lecanii, Beauvaria bassiana* and *Metarhizium anisoplae,* Borer guard, Derisom, Anosom, Margosom to manage insects, and *Trichoderm viride, T. harzianum, Pseudomonas fluorescence, Bacillus subtilis,* Bio-mycin, Bio-fit and Margo NF to manage different diseases. Similarly, eco-friendly IPM tools such as Pheromone trap used for the management of coffee white stem borer. Evaluation of bio-fertilizers such as nitrogen fixing bacteria, phosphorus solubilizing bacteria, potash mobilizing bacteria and agri VAM performed better.

Expected outputs: Increase in crop yield and beneficial organisms with minimum or no environmental/health hazards.

Task 1: Technology verification for coffee crop IPM package in coffee growing ecological regions of Nepal

Task 2: Technology dissemination of coffee crop IPM package in coffee growing district

Task 3: Training of coffee crop IPM package to technical staffs, service providers, interaction with stake holders, farmer-to-farmer program in each project districts.

Collaboration with Global Theme Projects:

Impact Assessment

Objective: To assess economic impacts of IPM packages in relation to global themes

Description: Price data collection for each IPM packages including input and output.

Activity: Monitoring and evaluation of IPM package in project districts (Lalitpur, Rupandehi, Palpa and Kaski) improved in awareness creation among stakeholders including leader farmers and neighbor.

Country: Nepal

Status: Continuing

Scientists involved: Dr. Luke A. Colavito, B. K. Gyawali, Ram Bahadur KC, Ram Devi Timila, Gopal Thapa, Arjun Khanal, Shiv Shanker Bhattari

Description: IPM impacts on poverty reduction are improving. Nutrient balance using bio-fertilizers improved food security. It also minimizes health risk and environmental pollution from the use of bio-pesticides on vegetable crops.

Progress to date: Improvements in ongoing IPM activities in project districts is advancing as compared to the past. IPM package comprised of non-chemical approach seems to have wide scope for organic vegetable products in local market and export.

Expected output: Increased in yield and profit from vegetables using eco-friendly IPM package.

Gender

Objective: To identify unique constraints facing women with respect to pest management in order to advance gender equity through research and extension

Description: Women farmers' constrains in adoption of IPM packages.

Activity: Monitoring and evaluation of IPM package in project districts (Lalitpur, Rupandehi, Palpa and Kaski) improved in awareness creation among research scientists and extension specialists.

Country: Nepal

Status: Continuing

Scientists involved: Dr. Luke A. Colavito and B. K. Gyawali, gender specialists from HICAST

Description: Non-chemical PM approach has positive impacts on health since women and children are vulnerable to chemical pesticides. Imbalance use of nutrients using chemical fertilizers on vegetables not only produces deficiency or toxicity to plants but linked to misuse and over use of chemical pesticides by agro-vets as service providers.

Progress to date: Based on the past report and information available from ongoing activities in IPM CRSP project district, the women farmer need to elaborate further.

Expected output: Increased awareness of the gender issue with respect to management helps to identify gender research team for further intensification in vegetable production and marketing.

IPDN

Objective: To establish the network of researchers/diagnosticians in Nepal.

Description: Expert list of diagnosticians prepared and documented in data management spread sheet by Nagendra Subedi.

Activity: Entomologist and plant pathologist surveyed for their capacity. Monitoring and evaluation of IPM packages in project districts (Lalitpur, Rupandehi, Palpa and Kaski) has improved in awareness creation due to diagnostic service.

Country: Nepal

Status: continuing

Scientists involved: IPDN specialist from University/ Research organization, Dr. Luke A. Colavito, B. K. Gyawali

Description: Non-chemical IPM package has positive impacts on plant and human health. Balance use of nutrients specially bio-fertilizers and bio-pesticides have shown not only positive impacts on vegetable crop but also helped to minimize the deficiency or toxicity to the selected vegetable crops ultimately affected misuse and overuse of chemical pesticide by the farmers.

Progress to date: Diagnostic services are available at Regional Plant Protection Laboratory, Hariharbhawan (DOA) to the visiting poor farmers seeking for the diagnostic service.

Expected output: Awareness of the diagnostic service among the farmers in the project district is increasing.

Plant Virus Diseases Network

Objective: To monitor virus disease in vegetables

Description: Samples of thrips and virus infected vegetables will be collected to document the distribution of virus species and their vector from the project districts (Lalitpur, Rupandehi and Kaski).

Activity: Monitoring and evaluation of IPM package in project districts (Lalitpur, Rupandehi and Kaski) has improved in awareness creation among research scientists and extension specialists.

Country: Nepal

Status: Continuing

Scientists involved: Subject matter specialist from University/Research organization (NARC), Dr. Luke A. Colavito, B. K. Gyawali

Description: Early detection of plant virus diseases and timely control of vector needs improvement in awareness creation not only to our technical field staffs but also to disseminate management technique among the participating farmers.

Progress to date: Mapping and monitoring of viruses in vegetables has not progressed as expected as due to lack of trained field staffs on plant virus disease. Nepal IPM CRSP is facing difficulty in IPM package development.

Expected output: Improved plant health by increasing awareness of the plant virus disease management among the participating farmers from the project districts.

Graduate Students and Post Doctoral Research Associates

Mr. Nagendra Subedi, for PhD under Dr. Sally Miller of Ohio State University

Mr. Nava Raj Acharya, M Sc. of VET

Mr. Sulav Paudel, M. Sc. under Dr. Ed Rajotte of Penn State University

Short- Term Training Planned

Workshops: 1

Seminars: 1

Field days: 9

Mass media events: 2

Annual meetings: 1

Program advisory body meetings: 3

Experience sharing meetings: 3

Review meetings: 1

Program planning workshop: 1

Monitoring and evaluation: 9

Central level field monitoring and visit: 1

Publications Planned

Research articles: 2

Books and book chapters: 1

Extension articles: 1

Posters: 2

Bulletins: 2

India

The IPM CRSP project in India involves three partner institutions. Our main partner is Tamil Nadu Agricultural in southern India (Coimbatore), most of the research and IPM package development is done there, but we also partner with an NGO, TERI, based in Delhi. TERI manages research and demonstration projects in northern India. A third partner is the company, BioControl Research Laboratories (BCRL) based in Bangalore. BCRL manufactures biopesticides, pheromones, soil amendments, parasitoids and other inputs required by IPM packages. BCRL also provides education and technical assistance to farmers to ensure that the BCRL products are used properly.

India – TNAU, Coimbatore

Institution Administrative Coordinators	Directors (CPMB) and Director (CPPS)
Names: PI(s)	S.Mohankumar and G. Karthikeyan
Co PIs	G.Chandrasekar, P.Karuppuchami, L.Pugalendhi, C.Durairaj, S. Ramakrishnan, G.Gajendran and D. Dinakaran, S. Thiruvudainambi
Objective 1	**Development and validation of IPM modules for major vegetables in Tamil Nadu**
Activity 1	**IPM in Gourds**
Country(ies)	India
Status: New or continuing	Continuing
Scientists involved	G. Karthikeyan, C.Durairaj, S. Ramakrishnan, S.Mohankumar
Description	The following IPM components as a package will be evaluated in farmers field: Selection of good and virus disease-free seed for planting Seed treatment with *Trichoderma viride* @ 4g/kg of seeds or Seed treatment with *Pseudomonas*

	fluorescens @ 10g/kg of seeds Removal of alternate hosts in close vicinity of field Application of neem cake @ 250kg/ha Soil application of *Pseudomonas fluorescens* @ 2.5kg/ha Roguing out of virus infected plants Set up fruit fly pheromone traps Install yellow sticky traps Spraying neem formulations / Neem seed kernel extract Need based application of eco-friendly nematicide / insecticides/fungicide
Progress to date	Field trials will be laid out
Expected outputs	Validation of cost-effective IPM package, awareness for adoption of different components and reduction of pesticide usage is expected
Task 1	Conducting IPM trial at different locations/seasons
Task 2	Organizing field days
Budget:	Included in budget work sheet
Activity 2	**IPM in cabbage and cauliflower**
Country(ies)	India
Status: New or continuing	Continuing
Scientists involved	C.Durairaj, G. Karthikeyan, , S. Ramakrishnan, S.Mohankumar

Description	The following IPM components as a package will be evaluated in farmers field for cabbage and cauliflower Seed / nursery treatment with *P. fluorescens* @ 10 g/ kg of seed / lit of water Seedling root dip with *P. fluorescens* @ 10 g/ lit of water Soil application of neemcake @ 250 kg /ha Soil application of *Pseudomonas* @ 2.5 kg /ha in main field Mustard inter crop to attract *Plutella* Use of yellow sticky traps against aphids *Plutella* adult monitoring with pheromone traps Application of neem products (azadirachtin based formulations/ NSKE) Need-based application of eco-friendly insecticides/fungicide/acaricide
Progress to date	Field trials will be laid out
Expected outputs	Validation of cost-effective IPM package, awareness for adoption of different components and reduction of pesticide usage is expected
Task 1	Conducting IPM trial at different locations/seasons
Task 2	Organizing field days

Budget:	Included in budget work sheet
Activity 3	**IPM in Chilies**
Country(ies)	India
Status: New or continuing	Continuing
Scientists involved	G.Gajendran and D.Dinakaran, S. Ramakrishnan, G. Karthikeyan S.Mohankumar
Description	Chilies Seed treatment with *Trichoderma viride* @ 5g/kg of seeds and *Pseudomonas fluorescens* @ 10g/kg of seeds Nursery application with *Trichoderma viride* and *Pseudomonas fluorescens* after multiplication with FYM / Seedling root dip with *Pseudomonas fluorescens* and *Trichoderma viride* at planting Application of neem cake @ 250kg/ha Soil application of *Pseudomonas fluorescens* @1.25 kg/ha and *Trichoderma viride* @1.25 kg/ha Selection of good and virus disease free seedlings for planting Growing castor as border trap crop Grow marigold as a trap crop in irrigation channels Roguing out of virus-infected plants upto 45 days of transplanting Set up *Helicoverpa* / *Spodoptera* pheromone traps @ 12 numbers / ha Release *Trichogramma chilonis* @ 50,000/ha

	Install yellow sticky traps Spraying neem formulations / neem seed kernel extract Need based application of eco-friendly nematicide / insecticides/fungicides
Progress to date	Module involving bio-products were validated in two seasons
Expected outputs	Validation of cost-effective IPM package, awareness for adoption of different components and reduction of pesticide usage is expected
Task 1	Conducting IPM trial at different locations/seasons
Task 2	Organizing field days
Budget:	Included in budget work sheet
Activity 4	**Breeding for pest resistance**
Country(ies)	India
Status: New or continuing	New
Scientists involved	L. Pugalendhi, C.Durairaj, G. Karthikeyan, , S. Ramakrishnan, S.Mohankumar
Description	The progenies of crosses made will be evaulated for pest resistance
Progress to date	Crosses were made in eggplant, tomato, okra, chilies and onion
Expected outputs	Pest-resistant lines will be identified

Task 1	Evaulating the performance of germplasm (brinjal/okra/tomato/chilies/onion) for pest resistance
Task 2	Crossing and hybridization with desirable parents
Budget:	Included in budget work sheet
Activity 5	**IPM for protected vegetable cultivation (validating IPM module for tomato)**
Country(ies)	India
Status: New or continuing	continuing
Scientists involved	L. Pugalendhi, C.Durairaj, G. Karthikeyan, , S. Ramakrishnan, S.Mohankumar
Description	Studies on IPM module suited to polyhouse vegetable cultivation will be done
Progress to date	Survey of the occurrence of major pests in vegetables cultivated in polyhouses/shadenets is in progress
Expected outputs	IPM module suited to polyhouse will be available
Budget	Included in budget work sheet
Activity 6	**Popularization of different components of IPM**
Country(ies)	India
Status: New or continuing	New
Scientists involved	G. Karthikeyan, G.Gajendran and D.Dinakaran, S. Ramakrishnan, S.Mohankumar ,C.Durairaj

Description	Popularisation of biocontrol agents in IPM - *Pseudomonas, Trichoderma, Trichogramma, Anagyrus* ; soil organic amendments in IPM; Monitoring of insect pests through pheromone trap and yellow sticky traps will be done through large-scale demonstrations
Progress to date	-
Expected outputs	Large-scale adoption of non-chemical eco-friendly IPM components will be popularised
Budget	Included in budget work sheet
Activity 7	**Capacity building on mass production of biocontrol agents - *Pseudomonas, Trichoderma, and Trichogramma* for Bangladesh and Nepal based on need basis**
Country(ies)	India
Status:	New
Scientists involved	G.Chandrasekar, P.Karuppuchami, G. Karthikeyan, G.Gajendran, D.Dinakaran, S.Mohankumar
Description	Scientists from different Asian countries will be trained at TNAU on mass production of biocontrol agents - *Pseudomonas, Trichoderma, Trichogramma*
Progress to date	-
Expected outputs	Scientists from different IPM CRSP host countries will be trained on mass production of biocontrol agents - *Pseudomonas, Trichoderma, Trichogramma*

Budget	**Separate budget to be allotted to Department of Plant pathology and Entomology, CPPS, TNAU, Coimbatore based on the fees charged**
Activity 8	**Organizing training to extension functionaries and farmers**
Country(ies)	India
Status:	Continuing
Scientists involved	G. Karthikeyan, G.Gajendran D.Dinakaran, S.Mohankumar, G.Chandrasekar, P.Karuppuchami,
Description	Training for pest diagnostics and training on IPM technologies will be done for extension functionaries
Progress to date	Farmers and agro input dealers from different regions were trained on pest diagnosis and IPM technologies
Expected outputs	Extension functionaries from different regions will be trained on pest diagnosis and IPM technologies.
Budget	Included in budget work sheet
Activity 9	**Publications**
Country(ies)	India
Status:	-
Scientists involved	G.Chandrasekar, P.Karuppuchami, G. Karthikeyan, G.Gajendran D.Dinakaran, S.Mohankumar , C.Durairaj, S.

	Ramakrishnan
Description	Two research articles on earlier research findings will be published; An IPM book is planned for this year; Posters in different conferences/ seminars/ symposium are planned; Plant protection Bulletins will be prepared for the benefit of farmers
Progress to date	-
Expected outputs	Large-scale adoption of non-chemical eco-friendly IPM components will be popularized
Budget	Included in budget work sheet

Graduate Students and Post-Doctoral Research Associates:	
Name	Will be decided based on discussion with Dr. Ed Rajotte/ Dr. Doug Pfeiffer/ Dr. Sally Miller/Dr. R.A. Naidu/Dr. R. Muniappan
Sex	
Nationality	
Discipline	
Site/Country	
Degree	
Start date	
Completion date	
IPM CRSP funds: 0%, partial or 100%	
Advisor/PI:	

Thesis topic:	
University:	
Short-Term Training planned	
Workshops:	One workshop is planned with all IPM-CRSP scientists and research scholars of TNAU, BCRL and TERI
Seminars:	one farmers seminar on vegetable IPM during two different seasons
Field days:	Four field days for demonstrating IPM technologies in major vegetable crops
Mass media events	Ten different talks through ALL INDIA RADIO about pest management; Two events through national telecasting channel, Doordarshan. Video clippings of pests and IPM will be done
Annual meetings	As suggested by ME, Virginia Tech, the annual meetings will be attended
Others	Field visits for pest diagnosis and providing solutions to farmers will be done based on need
Publications planned:	
Research articles	Articles on earlier research findings will be published
Books and book chapters	Books on IPM in different vegetable crops are planned for this year
Extension articles	Extension articles through dailies/magazines (English/vernacular language) on IPM is planned

Posters	Posters in different conferences/seminars/symposium are planned
Bulletins	Plant protection Bulletins will be prepared for the benefit of farmers
Others	Ten Guest lectures in different organizations on diagnostics and IPM will be delivered

TNAU Personnel

Four senior research fellows and five junior research fellows with M.Sc. &B.Sc. Qualifications will be paid for 12 months working with all aspects of the program.

S.No	NAME	DESIGNATION	Department	Description
Regional Program				
1.	S.P.Deepa	Senior Research Fellow	Nematology	Conducting field trial of vegetables crops and analyzing root nematodes in vegetables; popularization of IPM packages
2.	B.Preetha	Senior Research Fellow	Biotechnology	Screening of resistance variety by using molecular tools/characterization of pests, IPM for vegetable nursery co-ordination of activities between lab and land and Maintenance of the IPM CRSP budget
3.	B.K.Savitha	Senior Research Fellow	Horticulture-Vegetables	Conducting field trial of vegetables crops –weed management studies-developing germplasm of IPM vegetables for pest resistance and Nursery development
4.	M.Packiaraj	Junior Research	Pathology	Observations on diseases, Disease sample collection from

		Fellow		field, Conducting field trial and arranging farmers' exhibition and field days popularization of IPM packages
5.	S.Nirmala Devi	Junior Research Fellow	Agriculture (Entomology)	Conducting pheromone studies, field trial and monitoring of insects through pheromone trap , yellow sticky traps popularization of IPM packages
6.	Josephine Sophia	Junior Research Fellow	Working in Trichy centre	Conducting chilies field trial
Global Theme – Impact Assessment				
1.	To be posted	Senior Research Fellow	Trade	Impact assessment -Data collection and analysis
Global Theme – Gender Issue				
2.	Sivaranjani	Junior Research Fellow	ARM	Gender issue analysis
Global theme- IPDN				
1.	C.G.Balaji	Senior Research Fellow	Pathology	Disease diagnosis; Detection of viruses in leaf samples collected from field trials by using specific markers; preparation of SOP

India – TERI, New Delhi

TERI, The Energy Resource Institute, devotes its resources to sustainable development. TERI maintains research/demonstration sites in Uttar Pradesh, Andra Pradesh and Karnataka as an IPMCRSP collaborator.

Brief description of project: Demonstration of IPM technologies on vegetable crops

Objective: Transfer of IPM technologies for Okra, Eggplant, Tomato and Cucurbits at U.P., A.P. and Karnataka.

Chief Scientist: Dr. Nutan Kaushik

Activity 1: IPM trials on Okra, Tomato, Eggplant, Cucurbits and Cabbage in Meerut, Kolar and Chittoor.

Status: Some trials are ongoing and new trials will be carried out during October 2011-September 2012.

Scientists involved: Dr. Nutan Kaushik, Mr. Vivek Sharma, Field Assistant

Description: Minimum 10 trials each of Okra, Tomato and Eggplant and 5 trials each of Cabbage and Cucurbits will be conducted according to their respective season in all the three states. Thus total minimum 40 trials will conduct.

Progress to date: 34 trials were completed during October 1, 2011 to September 30, 2012.

Expected outputs: Acceptance of IPM Technologies for different vegetable crops and adoption of same in these areas

Task 1: Set up of IPM trials on different vegetable crops in different areas.

Task 2: Seed treatment, trap installation and providing microbial and botanicals biopesticides under IPM trials.

Task 3: Regular data collection on insect-pest and their management

Task 4: Analysis and report writing

Activity 2: Collect data on yield and Impact of farmer's income from these

Status: Some trials are ongoing and new trials will be carried out during October 2011-September 2012.

Scientists involved: Dr. Nutan Kaushik, Mr. Vivek Sharma, Field Assistant

Description: Data on yield of different vegetable crops will be collected under the IPM trials and impact on farmer's income will be measured from these trials.

Progress to date: Data on yield and income of farmer of current trials is being regularly collected on each picking in North as well as Southern trials. The same will be done for the new trials in future.

Expected outputs: Positive impact on the farmer's income expected from the IPM trials

Task 1: Collection of data on the yield of different vegetable crops in different areas

Task 2: Analysis of data and report writing

Activity 3: To assess efficacy of entophytes against viruses

Status: New activity

Scientists involved: Dr. Nutan Kaushik, Ms Rishu Kalra and Mr. Vikram Kumar.

Description: TERI will study viral efficacy of endophytes against viruses.

Progress to date: Active endophytes will be assessed for their bioefficacy.

Expected outputs:

Efficacy of endophytes against viruses will be assessed by TERI scientists.

Identification of virus in the field.

Task 1: Assessment of Efficacy of endophyes against viruses

Task 2: Collection of samples from virus identification

Activity 4: To Conduct Field days, farmer days, media publicity of IPM CRSP Programme

Status: New

Scientists involved: Dr. Nutan Kaushik, Mr. Vivek Sharma, Field staff and invitees will be involved.

Description: 4-5 Field days and Farmer days in each region will be conducted at different time and media publicity in Newspaper and others will be conducted to promote adoption of IPM in different vegetable crops.

Task 1: Field day, Farmer day and Media publicity will be conducted.

Budget: $ 3986.8.

Activity 4: Participation in Conferences and Workshops.

Status: New

Scientists involved:

Description: Active participation will be done by associated scientists in different conferences and workshops.

Task 1: Participation in conferences and workshops

India – Biocontrol Research Laboratories, a division of PCI, Bangalore

BCRL develops and sells inputs that are useful in IPM systems. These inputs include antagonistic fungi and bacteria, entomopathogenic fungi and viruses, botanical pesticides and pheromones. In addition, BCRL maintains a client education program that ensures that its products are used properly. IPMCRSP, in an effort to involve the private sector in the development and dissemination of IPM packages, hopes that private sector firms such as BCRL will carry IPM dissemination beyond the limited scope of IPMCRSP. Through this collaboration we hope to construct a business model that attracts private firms to IPM service.

IPMCRSP contact at BCRL: Malvika Chowdhury

The workplan contribution of BCRL for the coming year includes:

Activity 1: Through large cooperatives which have extensive cultivation area under their command, introduce IPM to those farmers who are

interested ingrowing with best practices. Trainings will transfer IPM knowledge through trainings on diagnostics, monitoring tools and plant protection practices to the scouts of the cooperatives.

Activity 2: Perform an impact assessment for IPM adoption.

Activity 3: Connect the vegetable traders to the retailers who can procure the IPM-produced vegetables at premium price.

Activity 4: Showcase the whole event to other traders to propagate this further.

Activity 5: Hold a field day for farmers as well as agri-dealers to assess the advantages of IPM plots in cooperating farmers' fields. This will also help dealers stock the inputs required for IPM practices in their shop. Availability of inputs is a critical criterion for the adoption, hence this activity will help the promotion.

Ecologically-based Participatory IPM for Southeast Asia

Clemson University

Regional objectives

Objective 1: to develop IPM knowledge with smallholder farmers producing vegetables and selected other high-value crops in Southeast Asia.

Activity 1: Provide technical backstopping to collaborating institutions in Cambodia, Indonesia, and the Philippines Responsible individuals: M. Hammig, M. Shepard, G. Carner, G. Schnabel, E. Benson.

- Task 1: Clemson scientists maintain contact with collaborators in each country and assist with design and implementation of field studies, including assisting with finding access to biocontrol agents that may be useful in IPM tactics.
- Task 2: Clemson scientists maintain contact with other international scientists developing IPM systems for target crops.

Objective 2: to improve IPM communication and education leading to widespread adaptation, adoption, and impact of IPM approaches in Southeast Asia.

Activity 1: Conduct economic impact surveys. Responsible individuals: M. Hammig, R. Rejesus (NCSU) and C. Yorobe (UPLB)

- Task 1: Continue data collection in the Philippines with samples from trained and untrained farmers to improve understanding of project success and to guide future activities.

Activity 2: Conduct gender impact surveys. Responsible individuals: A. Sri Lestari (Indonesia), H. Dayo (Philippines), Mam, S. (Cambodia)

- Task 1: Provide forum for gender specialists from each country to meet and plan coordinated research.
- Task 2: Implement coordinated survey activities in each country.

Objective 3: to enhance the capacity of host country institutions to support research and extension of IPM systems.

Activity 1: Provide training for host country scientists on identification and management of plant diseases. Responsible individuals: G. Carner, G. Schnabel.

- Task 1: A workshop in conjunction with the regional planning workshop will focus on plant disease management.

Activity 2: Provide training for host country scientists on plant pest diagnostics. Responsible individuals: G. Carner, G. Schnabel.

- Task 1: The plant disease management workshop will include diagnostics for diseases and insect vectors.

Activity 3: Conduct regional workshops in SE Asia for collaborators. Responsible individuals: M. Hammig, M. Shepard, G. Carner, G. Schnabel, E. Benson.

- Task 1: Conduct the regional workshop in Cambodia, planned for FY12, in October where collaborators will share experiences to learn from one another and invited international scientists.
- Task 2: Conduct another regional planning workshop in Indonesia in July 2013 to review progress and plan for activities in FY 2014.

Objective 4: to enhance the capability of smallholder farmers to produce and market high quality products for local, national, and international markets.

Activity 1: Work with collaborators in each host country to develop effective IPM systems for production of vegetables and high-value crops. Responsible individuals: M. Hammig, M. Shepard, G. Carner, G. Schnabel, E. Benson.

- Task 1: Clemson scientists will travel to each host country to provide input into research and training efforts of each collaborating institution. Field research activities will be implemented by collaborators. Marketing activities will be documented as part of each collaborator's reporting.

Philippines: University of the Philippines, Los Baños

Objective 1: Develop IPM knowledge with smallholder farmers producing vegetables and selected other high-value crops in Southeast Asia.

Activity 1: Evaluate biological control agents and cultural techniques for control of eggplant fruit and shoot borer [EFSB] and leafhoppers on eggplant. Responsible individuals: A. Adalla, N. Opina

- Task 1: Evaluate releases of Trichogramma for control of EFSB.
- Task 2: Evaluate removal of infested shoots for control of EFSB.
- Task 3: Evaluate botanical extracts for control of leafhoppers.

Activity 2: Evaluate trapping, sanitation and botanical extracts for control of fruit flies and whiteflies on bitter gourd. Responsible individual. A. Adalla.

- Task 1: Evaluate use of traps and removal of infested fruit to reduce populations of fruit flies.
- Task 2: Based on positive results from 2012, evaluate extracts of hot pepper and ginger for control of whiteflies.

Activity 3: Develop management strategies for bacterial wilt and other soil-borne diseases of eggplant, tomato, bitter gourd, and hot pepper. Responsible individual: N. Opina.

- Task 1: Conduct field tests with eggplant based on results of 2012 greenhouse and microplot tests. Pseudomonas will be evaluated specifically for control of bacterial wilt since it was the only effective treatment against this pathogen. Seedling treatment with VAM will also be evaluated because of positive results in microplot tests.
- Task 2: Conduct field tests with tomato to evaluate Pseudomonas for control of bacterial wilt and VAM and Trichoderma for control of other soil-borne diseases.
- Task 3: Conduct microplot tests with bitter gourd and hot pepper to evaluate Pseudomonas, VAM, Trichoderma, and plant extracts for control of soil-borne diseases.

Activity 3: Evaluation of mulching for weed control and conservation of natural enemies in bitter gourd and hot pepper. Responsible individual: A. Adalla

- Task 1: Monitor weed and natural enemy populations in field plots with and without straw mulch.

Objective 2: Develop approaches to improve methods and demonstration and widespread adoption of IPM and adapt these to the needs of local farmers

Activity 1: Responsible individual: A. Adalla. The Philippine Department of Agriculture model "Gawad Kalinga" (GK) is a new program for the very poor. There are 30 family units living in newly-built adjacent housing and they grow their own vegetables in plots that are given to them. The Philippine Government will replicate this model several hundred times in many areas of the country. The UPLB team will conduct the following activities to develop IPM guidelines for GK gardens:

- Task 1: Conduct training for selected individuals who will serve as IPM decision makers and who will then monitor insects, weeds and plant diseases for individual GK units.
- Task 2: Compare the use of Trichogramma and release of earwigs (Labidura riparia) in GK plots of eggplant and bitter gourd to demonstrate the efficacy of these tactics against insects.
- Task 3: Carry out trials using Trichoderma (UPLB strain) from Dr. Che Ceuvas' lab to demonstrate its efficacy against diseases in eggplant and bitter gourd.
- Task 4: Conduct training on grafting in eggplant and identify individuals who will be selected to do grafting for each GK unit.
- Task 5: Conduct training on the preparation of botanical pesticides.
- Task 6: Test botanical derived materials in small plots of eggplant and bitter gourd to assess their efficacy.

Objective 3: Enhance the capability of smallholder farmers to produce and market high quality vegetables for local, national, and international markets

Activity 1: Develop training materials (posters, brochures, leaflets) and conduct field demonstrations of promising IPM technologies in partnership with the Department of Agriculture, NGOs, universities and farmers. Responsible individual: A. Adalla.Responsible individual: A. Adalla. Location: Sariaya, Quezon (5 villages) and Region IV (Laguna area)

- Task 1: Implement IPM technology transfer to farmers and extension workers using field demonstrations in 5 villages in Sariaya, Quezon.
- Task 2: Implement IPM technology transfer to staff at state colleges and universities (SCUs) in Region IV (Laguna area)
- Task 3: Field demo plots at UPLB Central Experiment Station for observation by SCUs in Region IV (Laguna area)
- Task 4: One-day seminar workshop on IPM strategies at UPLB for SCUs

Philippines: Philippine Rice Research Institute (PhilRice)

Objective 1: Develop IPM knowledge with smallholder farmers producing vegetables and selected other high-value crops in Southeast Asia.

Activity 1: Promotion of IPM tactics for the management of insect pests of rice-based vegetables

Responsible individuals: H. Rapusas, G. Arida.

Crops: onion, garlic, eggplant, tomato, pepper, okra, bitter gourd, melon, etc

Location: Nueva Ecija, Pangasinan, Ilocos Sur, Ilocos Norte

IPM tactics:

a. Use of yellow board sticky traps for leafminers

b. Use of blue board sticky traps for thrips

c. Use of NPV for cutworms and armyworms

d. Use of *Paecilomyces* spp. for whiteflies

e. Use of Metarhizium and Beauveria species for whiteflies and other pests

f. Weekly removal of damaged shoots and fruits of eggplant for the management of the eggplant shoot and fruit borer (EFSB)

g. Use of resistant varieties of eggplant for EFSB management

h. Field sanitation

Activity 2: Promotion and utilization of IPM tactics for soil-borne diseases

Responsible individuals: H. Rapusas, G. Arida.

Crops: onion, garlic, eggplant, tomato, pepper, okra, bitter gourd, melon, etc

Location: Nueva Ecija, Pangasinan, Ilocos Sur, Ilocos Norte

IPM Tactics:

a. Use of vesicular arbuscular mychorrhiza (VAM) at seed sowing and transplanting of seedlings

b. Use of Trichoderma sp. (IPM CRSP isolate)

c. Use of Bacillus spp. and other indigenous soil-microorganisms

d. Field sanitation

Activity 3: Use of rice straw and stale seedbed techniques to reduce weeds and provide refuge for predators

Responsible individuals: H. Rapusas, G. Arida.

Crop: onion

Location: Guimba, Nueva Ecija

IPM Tactics: Rice straw mulch

Activity 4: Use of sex pheromones and NPV for the management of cutworm, Spodoptera litura in onion

Responsible individuals: H. Rapusas, G. Arida.

Crop: Onion

Location: Guimba and Talavera in Nueva Ecija

IPM Tactics: Sex pheromones and NPV

Objective 2: Improve IPM communication and education leading to widespread adaptation, adoption, and impact of IPM approaches in Southeast Asia

Objective 3: Enhance the capability of smallholder farmers to produce and market high quality products for local, national, and international markets.

Activity 1: Dissemination of Pest Management Technologies in Rice - Vegetable Cropping Systems

Responsible individuals: H. Rapusas, G. Arida.

a. Development of information and extension campaign materials
b. Short trainings, technical briefings, establishment of PTDs
c. Season-long farmers field schools (FFS)
d. Media publicity
e. Farmers educational tours
f. Farmers field days

Activity 2: Village-level production, integration and utilization and adoption of tactics involving microbial agents such as VAM, SeNPV, SlNPV,

***Trichoderma* sp. and fungal pathogens for whiteflies and thrips in rice - vegetable cropping systems.**

Responsible individuals: H. Rapusas, G. Arida.

a. Survey, isolation and culture of fungal pathogens of whiteflies and thrips.
b. Village level farmers training on mass production of microbial materials
c. Village production of BCAs
d. Village-level campaign for utilization and implementation
e. Production and distribution of campaign/extension materials for the biological control agents

Activity 3: Development of a Vegetable Diseases Diagnostic Kit for Farmers.

Responsible individuals: H. Rapusas, G. Arida.

a. The vegetable disease diagnostic kit VDDK is already in its final draft.
b. Pre-testing of the kit – evaluation by farmers
c. Modification of the kit based on the farmers' evaluation and finalization of the kit.
d. Mass production of the disease diagnostic kit.

Indonesia: Bogor Agricultural University (IPB)

Objective 1: Develop IPM knowledge with smallholder farmers producing vegetables and selected other high-value crops in Southeast Asia.

Objective 2: Improve IPM communication and education leading to widespread adaptation, adoption, and impact of IPM approaches in Southeast Asia.

Activity 1: Developing and Testing IPM Systems for Crucifers

Responsible individuals: Pudjianto, Dedih Ruhyatna

Task: *Trichoderma harzianum* mixed with bokashi and dipping of seedling in Bacillus subtilis and Pseudomonas fluorescence will be tested against club root on broccoli, while hand-picking and botanical insecticide (*Tephrosia vogelii*) will be used to control lepidopteran pests, and plastic mulch to maintain soil moisture and to prevent weed infestation.

Activity 2: Developing and Testing IPM Systems for Green Onion

Responsible individuals: Yayi Kusumah, Dedih Ruhyatna

Task: Field trials on green onion will test an IPM tactics consisting of hand-picking to control Spodoptera exigua, application of botanical insecticide to control black aphid Neotoxoptera formosana, use of sticky yellow traps to control leafminer infestations, and use of bokashi, Trichoderma harzianum, Bacillus subtilis, and Pseudomonas flourescens to induce plant resistance to diseases, and plastic mulch will be used to maintain soil moisture and to prevent weed infestation.

Activity 3: Development and Testing IPM Systems for Tomato

Responsible individuals: Giyanto, Supramana,Dedih Ruhyatna

Task: Field trials on tomato will test an IPM tactics consisting of use of Bt-insecticide to control Helicoverpa armigera, need-based application of fungicides to control leafblight, use of sticky yellow traps to control leafminer infestations, use of bokashi, Trichoderma, Bacillus subtilis, and Pseudomonas flourescens to induce plant resistance to diseases, and use of plastic mulch to maintain soil moisture and to prevent weed infestation.

Activity 4: Ecology and management of insect vectors (whiteflies, thrips, aphids)

Responsible individuals: Nina Maryana, Ruly Anwar, Sugeng Santoso

Task: Population dynamics of Bemisia tabaci, Trialeurodes vaporariorum, Thrip spp, and aphids will be monitored weekly on respective host plants. Natural enemies which include predators, parasitoids, and entomopathogens observed in the field will be collected and identified.

Activity 5: Farmer Level Production of Biotic Agents

Responsible individuals: Meity Sinaga, Giyanto, Aunu Rauf

Task: Four "Pos Pelayanan Agens Hayati (Posyanti)" / Biotic Agents Service Posts have been established during the project. We will improve the capability and quality control of the posts in mass-production of bokashi, Trichoderma harzianum, Bacillus subtilis, and Pseudomonas fluorescence.

Activity 6: Application of GPS/GIS and Smartphone Technology in IPM

Responsible individuals: Ali Nurmansyah, Lufti Nuriansyah, Aunu Rauf

Task: Use GPS/GIS to map geographic distribution of three most recent invasive pests; develop smartphone apps as a reference guide for pest identification,

information on pest lifecycle, natural enemies, and IPM practices for managing pest problems on vegetable crops.

Objective 3: to enhance the capability of smallholder farmers to produce and market high quality products for local, national, and international markets.

Activity 7: IPM Dissemination

Responsible individuals: Titik Yuliani, Idham Harahap, Aunu Rauf

Task: Establish pesticidal plant garden in collaboration with organic farmer group in Ciputri; produce various VCDs/DVDs relevant to IPM; disseminate IPM technology through community radio Edelweis and IPB's Green-TV; conduct mobile diagnostic plant clinics.

Indonesia: Sam Ratulangi University (UNSRAT)

Objective 1: Develop IPM knowledge with smallholder farmers producing vegetables and selected other high-value crops in Southeast Asia

Activity 1: Control of *Liriomyza sativae* and *Nesidiocoris tenuis* on tomato using *Lantana camara* in Toure, North Sulawesi.

Responsible individual: D. Sembel.

Task: Compare field plots of tomato where a range of concentrations of Lantana camara is applied weekly, to plots of farmer practice and unsprayed plots.

Expected outputs: A useful IPM tactic using botanical control

Activity 2: Biodiversity of IPM vs. non-IPM cabbage and tomato in Tomohon/Langowan, North Sulawesi

Responsible individuals: D. Sembel, K. Lala.

- Task: Quantify the difference in biodiversity in IPM and non-IPM cabbage and tomato fields
- Task: Measure the diversity indexes of important pests and natural enemies on IPM and non-IPM plots.

Expected outputs: A quantified measure of the impact of IPM tactics on biodiversity in vegetable fields

Activity 3: The effect of pesticide applications on the level of parasitism of *Diadegma semiclausum* on *Plutella xylostella* in cabbage in Tomohon and Minahasa, North Sulawesi.

Responsible individual: R. Dien.

Task: Measure the effect of pesticide applications on the effectiveness and level of parasitism on *P. xylostella* in cabbage.

Objective 2: Improve IPM communication and education leading to widespread adaptation, adoption, and impact of IPM approaches in Southeast Asia

Activity 1: Host SE Asia IPM CRSP regional workshop.

Responsible individuals: D. Sembel, J. Tatuh

Task: Organize venue and coordinate planning for the regional workshop.

Activity 2: Host International Agricuture and Biodiversity Symposium

Responsible individuals: D. Sembel, J. Tatuh.

Task: Organize venue and coordinate planning for symposium.

Objective 3: Enhance the capability of smallholder farmers to produce and market high quality products for local, national, and international markets

Activity 1: Determine the potential of rural financial institutions to support the agricultural economy of Rurukan and Kumelembuay, North Sulawesi.

Responsible individuals: J. Tatuh, H. Anapu.

- Task: Quantify the values of production, consumption, and savings/investments in the rural community to determine the feasibility of establishing a rural financial institution to support local agriculture and IPM.
- Task: Assess the impact of village financial institutions on farm families.
- Task: Estimate the probability that farmers will utilize a village financial institution.

Indonesia: FIELD/Indonesia

Objective 1: To develop IPM knowledge with smallholder farmers producing vegetables and selected other high-value crops in Southeast Asia.

Activity 1: Farmer field study to compare the use of netting vs NPV vs farmer practice for control of insect pests and diseases on shallots

Responsible individual: A. Hakim.

Task: Set up and monitor shallot fields using netting to protect plants from insects, compared to spray applications of NPV, and comparing to farmer practice of pesticides.

Location: East Java (collaboration with AVRDC)

Activity 2: Assessment of refuges for shallot pests during fallow period for shallots.

Responsible individual: A. Hakim.

Location: West Sumatra (collaboration with Provincial Agriculture Department and the Horticulture Crop Protection Agency; and integrated with USAID Disaster Risk Reduction & climate Change Adaptation Program)

Activity 3: Field studies to test the effect of VAM and other bioagents for sweet potato and other vegetables.

Responsible individual: E. Kuswara.

Location: North Sumatra

Activity 4: Field studies to test the effect of VAM and other bioagents for vegetables and citrus production.

Responsible individual. Cahyana.

Objective 2: Improve IPM communication and education leading to widespread adaptation, adoption, and impact of IPM approaches in Southeast Asia

Activity 1: Conduct farmer training on propagation and preservation of NPV.

Responsible individual: A. Hakim.

Activity 2: Conduct farmer training on community organizing for large scale implementation of ecological techniques for shallot pest management, including widespread dissemination of results of field studies.

Responsible individual: A. Hakim.

Location: East Java.

Activity 3: Support farmer to farmer training on propagation and utilization of VAM and other bioagents.

Responsible individual: E. Kuswara.

Location: West Sumatra

Activity 4: Conduct farmer training on the results of field studies on VAM and other bioagents.

Responsible individual: E. Kuswara.

Location: West Sumatra

Activity 5: Support farmer to farmer training on propagation and utilization of VAM and other bioagents

Responsible individual: Cahyana.

Location: North Sumatra

Activity 6: Conduct farmer workshop on results from field studies on use of bioagents in vegetables and citrus production.

Responsible individual: Cahyana

Location: North Sumatra

Cambodia: General Directorate of Agriculture Cambodia

Objective 1: To develop IPM knowledge with smallholder farmers producing vegetables and selected other high-value crops in Southeast Asia

Target Provinces: Kandal, Siem Reap, Kampong Cham, Battambang

Target crops: Dry season – Kandal: Cucumber, Tomato, Cauliflower; Kampong Cham: Cucumber, Yardlong Bean, Chinese Kale; Siem Reap: Cauliflower, Yardlong Bean, Tomato; Battambang: Yardlong Bean, Green Mustard. Wet season – Kandal:

French Bean, Chinese Kale, Bitter Gourd; Kampong Cham: Tomato, Green Mustard, Cucumber; Siem Reap: Cucumber, Chinese Kale, Bitter Gourd; Battambang: Cucumber, Chinese Kale.

Activity 1: Implement farmer production of Trichoderma at village level.

Responsible individual: Kean. S.

Task: Train farmer groups in procedures for propagation and use of Trichoderma at four sites each in Kandal and Kampong Cham, and two sites in Siem Reap Province during the dry season and repeat the same activity during the wet season.

Activity 2: Organize and implement field study sites using Trichoderma to control soil-borne diseases on selected crops in each target province.

Responsible individual: Kean. S.

Task: Set up three demonstration sites in each province with farmers from Kandal, Kampong Cham, and Siem Reap Provinces and two demonstrations in Battambang Province during dry season and repeat the same studies in each location during the wet season for a total of 22 participatory field studies.

Activity 3: Test and demonstrate the benefits of grafting tomato to eggplant rootstock at the Kbal Koh vegetable research station.

Responsible individuals: Chou C., Heng, C.H.

Activity 4: Test the efficacy of removing infected tips to control fruit and shoot borer in eggplant.

Responsible individuals: Chou, C., Heng, C.H.

Task: Widely separated fields will be used to compare the production of eggplant where farmers monitor plants and remove infected growing tips of plants showing infestation by EFSB and dispose of removed tips, to fields where usual farmer practice is followed. The studies will be repeated at Kbal Koh during the wet and dry seasons.

Activity 5: Test the viability of continuous planting of cabbage to preserve populations of the parasitoid Cotesia as a means of controlling diamondback moth.

Responsible individuals: Chou, C., Heng, C.H.

Task: Set up an area of continuous planting of cabbage, and other host plants that may be identified, to maintain populations of Cotesia.

Task: Compare production of fields where Cotesia is present to fields where farmers follow usual pesticide-based practices.

Objective 2: To improve IPM communication and education leading to widespread adaptation, adoption, and impact of IPM approaches in Southeast Asia

Activity 1: Conduct field days for farmers and extension workers to disseminate information on the use of IPM tactics for target crops.

Responsible individuals: Chou, C., Heng, C.H., Kean, S.

Task: Conduct two field days, one for wet season crops and the other for dry season crops.

Activity 2: Conduct refresher training for MAFF/GDA IPM trainers/researchers on tactics studied under the IPM CRSP project.

Responsible individuals: Chou, C., Heng, C.H., Kean, S.

Task: Conduct one refresher training workshop.

Development and Delivery of Ecologically-based IPM Packages in Tajikistan

PI: Dr. Karim Maredia, Michigan State University

Dr. Jozef Turok, CGIAR/ICARDA-Project Facilitation Unit, Tashkent, Uzbekistan

Wheat IPM Package:

Dr. Nurali Saidov, IPM CRSP Coordinator, Tajikistan

Dr. Doug Landis, Michigan State University

Dr. Mustapha El Bouhssini, ICARDA

Dr. Megan Kennelly, Kansas State University

Potato IPM Package:

Dr. Murat Aitmatov, IPM CRSP Coordinator, Potato Specialists from

Dr. Nurali Saidov, IPM CRSP Coordinator, Tajikistan

Dr. George Bird, Michigan State University

Dr. Walter Pett, Michigan State University

IPM Communication:

Ms. Joy Landis, Michigan State University

Links with IPM CRSP Global Theme Projects:

Pest Diagnostics: Dr. Sally Miller, Ohio State University

Viruses: Dr. Naidu Rayapati, Washington State University and Dr. Sue Tolin, Virginia Tech University

Gender Issues: Dr. Linda Racioppi, Michigan State University, Dr. Zahra Zamal, University of Chicago, and Dr. Maria Elisa Christie, Virginia Tech University

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

Michigan State University (MSU) in partnership with University of California-Davis, Kansas State University, ICARDA, and several local research and academic institutions and NGOs is implementing a regional IPM program in Central Asia.

The technical objectives of the Tajikistan IPM Program are as follows:

1. Develop ecologically based IPM packages for wheat through collaborative research and access to new technologies.

2. Disseminate IPM packages to farmers and end-users through technology transfer and outreach programs in collaboration with local NGOs and government institutions.

3. Build institutional capacity through education, training and human resource development.

4. Enhance communication, networking and linkages among local institutions in the region and with U.S. institutions, international agricultural research centers, and IPM CRSP regional and global theme programs.

5. Create a IPM Knowledge Network in Tajikistan" encompassing a cadre of trained IPM specialists, trainers, IPM packages, information base, and institutional linkages.

Objective 1: Develop ecologically-based IPM packages for wheat and potato cropping systems through collaborative research and evaluation of new technologies and approaches

Activity 1: Establish IPM Applied Research and Demonstration Sites for evaluation of IPM packages for wheat and potato, in Tajikistan.

Participating scientists/institutions: N. Saidov, IPM CRSP project coordinators in Central Asia, Collaborators from ICARDA, U.S. Collaborators, local scientists from research institutions and universities in host countries.

Description: IPM packages will include regionally appropriate: cultural practices, botanical and biopesticides, biological control agents/products, resistant varieties, pheromone traps, sticky traps, and chemical pesticides based on the best existing and new technologies. The locations for the research and demonstration sites have been selected to represent major wheat growing regions of the country and to address regional pest issues (see details in the following sections).

Expected output: Three IPM Applied Research and Demonstration sites established in Tajikistan for wheat crop; and two sites established for Potato crop.

Task 1: Wheat IPM Research Demonstration Sites in northern Tajikistan, Sogd region

Collaborating scientists: Dr. Anvar Jalilov and Mr. Tavakal Mirzoev from Institute of Plant Production "Ziroatparvar" of Tajik Academy of Agricultural Sciences and students from IPM wheat class from the National University of Tajikistan (biology faculty) and Tajik Agrarian University.

Description: Key Pest Problems: At this site the focus will be on the Sunn pest (Eurygaster integriceps) and diseases include the wheat rusts: yellow rust (Puccinia striiformis) and brown rust (Puccinia recondite). The key weeds in wheat field include; oat grass (Avena fatua), shepherd's purse (Capsella bursa-pastoris), pigweed or lambsquarters (Chenopodium album) and bermuda grass (Cynodon dactylon). Wheat will be planted in October-November 2012 and harvested in June-July 2013.

This demonstration site will test the following IPM package components:

- Resistant Varieties and Biological Control: Plots of 10 by10 m planted to a resistant variety "Ormon" from ICARDA to yellow and brown rusts, 4 reps with two strips of flowering plants including coriander (Coriandrum sativum L.), dill (Anethum graveolens L.), sweet basil (Ocimum basilicum L.), ziziphora (Ziziphora interrupta Juz.) and marigold (Calendula officinalis L.) along side the wheat plots to enhance Sunn pest egg parasitoids.
- Cultural practices (planting date, seed rate, fertilizer application, and weed control) will be as recommended in Tajikistanin the region.
- Hand collection of Sunn pest adults during 2-3 weeks beginning at the time of migration to wheat fields.

This package will be compared to farmer practices in the same area.

Task 2: Wheat IPM Research Demonstration Sites in southern Tajikistan, Hissor district

Collaborating scientists: Dr. Anvar Jalilov and Mr. Tavakal Mirzoev the scientists from Institute of Plant Production "Ziroatparvar" of Tajik Academy of Agricultural Sciences and students involved in IPM wheat class from the National University of Tajikistan (biology faculty) and Tajik Agrarian University.

Description: At this site the focus will be on the cereal leaf beetle (Oulema melanopus) and diseases include the wheat rusts: yellow rust (Puccinia striiformis) and brown rust (Puccinia recondite). The key weeds in wheat field include; oat grass

(Avena fatua), shepherd's purse (Capsella bursa-pastoris), pigweed or lambsquarters (Chenopodium album) and bermuda grass (Cynodon dactylon). Wheat will be planted in October-November 2012 and harvested in June-July 2013.

The IPM package components will be:

- Resistant Varieties and Biological Control: Plots of 10 by10 m planted to a resistant variety ("Ormon" from ICARDA) to yellow and brown rusts, 4 reps with two strips of flowering plants including coriander (Coriandrum sativum L.), dill (Anethum graveolens L.), sweet basil (Ocimum basilicum L.), ziziphora (Ziziphora interrupta Juz.) and marigold (Calendula officinalis L.) along side the wheat plots to enhance cereal leaf beetle parasitoids.
- Cultural practices (planting date, seed rate, fertilizer application, and weed control) will be as recommended in Tajikistan
- Weed management with cultural practices and application of low toxicity herbicides.

This package at these pilot sites will be compared to farmer practices in the same area.

Task 3: Wheat IPM package for eastern Tajikistan in the rainfed area (non-irrigated), Muminabad district

Collaborating scientists: Dr. Anvar Jalilov and Mr. Tavakal Mirzoev the scientists from Institute of Plant Production "Ziroatparvar" of Tajik Academy of Agricultural Sciences and Students involved in IPM wheat class from the National University of Tajikistan (biology faculty) and Tajik Agrarian University.

Description: At this site the focus will be on the cereal leaf beetle (Oulema melanopus), Russian wheat aphid (Diuraphis noxia) and diseases include the wheat rusts: yellow rust (Puccinia striiformis) and brown rust (Puccinia recondite). The key weeds in wheat field include; oat grass (Avena fatua), shepherd's purse (Capsella bursa-pastoris), pigweed or lambsquarters (Chenopodium album) and bermuda grass (Cynodon dactylon). Wheat will be planted in October-November 2012 and harvested in June-July 2013.

The IPM package components will be

- Resistant Varieties and Biological Control: Plots of 10 X10 m planted to a resistant variety to yellow and brown rusts, 4 reps with two strips of flowering plants including coriander (*Coriandrum sativum L.*), dill (*Anethum graveolens L.*), sweet basil (*Ocimum basilicum L.*), ziziphora (*Ziziphora interrupta Juz.*) and marigold (*Calendula officinalis L.*) along side the wheat plots to enhance cereal leaf beetle parasitoids.

- Cultural practices (planting date, seed rate, fertilizer application, and weed control) will be as recommended in the country.
- 3. Weed management with cultural practices and application of low toxic herbicides.

This package at these pilot sites will be compared to farmers' practices in the same area.

Task 4: Wheat seed multiplication initiative program for IPM CRSP Farmers

Description: Based on farmer requests from prior Wheat IPM Package demonstrations we will initiate a program to increase seed availability of the resistant wheat variety "Ormon". Seed increase plots will be established in each three targeted regions (1 ha seed multiplication plot/region) for a total of 3 ha. Harvested wheat seeds will be distributed among of IPM CRSP farmers for future sustainable seed multiplication.

Activity 2: Potato IPM Research Demonstration Sites in Tajikistan

Description: Develop ecologically-based IPM packages for potato cropping systems in Tajikistan through collaborative research and evaluation of new technologies and approaches. Based on result of evaluating the agronomic properties of eight potato cultivars-lines such as (Boulder, Missuakee, Dakota Diamond, Kalkaska, MSP270-1, MSQ176-5, MSL268D, MSM182-1) under low land and mountain production conditions in Tajikistan in 2013 will be evaluate specific pest resistant cultivars-lines under late blight, scab, Colorado potato beetle and potato cyst nematode population densities in excess of their damage thresholds.

Task 1: Potato IPM Package for lowland area of Tajikistan (Khatlon region)

Collaborating scientists: Names of the local scientists and collaborators: Senior researchers Mr. Mahmadzamon Sulangov and Mr. Bahrom Sanginov from Research Institute of Horticulture and vegetable of Tajik Academy of Agricultural Science, local students from the National University of Tajikistan (biology faculty) and Tajik Agrarian University.

Description: The IPM package for this site will focus on the Colorado Potato Beetle (Leptinotarsa decemilineata) and diseases such as late blight of potato (Phytophthora infestans) and PVM, PVS,PV X, and PVY. Potato root-knot nematodes (Meloidogyne chitwoodi and M. fallax). The key weeds in potato at this site include: weeds such as swine's-bane (*Chenopodium rubrum* L.) and houndsberry (*Solanum nigrum* L.).

In this research and demonstration sites we will test the following IPM package components:

- Three potato varieties for resistance to diseases and particularly resistance to late blight of potato (Phytophthora infestans); evaluate different potato varieties for resistance to insect pest and nematodes; Evaluate new potato varieties for adaptation to Khatlon region condition.
- Biological control of potato spring inoculation of potato seeds and of field soil with Biopesticides such as Thrihodermin, Strepmaitis and Bacillus thurengiensis; Application of immune-response modulating agent as "Baikal" type; Application of "*Bacillus subtilis*"; Application of "Biolegnin"
- Potato Post-Harvest Storage: Identified local traditional knowledge's on potato post-harvest storage; Application of biological control; Application of botanical pesticides.

Planting and harvesting time for potato at this site: The trials consist of two parts: The first experiments is storage of potato seeds in October 2012 within testing of Biopesticides such as Thrihodermin, Strepmaitis and Bacilus against of potato disease Bacterial ring rot and Black scurf of potat; And second experiment prior to potato seed sowing in the end of November 2012 and till of potato harvest in the of May 2013.

Task 2: Potato IPM Package for mountain area of Tajikistan (Jirgatol district)

Collaborating scientists: Senior researchers Mr. Mahmadzamon Sulangov and Mr. Bahrom Sanginov from Research Institute of Horticulture and vegetable of Tajik Academy of Agricultural Science, local students from the National University of Tajikistan (biology faculty) and Tajik Agrarian University.

Description: The IPM package for this site will focus on the Colorado Potato Beetle (Leptinotarsa decemilineata) and diseases such as late blight of potato (Phytophthora infestans) and Potato leafroll viruses PVM,PVS,PV X, and PVY. Potato cyst nematodes (Globodera rostochienses and G. pallida) and root-knot nematodes (Meloidogyne chitwoodi and M. fallax). The key weeds in potato at this site include: swine's-bane (Chenopodium rubrum L.) and houndsberry (Solanum nigrum L.).

In this research and demonstration sites we will test the following IPM package components:

- To test three potato varieties for resistance to diseases and particularly resistance to late blight of potato (Phytophthora infestans); evaluate different

potato varieties for resistance to insect pest and nematodes; Evaluate new potato varieties for adaptation to Khatlon region condition.

- Biological control of potato spring inoculation of potato seeds and of field soil with Biopesticides such as Thrihodermin, Strepmaitis and Bacilus thurengiensis; Application of immune-response modulating agent as "Baikal" type; Application of "Bacillus subtilis"; Application of "Biolegnin"
- Potato Post-Harvest Storage: Identified local traditional knowledge's on potato post-harvest storage; Application of biological control; Application of botanical pesticides.

Planting and harvesting time for potato at this site: The trials consist two parts: The first experiments is storage of potato seeds in October 2012 within testing of Biopesticides such as Thrihodermin, Strepmaitis and Bacilus against of potato disease Bacterial ring rot and Black scurf of potat; And second experiment prior to potato seed sowing in the end of May 2013 and till of potato harvest in the of September 2013.

Objective 2: Disseminate IPM packages to farmers and end-users through technology transfer and outreach in collaboration with local NGOs and government institutions

Activity 1: Establish Farmers Field Schools (FFS) at IPM Demonstration sites in Tajikistan to transfer knowledge and demonstrate existing and new IPM technologies to local farmers

Collaborating scientists: N. Saidov, in collaboration with local agriculture Ministry, local NGOs, universities, ICARDA regional program, and U.S. Collaborators.

Description: As outlines in the Objective 1, the sites have been selected in Tajikistan and plans are being developed for the next planting season. One FFS of 25-30 farmers each will be established at each site. These farmers will meet regularly to learn about how to produce a good wheat crop (for example, at pre-season to discuss variety selection, planting rate, etc. at planting to view planting methods, and 2-3 times per season to view various insects, diseases, weeds, and beneficial flowering plants). They will also learn about the biology of pests, diseases and weeds, and the damage they cause, the economic threshold, natural enemies, and cultural practices, and safe use of pesticides.

Expected output: Farmers Field Schools established at IPM Demonstration sites for wheat, in each of the demo plot sites, and information shared with local farmers and NGOs (20 -30 farmers per FFS).

Objective 3: Build institutional capacity through training and human resource development

Activity 1: Graduate Student Training in IPM in Wheat

Description: Ms. Shahlo Safarzoda from Tajikistan is currently a PhD student in the Department of Entomology at Michigan State University. Ms. Safarzoda has successfully completed her first year of graduate classes (2011-12) and is nearing the end of her first season of field research. Her research focuses on the: Influence of natural enemies on aphids and virus spread in wheat.

There is increasing interest in understanding the non-consumptive impacts of natural enemies on their prey. In aphids, non-consumptive responses to natural enemies include dropping behaviors and increased activity that can reduce prey life span, fecundity, and damage to the host. In contrast, for aphids that vector plant viruses, increasing vector movement may increase spread to other plants. She is using the bird cherry oat aphid (Rhopalosiphum padi), and Barley yellow dwarf virus (BYDV) system to explore the role of natural enemies in impacting population growth and virus spread in wheat under field and laboratory conditions. Research in 2012-13 will focus on the following questions.

1. What natural enemies are important in consuming the bird cherry oat aphid under Michigan conditions?
2. Are natural enemy communities effective in suppressing aphid populations in the field?
3. Do natural enemies influence virus transmission under laboratory conditions?

Activity 2: Pest Diagnostics and Viruses

Collaborating scientists: N. SaidovSally Miller-OSU, N. Rayapati-WSU, Sue Tolin-Virginia Tech.

Description: In collaboration with IPDN and IPVDN, Dr. Naidu Ryapati will conduct a one week survey for viruses in wheat, potatoes and tomatoes in Tajikistan. This will be carried out in collaboration with host country institutions. Symptomatic samples from potatoes and tomatoes will be tested using virus-specific immunostrips and ELISA kits, and select number of samples will be spotted on FTA cards and nitrocellulose membranes. The FTA cards and nitrocellulose membranes will be brought to Washington State University and processed for accurate identification of viruses by cloning and sequence analyses. During these visits, Dr. Rayapati will give

lectures on virus diseases and their management at local research institutions and universities in Tajikistan.

In addition, Dr. Naidu will host one scientist from Tajikistan for providing hand-on training in virus diagnosis and management for two to four weeks period at his research station at Washington State University.

Expected output: Enhance viruses and pest diagnosis skills of local scientists and NGOs, and efficient diagnosis of viruses in potato.

Objective 4: Enhance communication, networking and linkages with U.S. institutions, international agricultural research centers, and IPM CRSP regional and global theme programs to access IPM technologies, information and expertise

Activity 1: Participation in International Meetings and workshops:

Collaborating scientists: N. Saidov, Tajikistan, S.Safarzoda, MSU, K.Maredia, MSU

Description: Facilitate participation of IPM CRSP coordinators and local scientists from host countries to interact with IPM CRSP Regional Programs and other international meetings and workshops. In addition, facilitate participation of project PI or Co-PIs in ICARDA-PFU Annual meeting and other international meetings related to IPM to share research results and experiences of Tajikistan IPM CRSP project.

Expected output: Enhanced linkages and collaborations with IPM CRSP regional programs, and other international programs.

Objective 5: Create a "Tajikistan IPM Knowledge Network" encompassing a cadre of trained IPM specialists, students, IPM packages, information base, and institutional linkages.

Activity 1: Update, expand and enhance the website of the Tajikistan IPM program in collaboration with project team members

Participating scientistes/institutions: J. Landis, MSU.

Description: Use social networking and other means to publicize on-going activities of the project. The website address is: http://www.ipm.msu.edu/central-asia.htm

Expected output: Enhanced communication with stakeholders, expanded access to resources and knowledge developed in other activities, greater publicity for IPM CRSP project impacts.

Activity 2: Develop communication pieces about the Project's work and activities.

Participating scientists/institutions: J. Landis, MSU, and U.S. and Central Asia collaborators.

Description: Develop flyers about components of the project such as gender issues, success stories, or other communication resources. Contact media, university sources and IPM CRSP web editors with information about graduate student Shahlo Safarzoda's study and research in wheat and the capacity building this creates for Tajikistan, a Feed the Future country.

Expected output: Enhanced communication with stakeholders, increased awareness of the Project's impact

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

PI: Wondi Mersie (USA)

Co PIs: Jenipher Bisikwa (Makerere University -Uganda), Krissie Clarke (PAMS Foundation - Tanzania), Emily Wabuyele (East African Herbarium - Kenya), KassahunZewdie (Ethiopian Institute of Agricultural Research (EIAR), Yeshi Chiche (EIAR), Sintu Alemayehu (EIAR), LisaneworkNigatu (Haramaya University (HU) - Ethiopia), Ibrahim Fitawe (Mekelle University (MU) – Ethiopia), Steve Adkins (University of Queensland - Australia), Lorraine Strathie (Agricultural Research Council – Plant Protection Research Institute (ARC-PPRI) South Africa), Andrew McConnachie (ARC-PPRI - South Africa)

Brief description of the project:

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. In Eastern Africa, parthenium reduces the yield of many major crops such as sorghum, corn, competes with preferred pasture species and, when consumed by domestic animals, taints their milk and meat, reducing their value. It also

causes human health problems such as severe contact dermatitis and respiratory problems. In addition, because of its ability to release toxic chemicals, parthenium replaces natural vegetation and is thus a threat to one of the world's richest region of biodi¬versity, Eastern Africa. Despite its aggressiveness, parthenium is successfully managed in Australia and India using biological agents such as insects, pathogens and competitive smother plant species. 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.

Objective 1: To collect accurate information on the distribution and spread of parthenium in Kenya, Tanzania and Uganda with follow-up surveys in Ethiopia

Description: Surveys of parthenium was conducted in Kenya, Tanzania and Uganda, annually at least for two consecutive years.

Activity 1: Develop a manuscript

Country(ies): Kenya, Tanzania and Uganda.

Scientists involved: Jenipher Bisikwa (Makerere University - Uganda), Krissie Clarke (PAMS Foundation - Tanzania), Emily Wabuyele (East African Herbarium - Kenya).

Status: Manuscript is under review.

Progress to date: Parthenium survey has been undertaken in Kenya, Tanzania and Uganda.

Expected outputs: Information on the distribution of parthenium in participating countries becomes available.

Objective 2: Evaluate and demonstrate best management practices for the control of parthenium

Description: Parthenium is a major problem in pasture lands in Ethiopia and Uganda. Cultural practices that can suppress the growth of parthenium are needed to improve the productivity of desirable pasture species for livestock.

Activity 1: Evaluate native forage species including Panicum, Cenchrus, Chloris and Cynodon species for their ability to suppress parthenium

Task 1: Compile and interpret data from greenhouse and field trials conducted to evaluate the performance of various grass and legume species against parthenium.

Country(ies) – Ethiopia

Status: Continuing.

Scientists involved: Lisanework Nigatu

Description: Experiments on the effectiveness of various native plants and cultural methods against parthenium will be conducted in Ethiopia. First fodder species (grasses and legumes) will be evaluated for their competitive ability against parthenium in greenhouse trials. The most promising plant species from the above experiments will be further studied in field plots for their ability to suppress parthenium.

Progress to date: Forage species including Panicum, Cenchrus, Chloris and Cynodon species have been planted. Data has been collected during the last several months. Data collected by Haramaya University in Ethiopia will be compiled. Similarly, data collected at Makrere University will be summarized.

Expected outputs: Forage species that can suppress parthenium are identified and planted in large areas for demonstration.

Objective 3: Evaluate parthenium biocontrol agents for their safety to non-target plant species

Description: Evaluation of the biocontrol agents will be conducted under quarantine condition to determine their impact on major crops of the region, as well as on selected indigenous plants closely related to parthenium. The centrifugal phylogenetic method will be followed in selecting test plants for testing candidate control agents. Due attention will be given to indigenous genera and species of the tribe Helianthieae, with utmost attention being given to the endemic and cultivated taxa based on their affinity to Parthenium hysterophorus and having similar distribution and ecological preferences with the weed.

Activity 1: Objective III: Maintain/improve/update quarantine facility

Country(ies): Ethiopia.

Status: Continuing.

Scientists involved: Sintu Alemayehu, Kassahun Zewdie and Million Abebe

Description: Further improvements to the existing facility are needed to enable scientists to quarantine multiple biocontrol agents and evaluate their safety on major crops and selected native plants before applying for permission to release. The facility can be used to evaluate biological agents of other weeds or pests in the future.

Progress to date: Improvements have been made by installing new benches, cages and increasing the area. But these improvements will continue to optimize conditions for bioagents and ensure facility maintains established quarantine standards.

Expected outputs: Increased and improved capacity of the quarantine facility to assess and introduce biological control agents in Ethiopia.

Task 1: Develop specific tasks and hire a contractor to make the improvements

Activity 2: Conduct host range test of the stem-boring weevil Listronotus setosipennis and other bioagents (if permit is secured for other agents) as necessary under quarantine. Hosts include major crops and native plants taxonomically related to parthenium

Country(ies): Ethiopia

Status: completed currently preparing Environmental Assessment (EA) document

Scientists involved: Sintu Alemayehu, Kassahun Zewide and Million Abebe

Description: Evaluation of the host range of listronotus and other bioagents (if permit is secured) will start with no-choice tests (test plant species only), followed by choice tests (with parthenium) for those plant species where there is feeding, oviposition or development on non-target species. All non-target plant species tested will have approximately similar above-ground biomass (leaves, stems) as control plants. Each group of test plants evaluated at one time will include control plants (parthenium). Each plant species tested will be replicated at least three times. Variables measured will include oviposition, feeding, development and survival of bioagent.

Progress to date: The host range test for Listronotus has been completed.

Expected outputs: Information on the safety, establishment and effectiveness of biocontrol agents for parthenium management becomes available.

Task 2: Prepare EA to get clearance for release

Objective 4: To release and evaluate the impact of approved bicontrol agents for the control of parthenium

Description: Once the agents have been proven suitable for release in Ethiopia, based on the quarantine evaluation (objective 3), application permits for their release will be compiled. Data generated in objective 3 and relevant information from Australia, South Africa and other countries on the host range evaluation of parthenium biocontrol agents will be included in the applications. Permit applications to release biocontrol agents will be made first to the Ethiopian government and then to USAID. Once the appropriate permits have been received, the biocontrol agents will be taken out of the quarantine facilities to mass rearing sites. They will then be released to parthenium infested areas.

Activity 1: Apply to USAID for a clearance to mass rear and release the leaf-feeding beetle, *Zygogramma bicolorata*, for the control of parthenium.

Country(ies): Ethiopia.

Status: New.

Scientists involved: Wondi Mersie and Million Abebe.

Description: Clearance from USAID is needed before Zygogramma is reared and released in fields to control parthenium.

Progress to date: Application for clearance has been submitted to USAID.

Expected outputs: Permission to release Zygogramma in Ethiopia is granted by USAID.

Task 1: Organize a series of workshops to seek participation stakeholders in the rearing and in the release Zygogramma.

Activity 2: Establish rearing sites and train personnel on culturing biocontrol agents, collection of baseline and impact data

Country(ies): Ethiopia

Status: New

Scientists involved: Sintu Alemayehu, Kassahun Zewide, Million Abebe, Lisanework Nigatu and Wondi Mersie

Description: Establishment and training of personnel in rearing and evaluating the performance of bioagents will begin immediately after the receipt of release permit from USAID

Progress to date: Three potential sites for the rearing of bioagents have been identified.

Expected outputs: Biocontrol agents are reared in mass and released in at least in one of the sites – Willinchiti.

Task 1: Establish parthenium and begin to rear Zygogramma.

Graduate Students and Post Doctoral Research Associates:

Under recruitment: 2

Short-Term Training planned

Annual meeting: 1

Workshops: 3

Publications planned:

Research articles: 2

Posters: 2

Others: Continue to reprint and distribute parthenium ID and posters on the impact of parthenium on human health.

Performance Indicators for Monitoring and Evaluation:

ID	Description	Completion Date	Responsible Individual
Activity 1 **Obj. 1**	Survey the distribution of parthenium in Kenya, Tanzania and Uganda.	09-30-12	Jenipher Bisikwa, Krissie Clarke, Emily Wabuyele
Task 1	Prepare a manuscript on results of parthenium survey in Kenya, Tanzania and Uganda.	09-30-13	Jenipher Bisikwa, Krissie Clarke, Emily Wabuyele
Activity 1 **Obj. 2**	Evaluate native forage species for their ability to suppress parthenium.	09-30-13	Lisanework Nigatu

			Jenipher Bisikwa
Task 1	Compile and interpret data from greenhouse and field trials.	09-30-13	Lisanework Nigatu Jenipher Bisikwa
Activity 1 **Obj. 3**	Improve/update quarantine facility.	09-30-13	Sintu Alemayehu Kassahun Zewdie
Task 1	Develop specific tasks and hire a contractor start making the improvements.	09-30-13	Sintu Alemayehu Kassahun Zewdie
Activity – 2 **Obj. 3**	Compile data on host range testing of the stem-boring weevil, *Listronotus setosipennis*	09-30-13	Sintu Alemayehu Kassahun Zewdie Million Abebe
Task 2	Prepare an application for a permit to release *Listronotus setosipennis*.	09-30-13	Sintu Alemayehu Kassahun Zewdie Million Abebe
Activity -1 **Obj. 4**	Apply to USAID for a permit to release the leaf-feeding beetle, *Zygogramma bicolorata* against parthenium	11-30-12	Wondi Mersie
Task 1	Hold meeting of stakeholders on the release of Zygogramma	12-31-14	Wondi Mersie Million Abebe
Activity -2 **Obj. 4**	Establish rearing sites and train personnel	09-30-14	Sintu Alemayehu Kassahun Zewdie Million Abebe Wondi Mersie

Task 1	Rear Zygogramma at selected and approved sites	09-30-14	Sintu Alemayehu Kassahun Zewdie Million Abebe Wondi Mersie Lisanework Nigatu

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

PI: Sally Miller

Objective 1: Assess diagnostic capacity.

Activity 1a: Survey professionals involved in plant disease and pest diagnostics for infrastructural and human capacity to perform critical functions.

Scientists involved:

Tasks: Collate data and prepare publication, in collaboration with PVD-GT (see PVD-GT Activity 2:1)

Objective 2: Expand networks and implement digital diagnostics

Activity 2a: Expand the network in the IPDN regions (East and West Africa, LAC and South Asia) to include additional laboratories in participating countries.

Task 1: Train new participants in DDIS-CIMS at workshops (see below).

Task 2: Meet goal of 50 digital samples per region through DDIS in Year 4; 100 digital samples for South Asia.

Task 3: Assess use of DDIS-CIMS in each region, including number of samples entered (CIMS), number of digital samples, number of physical samples, and number of labs using DDIS.

Activity 2b: Expand lists of subject matter experts

Task 1: Expand list of experts at the Year 4 training programs (see below).

Task 2: Contact key individuals (pathogen and pest experts) in each cooperating country and elsewhere. Complete a spreadsheet indicating areas (s) of expertise for those willing to serve and post on the DDIS-CIMS web portal (access limited to IPDN members).

Objective 3: Develop diagnostic assays and protocols

Activity 3a: Prioritize needed diagnostic protocols, assays, etc.

Task 1: Develop, test and train stakeholders on use of membrane-based ELISA for indexing passion fruit plants for new strains of passion fruit viruses. (joint with PVD Global Theme and EA RP – see PVD-GT Task 1:1.5).

Task 2: Develop pictorial guides for diagnosis of target pathogens in priority crops

Task 3: Work with Regional Programs to identify needed diagnostic assays/protocols and begin implementation of protocols if available.

Task 4: Latin America – Continue work focus in *Clavibacter* and *Phytophthora* spp.

Objective 4: Report new diseases and pests and develop incidence maps

Activity 4a: Prioritize pathogens or pests to be surveyed/mapped

Task 1: Continue prioritization in cooperation with host country NPPOs, APHIS and IPM CRSP RPs (and PVD-GT for viruses).

Task 2: South Asia (all tasks in conjunction with SA RP – see SA RP workplan)

- Survey papaya mealy bug, *Paracoccus marginatus* and its parasitoid *acerophagus papayae* on different vegetables and fruits crops especially in the Indo-Bangla border belts;
- Survey virus diseases of vegetable crops in some districts of Bangladesh;
- Survey the occurrence of major pests in vegetables cultivated in polyhouses/shadenets in India;
- Complete analysis of *Ralstonia solanacearum* strains from Bangladesh, Nepal and India (OSU).

Task 3: West Africa

Document disease and insect pest problems as part of production surveys being conducted by the WA RP for potatoes and cabbage (Senegal), and tomatoes (Senegal and Ghana).

Task 4: Latin America

Continue collaborative work with the IPM-CRSP regional project on a survey sampling Guatemalan potato and tomato growing areas. Collected samples including plant and soil material have been analyzed in Agroexpertos lab.

Task 5: Search for additional funds to support surveys.

Activity 4b: Support identification/reports of new diseases and pests

Task 1: Provide supplies and technical advice to support host country researchers in identifying and reporting invasive species. Provide funds for page charges.

Objective 5: Develop Standard Operating Procedures (SOPs)

Activity 5a: Complete SOPs for at least three pathogen or pest targets

Task 1: East Africa

Test and fine-tune standard operating procedures (SOPs) for passion fruit, tomato and/or onion in East Africa (joint with IPM CRSP EA Regional Program – see EA Workplan).

Task 2: West Africa

Develop or adapt two SOPs for priority pests/diseases.

Task 3: South Asia

Publish insect pest and disease identification guides for target vegetable crops.

Task 4: LAC

Complete revisions of SOPs for *Clavibacter* and *Ralstonia*.

Objective 6: Write IPM recommendations (technology transfer and training)

Activity 6a: Access pest management solutions developed for key crops by the six RPs and write recommendations in digital and hard copy formats that will accompany diagnoses.

Task 1: Write one recommendation in the appropriate format per target crop (up to three crops) in each region, with cooperation of RPs.

Task 2: East Africa

Develop diagnostic and management fact sheets and posters on prioritized diseases of tomato, passion fruit and onion in East Africa (joint with IPM CRSP EA Regional Program – see EA RP Workplan).

Objective 7: Train pathologists and entomologists in targeted methodologies for pathogen or pest identification (technology transfer and training)

Activity 7: Conduct hands-on professional diagnostic training programs

Task 1: Organize the training programs, recruit local resource persons, provide supplies, equipment and reference materials, and identify participants. Coordinate with IPVD and Regional Programs for training.

- West Africa – conduct training program in Senegal in conjunction with WA Regional Program and PVD-GT (see PVD-GT Task 2:2.1)
- Central America – conduct a training program on identification and management of bacterial canker in tomato. Contingent on support from USAID Mission/USDA FAS
- East Africa - Train technical staff in diagnostics laboratories to strengthen the diagnostics capacity in Kenya and Tanzania (and participation in the plant doctors' training in Uganda)

Task 2: (OSU and participating US Institutions): Seek outside source(s) of funding to support the training programs.

Objective 8: Train key host country scientists from RPs in classical and modern diagnostics (technology transfer and training)

Activity 8: Select individuals for host countries in each region to attend OSU short course

Task 1 (optional): Explore possibility for International training of Central American lab technicians in the USA (OSU or UF)

Objective 9: Develop and hold web-based training programs (technology transfer and training)

Activity 9: Conduct one hour webinars on prioritized subjects.

Task 1: Identify subjects for 1-2 diagnostics webinars.

Suggested subject matter: Seed borne diseases, seed pathology, *Clavibacter* identification, *Fusarium* races, Phytoplasma diseases, *Liberobacter* epidemiology, vectors, mealybug identification, and identification of sucking pests in vegetables, tomato viruses, and eggplant fruit and shot borer.

Task 2: Conduct at least two webinars on disease or pest diagnostics.

Task 3: Develop a video documenting how to use two different kits to extract DNA from two different hosts.

This video will encourage labs to do DNA extractions, even if they can't utilize PCR; samples can be sent to regional labs for PCR analysis (University of Florida).

Objective 10: Develop and hold Train-the-Trainer programs (technology transfer and training)

Activity 10A: Training farmers and extension staff on diagnosis and management of common diseases of tomato and passion fruit (Latin America –LAC, East Africa and South Asia)

Task 1: Latin America

Organize at least two extension meetings with tomato growers in Salama (North-Eastern-tomato growing area) in Guatemala. Cooperation with Universidad Del Valle, Universidad Rafael Landivar and Univ. San Carlos.

Task 2: East Africa

Train and backstop farmers and extension staff on diagnosis and management of priority diseases of tomato and passion fruit (joint training with E.A. Regional Project).

Task 3: South Asia

Train extension functionaries and farmers on the diagnosis of the main diseases affecting eggplant, okra, tomato, and cucurbits in India. See SA RP workplan.

Short-Term Training planned

	US co-PIs	SA	SEA	CA	LA	EA	WA
Workshops	3				1*	1	1
Seminars/webinars	1	1			1	1	
Field days							
Mass media events							
Annual meetings	3	1	1	1	1	1	1
Train-the-trainers programs		1				1	
OSU Diagnostics Short Course	1						

*If USAID Mission/USDA FAS support is obtained

Publications planned

- Research articles/notes: 4
- Books and book chapters:
- Extension articles: 12
- Posters: 3

- Bulletins:
- Website contributions: 4

International Plant Virus Disease Network

PI: Sue Tolin, Virginia Tech

Brief description of the project:

Plant virus diseases transmitted by insect vectors and through seed or germplasm continue to be one of the major constraints on vegetable production in the tropics. These diseases present numerous challenges for detection and diagnosis, understanding pathogen biology, and management. This relates to the difficulty of identifying specific viruses based on symptomatology, the complexity of virus biology in the field and natural ecosystems, their effective dissemination by vectors (e.g. aphids, thrips and whiteflies) and by seed, and the lack of chemical controls for viral diseases. Activities are new or continuing from years 1-3.

Objective 1: Document the prevalence of the most economically important plant virus diseases and their vectors in the region of interest through surveys, and investigate the associated biology and ecology with a cropping systems perspective.

Description: In all sub-program regions of the PVD global theme, we will use available diagnostic assays and develop new assays to determine the identity of the viruses and virus-vector-crop complexes in high priority cropping systems being studied in regional programs. Host country scientists will be integral to the surveys and where possible, laboratory capacity and expertise will be developed in country. Results will be essential to understand ecological, biological, and economic factors that could be used to abate losses in vegetable agroecosystems to viruses.

Expected Outputs:

- Information packages for viruses of tomato, pepper (including chillies and hot peppers), and other priority crops according to interests of regions and host countries.
- Information packages for aphid, thrips, and whitefly-transmitted viruses for priority crops.
- Information packages for seed and propagule-borne viruses, providing host country scientists and organizations the scientific basis to produce and certify

virus-free potato, sweetpotato, and traditional seed (cucurbits, beans, okra, pepper, tomato) for disease management.

Activity 1.1: For priority crops selected by host countries and regions, compile information on virus diseases known to be prevalent or of potential importance, or documented in surveys conducted by this project or by regional projects.

Task 1.1.1: Survey vegetable production areas in Ghana and Senegal for virus diseases in collaboration with the West Africa Regional Project

Scientists involved: R. L. Gilbertson, T. Melgarejo (UC-D), M. Osei (Ghana), P. Demba Kane, S. Diao (Senegal).

Status: Continuing

Description and Progress to date: This work involves conducting surveys of vegetable production areas in West Africa, collecting samples of plants with virus-like symptoms. The samples are tested for various viruses using PCR and other methods. In addition to tomatoes, two surveys of peppers and other crops (okra) have been conducted in Mali and viruses infecting pepper, okra and other crops identified. One survey has been conducted in Senegal and viruses in tomato and a few cucurbit samples were identified. In okra, at least two begomoviruses and a betasatellite have been shown to cause leaf curl disease, but another virus may be involved in a mosaic-type disease. A complex of insect-transmitted viruses have been found to infect peppers. Management strategies will have to take into account both aphid- and whitefly-transmitted viruses. In cucurbits, aphid-transmitted *Zucchini yellow mosaic virus* (ZYMV) and whitefly-transmitted *Cucurbit yellow stunting disorder virus* (CYSDV) were detected in Senegal. In Ghana, *Cucumber mosaic virus* was found to be an important virus of peppers. Year 4, activities will continue with peppers and cucurbits in Ghana and Senegal and expand to include okra in Ghana,

Task 1.1.2: Survey pepper, tomato, potato, and sweetpotato for virus diseases in Guatemala and Honduras, and identify viruses and virus-like agents, in collaboration with the Latin America and Caribbean Regional Project.

Scientists involved: M. Palmieri (UVG, Guatemala), Mauricio Rivera (FHIA, Honduras), J. Brown (UAZ); S. Tolin (VT), R. L. Gilbertson, T. Melgarejo (UC-D), LAC Region (Guatemala, Honduras)

Status: Continuing.

Description and progress: This work involves continuing to document viruses and virus-like agents infecting crops in the LAC region. In Honduras potyvirus and closterovirus positive samples of sweet potato have been documented. The source of these viruses -- introduced in planting material or by in-field transmission – is possibly endemic. Potato has been confirmed positive for *Ca*. Liberibacter solanacearum infection. Incidence and distribution studies in Honduras and Guatemala were conducted in 2011 and 2012. Monitoring studies of tomato, pepper and potato conducted in three regions of Guatemala in collaboration with LAC have revealed several viruses, depending on crop and location.

Task 1.1.3: Identify the viruses in tree tomato, melon, and watermelon in Ecuador, their importance, biology, and ecology in cropping systems.

Scientists involved: Ecuador- INIAP: J. Ochoa, R. Delgado, M. Insuasti, V. Barrera. CIBE-ESPOL: Peralta, D. Quito. J. Brown, (UAZ); S. Tolin (VT).

Status: New

Description: Melon (Cucumis melo) and watermelon (Citrullus lanatus) in the dry coastal areas and tree tomato (Solanum betaceum) in the highland valleys are important cash fruit crops for small scale farmers in Ecuador. Viral diseases are important constraints of these crops, causing serious yield losses and significantly reducing harvesting period. Tree tomato is one of the crops targeted by the LAC Regional Project for several years, but viruses have not been addressed. Viruses reported in the 1990's include Tomato mosaic virus (ToMV). Cucumber mosaic virus (CMV), Tomato spotted wilt virus (TSWV), Potato leaf roll virus (PLRV), Potato virus Y (PVY), Tomato ring spot virus (ToRSV), Alfalfa mosaic virus (AMV), Tamarillo mosaic virus (TaMV), and a potyvirus identified only to genus. Additional work by INIAP using mechanical and aphid vector inoculations determine PVY and/or a serologically related Potyvirus (s) as the most important tree tomato virus causing most of the symptoms found in Ecuador. PLRV caused slight leaf deformation and ToRSV was asymptomatic. Contribution of other viruses to the disease syndrome is unknown. In melon and watermelon, viral diseases are commonly observed, but their etiology is poorly understood. Papaya ringspot virus (PRSV), CMV, and a potyvirus have been detected by INIAP using ELISA tests.

Actions:

- Characterize virus etiology of tree tomato, melon and watermelon diseases in Ecuador.
- Establish the epidemiological importance of cross infection by a virus on multiple crop hosts and volunteer weeds.
- Viral disease of tree tomato will be surveyed in Tumbaco-Pichincha, Atuntaqui-Imbabura, Ambato-Tungurahua and Paute-Azuay. Viral diseases of melon and watermelon will be surveyed in Montecristi, Rocafuerte-Manabí, and Yaguachi-Guayas.
- Etiological studies will be collaboratively conducted between INIAP and ESPOL.
- Inoculation studies will be conducted at Literal Sur and Santa Catalina Experimental Stations (INIAP), and the ELISA and PCR detections will be done at Santa Catalina Experimental Station and ESPOL, respectively.
- Plant parts of crops and weeds showing viral symptoms and symptomless weeds will be collected and transported to laboratories of Santa Catalina Experimental Station (INIAP) and ESPOL. ELISA and PCR tests will be used to pre-establish the virus infecting the samples and mechanical and vectors inoculations conducted on differentials and crops to individualize infections. Individualized viruses will be then inoculated to the main host plants to establish symptoms and the importance of each virus in the complex. ELISA and PCR tests will confirm viral infections.

Task 1.1.4: Survey selected vegetable production areas in host countries of Asia for virus diseases in collaboration with Central Asia, South Asia and Southeast Asia regional projects.

Scientists involved: N.A. Rayapati (WSU), G. Karthikeyan (India), A. Muqit (Bangladesh), T.A. Damayanti and S. H. Hidayat (Indonesia), C. Cheythyrith (Cambodia), Nurali Saidov (Tajikistan). Regions/Countries: South Asia (Bangladesh, India), Southeast Asia (Indonesia, Cambodia), Central Asia (Tajikistan)

Status: Continuing.

Description: Surveys are underway in Asian countries in collaboration with host country scientists for seed-borne and vector- (aphid, whitefly and thrips) transmitted viruses (Rayapati).Samples suspected for virus infections, based on visual symptoms, were collected from a variety of vegetable crops (tomato, chilli peppers, potato, okra, onion, peas, beans, bitter gourd, bottle gourd, cucumber, pumpkin and ridge gourd) in farmers' fields from India, Bangladesh, Nepal, Cambodia, and Indonesia. These samples were imprinted on FTA® cards or nitrocellulose (NC) membranes in the field, air dried and shipped to Washington State University (WSU). Total nucleic

acids recovered from FTA cards and NC membranes were tested by PCR and RT-PCR using group- and species-specific primers for the detection of a range of viruses. The DNA fragments amplified from these assays were cloned and nucleotide sequence determined. A comparison of these sequences with corresponding sequences available in GenBank revealed the presence of distinct virus species belonging to the genera *Begomovirus*, *Potyvirus*, *Tospovirus*, *Ilarvirus*, and *Cucumovirus*. A begomovirus causing tomato leaf curl in Bangladesh is being characterized at UC-D.

Further surveys are planned during this year in all three regions in collaboration with Regional programs. Symptomatic samples will be tested by serological and molecular methods to gather region-wide information on viruses in vegetable crops. These results will provide a foundation for a better understanding of the spectrum of viruses in select vegetable crops across the Asia regions and help with the development of field-based assays for their monitoring in multi-location varietal evaluations and IPM trials in host countries.

Task 1.1.5: Plant virus diagnostics with case studies of tomato, pepper, and passion fruit viral diseases in East African countries.

Description and Proposed Activities:

Status: New

Region/Countries: Kenya, Tanzania, and Uganda, and collaboration with EA-RP and IPDN

Task 1.1.5a: Develop, test and train stakeholders on use of membrane-based ELISA for indexing passion fruit plants for new strains of passion fruit viruses.

Scientists involved: Sseruwagi, P., Ochwo-Ssemakula, M., Opita, M.J., Kyamanywa, S., Maerere, A. (Kenya, Uganda), Erbaugh, M., Qu, F.(OSU) and Tolin, S. (VT)

Description: A membrane-based ELISA assay will be developed for the new passion fruit virus isolates using available polyclonal antibodies. Additionally, antibodies will be made at OSU against the capsid proteins of passion fruit viruses and strains in East Africa. Assays will be validated against traditional ELISA assays and RT-PCR in terms of sensitivity and specificity. Training will be conducted for nursery operators/seedling stock providers on use of ELISA assays for virus screening. The target group will include scientists/technicians and nursery/seedling stock producers.

Task 1.1.5b: Conduct comprehensive epidemiological and molecular characterization studies to better understand the complexes of tomato infecting virus diseases and associated viruses.

Scientists involved: Sseruwagi, P., Ochwo-Ssemakula, M., Opita, M.J., Kyamanywa, S., Maerere, A., Erbaugh, M., Qu, F., Gilbertson, R.

Description: The viruses causing the tomato virus diseases will be identified using molecular tools. An initial survey for RNA viruses has been conducted in Uganda, funded by AFSI and IPDN, using ELISA and PCR. Severe symptoms were observed in over 60% of the fields examined. In 71 samples, ELISA-positives included *Tomato mosaic virus* (ToMV), *Tobacco mosaic virus*, *Cucumber mosaic virus*, Potyvirus, and *Tomato spotted wilt virus*, with mixed infections in 85% of the samples. The full-length sequence of ToMV-Uganda was determined, suggesting it is a distinct strain of this virus.

Field trials wills be conducted to determine the epidemiology (infection and spread) of tomato virus diseases in key tomato growing areas of Uganda. Insect vectors, population dynamics, and source of viruses will also be determined.

Activity 1.2: Develop diagnostic methods and capacity for detecting sweetpotato (LAC) and potato (CA) viruses and virus-like agents

Scientists involved: Brown, Rivera , LAC RP; Rayapati, CA RP.

Status: Continuing and nearing completion.

Description and progress: This work is to develop diagnostic assays for viruses frequently carried in vegetative seed of sweetpotato and potato, and to propagate and distribute virus-tested seed to farmers as a management package. Diagnostics tests consisting of PCR, RT-PCR, and dot blot assay with non-radioactive probes will be developed and employed. In addition serological assays already available commercially will be employed and tested in relation to nucleic acid methods. Sources include Agdia, CIP, and others depending on availability.

Expected outputs: Management of virus diseases of sweet potato and potato through reduction of viruses in seed pieces, enabling production of a local supply of clean seed

Task 1.2.1: Explore the feasibility of establishing a center for production of virus-free sweetpotato germplasm, involving tissue culture, acquisition of positive controls, and design and testing of primers for PCR and RT-PCR, in Honduras.

Description: A survey of current literature for sweet potato viruses was completed to inform the diagnostics priorities. Viral genomic and/or coat protein sequences were pulled from the GenBank database to guide RT-PCR primer design for known viruses, all RNA viruses. Viruses to be targeted initially will include among others, sweet potato feathery mottle, sweet potato chlorotic stunt, and sweet potato mild mottle viruses. Primers were designed to PCR amplify begomoviruses and positive controls are available for two begomoviruses of Ipomoea in Puerto Rico. Several colleagues were contacted as potential sources of material to use as positive controls for the RNA viruses.

Task 1.2.2: Detection of the virus-like agent causing Zebra chip in potato

Description: A high throughput hybridization assay for *Ca*. Liberibacter solanacearum in individual psyllids and plant samples, using a DIG-labeled probe, has been developed. Specificity and sensitivity tests of the assay indicated that *Ca*. Liberibacter is detectable in the non-diluted and 1:10 dilution in all suspected positives for psyllids, and in some diluted 1:100. For plant samples, detection was more erratic, probably because the bacterium is unevenly distributed in the leaves and plants. This assay was successful in Year 3 using field-collected psyllids from Honduras. PCR primers and a positive control have been provided to Guatemala for Ca. Liberibacter detection in plants and in psyllids.

Activity 1.3: Conduct research on biology and ecology of clusters of viruses and viral-like pathogens relative to their means of survival and dissemination in cropping systems

Expected outputs: Improved understanding of the etiology, ecology and biology of these diseases, improved diagnostics and understanding of disease epidemiology

Task 1.3.1: Etiology and ecology of tomato, pepper and potato virus and virus-like diseases in various countries

Scientists involved: Several.

Status: Continuing and New.

Description, progress and actions for sub-tasks:

Task 1.3.1a: Senegal and Ghana: Etiology of Pepper yellow vein disease and assess the incidence and prevalence of a tomato viroid. (Gilbertson/ UCD; WA-RP)

Description: Peppers in West Africa showing mottle/mosaic symptoms can be infected with *Cucumber mosaic virus* (CMV) and the potyvirus, *Pepper veinal mottle virus*, whereas those showing leaf curling, distortion and stunting are infected with a begomovirus, which was subsequently determined to be *Tomato yellow leaf crumple virus* (ToLCrV)/*Pepper yellow vein Mali virus*. Peppers with severe stunting and distortion were found to be infected by all three viruses. However, Koch's postulates have not been completed in pepper with this begomovirus and will be attempted with whitefly transmission at the UC Davis containment facility. Because a complex of insect-transmitted viruses can infect peppers, further surveys are needed in Ghana and Senegal to assess the relative importance of these viruses in pepper. Sorting out this complex will define the management strategies as they will have to take into account both aphid- and whitefly-transmitted viruses. A virus-like agent associated with leaf curl and necrosis of tomato in Ghana has been identified as *Columnea latent viroid* (CLVd). A PCR test has been developed and the host range of the viroid determined. Surveys will be conducted to determine the incidence of this new pathogen of tomato in West Africa.

Task 1.3.1b: Guatemala: Begomoviruses and other viruses in solanaceous crops in Guatemala. (Palmieri, Brown, Tolin, Gilbertson; LAC)

Description: This year we will continue to focus on potatoes, peppers and tomatoes. We will work in two regions of Guatemala: Salamá (north central region) and Sololá (western highlands region). We will evaluate symptomatic plants as well as weeds and vectors, if possible, for selected viruses such as begomoviruses, potyviruses, tobamoviruses, and tospoviruses. If suspicious symptoms appear, other viruses will be evaluated; an example would be *Tomato chocolate spot virus* of tomato and *Trialeurodes vaporariorum* (the possible vector) if the problem is found to persist and a culture can be established. The University of Arizona will assist with cloning and sequencing of PCR products and sequencing for begomoviruses and other viruses, as needed.

Monitoring of these crops in Year 3 detected a high incidence of mechanically and potentially seed-borne viruses in tomato, weeds, and pepper. Studies will be initiated to confirm the source of these viruses and direct later research to reduce incidence of these RNA viruses that are not insect-transmitted. (New)

Task 1.3.1c: Honduras: Tomato and pepper viruses (Brown, Tolin, Rivera)

Description: No new collections were made for begomoviruses or potyviruses this year. Efforts were focused on *Ca*. Liberibacter since this bacterium-psyllid complex was the over-riding problem in year 2, but decreased in Year 3. Symptomatic samples that have tested negative for many viruses by ELISA and DNA PCR to

usually prevalent viruses will be collected for deep sequencing analysis by the USDA Vegetable Laboratory, in collaboration with a USDA-funded project on tomato viruses (K. Ling).

Task 1.3.1d: Honduras and Guatemala: Sweetpotato viruses (Brown, Rivera; Palmieri)

Description: A survey of sweet potato plantings for virus-like symptoms and associated insect vectors will be undertaken in Guatemala during 2012-2013. In Year 3 in Honduras, assays using the CIP immunoassays revealed *Sweetpotato feathery mottle virus* as the most prevalent virus. Additional samples will be collected and preserved for analysis in the AZ laboratory as the first step toward applying diagnostic assays under development to field detection.

Task 1.3.2: India: Verify and document the identity of virus (es) associated with necrosis diseases of tomato.

Scientists involved: Karthikeyan (India) and Rayapati, WSU.

Status: Continuing.

Description and progress: So far, tomato plants showing various types of necrosis in farmers' fields in Tamil Nadu in India were tested positive for *Peanut bud necrosis virus*. This activity will be continued to identify by RT-PCR if other tospoviruses such as *Capsicum chlorosis virus* and plant picorna-like viruses such as *Tomato torrado virus* and *Tomato marchitez virus* are present.

Task 1.3.3: Honduras, Guatemala: Conduct epidemiological research on a vector-borne, virus-like pathogen, the causal agent of zebra chip of potato and vein-greening of tomato and pepper. (Brown, U AZ; FHIA, UVG; LAC)

Description: Field collections of plant samples and psyllids, and trapping of psyllids on sticky cards is underway for epidemiological studies in two major potato growing areas of Honduras. Sticky traps are going to be used for the following collections of psyllids because the previous collections have been done by collections with nets and aspirators in Guatemala. Plant samples have been analyzed and will continue to be sampled during 2012 and 2013 principally in a location in the western highlands of Guatemala. The spring months are the active time for psyllid dispersal. Samples will be analyzed soon for the 2011 collections. *Ca.* Liberibacter was identified in both highland potato and tomato and eggplant fields on nearby descending slopes. *Datura* spp. was identified as a wild host of the bacterium and of the potato psyllid. More tests for identifying the bacterium in different parts of the plant will be conducted because until now the best tissue for detection is the tuber. Detection from leaves

and stems is less consistent, probably because bacterial cells are in low concentration or are unevenly distributed. The University of Arizona will assist with cloning and sequencing of the Zebra chip amplicon for validation of the diagnostic assay transferred to the University del Valle laboratory.

Objective 2: Develop long-term institutional capacity building and conduct scientist training in host countries for detection and diagnosis of plant virus (and virus-like) diseases, in screening and monitoring for resistance, and in ecological research of virus-vector-host interactions in selected vegetable cropping systems.

Description and Status: This activity was begun in the last phase under the two previous global theme projects on viruses, and collaboration with the IPDN Diagnostics Global Theme and Regional Projects.

Expected outputs: The result of this objective will be enhanced institutional capacity for diagnosis of viral disease problems, research on virus ecology and vector interactions, and on virus management in specific cropping systems.

Activity 2.1: Assess virus detection and diagnosis capacity and vector expertise in regions and host countries.

Task 1: Summarize virus diagnostic capacity surveys from previous years, in collaboration with IPDN-GT. Review level of expertise in host countries for also conducting lab and field research (ecological, vector, resistance, impact) on virus diseases.

Task 2: Follow up on recommendations from the virus workshop in India in Year 3 and develop on-line resources for information on globally common virus diseases identified by previous IPM CRSP activities.

Activity 2.2: Conduct training of host country scientists to enhance ability to recognize virus disease by visual symptoms, apply appropriate diagnostic assays, associate disease incidence with vector biology and virus-vector interactions, and predict intervention approaches from virus ecology.

Progress to date: Rayapati, Brown and Gilbertson participated in the workshop on viruses at TANU in July 2012. Activities for capacity building in virus research and teaching were discussed and are being initiated in several regions to enhance capacity to diagnose and manage virus diseases. Scientists and institutions from

Kenya, Tanzania, and Uganda, and also from Ecuador, have been added to the IPVD host country scientists.

Tolin helped plan the East Africa IPDN Workshop in Tanzania in May/June 2012, for which the IPVD provided expendable laboratory supplies and reviewed SOPs for two viruses (*Passion fruit woodiness virus* and *Tomato yellow leaf curl virus*). This initiated linkages and permitted assessment of the current research and capacity building activities. Host country scientists received training in various aspects of viruses, their spread and management, as well as recognition of field symptoms and diagnosis by lab-based methods like TBIA, ELISA and PCR techniques.

Task 1: Collaborate with IPDN GT to integrate virus diagnostics into a Senegal (West Africa) workshop in Year 4.

Task 2: Review short-term and long-term training needs and activities and identify new training opportunities.

Task 3: Conduct short-term training for faculty members, professionals, and students, including facilitating attendance at professional meetings to present research.

Current year activities: We plan to take advantage of the meeting of the International Plant Virus Epidemiology conference to be held in Arusha, Tanzania in January 2013, the APS Caribbean Division meeting in Tucson AZ in June 2013, and the Biodiversity Conference in conjunction with the TC meeting in Indonesia in 2013. Funding will be sought for US PIs and host country scientists to attend these meetings and also meet to review activities.

Task 4: Conduct long-term graduate student training as funding can be obtained and suitable candidates identified.

Objective 3: In cooperation with regional projects, design and implement applied research on specific virus diseases in selected crops in order to develop or improve IPM packages that employ results obtained in Objectives 1 and 2.

Description: The aim of this objective is to develop IPM strategic packages that minimize yield loss caused by plant viruses and virus-vector complexes, or by seed-borne viruses, to improve farm income and sustainability using knowledge gained in Objective 2 activities. These projects will be designed and performed in cooperation with Regional Projects, using funding allocated to host countries. Training host country scientists in the conducting field research to observe successes and validate results will be implicit in all activities. Impact of IPM packages measured by yield

changes, economic impact of virus infection, and adoption of IPM packages by farmers will be done in association with RP and Impact Assessment Global Theme projects in the respective host countries or regions. Guidance documents will be developed on protocols for screening germplasm for resistance to virus, selecting and maintaining virus-free seeds and seedlings, and will be provided to in-country collaborators and other entities, including private seed companies.

Activity 3.1: Conduct applied research for IPM packages that include devising best management practices to manage virus diseases, and impact assessment, as indicated in region and country work plans.

Task 3.1.1: Monitoring the host-free period for tomato virus management (LAC – Guatemala; W Africa – Ghana, and Senegal)

Scientists involved: M. Palmieri, M. Osei, S. Diao and R. Gilbertson.

Status: Continuing

Description and Progress: The IPM program has been a success in Mali, as well as in the Caribbean, for whitefly-transmitted viruses. We are in the process of expanding it to other areas of Ghana and Senegal. Implementation is needed in Guatemala.

Actions

- Continue to expand the tomato IPM program for whitefly-transmitted viruses into improved varieties and regional sanitation, as well as implementation of the host-free period, use of improved varieties and regional sanitation.
- Continue to work to establish IPM programs for insect-transmitted viruses in tomato in Guatemala, mainly toward the implementation of the tomato IPM package for whitefly-transmitted begomoviruses. The general package has been developed, the challenge now is implementation.

Task 3.1.2: Uganda: Develop and evaluate IPM options that target insect vector control for pepper and tomato virus diseases.

Scientists involved: Sseruwagi, P., Ochwo-Ssemakula, M., Opita, M.J., Karungi, J., Kyamanywa, S., Maerere, A., Erbaugh, M., and Gilbertson, R.

Status: New

Actions: Field trials will be conducted to evaluate cultural IPM practices that target insect vector control to manage pepper and tomato virus diseases in smallholder farmers' fields. The cultural practices to be evaluated should be accessible, affordable and user friendly.

Task 3.1.3: Management of necrotic viral diseases in tomato through clean seedling production, roguing, variety selection, and IPM strategies (South Asia – India)

Scientists involved: G. Karthikeyan, Nutan Kaushik, Naidu Rayapati

Status: Continuing

Actions:

- Conduct roguing trials in two locations in Karnataka (Kolar area) during the main cropping season (January-June) and gather yield data.
- Conduct IPM trials for PBNV management in Tamil Nadu and Karnataka (two locations per season)
- Continue developing a list of nurseries in major tomato-growing areas of Tamil Nadu, document methods of raising tomato seedlings and assess risk level for early infection of plants with PBNV in selected nurseries.
- Compare marketable quality of tomato fruits produced by healthy and PBNV-infected tomato varieties and hybrids.

Expected outputs: Information on roguing for reducing Peanut bud necrosis virus (PBNV) spread made available. Information on value of IPM components for management of PBNV made available.

Task 3.1.4: India: Initiate studies on seed transmission of viruses in cucurbits (South Asia – India)

Scientists involved: G. Karthikeyan, Naidu Rayapati

Status: New

Description and Expected outputs: Recent observations of cucurbit fields indicated possible transmission of viruses via seed. Grow-out tests under greenhouse conditions using seed from commercial sources will help to assess the risk of virus dissemination via seed and to distinguish seed transmission from initial introduction by insect vectors. Information gathered on virus transmission via seed supplied by commercial entities will help devise strategies for encouraging farmers to use virus-free seed for growing healthy cucurbits to produce quality fruits for human consumption.

Task 3.1.4: Conduct grow-out tests in greenhouse and document symptoms in seedlings of select cucurbits, and test symptomatic and asymptomatic plants for the presence of candidate virus(es) by ELISA and/or RT-PCR.

Task 3.1.5: Evaluate the use of non-host barriers and roguing to reduce early infections in cucurbitaceous crops (Ecuador)

Scientists involved: Ecuador- INIAP: J. Ochoa, R. Delgado, M. Insuasti, V. Barrera. CIBE-ESPOL: Peralta, D. Quito. J. Brown, (UAZ); S. Tolin (VT).

Status: New

Description: In melon and water melon as described in Activity 1:1.3, few determinations have been done and the etiology of viral disease are poorly understood. *Papaya ringspot virus* (PRSV), CMV and a potyvirus have been determined in Ecuador by INIAP using ELISA tests. A field study to monitor the efficiency of non host barriers and weed roguing will be conducted in Montecristi and Yaguachi. These studies will be monitored by ESPOL and INIAP to follow up the epidemic with PCR techniques at ESPOL.

Melon and watermelon are grown in Manabí and Guayas in plots dispersed one from each other. Non-host barriers surrounding crop plots, and roguing of weeds and early infected plants can contribute to disease management in these crops. To monitor the potential use of non-host barriers and roguing, a plot of melon and watermelon will be established in Montecristi and Yaguachi (INIAP). Maize will be used as a plant barrier and potential host weeds will be rogued before planting and plants with early viral symptoms removed. The virus of rogued plants will be established and the epidemic built up established during the crop development.

Task 3.1.6: Epidemiology of psyllid vector/Liberibacter and whitefly vector/virus in potato and other crops to design management practices (LAC – Honduras, Guatemala)

Scientists involved: Brown, Rivera, Espinosa, Palmieri

Status: Continuing.

Description and Expected outputs: Validated detection methods are being used to monitor *Ca.* Liberibacter in psyllids trapped or collected in study fields to determine the percentage of the psyllid population harboring the bacterial pathogen of zebra chip and tomato/pepper veinal greening diseases. Infestations were lighter this year than last year but trapping initiated during the late winter/spring seasons when psyllid dispersal occurs into potato crops in Honduras. Psyllids will be counted at weekly intervals for each field (4 traps/field), removed from sticky traps and placed in ethanol for shipment to the AZ lab where DNA-hybridization assays, backed up with PCR for selected samples, will be carried out to assess pathogen presence. Management will rely on epidemiological information and vector dynamics gained from surveys of study fields and insect vector populations conducted throughout the

growing season and intervening timeframe. Research to test candidate insecticides and methods of placement of compounds, including nozzle technologies, is in progress in Honduras in the LAC regional activities.

Actions:

- Determine psyllid dispersal and transmission times by yellow sticky trap catches.
- Recommend targeted insecticide use to avoid continuous sprays by farmers.

Activity 3.2: Conduct trials to evaluate germplasm for resistance to viruses.

Scientists involved: N. Rayapati, R. Gilbertson.

Status: Continuing and new

Task 3.2.1: Conduct germplasm field-testing within the solanaceous crop cluster (pepper, potato, tomato) in South Asia (India, Bangladesh)

Task 3.2.2: Conduct evaluation of tomato varieties for resistance to begomoviruses in West Africa (Ghana and Senegal) and begin programs in East Africa (Tanzania, Uganda).

Activity 3.3: Participation of host country scientists in workshops and field days to transfer virus management technologies to farmers as part of an IPM package

Task 3.3.1: Conduct one field day on vegetable IPM in Tamil Nadu for farmers and nurseries (South Asia – India)

Scientists involved: G. Karthikeyan, S. Manoranjitham, N. Balakrishnan, N. Rayapati

Status: Continuing

Description and Progress to date: Field studies were conducted during previous phase on roguing as a practical approach for minimizing the spread of *Peanut bud necrosis virus* (PBNV) in tomato. This approach has been accepted in the 'Scientific Workers Conference' of the Tamil Nadu Agricultural University for adoption and dissemination. This information is being shared with farmers via "Farm School on Vegetable IPM" organized by the All India Radio and other avenues to promote roguing as a tactic for the management of PBNV. In addition, field trials were carried out to evaluate response of tomato hybrids and cultivars to PBNV. This information will be shared with farmers via various dissemination pathways to

encourage them grow agronomically acceptable varieties and/or hybrids that are least susceptible to PBNV. Knowledge about PBNV infection in seedlings at nurseries is being disseminated to stakeholders for the supply of 'clean' seedlings to farmers.

Task 3.3.2: Develop a plan for inclusion of virus disease management as part of IPM field days. (All Host country scientists in all countries/regions)

Activity 3.4: Assemble information for management of viruses as a component of IPM packages, and success stories obtained in the various countries of the IPM CRSP

Scientists involved: Several

Status: New

Regions/Country(ies): All

Task 3.4: Prepare documentation of success stories for managing virus diseases in formats that can be distributed as reviewed technical publications, news releases by the IPM CRSP, and online access globally. These will be crop specific, as well as region-specific, and demonstrate the commonalities across regions and crops, as well as differences.

Graduate Students and Postdoctoral Research Associates

Name: Tomas Melgarejo

Sex: Male

Nationality: Peruvian

Discipline: Virology

Site/*Country:* Guatemala/Ecuador

Degree: Ph.D.

Start date: Sept 30, 2009

Completion date: December 31, 2013

IPM CRSP funds: partial + Fulbright Fellowship + OAS Fellowship

Advisor/PI: R. Gilbertson

Thesis topic: Virus characterization, detection and management of a tomato-infecting begomovirus from Peru and a Jatropha-infecting begomovirus from the Dominican Republic.

University: University of California - Davis

Name: Sudarsana Poojari

Sex: Male

Nationality: Indian

Discipline: Virology

Site/Country: USA

Degree; PhD

Start date: Spring 2009

Completion date: Spring 2013

IPM CRSP funds: Partial

Advisor/PI: Naidu Rayapati

Thesis topic: TBD

University: Washington State University

Name: K. Nagendran

Sex: Male

Nationality: Indian

Discipline: Virology

Site/*Country:* India

Degree: PhD

Start date: 17th August 2011

Completion date: May 2014

IPM CRSP funds: Full

Advisor/PI: Gandhi Karthikeyan/Naidu Rayapati

Thesis topic: Documentation and characterization of viruses infecting Cucurbitaceous vegetable crops in Tamil Nadu
University: Tamil Nadu Agricultural University

Name: To be named

Sex: To be determined

Nationality: Guatemalan

Discipline: Virology and vector biology

Site/*Country:* Central American/Guatemala

Degree: M.S.

Start date: January 2013

Completion: December 2014

IPM CRSP funds: Partial, with LAC RP funding (2 yrs)

Advisor/PI: Judith Brown

Thesis topic: Molecular diagnostics development for identification of sweet potato and other viruses

University: The University of Arizona

Short-Term Training planned

In collaboration with South Asia Regional Program, provide 6-9 month training in virology for a scientist from Bangladesh Agricultural Research Institute to conduct virus research in Bangladesh (Rayapati).

In collaboration with Central Asia Regional Program, provide 6-9 month training in virology for a scientist from Tajikistan to conduct virus research (Rayapati).

	US co-Pis	**SA**	**SEA**	**CA**	**LAC**	**EA**	**WA**
Workshops:	1	1	1		1	2	1
Seminars:	5				1		5
Field days:	1	1	1	0	3	1	2

Mass media events	0						
Annual meetings	5	2	2	1	3	5	2

Publications planned:

- Research articles 4
- Books and book chapters 1
- Extension articles 2
- Posters 1
- Bulletins 2
- Others (Symposium Proceedings) 2
- Conference/Symposium Abstracts 8

IPM Impact Assessment for the IPM CRSP

PI(s): George Norton

Co PIs: Jeffrey Alwang and Daniel Taylor

Objective 1: Apply Common Set of methods for Impact Assessment

Description: A common set of methods will be used that will link data, methods, and impacts at different geographic scales and types of outcomes. For example, costs and yield data at the plot or field level will be combined with data on prices, quantities, IPM adoption rates, and other factors in models that produce indicators of impacts on income for every regional package, and on poverty, nutrition, and environmental improvement for selected IPM packages

Activity 1: Work with regional programs to complete farm level surveys and summarize the data in reports (India, Nepal, Uganda, Ecuador, Guatemala, and Ghana)

Scientists involved: Norton, Alwang, Taylor

Status: Continuing

Description: Some surveys are baseline surveys and others as follow-up surveys for impact assessment using adoption information.

Progress to date: The India survey was completed and analysis of the data has begun as part of Ph.D. dissertation at TNAU. A new survey is being completed this year in Ecuador and the data are being entered. Analysis of the data will occur in 2012-2013 and be included in MS thesis. Ghana survey was completed this year and is being written up. Guatemala survey was completed and will be written up and analyzed in 2012-2013. Nepal survey has begun but is not yet finished. Bangladesh survey is being completed for gourds and data will be analyzed this year as part of Ph.D thesis.

Expected outputs: Reports with baseline data on adoption of IPM practices disaggregated by gender, perceptions of pest problems, etc (Guatemala, Nepal, and Ghana). For follow-up surveys, impact assessments will use these data (India, Bangladesh, and Ecuador).

Task 1: Finish surveys and reports in Guatemala and Nepal; finish report on Ghana; finish analysis of data in India, Ecuador, and Bangladesh

Activity 2: Short term training on impact assessment (India, Bangladesh, Uganda)

Scientists involved: Taylor, Norton, and Alwang

Status: Continuing

Description: Short term training at Virginia Tech for an economist from India. Short term training in Guatemala and Uganda on impact assessment

Progress to date: Meetings were held on impact assessment with economists in Bangladesh, Nepal, India, Ecuador, and Uganda in collaboration with regional planning meetings. Three-week short term training was completed this past year at Virginia Tech for scientist from Ghana. Short term training for economist from India began at Virginia Tech in April and will continue into October.

Expected outputs: Increased understanding by host country scientists of impact assessment methods.

Task 1: Complete six month training for economist from India at Virginia Tech.

Task 2: Provide short term training in regional programs on impact assessment

Objective 2: Specialized in-depth Impact Assessments of Poverty, Environmental, Nutritional, and Other Impacts

Description: These studies are conducted for regional IPM programs as part of theses and dissertations to assess a variety of impacts such as poverty impacts, intra-household impacts, the value of impacts on institutional changes, and more detailed health, environmental, gender, and nutritional impacts.

Activity 1: Revise manuscript out of West Africa tomato IPM impact assessment

Regions/Countries: Mali, Senegal, and complete simple impact analysis for another IPM technology in the region.

Scientists involved: Norton, Alwang, Taylor

Status: Continuing

Progress to date: Draft of journal article manuscript from master's thesis submitted to journal with data from Mali and Senegal. Work was begun on impact assessment for IPM adoption in Ghana.

Description: Working with Theo Nouhoheflin from the West African site, we will revise as needed the manuscript which was submitted to a journal out of his thesis.

Expected outputs: Journal article accepted for publication from tomato work in West Africa

Task 1: Revise manuscript and submit from West Africa tomato work

Activity 2: Assessment of IPM CRSP impacts in LAC (Honduras, Ecuador, Guatemala)

Scientists involved: Norton, Alwang

Status: Continuing

Progress to date: Impact assessment conducted in Honduras was published. Masters thesis begun to conduct ex post analysis of Ecuador potato research in Carchi.

Description: Conduct an ex post impact assessment of IPM potato package in Ecuador with graduate student.

Expected outputs: Thesis and Journal article

Task 1: Complete analysis with survey data and prepare thesis (Ecuador).

Task 2: Complete journal article manuscript and submit to journal.

Activity 3: Assessment of optimal mix of IPM dissemination approaches (Bangladesh and Nepal)

Scientists involved: Norton, Alwang, Taylor

Status: Continuing

Progress to date: Ms. Harris submitted manuscript to journal and we are awaiting response.

Description: Revise journal manuscript out of Bangladesh impact work with former graduate student Leah Harris. The paper assesses the effectiveness and optimal mix of funding for a set of dissemination approaches for specific types of IPM practices. Conduct follow up work on methods for IPM technology dissemination in Nepal.

Expected outputs: Journal article on modeling approach for assessing optimal dissemination approaches for different types of IPM practices (with results for Bangladesh).

Task 1: Conduct data collection and analysis for Nepal

Activity 4: Assessment of IPM impacts in India and Bangladesh

Scientists involved: Norton, Alwang, Taylor

Progress to date: Thesis well along in India and data collection still on-going for Bangladesh thesis. Papaya mealy-bug analysis in process.

Status: Continuing

Description: Complete dissertation at TNAU (India) on impacts of onion IPM program. Continue with dissertation at Virginia Tech (Bangladesh) in impacts of gourd IPM program. Prepare journal article out of each dissertation. Prepare journal article out of papaya mealy bug bio-control impact assessment.

Expected outputs: Three journal articles

Task 1: Finish onion dissertation in India

Task 2: Continue Bangladesh impact assessment dissertation

Task 3: Complete analysis and journal article out of papaya mealy bug work

Graduate Students and Postdoctoral Research Associates:

1. Name: Vanessa Carrion

Sex: Female

Nationality: Ecuador

Discipline: Agricultural Economics

Site/*Country:* LAC

Degree: Masters

Start date: August 16, 2011

Completion date: August 1, 2013

IPM CRSP funds: 100%

Advisor/PI: George Norton

Thesis topic: To be decided

University: Virginia Tech

2. Ahsanuzzaman

Sex: Male

Nationality: Bangladesh

Discipline: Agricultural Economics

Site/*Country:* Bangladesh

Degree: Ph.D.

Start date: January 1, 2012

Completion date: December 31, 2013

IPM CRSP funds: 100%

Advisor/PI: George Norton

Thesis topic: Economic impacts of IPM in Bangladesh

University: Virginia Tech

3. Kiruthika Natarajan

Sex: Female

Nationality: India

Discipline: Agricultural Economics

Site/*Country:* India

Degree: Ph.D.

Start date: August 2009

Completion date: May, 2013

IPM CRSP funds: 100%

Advisor/PI: R.N. Selvaraj and George Norton

Thesis topic: Economic impacts of onion IPM program in Southern India

University: Virginia Tech

Short-Term Training planned

- Annual meetings: South Asia, Latin America, East Africa
- Others: Individual short term training for person from India in US.

Publications planned:

- Research articles: 4
- Books and book chapters:
- Extension articles:
- Posters: 1
- Bulletins
- Others: 2 impact assessment briefs

Performance Indicators for Monitoring and Evaluation:

ID	Description	Completion Date	Responsible Individual
Obj1: Activity 1	Baseline surveys completed in target countries	Sept 2013	Norton
Task 1	Survey reports completed	Sept 2013	Norton, Alwang, and Taylor
Activity 2	Short term training	Sept 2013	Norton, Taylor
Task 1	Completed six-month short term training at VT for TNAU student	October 2012	Norton
Task 2	Provided training to economists in regional programs	September 2013	Norton, Taylor
Obj. 2 Activity 1	Revised West Africa manuscript	April 2013	Norton
Activity 2	Assessment of IPM impacts in LAC	September 2013	Norton, Alwang
Task 1	Completed analysis and thesis	June 2013	Norton, Alwang
Task 2	Completed journal article Manuscript	July 2013	Norton, Alwang
Activity 3	Assessment of IPM dissemination approaches	September 2013	Norton, Alwang, Taylor
Task 1	Conduct data analysis for Nepal	September 2013	Norton
Activity 4	Assess IPM in India and Bangladesh	September 2013	Norton, Alwang
Task 1	Onion IPM dissertation completed	April 2013	Norton
Task 2	Progress on Bangladesh dissertation	September 2013	Norton
Task 3	Completed analysis of papaya mealy bug impact assessment and journal article prepared	June 2013	Norton

Gender Knowledge

PI: Maria Elisa Christie, Virginia Tech

Overall Goal: Increase gender equity and broaden impacts of IPM CRSP

Objective 1: Gender equity: Increasing participation of and benefits to women

Task	Description and purpose	Output	Responsible Party	Specific Regional Activity	Location (Country)	Date
1	Prepare workplan for year five to mainstream gender activities. Include monitoring and evaluation plan and reporting system.	RP: Program-specific and qualitative indicators; opportunities for impact identified; participation strategies incorporated GGT PI: Provide guidance with reporting format; compile CRSP-wide report	GGT PI; for RP Gender Coordinators: SE Asia: Lestari S. Asia: Uma and Mian LAC: Valenzuela W Africa: Haleegoah E Africa: Mangheni	Provide guidance with GGT workplan for RPs and compile CRSP-wide GGT workplan.	All	June-July 2013
2	Prepare	Gender	RP Gender	N/A	All RPs	August

Task	Description and purpose	Output	Responsible Party	Specific Regional Activity	Location (Country)	Date
	gender components of the annual report and submit to Regional Program PIs.	componen ts included in RP annual report	Coordinators as above			2013
3	Prepare GGT annual report to be submitted to GGT PI using GGT format.	GGT annual report	RP Gender Coordinators as above	Compile informatio n for GGT annual report	USA	August-Septembe r 2013
4	Integrate gender in Regional Program activities including training	Gender checklist for activities; will go into RP reports	RP Gender Coordinators as above and GGT PI	All team members use gender checklist for field activities	All	Througho ut year
5	Prepare GGT report for ME	GGT annual report	GGT PI	none	US	Septembe r 2013

Objective 2: Capacity building: Empowering teams to integrate gender

Task	Description and purpose	Output	Responsible Party	Specific Regional Activity	Location
1	Long term training: select, advise, and support student working on IPM gender research.	Student name, level, program, university, progress, research abstract in report, and student outputs (see Research below).	Bangladesh: Huq Hussein; Indonesia: Puspitawati; Uganda: Mangheni; Honduras: Valenzuela	Theses: Umme Habiba & Tahera Sultana (University of Dhaka); Robert Ochago, Robinah Atukunda & Richard Miiro (Makerere University); Atika Rahma (Bogor University); student in Honduras	USA, Bangladesh, Indonesia, Uganda, Honduras
2	Short-term trainings targeting women or specifically focusing on gender issues	Training topic, date, location, and participants by gender in report; work with women's organizations	RP Gender Coordinators as above		All RPs
3	Hands-on training through site visits to build capacity of gender teams	Fieldwork in each site	Indonesia: Puspitawati, Lestari; Cambodia: Sitha, Lestari; Honduras: Valenzuela; Kenya: Gitonga,	Fieldwork on gender and *Trichoderma* in Bangladesh, Indonesia, Cambodia, and Honduras; Fieldwork on	Indonesia, Cambodia, Honduras, Kenya, Tanzania

Task	Description and purpose	Output	Responsible Party	Specific Regional Activity	Location
			Mangheni; Tanzania: Lyimo-Macha, Mangheni; Laura Zseleczky; GGT PI	gender and grafting in Kenya; Rapid Gender Assessment in Tanzania	

Objective 3: Research: Producing and disseminating knowledge of gender issues in IPM

Task	Description and purpose	Output	Responsible Party	Specific Regional Activity	Location
1	Student research	Field reports, theses, and publications	Bangladesh: Mian and Huq Hussein; Indonesia: Puspitawati; Uganda: Mangheni; Honduras: Valenzuela	Masters Theses, Research abstracts, Articles	USA, Bangladesh, Indonesia, Uganda, Honduras
2	Rapid Gender Assessment	Case study	Lyimo-Macha and Mangheni in Tanzania; Mangheni, Christie, Gitonga, and Waiganjo in Kenya; Sitha in Cambodia	RGA using Gender Dimensions Framework	Tanzania, Kenya, Cambodia, Ghana TBD

Task	Description and purpose	Output	Responsible Party	Specific Regional Activity	Location
3	Analysis of sex-disaggregated data from baseline survey.	Article for regional publication	Mangheni in Uganda; GGT PI and IPM Impact Assessment Global Theme collaborators (Norton and Dankyi) in Ghana; GGT PI and Mah Koné in Mali	Collaboration with Impact Assessment Global Theme	Uganda, Ghana, Mali
4	Mapping the research impact pathway of IPM CRSP and *Trichoderma* from a gender perspective	Collection of case studies for publication	Puspitawati and GGT PI in Indonesia; Sitha and GGT PI in Cambodia; Laura Zseleczky; Valenzuela and GGT PI in Honduras	Baseline survey and qualitative research	Cambodia, Indonesia, Honduras
5	Mapping the research impact pathway of IPM CRSP work with grafting from a gender perspective	Case study for publication	Mangheni, GGT PI, Gitonga, and Waiganjo	Rapid Gender Assessment (specifically looking at the women-run Kangai-Tisa tomato growers association in Kirinyaga)	Kenya

Task	Description and purpose	Output	Responsible Party	Specific Regional Activity	Location
6	Gender and the productive chain of potato and tomato	Case study report for publishing as research note on IPM CRSP website and for local publication; Undergraduate thesis (Zamorano)	Valenzuela. Alwang	Case study of productive chain of potato and tomato in Honduras	Honduras
7	Productive and reproductive roles and spaces and adoption of IPM technologies	Case study for publication	Puspitawati in Indonesia; Lestari in Philippines	Continuation of FY 2 and 3 research	Indonesia, Philippines
8	Present research results of FY 1, 2, and 3 at local, regional, or international fora including RP annual meetings to increase visibility of gender work in IPM CRSP.	Conference presentations PowerPoint of same presentation to post on IPM CRSP website	RP Gender Coordinators; GGT PI		All
9	Research on gender roles	Rapid Gender	Joyce	RGA	Ghana

Task	Description and purpose	Output	Responsible Party	Specific Regional Activity	Location
	and IPM in cabbage production in Ghana	Assessment	Haleegoah		