Integrated Pest Management
Collaborative Research Support Program (IPM CRSP)

Technical Workplan

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Virginia Polytechnic Institute & State University (Virginia Tech)

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IPM CRSP

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Due to budget cuts in FY 2012, IPM CRSP activities will cease in the Dominican Republic (Latin America and the Caribbean) and both Kyrgyzstan and Uzbekistan (Central Asia).

All other proposed activities remain the same.

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

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Lead partner institutions:

Purdue University

Penn State University

Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP-Ecuador) and Escuela Agricola Panamericana (Zamorano-Honduras)

Honduras: Fundación Hondureña de Investigación Agropecuaria (FHIA)

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 the Dominican Republic and Guatemala is less well advanced. In the former two countries, we are moving toward refinement of IPM packages, which is at various stages depending on the crop. In the latter two, we have identified key pest complexes, have prioritized research to meet pest control needs, and are establishing or have established field plots.

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 years one and two and many of these will be carried over into the third year. In the Dominican Republic and Guatemala, we are continuing to establish field trials for promising technologies and important pests of tomato, peppers and other horticultural crops. In all cases, we will collect information on costs and benefits of promising practices and this information will be used in impact assessment.

Progress to date: Trials set up on farmer fields in Ecuador (Andean Fruits and maize) and Honduras (peppers, tomatoes, onions and others).

Ecuador. Several varietal trials for diseases in naranjilla have been established. Means have been identified for managing *Fusarium oxysporum,* nematodes (*Meloidogyne incognita*), late blight (*Phytophthora infestans*), anthracnose (*Colletotrichum acutatum*), bacterial canker (*Clavibacter michiganensis*) and naranjilla fruit borer (*Neulocinodes elegantalis*). Minor adjustments to the IPM package are needed. Tree tomato and blackberry research is ongoing. The main pest problems are: anthracnose (*Colletotrichum* spp.), late blight (*Phytophthora infestans*) and various leaf insect pests; and botrytis (*Botrytis cinerea*), downy mildew (*Peronospora* spp.) 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 (*Premnotrypes vorax),* Central American Tuber Moth (*Tecia solanivora*) and a specific cyst-type nematode (*Globodera pallida*).

Guatemala. We have detected the diseases that should be emphasized in the three regions (the highlands, principally in Sololá, the oriental part of the country, principally Chiquimula, Jutiapa and Zacapa and the northeastern region that is represented by Salamá; Baja Verapaz). We will evaluate the incidence and severity of the following diseases: *Liberibacter solanacearum* (causal agent of Zebra chip in potato and affects tomato); *Ralstonia solanacearum* (causal agent of bacterial wilt of tomato and potato); some fungi, principally *Phytophthora infestans, Rhizoctonia* spp. and *Fusarium* spp.; and nematodes, principally *Meloidogyne* spp., *Pratylenchus* spp., and *Helicotylenchus* spp. in the three regions. We will also evaluate the prevalence of important viruses such as *Begomoviruses* (in tomato, pepper, potato, weeds and vectors if possible), *Potyviruses* (as group in the three crops), *Tospoviruses* (tomato, potato, pepper, weeds and vectors). If suspicious symptoms appear, other viruses will be evaluated. An example would be Chocolate Spot Virus for tomato and *Trialeurodes vaporariorum* (the possible vector).

We will include the sweet potato virus diagnosis in collaboration with the University of Arizona; also, this laboratory will help us principally with Zebra chip and sequencing and analysis in comparison with other pathogens. Soil samples will be collected before planting to determine needed amendments. The agro-social economic questionnaires are going to be given to the growers during the last part of current year. The analysis of this survey will take place in year three.

Task 1: (Guatemala, DR) Continue to establish and modify as necessary experiment-station and farmer field research activities in Guatemala and Dominican Republic. Status: ongoing. Scientists involved: Weller (Purdue), Backman and Gugino (Penn State), Palmieri (Guatemala), and Martinez (IDIAF).

Guatemala. Field trials will be conducted in the three focal regions in fields of growers. We will try to implement the trials in two fields in each region; this will depend on the agreements with the growers and availability of funds. Also in the highland region (Sololá), we will do a trial in the university plots and include a trial in the greenhouse if permission is obtained. We are going to implement three experimental plots; the first one will be managed using standard grower practices, the second one will be based on IPM (with pesticides managed adequately), and the third will be based on an organic system. The plots will be surrounded by sorghum or maize to avoid contamination from one plot to the other. The plots for the Oriental and North Central regions will be only for tomato and pepper. The plots from the Occidental region will be for tomato, pepper and potato. Evaluations for diseases and pests will be done first before the planting of the crop, the second just before flowering, the third when fruit is present, and the last after the crop ends. The design is as follows:

Plot 1: Grower's technology;

Plot 2: IPM management (rational use of pesticides), spraying decisions based on field data (periodical pest assessments/scouting), use of trap crops (strips of sorghum-corn), use of local plants with repellent/botanical extracts properties, use of plants (strips) for potential biological control agent shelters, use of plastic or organic soil covers (mulch), use of Agribon or Agryl, or multicropping;

Plot 3: System base on a non-chemical pesticide use for pest/disease control, use of local plants with repellent/botanical extracts properties, use of plants (strips) for potential biological control agents as shelter, use of NVP (nuclear polihedrosis virus)–entomopathogenic fungi–nematodes, soil solarization, use of plastic or organic soil covers (mulch), use of Agribon or Agryl, or multicropping.

Dominican Republic. Penn State will work with IDIAF scientists in the DR to design focused on-farm and research farm experiments to address specific priority pathogens/diseases identified on solanaceous field and protected structure crops (peppers and tomatoes) with an emphasis on soil-borne pathogens and as identified in the 2012 work plan. For example, infesting research farm sites with known pathogens prior to treatment application to ensure a more uniform distribution of the pathogen in the soil or by characterizing the pathogen population prior to establishing on-farm trials. In Ecuador and Honduras, scientists will continue to analyze field-plot data as they become available.

Task 2: (Ecuador) Continue to refine and validate naranjilla pest management techniques in Ecuador. *Status*: continuing. Scientists involved: J. Ochoa, P. Gallegos, Patricia Poveda, C. Asaquibay (INIAP–DNPV); W. Vásquez, A. Martínez (INIAP Fruit Program); Barrera, Escudero (INIAP-RRNN); Backman, Gugino (Penn State). *Description*: (i) validation trials for the grafted naranjilla (resistant to *Fusarium* and, thus less susceptible to other problems) are being conducted. A second year of trials for alternative fungicides to control common foliar fungal diseases are also being conducted (Captan, Copper Hydroxide, Copper Sulfate, Difenoconazol 250 g/l, Triadimefon 20 g/l, Azoxistrobin, *Bacillus* spp.). Penn State will continue to offer support on the identification of *Fusarium* spp. through the Penn State *Fusarium* Research Center; (ii) INIAP has initiated studies on the efficiency of using a virus, already isolated, in control of the naranjilla fruit borer. This experiment will open promising areas of research. The fruit borer has been found to affect eggplant, and, under certain conditions, tree tomato. We suspect that there are different insect races and will work with CIAT to study the effect of the virus under different conditions.

Task 3: (Ecuador) Development of IPM components for tree tomato IPM package. *Status:* continuing. *Scientists involved:* Ochoa, Gallegos, Poveda, Asaquibay, Vásquez, Martínez, Barrera, Escudero (INIAP); Backman, Gugino. *Description:* (i) Continuation of trials on farmer fields to evaluate laboratory-identified techniques for control of anthracnose (*Colletotrichum acutatum*), root-knot nematode (*Meloidogyne incognita)*, and viruses (TaMV, PVY) using field sanitation procedures; (ii) Continuation of trials for managing late blight and mildew using low-toxicity fungicides (Captan, Copper Hydroxide, Copper Sulfate, Difenoconazol 250 g/l, Triadimefon 20 g/l , Azoxistrobin, *Bacillus* spp.); and (iii) Continued testing of uses of bio-rational controls for insect (B.t, insect pathogens, etc.) and disease management (*Bacillus* spp., *Trichoderma* spp., etc.). Penn State will support biological control of foliage and fruit disease by sending known biological control isolates (from the Pichilingue station) for evaluation against the complex of other diseases on solanaceous crops.

Task 4: (Ecuador) Development of IPM components for blackberry IPM package. *Status:* continuing. *Scientists involved:* Ochoa, Gallegos, Poveda, Asaquibay, Vásquez, Martínez, Barrera, Escudero (INIAP); Backman, Gugino. *Description:* An experiment with three treatments has been established for blackberry IPM on farmer fields: (i) farmer practice; (ii) INIAP recommendations with reduced chemical inputs (IPM); and (iii) an organic production system. Components of each system are being monitored and will be evaluated. Penn State will collaborate on practices aimed to control Botrytis fruit rot and anthracnose using alternative pesticide practices.

Task 5: (Honduras and Guatemala) Detection of virus and virus-like pathogens in Honduras and Guatemala. *Status:* ongoing. *Scientists involved:* Brown (AZ), Palmieri (UDV Guatemala), several at FHIA (Honduras).

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

Progress to date: Yellow sticky traps (four per field) for 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). 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) are being evaluated to improve coverage for better psyllid control. Variety trials are planned for the fall 2012 season. Plots will be established and monitored in the fall 2012-winter. Yellow sticky traps will be used to monitor psyllid infestation and samples will be collected to verify infection in plants considered symptomatic.

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

Task 6: (Honduras) Developing/optimizing the diagnostics for the sweet potato viruses in Honduras. *Status:* ongoing. Scientists involved: Brown (U-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 of 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. This component will be carried out with the assistance of the M.S. graduate student from Guatemala (Jan 2012). The reason for the delay in designing RT-PCR primers and moving ahead full force on this task is that the graduate student was expected to begin in January 2011 but was unable to do so.

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 7: (Dominican Republic) Use of four tactics for the management of whitefly, aphids, and thrips on pepper. *Status*: New. Scientists involved: S. Medrano Cabral, M. Ferreira, A. Viloria (IDIAF), Gugino, Brown. *Description*: Task consists of four separate activities; these will be integrated along with cultural and agronomical practices used by producers that are considered to be good agricultural practices.

(i) Protective mulches and pest monitoring (Yellow traps and hand collecting). Hand collecting is a method to monitor the incidence of pests other than whitefly. Beds will be covered with clear polyethylene plastic mulch used as a repellent and will remain covered though the crop cycle. The three major vector pests will be monitored two times a week with the use of sticky yellow traps and scouting methods once a week to identify the presence of mites, other arthropods, and diseases. The method consists of taking ten samples from the crop. Each sample will be coded using the divisions created by block and rows, and each sample will consist of ten leaves from different strata on the plant. Plants with viral or other pathogenic symptoms will be removed promptly and the pathogen/disease will be identified. The level of infestation of the crop will be determined by calculating the percentage of individual pests per block per week and by ranking the number of individuals per leaf (size of colonies).

(ii) Diversification using basil and cilantro. In order to diversify, break the rows, attract natural enemies and pollinators, we will transplant basil and cilantro. The organization of the alternating two crops is as follows: cilantro on the wind break rows; three basil plants inside the crop transplant alternated in a progressive formation pattern every seven pepper plants per row. (iii) Use of two entomopatogenic fungi (*Beauveria bassiana* & *Verticillium lecanii*). To manage and control whiteflies and aphids when populations exceed three individuals per plant or when the traps have more than four individuals of different species for more than two weeks, inoculations of *Beauveria bassiana* and *Verticillium lecanii* will be used to reduce the populations. (iv) Insecticidal soap and neem oil. To manage and control mites and other arthropods that are not part of this study but have to be controlled in order to obtain better yield, we will apply, based on monitoring results, control measures with neem oil and insecticidal soap to affected areas. Pest and natural enemy populations will be quantified before and after the applications.

Task 8: (Dominican Republic) Research on the use of associated flowering plants as attractive hosts for natural enemies. Status: Continuing. Scientists involved: Medrano, Foster, Gugino. Description: Propagate ten aromatic, cereal and ornamental plants to be used as hosts for natural enemies. Subsequently we will conduct an open field evaluation of the effectiveness of the plants used to attract natural enemies and their impact on the cropping system. Plants to be tested are: *Ocimum basilicum*, *Coriandrum sativum*, *Tagetes* spp., *Helianthus annuus*, *Cleome viscosa*, *Salvia* spp., *Calotropis procera*, *Asclepias* spp., *Solidago* sp. and *Zea mais.*

Task 9: (Dominican Republic) Identification and management of nematodes using organic mulch (boscashi, an animal manure) on oriental vegetables (long bean, bitter melon and hot pepper). *Status:* continuing. *Scientists involved:* M. Martinez (IDIAF), Gugino. *Description:* install trial in an experimental plot; monitor nematode populations. Trial will include applications of organic mulch and a control plot in a randomized block design. *Progress to date:* in current year, nematodes were identified. Outputs: This research forms part of the MS thesis in IPM from Universidad Autonoma de Santo Domingo (UASD) for Ms. Teofila Reynoso.

Task 10: (Dominican Republic) Evaluation of biological control of *Ralstonia solanacearum* in tomato. *Status:* new. *Scientists involved*: Martinez, Halpay (IDIAF), Gugino. *Description:* A field and laboratory study will be conducted to test *Pseudomonas fluorescens* and *Bacillus subtilis* as a preplant soil treatment for controlling bacterial wilt and root-knot nematode on tomato (*Solanum lycopersicum*). Treatment of both agents will be applied to determine whether combining these tactics could improve

bacterial wilt management. The test sites will be artificially infested with *Ralstonia solanacearum* and *Meloidogyne. A* laboratory test will also be conducted.

Task 11: (Dominican Republic) Evaluation of the use of grafting susceptible scion variety onto select resistant rootstocks for the control of *Ralstonia solanacearum* in tomato. *Scientists involved*: Martinez (IDIAF), Gugino. *Description:* The objective of this study is to investigate the use of grafting to control *Ralstonia solanacearum* on tomato under field condition and also in greenhouse. Experiment will be established in open fields using accepted experimental designs. Soil will be infested with cultures of *Ralstonia* obtained from infested plants in the field. This trial will build-off the successful use of grafting to reduce bacterial wilt losses in the U.S. and elsewhere worldwide including Honduras, a partnering county in this project. Where possible, promising resistant rootstocks from other countries as well as those identified in the DR will be evaluated using one susceptible scion variety. Un-grafted and self-grafted controls will be used to assess the performance of the grafted treatments. The incidence and severity of bacterial wilt will be recorded weekly and yield data will collected at the end of the season.

Task 12: (Dominican Republic) Evaluation of the antagonistic effects of *Trichoderma* spp. and *Bacillus* spp. against *Fusarium oxysporum* and *Rhizoctonia solani* on tomato and pepper. *Status*: continuing. *Scientists involved*: Mendez (IDIAF), Backman. *Description*: Task will involve the following steps (i) Isolation and purification of the antagonists; (ii) inoculation of pepper and tomato plantlets with *Trichoderma* spp.; (iii) quantify level of damage to seedlings and the growth of fungi in Petri dishes; (iv) measure the level of inhibition of *Trichoderma* spp. against *Fusarium*, Rhizoctonia and Sclerotium. Expected outputs: preliminary knowledge of effects of Trichoderma on disease supression. Some commercial isolates will be utilized as internal controls.

Task 14: (Dominican Republic) Evaluate the effectiveness of solarization in reducing soilborne pathogens on pepper. *Status:* continuing. *Scientists involved*: Mendez and Polanco (IDIAF), Backman. *Description:* Task involves the following (i) preparation of land; (ii) seedling production and test facility; (iii) evaluation and data collection; (iv) pathogenicity test. *Expected outputs:* preliminary knowledge of effects of solarization on reduction of soil-borne pathogens.

Task 15: (Dominican Republic) Evaluate the effect of agronomic practices on the aphid populations and the reduction of virus incidence on pepper. *Status:* continuing. *Scientists involved:* Medrano, Martinez (IDIAF), Tolin (VT). *Description:* Task will involve the following steps (i) installation of experimental plot; (ii) diagnose viruses and (iii) monitor viral disease

Task 16: (Honduras) Management of the complex Zebra-chip disease-psyllid of potato and like diseases of other solanaceous crops. *Status:* continuing. Scientists involved: FHIA: H.R. Espinoza and J. C. Melgar. Purdue: Foster and Weller. AZ: Brown. *Description:* Because of their economic value and widespread consumption potato, tomato and peppers have historically ranked as the most important vegetable crops of Honduras. In the last decade a pathological problem has gradually arisen 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. The magnitude of the loss and the local importance of the crop are such that in the last year public and private institutions have initiated actions toward combating the problem. For the disease to occur the bacteria have to be necessarily transmitted to healthy plants by a vector, the Potato psyllid (*Bactericera cockerelli*). According to literature generated elsewhere, the control of this complex relies essentially on combating the vector. In addition, it has been reported elsewhere that tomato and pepper also are hosts of the complex, as well as some weeds; in Honduras the problem has been reported so far only on potatoes but, if also occurring on tomato and pepper, it would endanger production of these crops. Some activities will be continuation of those initiated the previous year and some are new ones, as follows:

a) 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. Additionally, this year some 20 yellow traps will be deployed 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.

b) Validation of the most promising management strategies. Particular consideration will be paid to evaluate in separate trials insecticidal chemicals of different modes of action, improved spraying technology, and use of the entomopathogen *Metarhizium anisopliae* for control of the psyllid.

c) Continue the characterization of the reaction of potato varieties**.** At least one trial will be established in collaboration with individuals, associations of growers and seed providers to evaluate the reaction of cultivars of current use in Honduras to the complex Zebra chip-psyllid.

Progress to date: The results of samples are currently being analyzed, along with data from monitoring being carried out in grower fields. Preliminary evidence shows the widespread occurrence of the problem in the main potato growing areas of Honduras. Two potato varietal trials were completed (one at La Esperanza and one at Ocotepeque) in collaboration with growers, seed importers and local producers of certified seed that provided the seed tubers; these trials showed that there are differences in varietal expressiveness of the symptoms of the disease. A bulletin was published based on literature review, 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 also produce information required to support recommendations on chemical control, variety utilization, cultural and biological alternatives to chemical control, management of alternative hosts and other management practices; transfer to growers and field extension workers of information leading to improved management of the problem.

Task 17: (Honduras) Management of late blight in potatoes. *Status:* continuing. *Scientists involved:* FHIA: J. C. Melgar and J. Mauricio Rivera. Purdue U.: R. Foster and S. Weller. *Description:* Late blight in solanaceous crops (caused by the Stramenopyle *Phytophthora infestans*) is regarded locally as the most important disease of potato. In the absence of resistant potato cultivars, in Honduras the control of this disease relies 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 mancozeb, 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 though 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 the population of the pathogen. It has been found that in sites with the two known mating types of the organism the frequency and speed of development of mefenoxam-resistant strains are much higher than where only one mating type occurs. It is then 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 anecdotal reports of failure of mefenoxam to control late blight.

Current year activities: We will be continuing those activities initiated the previous year, as follows: (i) Isolation and in-vitro laboratory assays to determine if resistance to mefenoxam occurs in local isolates obtained from the main potato cropping areas. (ii) Determination of the status of the mating nature of isolates of the organism obtained

from the main potato cropping areas. (iii) Publication of a pictorial guide to assist in decision-making for spraying chemicals for late blight control.

Progress to date: In 2010-11 work was started with an undergraduate intern from Universidad Nacional de Agricultura (UNA) to test the sensitivity to mefenoxam and to determine the sexual status of the pathogen. Unfortunately, the laboratory tests carried out failed to provide the information they were meant for. To prevent that from happening again, in 2011 J. C. Melgar spent time at North Dakota State University (as a grantee of the Borlaugh program of the USDA) where, among other activities, he received hands-on training in the field and laboratory protocols necessary to do the necessary analyses. We completed a review of literature on late blight control, and finished the illustrations for the pictorial guide.

Expected outputs: To complete determination of the status of *P. infestans* regarding sensitivity to mefenoxam in a reduced number of isolates of the pathogen. To determine the sexual status of the pathogen in Honduras. Produce 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 18: (Honduras) Management of bacterial leaf and fruit spots of tomatoes and peppers. *Status*: continuing. *Scientists involved:* FHIA: J. C. Melgar and J. Mauricio Rivera C. Purdue U.: S. Weller. *Description:* In order to provide local market a steady supply of tomatoes and peppers, producers must grow the crops throughout the year. During the rainy period from June thru October these crops are field-grown under environmental conditions highly favorable for occurrence of leaf and fruit diseases of bacterial and fungal etiology, forcing growers to make higher investments in chemicals for disease control. The higher production cost is offset by better prices of the produces in the rainy season and result in higher profits. Based on historical records generated from specimens analyzed at FHIA's plant pest diagnostic clinic and also field observations by FHIA scientists, we have found that 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 inappropriate chemical control measures and has provoked heavy losses to some growers since the control applied for one disease is not necessarily the appropriate for the actual cause of the symptoms. It is therefore necessary to provide the extension workers and growers with information leading to correct application of the right control measures.

Current year activities: Activities this year include: (i) one more round of collection in the field of specimens representative of the leaf and fruit spots occurring in tomato and pepper fields; (ii) laboratory analysis using standard plating techniques and ELISA testing; (iii) finalization and publication of a field guide for recognition and management of the diseases; (iv) training and technology transfer events to transfer to growers and field extension workers 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 mis-diagnosis.

Task 19: (Honduras) Management of bacterial wilt in solanaceous and other key crops. *Status:* Continuing. *Scientists involved:* FHIA: J. C. Melgar and J. Mauricio Rivera C. Purdue: Foster and Weller. AZ: Brown. *Description*: Bacterial wilt (caused by *Ralstonia solanacearum*) has become an important cause of death of plants in tomato, pepper, eggplant and occasionally potato. Tools available for management of the disease are limited, and are based on preventive measures to avoid ingress of the pathogen into the fields and into the plants.

Grafting on resistant eggplant (*Solanum melongena*) rootstocks has been successful in Asia as an effective means of controlling bacterial wilt on eggplants, tomato and peppers. Likewise, soil biofumigation with brassica residues, alone or combined with solarization has also been reported to reduce occurrence and damage of bacterial wilt.

Current year activities: Some activities will continue or complete those initiated the previous year and some are new ones, as follows: (i) Publication of growers' guides for recognition and management of bacterial wilt in vegetable crops. (ii) Conduct field evaluations of grafting of tomatoes and eggplants as a means to control the disease, using rootstocks introduced from AVRDC-Taiwan in 2011. (iii) Transfer to growers and field extension workers information leading to improved management of the problem.

Progress to date: Collection of literature on bacterial wilt was finished and we have a draft of the growers guide for recognition and management of bacterial wilt disease. A trial is being 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^2) as the source for the biofumigation principle. Seeds of four lines resistant to Bacterial wilt were introduced from AVRDC-Taiwan for evaluation next year.

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 20: (Honduras) Management of root knot nematode in solanaceous and other key crops. *Status:* Continuing. *Scientists involved:* FHIA: F. J. Diaz and J. Mauricio Rivera C. Purdue: Foster and Weller. AZ: Brown. *Description*: *Meloidogyne* is the most important genus of nematodes worldwide. In Honduras, root-knot nematodes are a major problem, especially in Solanaceous crops. Its 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 on 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; it was twice found that some of the accessions were associated with significant reduction of populations of the root-knot in the soil prior to the follow-up commercial crop. The literature has documented that the efficacy of use of 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 complete those initiated the previous year and some are new ones, as follows: (i) Publication of growers' guides for recognition of root knot nematode in vegetable crops. (ii) Establish trials at FHIA's station in the Comayagua Valley of the Caliente Brand Mustard cvs. NEMAT/199 and NEMAT to evaluate its effect as a rotation crop and as a biofumigant. (iii) Country-wide collection of field specimens of the root-knot nematode occurring on tomatoes, peppers, eggplant, cucurbits and other crops of importance to ascertain the species by morphological and molecular analyses at Purdue by graduate student David Perla. (v) At least one validation plot with the two best-performing nematode-resistant cowpea lines in grower's field representative of tomato, pepper or export oriental vegetables in the Comayagua Valley. (vi) Establishment of a seed production plot of the best two performing Cowpea lines at FHIA's research station in the Comayagua valley. (vii) Transfer to growers and field extension workers of information leading to improved management of the problems.

Progress to date: The guide on the root knot nematode is still being worked on. A draft has also been prepared on the specific use of solarization as management tool for root knot nematode.

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 21: (Honduras) Integrated management of viruses of sweetpotato. *Status*: continuing. Scientists involved: FHIA: F. J. Díaz, José C. Melgar, J. Mauricio Rivera C.; Purdue: Foster; AZ: Brown. *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, among several limitations, virus diseases appeared to be one of the main causes of 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, promoting the production of virus-free propagative material, as joint activity together with the project Global Theme on Insect Transmitted Viruses.

Current year activities: Continuation what was initiated the previous year, namely: (i) Collection and analyses of plant specimens to identify the prevalent viruses. (ii) Preparation 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 initiated; the analyses were performed at UAZ (as part of the collaborative activities linking with the Global Theme on Insect Transmitted Viruses), and also at the commercial diagnostic lab, AGDIA (Elkhart, IN, USA). Introduction from CIP/Peru of seed of *Ipomoea setosa* ("Campanilla") to utilize as rootstock on which to graft scions of desired commercial varieties to test if they are free of virus diseases (the rootstock works as an indicator plant, inducing the scion to express symptoms in positive cases)

Expected outputs: A publication presenting a national profile on the identity of commonly prevalent virus diseases and their management strategies. Transfer to growers and field extension workers of updated information leading to improved management of the problem. Reduction in field crop losses due to the negative effect of viruses in sweet potato.

Task 22: (Honduras) Management of Thrips and mites in eggplants and other horticultural crops. *Status:* Continuing. *Scientists involved:* FHIA: H. R. Espinoza, F. J.

Díaz; Purdue U.: Foster. *Description:* Thrips and mites are important pests attacking different vegetable crops in Honduras. The damage they provoke to foliage results in yield reduction and, in the case of crops in which the fruit is attacked, like eggplants, their damage to the skin of the fruit renders them unacceptable for the market. This kind of damage is particularly critical in crops destined for the export market, 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 which, in the case of thrips pose a high risk of development resistance by the insect.

Current year activities: Completion of and analyses of data from current field trial monitoring in 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.

Progress to date: In 2011 a third run of the trial was conducted, in which interplanting of sunflower plants is evaluated for effects on reducing cosmetic damage provoked by mites on the skin of fruits of a crop of eggplant. The second trial (2010-2011) was partially lost due to a severe epidemic of bacterial wilt and incomplete data were obtained. The results of this third run show results consistent with those of the previous years: in the plots diversified with sunflower interplants, with out any application of insecticides, the populations of *Orius* have been higher, the populations of mites and thrips have been much lower, and the incidence of scarred fruits has also been significantly lower, and their exportable yield has been higher than in the insecticide-treated plots.

Expected outputs: Identification and dissemination of environmentally friendly practices leading to successful control of mites and thrips. 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 the negative effect of mites and thrips.

Task 23: (Honduras) Management of purple nut sedge (*Cyperus rotundus*) in horticultural crops in Honduras. *Status*: New. *Scientists involved:* FHIA: F. J. Díaz; Purdue: Weller.

Description: Purple nutsedge and its relative, yellow nutsedge, are among the most difficult weeds to control and their management can become very expensive. In the Comayagua valley of Honduras nutsedges have become a serious problem, adding to the production cost by having to incorporate additional work hours to do cosmetic hand control. There has been no research performed locally to manage this problem and all

the practices applied for its control are not based on sound studies relating cost to benefit of the application.

Current year activities: Initiate control studies establishing a trial evaluating several alternatives that have shown effectiveness elsewhere.

Expected outputs: Identification of environmentally friendly practices leading to successful control of the weed. Reduction in use of pesticides for its control. Transfer to growers and field extension workers of updated information leading to improved management of the problems. Reduction in field costs and losses.

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 from one region/country to another. Most of the technology sharing takes place during annual meetings of the LAC group, but others (such as grafting for control of *Fusarium* wilt in naranjilla) are brought in from other CRSP regions. This year, the entire regional project expects to benefit from training received by M. Rivera (FHIA, Honduras) on the use of *Trichoderma* spp. and other bio-controls. A working group within Honduras has identified some opportunities for technology transfer. Group consists of members from Honduras and working group will prepare candidates for transfer and report to full project during annual meeting.

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

Task 1: Adaptation and development of an IPM package for potato pests in Ecuador. Status: continuing. *Scientists involved:* Ochoa, Gallegos, Poveda, Asaquibay, Barrera, Escudero (INIAP); Backman, Gugino. *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 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 2: 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), Rivera (Honduras-FHIA).

Description: the global IPM CRSP and the LAC regional project have 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 3 identified several Bacillus spp. that showed excellent potential for biological control of diseases.

Task 3: 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.

Task 4: Present overview at annual meeting in Guatemala.

Activity 3: Continue to coordinate activities with global themes

Description: 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)

Progress to date: In the first two years of the project, significant accomplishments have been achieved in coordinating with the global themes. Three of the four (excluding the gender theme) had representation at the annual meeting (May 2011 in Dominican Republic). The impact assessment global theme is currently conducted a baseline survey in DR in 2011 fiscal year; analysis will be completed in 2011-2012. Impact assessment data collection and analysis will continue for Ecuador (data collection in Carchi to measure the impact 6 years after our IPM potato program ended) and Guatemala (baseline data are currently being collected). In both countries, the impact activities will be combined with analysis suitable for gender global theme outputs. The IPDN and virus global themes have active research and training programs in the LAC region.

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:* ongoing. Scientists involved: Norton, Alwang (VT), Barrera (INIAP). *Description:* during current year, the impact assessment global theme together with partners in Ecuador completed a baseline

survey. A compilation of this data and a brief description will be produced. Expected outputs: report on baseline data.

Task 2: Baseline survey for Dominican Republic. *Status:* continuing. *Scientists involved:* Norton, Alwang (VT), Martinez (IDIAF). Description: the impact assessment global theme together with partners in DR, has undertaken a baseline survey. An analysis of this data will be completed; this analysis will include an analysis of gender-specific information.

Task 3: Gender and Participatory Methodologies Workshop (Dominican Republic). Status: new. Scientists involved: Gender global theme. (i) Analysis of methodology; (ii) invitation to groups of interest; (iii) Workshop (2 days).

Task 4: Rapid Gender Assessment (Dominican Republic). Status: new. Scientists involved: Gender global theme. (i) Identification of 2 communities to visit. (ii) Selection of households (10 per community). (iii) Field work (3 days)

Task 5: Complete analysis of gendered constraints to technology adoption in Ecuador. *Status:* continuing. *Scientists involved:* Alwang, Barrera (INIAP). *Description:* The baseline survey (described above) contained several modules that were focused on women and a qualitative study was undertaken by an MS student (Megan Byrne). These studies will be synthesized during the 2012 fiscal year. *Outputs:* Report.

Task 6: Creation of a technique to identify "women's crops" with an application to Honduras. Status: continuing. Scientists involved: Alwang (VT). Description: USAID is interested in understanding ex-ante the potential impacts of CRSP research on women. This information can help prioritize research. While it is possible to apply a comprehensive survey to gain this information, most countries where the CRSP works avail of alternative household data sources that might contain sufficient information to address the gender issue. We are working on a framework to summarize these impacts and identify key parameters. Outputs: research paper.

Task 7: Analysis of baseline survey (Guatemala). *Status:* New. *Scientists involved:* Norton, Alwang (VT), Valenzuela (Zamorano), Palmieri (UVG). *Description:* the impact assessment global theme together with partners in Guatemala, is fielding a baseline survey. An analysis of this data will be completed; this analysis will include an analysis of gender-specific information.

Task 8: Evaluation of impact of IPM in potatoes for Carchi, Ecuador. *Status:* New. *Scientists involved:* Norton, Alwang (VT), Barrera(INIAP). *Description:* The IPM CRSP worked for approximately 6 years from 1999-2005 developing and disseminating an IPM package for potatoes in Carchi, Ecuador. Dissemination involved field days, farmer field

schools and other techniques. An evaluation conducted in 2005 (Maucieri) indicated that uptake of the package was significant. We propose to revisit the area, resurvey and examine whether potato IPM is still wide-spread and which, if any, of the technologies have had the most impact. We will: (i) field a follow-up survey among potato producers in Carchi; (ii) analyze the data; and (iii) produce a report. Analysis will include an examination of impacts on women.

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*: ongoing. *Scientists involved*: Barrera, Ochoa, Gallegos, Martínez and Vásquez (INIAP); Robert Andrade (CIAT); Alwang and Norton (VT); Andrew Sowell and Gerald Shively (Purdue University). *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 and Andrade). This information serves as a baseline prior to introduction of the new technology. Sowell finished analysis in 2011 and Barrera will incorporate Sowell's and other findings and finalize this activity during 2011-2012. *Expected outputs:* Draft publication.

Task 2: Validation of IPM packages for tomatoes and peppers (Honduras). *Status:* ongoing. *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: Identify priorities (demand for training) and supply of training during annual meeting in Guatemala.

Task 2: Conduct at least 3 formal short-term trainings of regional project staff in third year (Purdue internships, bio-control training at Penn State, and impact training in US).

Task 3: Offer in Honduras a regional workshop on "Status of Management of the Zebra-chip-Potato/Tomato Psyllid", with an audience made up with participants from the Central America-Caribbean region and instructors from the American Universities and institutions from Honduras involved in the project.

Task 4: Offer training on IPM to field extension workers, growers and staff of agrichemical companies in at least 20 training events in Honduras.

Task 5: Enroll at least one outstanding undergraduate student 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

Activity 2: Design comprehensive long-term training plan

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 5 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 to foster quicker development and use of effective IPM packages.

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), Martinez (IDIAF-Dominican Republic). Gender: Hamilton (DU), Alwang (VA Tech), Barrera (INIAP), Valenzuela (Zamorano—Honduras), Cuevas

(IDIAF). IPDN: Palmieri and Arevalo (Guatemala). Virus: Tolin (VT), Brown (AZ), Palmieri (UDV-Guatemala), Rivera (FHIA-Honduras), Martinez (IDIAF).

In current year, these linkages will be continued by: engaging in jointly sponsored research (see above) and participation in the LAC annual meeting (2012 in Guatemala).

Task 1: Management of diseases caused by virus, viroids, fastidious bacteria and the like. *Country:* Honduras. *Status:* Continuing. *Scientists involved*: FHIA: J. C. Melgar, H. R. Espinoza, J. M. Rivera C.; U. of Arizona: J. Brown; Virginia Tech: S. Tolin; Purdue: R. Foster.

Progress to date: A workshop on the integrated management of virus diseases and similar was offered jointly in November 2010. Information from this workshop needs to be systematized and diffused to stakeholders.

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.

Graduate Students and Post Doctoral Research Associates:

1. Name: Amy Buckmaster
Sex: Female
Nationality: US
Discipline: Agricultural Economics
Site/Country: LAC
Degree: Masters
Start date: August 16, 2010
Completion date: August 1, 2012
IPM CRSP funds: 40%
Advisor/PI: Jeffrey Alwang
Thesis topic: Unknown
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. Name: David Perla
Sex: Male
Nationality: Honduras
Discipline: Weed science/nematology
Site/Country: Honduras
Degree: MS
Start date: August 2011
Completion date: Aug 2013
IPM CRSP funds: All
Thesis topic: Unknown
University: Purdue

5. Name: Mr. Andres Weinfeld Avalos Figueroa
Sex: Male
Nationality: Guatemala
Discipline: Plant pathology
Site/Country: Guatemala
Degree: MS
Start date: August 2011
Completion date: Aug 2013
IPM CRSP funds: All
Thesis topic: Unknown
University: Arizona

6. Name: Ms. Teofila Reynoso
Sex: Female
Nationality: Dominican Republic
Discipline: Plant pathology/IPM
Site/Country: Dominican Republic
Degree: MS
Start date: February 2011
Completion date: Aug 2013
IPM CRSP funds: All
Thesis topic: Organic mulch control of nematodes in oriental vegetables
University: Universidad Autonoma de Santo Domingo (UASD)

Short-Term Training planned:

Workshops: Dominican Republic, Ecuador, Guatemala and Honduras. Workshops will cover various topics, depending on needs.

Internship at Purdue University for UG students from Honduras

Annual meeting: Guatemala

Others: Individual short term training for person from Ecuador and Honduras in US.

Publications planned:

Graduate theses:	3
Research articles:	3
Books and book chapters:	1
Extension articles:	4
Posters:	6
Bulletins:	2

Performance milestones and impacts:

Our research and outreach partners will collect information on participation in all research and training events. We will generate a standardized reporting framework and any events using IPM CRSP funds will be required to collect and report on the information. We will also devote a special section of each year's annual meeting to collecting this information and discussing the importance of performance milestones. We will report annually on the following:

Beneficiaries

- Number of households and female-headed households benefiting directly from interventions
- Number of partner organizations and active institutional members of those partner organizations
- Number of agriculture-related firms benefiting directly from interventions
- Number of women's organizations/associations assisted/benefiting
- Number of new public-private partnerships formed/benefited
- Number of ongoing public-private partnerships assisted/benefited

Training

- Male participation in short-term training
- Female participation in short-term training
- Male participation in long-term training (part of annual reporting)
- Female participation in long-term training (annual reporting)

Our annual report will collect information on:

Technologies

- Technologies under research
- Technologies being field tested
- Technologies available for transfer

Policy development

- Policy studies undertaken & disseminated
- Number of institutions/organizations undertaking capacity/competency strengthening as a result of IPM CRSP assistance
- Information on policy reforms and the role of the IPM CRSP in promoting the reforms will also be collected. We will devote a special section of each year's annual meeting for collecting and reinforcing the importance of this information.

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.

1) Facilitate and expedite project administrative activities. *Task:* Maintain and update subcontracts and expedite financial flows.

2) Strengthen the regional collaborative IPM research and development model. *Tasks:* Plan and implement fifth meeting of RTC in the region; Improve RP/EA website portal (http:/www.aaec.vt.edu/ipmcrspuganda/IPMCRSPEA/).

3) Improve IPM research and technology transfer in the region. *Tasks:* Approve research work plans for Year 3 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.

4) Ensure integration of Global Theme Programs into the regional program. *Task:* Integrate prioritized GTP activities into Year 3 work plan.

5) Strengthen regional capacity for performance monitoring. *Task:* Implement integrated plan for performance monitoring including the use and compilation of Activity Reporting Forms.

6) Build IPM human resource capacity in the region through advanced degree training. *Tasks:* Implement training plans for each country; Implement first year advanced degree training programs.

7) Support presentation and publication of research results. *Tasks:* Co-PIs 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.

1) Develop IPM packages that address priority pests of tomato.

Uganda:

1. Activity Title: IPM Technologies Transfer to Tomato Farming Communities

Co-PIs: J. Karungi, S. Kyamanywa; Z. Muwanga, G. Bisso, P. Sseruwagi, M. Kleinhenz, J. Kovach, and M. Erbaugh

Priority Pests: Bacterial wilt (*Ralstonia solanaceurum*) and late blight (*Phytophthora infestans*)

IPM tasks or strategies to be disseminated: The IPM package developed during previous IPM CRSP phases to be disseminated includes use of tolerant varieties (MT56; AVRDC series: CLN3022C, CLN3008A, CLN2413L, LBR16, LBR17); raised beds, mulching, staking, and grafting as strategies to reduce incidence and severity of bacterial wilt and late blight of tomato. MT 56 is resistant to bacterial wilt in Uganda, but sometimes farmers prefer other varieties; in the latter case, we recommend that they use MT 56 as a rootstock for their preferred varieties.

Description: Efforts will be put in scaling up dissemination of the package to Mukono and Wakiso districts in Central Uganda where tomato growing is a thriving commercial enterprise. Demonstration plots and a modified farmers' field school approach will be the transfer approach utilized. We will also continue to seek out and evaluate other potential rootstocks and improved germplasm as a continuous process to improve the package for managing bacterial wilt and *Phytophthora* blight.

Current research status: The IPM technologies being transferred have been verified and proven effective; pioneer farmer groups that were exposed to the technologies were well received.

Expected outputs: More farmers would be aware of the benefits of IPM in the production of tomato; increased tomato yields.

Location: Mukono and Wakiso districts, Central Uganda

Farmer or NGO group identified: (Balikyewunya Farmers group and Namulonge Horticultural farmers Association).

2. Activity Title: Facilitate registration and release of tomato variety MT56 to the Ugandan farming community

Co-PIs: P. Rubaihayo, S. Kyamanywa, G. Tusiime, D. Asiimwe (MSc. Student), P. Sseruwagi, M. Kleinhenz, S. Miller, and M. Erbaugh

Priority pests to be addressed: Bacterial wilt

IPM objectives/strategies to be tested: Resistant/tolerant germplasm for management of bacterial wilt of tomato

Description: The variety MT56 was screened alongside popular tomato varieties in six agro-ecological zones in Uganda for tolerance to bacterial wilt and yield stability. The performance of the variety was found to be very high. This data will be documented and presented to the Varietal Release Committee for clearance to release and promote. Efforts will also be put in establishing linkages with seed companies for distribution of the variety.

Current research status: Multi-location verification of MT56 for tolerance to bacterial wilt completed; mechanism of resistance also established.

Expected outputs: MT56 cleared for official release to farming communities

Location: Kampala

Farmer or NGO group identified: (to be confirmed).

3. Activity Title: Develop and promote novel techniques for management of boll worm, spider mites, and leaf mining flies on tomato

Co-PIs: M. Otim, S. Kyamanywa, Z. Muwanga (MSc student), M. Kleinhenz, J. Kovach

Priority pests to be addressed: Boll worm (*Helicoverpa* spp.*)*, leaf miners (*Liriomyza* spp.*)*, spider mites (*Tetranychus* spp.*)*.

IPM objectives/strategies to be tested: Reduced pesticide usage on tomato against the boll worm and other insect pests of tomato.

Description: Finalization (season II) of the trial assessing the effect of different spray regimes consisting of: i) spraying once a week with a mixture of an insecticide (Dimethoate) and a fungicide (Agrolaxyl); ii) spraying the mixture once in vegetative growth & once during flowering; iii) spraying the mixture twice during flowering and twice during fruiting; iv) weekly application of Agrolaxyl fungicide sprays only; v) weekly application of Dimethoate insecticide only; and vi) untreated control. The design is a RCBD with three replications.

Current research status: Continuing activity; season two of the trial is on-going.

Expected outputs: Reduced pesticide spray schedule.

Location: On-farm; Namulonge, Wakiso district.

Farmer or NGO group identified: Mr. Nsamba's farm.

4. Activity Title: Establishment of the effectiveness of seed/soil treatment with the Arbuscular Micorrhizal Fungi (AMF) in the management of fungal, bacterial and nematode problems of tomato

Co-PIs: M.S. Rwakikara, S. Kyamanywa, M. Kleinhenz, M. Erbaugh

Priority pests to be addressed: Bacterial wilt (by *Ralstonia solanaceurum*) and late blight (by *Phytophthora infestans*); *Fusarium* wilt; gray leaf spot of tomato; and nematodes.

IPM objectives/strategies to be tested: Use of naturally occurring soil micro-organisms (AMF) to improve tomato nutrition and fight disease causing pathogens.

Description: This is new idea of IPM and will involve AMF inoculum multiplication (bulking) in order to produce sufficient quantities for evaluation trials. Initial screening for effectiveness will be done in the screen house.

Current research status: AMF inoculum has been collected and bulking procedures are to follow in the laboratory; thereafter, efficacy testing in the screen house will be implemented.

Expected outputs: AMF genera/spp. identified, bulked, and screened for efficacy.

Location: On-station; MUARIK.

Farmer or NGO group identified: To be included in year III.

5. Activity Title: Effect of soil fertility amendments on incidence and severity of the insect vectors and viral diseases of tomato in Uganda

Co-PIs: M.S. Karungi, S. Kyamanywa, M. Ochwo-Ssemakula, P. Seruwagi, M. Kleinhenz, J. Kovach, M. Erbaugh

Priority pests to be addressed: Insect vectors and viral diseases of tomato.

IPM objectives/strategies to be tested: Soil management technologies for pest management.

Description: Currently, tomato viruses are causing high yield losses. A recent study shows that tomato mosaic virus, cucumber mosaic virus, tobacco mosaic virus, potyviruses, and tomato spotted wilt virus (in that order) were the most important viruses infecting tomato in Uganda. Since there are no recommended virus management practices as of yet, this effort will be focused on improving plant vigor and health so that a farmer can achieve reasonable yields despite the occurrence of viruses. Various

methods to improve plant health will be evaluated; different soil amendment options—plastic mulch, cattle manure, straw mulch, coffee husks, and weeding—will be included.

Current research status: Research concerning distribution and occurrence of viruses affecting tomato in Uganda has been done. Sometimes a single plant will have more than one virus affecting it, and so far there is no tolerant variety.

Expected outputs: Foundation for building IPM technologies for control of tomato viruses.

Location: On-station; MUARIK.

Farmer or NGO group identified: To be identified.

Kenya: Tomato

1. Activity title: **Tomato grafting trials**

Co-PIs: M. Waiganjo, C. Kambo, S. Kuria, C. Njer, J. Mbaka, R. Amata, M. Erbaugh, S. Miller, S. Kyamanywa, M. Kleinhenz, J. Kovach, C. Gathambiri, S. Wepukhulu

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 objectives/strategies to be tested: Carry out grafting trials on-farm in Kirinyaga for two seasons using new commercial tomato scions and wilt tolerant rootstock lines.

Brief description of tasks: Grafting susceptible varieties (Onyx, Ana F1 Hybrid) onto resistant ones (MT56, TKA193-31, TKA 155-18, TKA 81-1) is an effective approach to control bacterial wilt in tomato, but the technology has not been explored in tomato production in Kenya. High tunnel production is rapidly gaining importance among smallholder tomato growers in Kenya owing to its many benefits. The technology enables continuous or prolonged higher and better quality yield in a relatively small area regardless of weather changes and enables better pest management. However, limited technical knowledge on high tunnel production among poor small holder farmers is a major challenge.

Two on-farm trials done using one bacterial wilt tolerant line (MT56) have shown promising results. However, more wilt tolerant rootstocks (locally available TKA-lines) need to be grafted on commercial indeterminate varieties adapted for high tunnel

production systems. Such a technology would address an existing gap among the users of tomato high tunnel production systems in the region. The objectives of these trials are: to test new rootstocks for tolerance to soil-borne pests including nematodes using already commercialized high tunnel adapted scions; and to assess the plant vigor, yield, and fruit quality of the tomatoes.

Current research status of the strategy: On-farm.

Where on-farm trials will occur: Kirinyaga.

Farmers: Simon & Bayer tomato farmers group.

2. Activity title: **Tomato farmer/extension training**

Co-PIs: M. M. Waiganjo, Z. Kinyua, Otipa, Amata, M. Erbaugh, S. Miller, P. Seruwangi, C. Kambo, C. Njeru, J. Charity Gathambiri Gitonga

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.

Description: Tomato represents an important cash crop for small-scale growers. The crop is associated with increased rural incomes, living standards, nutrition, and employment. Tomato production is limited in the region by a plethora of pests and diseases. The most important tomato pest problems in the region are late blight *(Phytophthora infestans),* bacterial wilt *(Ralstonia solanacearum),* bollworm (*Helicoverpa armigera*), and thrips *(Thrips tabaci* and *Frankliniella* sp.*).* The small-scale growers' and extension staff's knowledge of pest identification and management strategies are limited. The objectives of this activity are: to assess the pest knowledge of farmers and extension staff on tomato pest diagnostics and management; to carry out a two-day tomato IPM training at KARI-Thika; and to improve their knowledge.

Current research status of the strategy: On-going.

Training Location: KARI-Thika and Kirinyaga tomato fields.

Farmer group: Mwea Bayer tomato farmers group.

3. Activity title: Initiate trials on use of bio-pesticides *Trichoderma* spp. as soil amendment to control bacterial wilt, *Ralstonia solanacearum*

Co-PIs: K. Sylvia, G. Tusiime, M. Waiganjo, S. Wepukhulu, M. Erbaugh, S. Miller, S. Kyamanywa

Priority Pests: Bacterial wilt (*Ralstonia solanacearum)*

IPM strategies to be tested/disseminated: Management of a serious, tomato bacterial disease, *Ralstonia solanacearum,* using safe, environmentally-friendly bio-pesticides to control the soil borne disease.

Description: Biopesticides have been tested effectively against *Fusarium* wilt in passion fruit and are currently undergoing efficacy trials towards registration against root knot nematodes in French beans. However, *Trichoderma* sp. has not been tested against bacterial wilt in tomato; such trials would provide useful information on its effect against tomato bacterial wilt, a major constraint in tomato production in the region. The trials will be initiated in year three to coincide with the year two of a student's MSc study, during which *Trichoderma* spp. will be made available.

Current research status of the strategy: New.

Status: Laboratory and on-station.

Where on-farm trials will occur: Makerere University Kabanyolo (laboratory/screen house trials.

4. Project Title: Validation of tomato IPM technologies through Farmer Field schools and development of a Tomato training handbook.

Co-PIs: M. Waiganjo, R. Amata, J. Gitonga, K. Sylvi, M. Menza, M. Erbaugh, S. Miller, G. Tusiime, S. Kyamanywa, M. Kleinhenz, J. Kovach

Priority Pests: Tomato production constraints including pests (*Ralstonia solanacearum*, *Begomoviruses*, *Phytophthora infestans*, physiological disorders [blossom end rot]), insect pests (*Liriomyza* spp., *Bemisia tabaci,* Thrips, *Helicoverpa armigera*, *Tetranychus* spp.).

Tasks: Develop and disseminate appropriate crop and pest management technologies.

Description: This is a technology transfer activity. A step-wise learning process will be carried out highlighting the tomato production practices including plant nutrition, seed selection, nursery preparation, pest management, harvesting, and postharvest handling. The pest management training options will include: use of pest- and disease-free seedling protection produced through solarization and insect netting; control of arthropod pests (whiteflies, aphids, thrips, bollworm, mites) through mulching or

staking; and use of bio-pesticides (*Metarhizium anisopliae, Bacillus thuringiensis*), diseases (*Phytophthora infestans, Alternalia solani*), and cultural control methods (proper watering and fertigation) for physiological disorders (blossom end rot, sun scotch etc). Technology transfer through field discussions will be supported by publications. Tomato handbooks to be developed include a tomato arthropod pest management guide, a tomato disease management guide, a greenhouse tomato production guide, and a tomato grafting handbook. A tomato arthropod pest management draft has already been completed.

Current Status: Continuing activity.

Expected Outputs: At least 30 farmers have participated in a tomato farmer field school in Kirinyaga District. Preparation of tomato grafting and greenhouse production handbooks is on-going. Two handbooks will be developed and issued to the smallholder farmers and extension workers. The researchers are expected to publish the research findings and present in the findings in local and international conferences.

Location: Mwea and Kangai area, Kirinyaga District.

Farmer or NGO group identified: Kangai Tisa farmers group.

Tanzania: Tomato

1. Activity title: Impact of management practices on post-harvest physiology and shelf life

Co-PIs: A.P. Maerere and H. Mtui (Ph D student registered at SUA); Collaborating Co-PI from USA: M. Bennett, S. Miller, M. Kleinhenz

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 (*Frankinnela occidentalis*), and bollworm (*Helicoverpa armigera*).

Tasks and/or IPM strategies to be tested: A field trial will be established using two varieties (Tanya VF and Tengeru 97). Disease incidence and severity will be scored using standard procedures. Fruits with symptoms will be collected for pathogen identification. On-farm demonstration of the effect of different pest management practices (Farmer practice, IPM and Pesticide spray based on manufacturers recommendations) on tomato shelf-life will take place. Tomato fruits will also be collected from farmers fields (with known spray records) in the target areas for comparison.

Current research status: On station and on-farm

Location: SUA, Mlali, Mateteni.

Farmer or NGO group: Twiyambe, Juhudi Farmer Groups.

2. Activity title: Evaluation of indeterminate tomato varieties under controlled conditions

Co-PI: 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

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 (*Frankinnela occidentalis*) and bollworm (*Helicoverpa armigera*)

Tasks and/or IPM strategies to be tested: A high tunnel will be built on station to modify environmental conditions and evaluate impact on incidence of pests and diseases. This demonstration trial will evaluate the performance and production of selected commercially available indeterminate tomato varieties. Two varieties will be tested outside and under high tunnel conditions, and pests and disease incidence will be assessed.

Current research status: On station

Location: SUA.

Farmer or NGO group: Twiyambe, Juhudi Farmer Groups.

3. Activity title: Disseminate recommended IPM package

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

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*); **Weeds** Nutsedge **(***Cyperus rotundus, pigweeds (Amaranthus spp.,* Wandering Jew (*Commelina benghalensis)* and Mexican poppy *(Argemone mexicana)*)

Tasks and/or IPM strategies to be tested: A**doption assessment:** 40 farmers will be exposed to the IPM package and monitored during bimonthly field visits to be conducted. The IPM package consists of seed treatment, mulching, insect and disease scouting, and rational application of pesticides. To evaluate impact, farmers will be assessed at the end of the growing season to compare knowledge bases. 40 farmers who have not participated will be assessed and evaluated as a control group.

Training and Training materials: Mass production of the already prepared leaflets will be done. The leaflets will be distributed during sensitization and follow-up visits. Farmer training on implementation of IPM package will be conducted at Mateteni village in Mvomero district (Morogoro region) and Msosa village in Kilolo district (Iringa region).

Current research status: Scaling out

Location: Mvomero and Kilolo (2 villages)

Farmer or NGO group: Juhudi Farmers group and others to be identified)

2) Develop IPM packages that address priority pests of passion fruit.

Uganda

1. Activity Title: Establish Influence of Grafting and Soil Fertility Amendment in the Management of Soil Borne *Fusarium* Diseases of Passion Fruit

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

Priority pests: Collar rot, *Fusarium* wilt

IPM strategies to be tested: Grafting and soil fertility amendments

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*), passion fruit wilt (*Fusarium oxysporum*), and viruses. This research will start with laboratory screening of collected germplasm; after this, tolerant lines will be used as rootstocks in field trials in addition to different soil fertility amendments that will include use of *Trichoderma* spp. and mulching.

Current status: Passion fruit germplasm have been collected from growing areas of western, central and eastern Uganda and assembled at NaCCRI. We are also expecting

to acquire passion fruit lines (KP rootstock lines) that have been found tolerant to the diseases in Kenya.

Expected outputs: Effectiveness of identified technologies for management of key diseases of passion fruit will be validated.

Location of trial: On-station (NaCRRI)

Farmer or NGO Group identified: (to be identified)

2. Activity Title: Identify Environmentally-Friendly Management Options for Vectors of Viral Diseases of Passion Fruit

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

Priority pests: Aphids (*Aphis gossypi, Myzus persicae*) and viral diseases

IPM strategies to be tested: Cultural practices

Description: Several different cultural practices will be evaluated for management of insect vectors of passion fruit viruses: mixed cropping (push-pull strategy: a more attractive crop [*to be confirmed*] to the pest's natural enemy will be grown around the perimeter, whereas a crop that is a repellent to the pest [dill] will be grown within rows of the passion fruit), mulching (straw and plastic), and weed management. A grafted Kawanda clone 7 hybrid will be used in the trial.

Current status: Preliminary findings indicate that the insect vector, aphids (*Aphis gossypi and Myzus persicae*), only appear on passion fruit plants infrequently as it is not the preferred host plant. The vector spends most of the time on alternate hosts of which some are weeds. This trial is therefore aimed at eliminating alternate hosts and interfering with the interaction between the passion fruit plant and the aphid vectors.

Location of trial: On-station (NACRRI)

Farmer or NGO group identified: (to be identified)

Kenya: Passion Fruit

1. Activity title: Validate virus detection procedures and establish clean virus free passion fruit mother block seedling nursery at KARI Thika

Co-PIs; Miriam Otipa; Ruth Amata; Waiganjo M; Juster Gitonga; Simon Wepukhulu; Sally Miller; Mark Erbaugh.

Priority Pests: Passion fruit woodiness virus complex (Potyviruses)

Tasks: Evaluate cleanliness of passion fruit seedlings at KARI Thika using designed primers

Description: Development of virus detection tools that will enable proper virus identification and facilitate proper management has been done at Ohio State University in Years 1 and 2 of the project. Sequences of two strains of the Kenya Passion fruit virus (KPFV) particles have been determined. Sequencing of more samples is ongoing. Primers are being designed based on the sequence information being generated. These primers will be useful in diagnostics of viruses affecting passion fruit in Kenya and determination of virus free seedlings at farmer nurseries. During this activity, virus free passion fruit seedlings will be established at KARI Thika, and virus detection tests will be undertaken to ensure cleanliness of the seedlings.

Current research status: On-station KARI Thika.

Where on-farm trials will occur: On-station.

Farmer or NGO group identified: attempt to identify women's group or NGO.

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

Co-PIs; Ruth Amata; Miriam Otipa; Waiganjo Monica; Juster Gitonga; Simon Wepukulu, Zachary Kinyua; Sally Miller; Mark Erbaugh.

Priority Pests: *Fusarium* wilt (*Fusarium 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).

Tasks: Train farmers and extension officers on diseases of passion fruit and their management. 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*).

Description of tasks: Passion fruit diseases pose a major constraint to passion fruit production in the East African region. Growers' pest identification and management knowledge is limited. This activity will involve training of selection passion fruit farmers (15-20) and their frontline extension staff in Central Kenya

Training Location: KARI-Thika

Farmer or NGO group: Passion fruit Farmers in Central Kenya

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

Co-PIs; Ruth Amata; Miriam Otipa; Waiganjo M; Juster Gitonga; Simon Wepukulu, Sally Miller; Mark Erbaugh.

Priority Pests: *Fusarium* wilt (*F. oxysporum* fsp. *passiflorae*), Dieback disease complex (*Fusarium* spp. and *Phytophthora* spp.) and brown spot disease (*Alternaria pasiflorae*).

Tasks: Evaluate IPM technologies (*Trichoderma harzianum* and *T. asperellum* and copper based fungicides) in the management of passion fruit fungal diseases.

Description: Trials are ongoing on 2 biocontrol agents and a Copper based fungicide (Copper oxychloride/Kocide) will be evaluated for the management of brown spot, *Fusarium* wilt and dieback disease complex.

Current research status: on-farm

Where on-farm trials will occur: Juja Farm

Farmer or NGO group identified: Juja Farmers group

3) Develop IPM packages that address priority pests of coffee.

Uganda: Coffee

1. Activity Title: Transfer of IPM Technologies for Management of Priority Insect Pests and Diseases.

Co-Pi: Kyamanywa S, Kucel P. and Kagezi G.

Collaborating Co-Pi: Erbaugh, J.M., Kovach J.

Priority pests: Coffee Stem borer (*Bixadus seirricola*), coffee root mealybug (*Plannococcus ireneus*), Common coffee mealybug (*Planococcus kenyae*) 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; use of stem wrapping and stem smoothening for control of stem borers.

Current research Status: On-station trials concluded in 2008/2009 compared conventional coffee pest control methods involving chemical pesticide applications (Furadan and Marshal granules for control of root mealybugs and Dursban and Diazinone stem banding for control of stem borers) against selected IPM management tactics (fertilizer application [CAN], organic manure and bean intercrop for root mealybugs and stem wrapping and stem smoothing for stem borer management). The IPM options were found to be effective and advanced for further evaluation on-farm during 2009/2010. The IPM options again performed consistently well on-farm and up-scaling of the packages began during 2010/2011 using a modified farmer field school established at one of three on-farm evaluation sites. During 2011/2012, further up-scaling of the packages will be implemented through additional FFSs established at the other two on-farm trial sites. Further, dissemination materials shall be produced and the packages introduced into the curriculum of other existing FFSs.

Location of on farm trials: Sironko district

Farmer/NGO group: Kibowa United Coffee Farmers Field School (Buwasa sub-county)

2. Activity Title: Establish the Action Thresholds for Key Priority Pests of Coffee

Co-PIs: Rwomushana I, Kyamanywa S, Kucel, P

Collaborating Co-PI: Kovach J.

Priority pests: Coffee root mealybug (*Planococcus ireneus*), common coffee mealybug (*Planococcus kenyae*), Coffee Stem borer (*Bixadus seirricola*), Antestia bug (*Antestiopsis* spp.), coffee lace bugs (*Habrochila* spp.), the coffee stem borer (*Hypothenemus hampei*), leaf miners (*Leucoptera* spp.) and coffee scales. Coffee leaf rust, Coffee Berry Disease.

IPM strategies: Developing a diagnostic tool to assist in determining whether to apply control methods will help in promoting need based application and minimize pesticide use.

Brief Description: This study is being done in phases. Phase one includes a trial in which three pesticide spray schedules are being used to segregate coffee insect pest effects to determine which insect guilds contribute most to yield loss: foliar insecticide spray (with simuthion a contact insecticide); soil-based insecticide application (with Furadan, a systemic insecticide); and a combination of foliar and soil insecticide spray

vs. the untreated control. Thereafter, action thresholds (ATs) and economic injury levels (EILs) of the selected key pests will be calculated based on the yield function.

Current Research status: Data collection is in progress. Validation of ATs and EILs will be done on-farm

Location: On station - Sironko district

Farmer/NGO group: Bugusege Coffee Farmer Association group. Bugusege parish in Sironko district

3. Activity Title: **Use of Community Based Phyto-sanitary Interventions and Innovative Approaches for Management of the Coffee Twig Borer**

Co-PIs: Kucel P, Kagezi G, Kyamanywa S

Collaborating Co-PI: Kovach, J

Priority pests: Black coffee twig borer (*Xylosandrus compactus*)

IPM strategies to be tested: Use of community based phyto-sanitary interventions and trapping in management of the coffee twig borer. The phyto-sanitary interventions include pruning, stumping, and burning of infested coffee plant parts and alternate host plants. The emphasis is on working as a group to solve community problems using farmers own tools. Innovative approaches for managing the damage caused by the BCTB will include continued assessment of the effect of BROCARP Traps, as well as establishment of the efficacies of selected novel insecticides against the ambrosia fungus that is associated with the BCTB.

Current research Status: This activity began in Year 1 (2009/2010) with the identification and mobilization of two participating coffee farmers' groups in Mukono district. During Year 2 (2010/2011), an additional participating farmer group in Nakaseke district was identified and mobilized. The phyto-sanitary interventions and community participatory search for BCTB alternate hosts were implemented. During 2011/2012, evaluation of the phyto-sanitary interventions, search for alternate hosts and on-station trapping trials shall continue. The up-scaling of the packages shall also commence with transformation of the three participating groups into FFSs.

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);

Tanzania: Coffee

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

Co-PI: J.M. Teri, F. Magina, A.P. Maerere, K.P. Sibuga, D. Mamiro, M.W. Mwatawala

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.).

Tasks and /or IPM strategies to be tested: 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 wondering jew) to assess the effects of shade on the level of infestation. The behavior of key coffee pests under natural shade and open field will be assessed in respect to damage (infestation) level, impacts on yield and quality of coffee.

Status: On station

Location: TaCRI-Lyamungu

Farmer or NGO group identified: None

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

Co-PI: J.M. Teri, F. Magina, A.P. Maerere, K.P. Sibuga, D. Mamiro, M.W. Mwatawala

Collaborating Co-PI from USA: J. Kovach

Priority pests: Insect: Coffee berry borer (*Hypothenemus hampei*)

IPM strategies to be tested/Description of tasks: 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) in trapping coffee berry borer in Arabica and Robusta coffee.

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

Location: TaCRI – Lyamungu (for Arabica coffee) and Maruku (for Robusta coffee), TaCRI-Mbimba, Maruku and Lushoto (assess locally made traps)

Farmer or NGO group identified: Undugu farmer group at Kombo village

4) Develop IPM packages that address priority pests of <u>onions.</u>

Kenya: Onions

1. Activity title: Development of action thresholds for thrips infesting onion.

Co-PIs; Waiganjo M; Amata, R; Wepukhulu, S; Sylvia K; Gitonga, J; M. Erbaugh, S. Miller, D. Taylor, Maerere, J. Kovach

Priority Pests: Thrips, *Thrips tabaci, Frankliniella occidentalis*

Tasks: Carry out on-station and on-farm trials to test cost effective IPM options for onion..

Description: On-station trials will be carried out to determine the most cost effective option for thrips management. Onion thrips (*Thrips tabaci)* has been recorded among the most important onion production constraint 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 anisoplae*) will be used at different frequencies during the onion growth period, and the most economically beneficial option determined.

Current research status: The study will be carried out on-station at KARI-Thika and later in farmers' fields.

Where on-farm trials will occur: Kirinyaga

Farmer group identified: Kirinyaga Farmers

2. Activity title: Participatory evaluation of onion accessions on bulb quality, yield and biotic stress and pest tolerance

Co-PIs; Waiganjo M; Amata, R; Wepukhulu, S; Sylvia K; Gitonga, J; M. Erbaugh, S. Miller and Mtui Hose**a** Ruth Amata; Miriam Otipa; Waiganjo Monicah; Juster Gitonga; Simon Wepukulu, Zachary Kinyua; Sally Miller; Mark Erbaugh.

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*

Tasks: Evaluate varieties for tolerance to major onion pests and diseases and assess bulb yield and qualities.

Description of tasks: A plants natural 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*. Morphological and anatomical characters 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. White onions have also been reported to be less susceptible to onion thrips attack than the red onions. 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 the yield performance and tolerance to onion thrips, and foliar and postharvest diseases.

Current research status: on-farm

Where on-farm trials will occur: Kirinyaga

Farmer or NGO group identified: Kirinyaga Farmers

Tanzania: Onions

1. Activity title: Conduct weed management options

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

Priority pests: Weeds: Mexican poppy (*Argemone mexicana*), pigweeds (*Amaranthus* spp.), star grass (*Cynodon* spp.), black jack (*Bidens pilosa*) nut sedges (*Cyperus* spp.)

Tasks and/or IPM strategies to be tested: A field trial to evaluate cultural weed management options (mulching, stale seedbed technique and post-emergent herbicide, weeding frequency) will occur on station for one season before transfer to on-farm. Major weeds will be identified and quantified before and after imposing weed management treatments; onion yields will be assessed along with other quality factors. Insect pests and diseases will be controlled by using standard procedures.

Current research status of the strategy: On-station

Location on-farm: None

Farmer or NGO group identified: None

2. Activity title: Conduct insect pests and disease management options

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

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.).

Tasks and/or IPM strategies to be tested: Field and on-farm trials will be conducted to evaluate different insect pests and disease management options (Mulching, trap and repellant plants, resistant varieties and time of planting). Major insect pest and disease incidences, type of damage, and onion yields will be assessed. Effectiveness of each pest and disease management option will be compared.

Current research status of the strategy: On-station and on-farm

Location on-farm: Kilosa and Kilolo Districts

Farmer or NGO group identified: Chabi, Msosa and Kilolo B water user association

3. Activity title: Conduct variety evaluation and fertilizers application

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

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.).

Tasks and/or IPM strategies to be tested: Varieties will be evaluated to identify types that are resistant or tolerant to priority pests and diseases. Use of different rates of fertilizer will be evaluated to assess direct/indirect effects on plant health and tolerance to pests. A wide range of onion germplasm will be evaluated under local conditions in respect to adaptability and fertilizer response. Performance of each variety and different rates of fertilizer will be evaluated.

Current research status of the strategy: On-station and on-farm

Location on-farm: Chabi and Malolo B villages Kilosa District, Morogoro Region and Msosa village, Kilolo District in Iringa Region

Farmer or NGO group identified: Chabi, Msosa and Kilolo B water user association

5) Develop IPM packages that address priority pests of <u>scotch bonnet peppers</u>.

Uganda: Hot pepper

1. Activity Title: Exploiting Host Plant Resistance to Manage Hot Pepper Root Rot/Wilt

Disease in Mubuku Irrigation and Settlement Scheme

Co- PI: Geoffrey Tusiime; Karungi J., Bonabana J., Kyamanywa S., Sally Miller

Priority pests to be addressed: *Phytophthora* root and wilt disease (*Phytophthora capsici*)

IPM objectives or Strategies to be disseminated: Continue screening hot pepper germplasm for resistance to root rot/wilt disease in Uganda.

Description: 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 (*Phytophthora*) disease. Another 50 were multiplied at the Makerere University Research Institute, Kabanyolo (MUARIK). Further screening of the promising lines using more parameters will be implemented.

Current research status: First level screening of the improved hot pepper lines was completed.

Expected outputs: resistant hot pepper germplasm identified

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.)

2. Activity Title: Establishing the Effect of Soil Water Amount on Hot Pepper Wilt

Incidence and Severity in Mubuku Irrigation Scheme

Co-PIs: Geoffrey Tusiime; Karungi J., Bonabana J., Kyamanywa S., Sally Miller

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.

Description: Different ridge sizes and frequency of irrigation were studied to determine the optimum in reducing infection. Three ridge sizes—6cm, 18cm, and 30cm high—and three irrigation frequencies—after two, four, and eight days—were tested. Preliminary results indicate that the highest incidence of the disease was in the 6cm high ridge; ridge size had no significant effect on yield parameters. Less frequent irrigation was found to lower the incidence of the wilt, but reduced frequency of irrigation had a negative effect on yield parameters. These studies will be repeated to confirm results.

Current status: Data of season I of this trial has been analyzed. The Mubuku irrigation scheme is currently observing a closed season and the trial's repetition will be implemented as soon as the closed season is lifted in September 2011.

Expected outputs: Optimum ridge size established; optimum irrigation frequency established.

Location of trial: On station; on-farm - Mubuku Irrigation and Settlement Scheme.

Farmer or NGO Group identified: Abasaija Kweyamba Mubuku Farming Co-operative Society Limited. (AKMFCS Ltd.)

3. Activity Title: Developing a System for Small-Holder Virus-Free Seed Production in Uganda

Co-PIs: Geoffrey Tusiime; P. Sseruwagi, Mukasa S. B., Karungi J., Bonabana J., Kyamanywa S., Munyazikwiye D; Sally Miller

Priority pests: Seed and vector-transmitted pepper viruses.

IPM strategy to be addressed: Evaluate an in-door (tunnel) production system for virus free hot pepper seed.

Description: Hot pepper seedlings are now growing in the tunnel production system. The 'virus-free' seedlings will be taken to the field to study the re-infection rate so as to generate appropriate recommendations for farmers.

Current status: the tunnel house was constructed and seedling production has commenced.

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

Location of trial: on station; on-farm - Mubuku Irrigation and Settlement Scheme.

Farmer or NGO Group identified: Abasaija Kweyamba Mubuku Farming Co-operative Society Limited. (AKMFCS Ltd.)

Global Themes for East Africa

Impact Assessment Global Theme

Activity Title 1: Economic Analysis of Hot Pepper Activities in Uganda

Co-PIs: J.Bonabana-Wabbi, D.B Taylor, M. Erbaugh, S. Kyamanywa, M. Mangheni,

Priority pest: *Phytopthora infestans* (wilt)

Objective: Complete analysis and write-up for the hot pepper baseline survey and conduct partial budget analysis

Description: A publication of the descriptive analysis will be produced and multivariate analysis will be explored. Partial budgets for farmer practices versus IPM packages will be developed. This information will provide the foundation for the impact assessment for this activity.

Current research status: Baseline data was collected for hot peppers in 2010. The data has been coded, and descriptive statistics have been compiled

Expected outputs: baseline survey publications and partial budgets for Hot Pepper

Location of trial: Uganda: Kasese.

Farmer or NGO Group identified: Mubuku Irrigation Scheme

Activity Title 2: Analysis of Baseline Socioeconomic Survey Data for Onion in Kenya and Tanzania

Co-PIs: J.Bonabana-Wabbi, D.B Taylor, M. Erbaugh, M. Mangheni, S. Kyamanywa, Monicah Waiganjo, Juster Gitonga, M. Menza, A. Maerere H. Mtui, C. Msuya-Bengezi

Priority pest: to be determined

Objective: Establishment of baseline conditions/research needs assessment for onion as a tool for Impact Assessment

Description: Onion IPM research needs assessment with aspects on production, processing and marketing conditions of onions will be developed. A needs assessment will establish the current production and marketing aspects of onions and identify key constraints of onion production and marketing processes. Additionally, the baseline will establish the current socioeconomic and demographic characteristics of onion production.

Current research status: Biological research to begin this year; Nned to initiate baseline activities.

Expected outputs: baseline instrument designed and implemented

Location of trial: Kenya: Kirinyaga, Bungoma and Loitokitok Districts and market survey in Karatina and Nakuru markets; Tanzania: Morogoro region.

Farmer or NGO Group identified: To be identified.

Activity Title 3: Passion Fruit Baseline Survey in Central Uganda

Co-PIs: Dr. J.Bonabana-Wabbi, Dr. P. Seruwagi Dr. M. Ochwo-Semakula, Prof. D.B Taylor, Dr. M. Mangheni, Dr. M. Otim, Prof. G. Norton, Dr. M. Erbaugh, Prof. S. Kyamanywa, and Robina Atukunda (MSc Student).

Priority pest: Passion fruit viral diseases and collar root rot

Objectives: To establish baseline conditions/research needs assessment for passion fruit in the major growing areas in Uganda as a tool for Impact Assessment on Passion fruit.

Description: Passion fruit IPM research needs assessment focused on production, processing and marketing conditions of passion fruit will be developed. Needs assessment will establish the current production and marketing aspects of passion fruit and identify key constraints of passion fruit production and marketing processes. Additionally, the baseline will establish the current socioeconomic and demographic characteristics of passion fruit growers.

Current research status: Biological research established efficacy of cultural practices in management of pests and diseases, evaluated resistance of cultivars to collar rot, and identified environmentally-friendly management options of viral disease vectors on station.

Activity Title 4: Impact and Indicator Monitoring for Eastern Africa Regional Site

Co-PIs: J.Bonabana-Wabbi, D.B Taylor, M. Erbaugh, S. Kyamanywa, Monicah Waiganjo, Juster Gitonga, M. Menza, A. Maerere and Msuya-Bengezi

Objectives: To refine the tools and instruments for monitoring impact assessment and measuring indicators including activity reporting forms and reporting forms for biological scientists.

Description: A draft Activity Reporting Form (ARF) that was developed in Year II will be revised and distributed for use by the EA regional IPM CRSP scientists.

Current research status: A reporting form to aggregate the data from the ARFs has been developed.

Training Plan:

Countries and focal crops: Uganda, Kenya and Tanzania working on Hot Pepper, Passion fruit and Onions

Full name of trainee:	To be determined. MSc degree
Advisor:	Jackline Bonabana-Wabbi
Institution studying at:	Makerere University
Date of Initiation:	Aug 2011 – Aug 2012

Gender Global Theme

Project Title: **Supporting Regional Projects in Impact Assessment and Identifying Gender Based Constraints and Opportunities for IPM Technology Development and Adoption.**

Co-PIs: Margaret Najjingo Mangheni, Jackie Bonabana, Catherine Msuya, M. Erbaugh, Kalunda Sibuga, S. Kyamanywa, Monica Waiganjo, Ruth Amata, J. Gitonga, M.E. Christie.

Activity Title 1: **Support for integrating gender component into Impact Assessment**

1. Support analysis of baseline survey data on onion for Tanzania and Kenya
2. Support analysis of hot pepper impact assessment data for Uganda; writing publications.
3. Support analysis of passion fruit baseline survey data for Uganda; writing publications.

Activity Title 2: Baseline survey

Baseline survey of FFS for control of coffee berry borer in Arabica Coffee Uganda (Student Robert Ochago).

Activity Title 3: Support to IPDN and Plant Virus Global Theme

Testing of plant disease diagnostics fact sheets on men and women farmers in Uganda and Tanzania; editing fact sheets based on results.

Activity Title 4: Rapid Gender Assessment in Tanzania *(implementation of this activity will depend on contribution of top up funds from the USA PI)*

1. Tomato in Mlali Morogoro (mulching)
2. Arabica Coffee in Kirimanjaro Region, Arusha (trapping of adult CBB using local brew mbegge)

Plant Virus Global Theme

Project Title: Plant Virus Diagnostics with Case Studies of Tomato and Passion fruit

Activity Title 1: Training Program – Train Participants in Virus Diagnostics Using Standard Operating Procedures (SOPs)

Co PIs: Sseruwagi, P., Kinyua, Z.M., Amata, R.L., Opita, M.J., Waiganjo, M., Kyamanywa, S., Ochwo-Ssemakula, M., Tusiime, G., Maerere, A., Miller, S., Erbaugh, M., and S. Tolin

Countries: Kenya, Tanzania and Uganda

Crops: Tomato and passion fruit

Priority pests: Tomato and passion fruit viruses

Tasks: Write SOPs and fact sheets

Brief description of tasks: Individuals will write drafts/sections of SOPs and hold a joint meeting to write the SOPs. The SOPs will be tested to: i) look for symptomatic plants in the field; ii) bring samples to lab; iii) run tests and identify gaps in capacity. Fact sheets will be written, outreach to farmers will be conducted (via fact sheets, phones and pictorials), and webinar will be tested to improve delivery.

Target group: Scientists and extension/farmers

Activity Title 2: Link with Regional Program Activities – on Activity 2 of Passion Fruit

Work and Activity 5 of Tomato Work (Uganda Site)

1. Country: Uganda

Co PIs: Karungi, J., Ochwo-Ssemakula, M., and Kyamanywa, S.

Crops: Tomato and passion fruit

Priority pests: Tomato and passion fruit viruses

Tasks: Confirmation of alternate host plants for the aphids.

Brief description of tasks: Collect plant virus isolates and insect vectors on alternative hosts. Conduct diagnostic analyses of viruses.

Expected outputs: Host range and transmission pathways confirmed.

Location: Namulonge (NaCRRI)

IPDN Global Theme activities:

Country: Kenya, Uganda and Tanzania

Crop(s): Tomato, passion fruit and onion

1. Activity title: Developing diagnostic and management fact sheets and posters on prioritized diseases of tomato, passion fruit and onion in East Africa

a. Co-PIs: 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

b. Priority pests to be addressed: Fungal, bacterial, viral and nematode diseases

c. 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.

d. Description of activity: Several diseases affect the production of tomatoes, passion fruit and onions in Kenya, Uganda and Tanzania. At the farm level, lack of knowledge on early disease recognition and poor understanding on their causes and mode of spread greatly limits the application of both preventative and management strategies. Therefore, farmers and extension staff require quick, guided 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.

e. Current research status: a) on-going; b) To be executed through email and telephone communications and refined through focus group discussions.

f. Expected outputs by the end of Year 3 (September 30, 2012): Selected fact sheets and posters on recognition and management of priority diseases will have been developed.

g. Location of trials: Kenya, Uganda, Tanzania (lead Co-PIs consolidate information into fact sheets and posters and hold focus group discussions with farmers and agricultural extension staff).

h. Farmer or NGO group identified: Literature searches (grey & published) and visits/interviews with a selection of farmer groups and extension agents in East Africa.

Country: Kenya, Uganda and Tanzania

Crop(s): Tomato, passion fruit and onion

2. Activity title 2: Train selected project partners on the use of priority standard operating procedures (SOPs) for Passion fruit, tomato and/or onion in East Africa

a. Co-PIs: 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.

b. Priority pests to be addressed: Fungal, bacterial, viral and nematode diseases

c. IPM Strategies to be tested/disseminated: Standard procedures for diagnosis of major diseases affecting tomatoes, passion fruit and onions.

d. Description of activity: 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, resulting in enhanced 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.

e. Current research status: a) new; b) To be executed through a training workshop involving both field sampling and laboratory sessions.

f. Expected outputs by the end of Year 3 (September 30, 2012): Focused capacity of diagnosing critical, economically important diseases.

g. Location of trials: Kenya, Uganda, Tanzania (for selected diagnostic procedures)

h. Farmer or NGO group identified: A selection of established laboratories with operations involving disease diagnostics in East Africa.

Country: Kenya (with backstopping in Uganda and Tanzania)

Crop(s): Tomato and passion fruit

3. Activity title: 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)

a. Co-PIs: Kinyua, Z.M., R.L. Amata, M.J. Otipa, S. Miller, M. Waiganjo, S. Miller and M. Erbaugh.

b. Priority pests to be addressed: Fungal, bacterial, viral and nematode diseases

c. IPM Strategies to be tested/disseminated: Recognition and management options for various diseases affecting tomatoes and passion fruit.

d. Description of activity: 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.

e. Current research status: a) New; b) To be undertaken through pre-arranged training sessions.

f. 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.

g. Location of trials/activity: i) A joint training workshop at KARI Thika and on-farm sessions in Kirinyaga; ii) KARI NARL Kabete for laboratory analysis of project samples.

h. Farmer or NGO group identified: Farmers and extension staff to be identified during field assessments.

West Africa Regional Consortium for IPM Excellence

PI: Donald E. Mullins, Virginia Tech

Co-PIs: 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
Doug Pfeiffer, Virginia Tech
Jim Westwood, Virginia Tech

Institutional Collaboration:

DPV- Senegal	INSAH- W. Africa
ISRA- Senegal	IER- Mali
ETQCL - Mali	CERES-Locustox-Senegal
OHVN-Mali	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. 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 three West African countries (Ghana, Mali, and Senegal). 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 our 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. 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, International Plant Virus Disease Network (via IPDN Global Themes). We also expect to greatly improve the overall diagnostic capacities of all three countries. In documenting the impact of the IPM packages, we will compare farmers using the IPM package versus 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 so our IPM packages will have maximum impact with women farmers.

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

Activity 1a: Establish locations for implementation of tomato IPM programs and conduct surveys in each location for tomato production practices, yields and disease and pest problems

Country: Ghana

Status: Continuing

Scientists involved: Bob Gilbertson/UC-Davis; Michael Osei/CSIR-CRI

Description: The farmers and the locations for the implementation of the tomato IPM plots have been identified. The surveys have been completed and are being analyzed. The seeds of the improved varieties have been delivered and the basic IPM program is ready to be implemented in the three selected locations in Ghana.

Progress to date: Continuing

Expected outputs: The first year of the IPM plot implementation will be completed. This will allow us to assess the local production practices and then determine if our IPM package will result in improved production.

Task 1: The tomato IPM plots will be implemented and the initiation of the assessment of the grower's production practices.

Country: Mali

Status: Continuing

Scientists involved: Bob Gilbertson/UC-Davis; Moussa Noussourou/IER

Description: The first year of the implementation of the IPM plots has been completed. We will complete the analysis of the grower's surveys and the yield data from the plots. Based upon these analyses, we will make appropriate adjustments in the IPM plots for the 2011-2012 growing season in terms of the growers, locations, varieties, etc. Upon doing this, the implementation of the second year of the IPM plots will commence.

Progress to date: Continuing

Expected outputs: The locations will be set for this part of the project and an understanding of the issues associated with tomato production in the locations where the project will be conducted.

Task 1: The geographical locations for the implementation of the IPM package for tomato will be established and the surveys of the growers conducted.

Country: Senegal

Status: Continuing

Scientists involved: Bob Gilbertson/UC-Davis; Samba Diao and Papa Dembe Kane/ISRA-CDH and Lamine Senghor/DPV

Description: Following the survey and meetings conducted in Senegal, the plans for the IPM plots have been finalized, and the locations and the growers have been identified. The seeds of the improved varieties have been delivered, and the basic IPM program is ready to be implemented. The growers have been identified, and the surveys have been completed, so we should be ready to implement the first year of the IPM plots in Senegal.

Progress to date: Continuing

Expected outputs: The first year of the IPM plot implementation will be completed. This will allow us to assess the local production practices and then determine if our IPM package will result in improved production.

Task 1: The tomato IPM plots will be implemented and the initiation of the assessment of the growers production practices.

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

Countries: Ghana, Mali and Senegal

Status: New

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, 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 used 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: New

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, Mali and Senegal and seed produced from these plants.

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

Country: Ghana

Status: New

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; it 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 3 of the project we will shift 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 the three 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 3. Later, we will look at predators and will determine the functional roles of each group of natural enemies in the suppression of whitefly populations.

Progress to date: Planning

Expected outputs: An inventory of whitefly parasitoids with *Eretmocerus* spp. and *Encarsia* 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: Mali

Status: Continuing

Scientists involved: Carlyle Brewster/VT; Moussa Noussourou/IER

Description: Same plan as outlined for Ghana provided above

Progress to date: Planning

Expected outputs: An inventory of whitefly parasitoids with *Eretmocerus* spp. and *Encarsia* 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 + ISRA-CDH + CERES-Locustox

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 *Encarsia* 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 1d: Develop management strategies for *Ralstonia* bacterial wilt of tomato

Country: Senegal

Status: New

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

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: New

Expected outputs: Resistant tomato varieties and rootstocks will be identified and 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: Obtain seeds of *Solanum* spp. known to be resistant to *Ralstonia solanacearum* from AVRDC and other IPM CRSP regional programs.

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

Task 4: Begin to 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 its management for tomato growers and associated personnel for northern Senegal.

Activity 1e: Gather data on weed incidence and whitefly occurrence on weeds.

Country: Mali

Status: Continuing

Scientists involved: Jim Westwood & Carlyle Brewster/VT; Moussa Noussourou/IER

Description: Weeds have potential to harbor insects and diseases of tomato during periods when no crop is present in the field. This has the potential to undermine the value of the "no-host-period" and contribute to rapid disease cycles.

Progress to date: Completed first version of Weed Guide (based primarily on weeds of Mali). Collected data on whitefly incidence on weeds.

Expected outputs: 1. A practical Weed Guide that can be used by researchers and growers to identify common weeds that may act as disease reservoirs in tomato production. 2. Data on white fly incidence on weeds in tomato fields.

Task 1: Publish first edition of Weed Guide for field testing. Print and internet versions will be produced, but each needs specific formatting. The online version will be incorporated into the project website and database.

Task 2: Continue surveying whitefly incidence on tomatoes and associated weeds throughout the year.

Country: Senegal

Status: Continuing

Scientists involved: Jim Westwood & Carlyle Brewster/VT; Souleymane Diallo/ISRA/CDH+DPV+ CERES-Locustox

Description: Weeds have potential to harbor insects and diseases of tomato during periods when no crop is present in the field. This has the potential to undermine the value of the "no-host-period" and contribute to rapid disease cycles.

Progress to date: Expand first edition of Weed Guide to represent more species from Senegal. Collected data on whitefly incidence on weeds.

Expected outputs: 1. A practical Weed Guide that can be used by researchers and growers to identify common weeds that may act as disease reservoirs in tomato production. 2. Data on white fly incidence on weeds in tomato fields.

Task 1: Publish first edition of Weed Guide for field testing. Print and internet versions will be produced, but each needs specific formatting. The online version will be incorporated into the project website and database.

Task 2: Continue surveying whitefly incidence on tomatoes and associated weeds throughout the year.

Country: Ghana

Status: Starting

Scientists involved: Jim Westwood & Carlyle Brewster/VT; Michael Osei/CSIR-CRI

Description: Weeds have potential to harbor insects and diseases of tomato during periods when no crop is present in the field. This has the potential to undermine the value of the "no-host-period" and contribute to rapid disease cycles.

Progress to date: This work has been underway in Mali and Sengal, but is just starting in Ghana.

Expected outputs: A practical Weed Guide that can be used by researchers and growers to identify common weeds that may act as disease reservoirs in tomato production. 2. Data on white fly incidence on weeds in tomato fields.

Task 1: Begin inventory and photography of weeds associated with tomato culture in Ghana.

Task 2: Begin collecting data on incidence of whitefly on tomato and associated weeds in Ghana.

Activity 1f: 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 (Mohameth Kane?)

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

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

Activity 1f: 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: Mali

Status: Planning

Scientists involved: Don Mullins, Pat Hipkins/VT & Bob Gilbertson/UC-Davis; Moussa Noussourou/IER; Issa Sidibe/OHVN

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

Task 2: Identify and work with potential vendors/suppliers of disease-resistant tomato cultivars to make them accessible to growers

Country: Senegal

Status: Planning

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

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 1g: Plan for institutional capacity-building and long-term training

Country: Ghana

Status: Planning

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

Description: Using research recommendations, produce training materials for field agents.

Progress to date: Ongoing

Expected outputs: Training materials and methods and techniques for field agents will facilitate adoption of IPM tomato packages

Task 1: Begin to collect and assimilate materials and procedures for package development

Country: Mali

Status: Planning

Scientists involved: Don Mullins & Pat Hipkins/VT; Moussa Noussourou/IER; Issa Sidibe/OHVN

Description: Using research recommendations, produce training materials for field agents.

Progress to date: Ongoing

Expected outputs: Training materials and methods and techniques for field agents will facilitate adoption of IPM tomato packages

Task 1: Begin to collect and assimilate materials and procedures for package development.

Country: Senegal

Status: Planning

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

Description: Using research recommendations, produce training materials for field agents.

Progress to date: Ongoing

Expected outputs: Training materials and methods and techniques for field agents will facilitate adoption of IPM tomato packages

Task 1: Begin to collect and assimilate materials and procedures for package development

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

Country: Ghana

Status: New

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: New

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.) to 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 1i. Produce a tomato production guide for West Africa

Countries: Ghana, Mali and Senegal

Status: New

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

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.

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

Activity 2a: Begin the implementation of the potato IPM packages in Mali and Senegal

Country: Mali

Status: ongoing

Scientists involved: Sally Miller/OSU, Bob Gilbertson/UC-Davis; Seriba Katile/IER

Description: Initiate implementation of potato IPM packages

Progress to date: Beginning

Expected outputs: The first potato IPM packages will be implemented

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

Country: Senegal

Status: ongoing

Scientists involved: Sally Miller/OSU, Bob Gilbertson/UC-Davis, & George Mbata/FVSU; Papa Dembe Kane and Emile Coly/ISRA-CDH

Description: Initiate implementation of potato IPM packages

Progress to date: Beginning

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: Mali

Status: Ongoing

Scientists involved: Sally Miller/OSU, Bob Gilbertson/UC-Davis, & George Mbata/FVSU; Seriba Katile/IER

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 Segou was conducted in March 2011

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

Task 1: Conduct a survey for potato pests and diseases in Sikasso

Country: Senegal

Status: Ongoing

Scientists involved: Sally Miller/OSU, Bob Gilbertson/UC-Davis, & George Mbata/FVSU; Emile Coly/ISRA-CDH + DPV

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: Mali

Status: Ongoing

Scientists involved: Sally Miller/OSU & Bob Gilbertson/UC-Davis; Seriba Katile/IER

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

Country: Senegal

Status: Ongoing

Scientists involved: Sally Miller/OSU & Bob Gilbertson/UC-Davis; Emile Coly/ISRA-CDH + DPV

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 Mali in the use of diagnostic tools for the identification of the strains of *Ralstonia* and *Erwinia*

Country: Mali

Status: Ongoing

Scientists involved: Sally Miller/OSU & Bob Gilbertson/UC-Davis; Seriba Katile/IER

Description: Training of selected individuals with experience in plant pathology will be conducted in the use of diagnostic tools for these bacterial pathogens of potato.

Progress to date: Efforts will continue to identify individuals suitable for training in Mali; note that to date it has been difficult to identify qualified individuals for this training in Mali.

Expected outputs: Improved capacity to diagnose bacterial wilt and soft rot diseases

Task 1: Expand our search and training efforts in Mali in order to find qualified individuals

Country: Senegal

Status: Continuing

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

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

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: Attempt to find a role for Mohameth Kane to conduct research on bacterial wilt and soft rot diseases, and improve diagnostic capabilities for plant pathogenic bacteria in Senegal.

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 Mali and Senegal

Country: Mali

Status: New

Scientists involved: Sally Miller/OSU & Bob Gilbertson/UC-Davis; [To be identified]/IER

Description: We will collaborate with the US Potato Board 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 Mali

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

Country: Senegal

Status: New

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

Description: We will collaborate with the US Potato Board 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 Mali

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: Mali

Status: On going

Scientists involved: George Mbata/FVSU; Seriba Katile/IER; Fatogoma/IER Sikasso

Progress to date: Sentinel traps were set up in the towns of Kati and Sikasso between December 2010 and February 8, 2011. In Kati, traps were set up in the following villages: Sanebougou, N'Pegnesso, Longorola and Zanadougouin. Kati traps caught some tubermoth males and also several other insects that might have wandered into traps. Trapped insects were re-examined to corroborate previous identification. The traps from Sikasso did not have any insects on them. The possible explanation may be that the traps were not deployed correctly with lures since no insects were caught in traps.

Description: In Mali, potatoes are considered to be one of the most economically important vegetable crops; they are becoming more important because of high nutritional value, position as a high value cash crop, and potential export for Malian farmers. It appears that infestation by the potato tubermoth, *Phthorimaea operculella* Zeller, may pose a significant problem in potato production, limiting both yield and storage potatoes. Traps baited with pheromone lures will be used in monitoring moth populations in Mali. A sentinel monitoring of the PTM was instituted last year, and it was inconclusive; the moths that were trapped were only suspected to be PTM. The specimens were too discolored and damaged to be positively identified.

This study will provide information on periods of peak infestation of potato by PTM, phonological stages of potato that are most susceptible, and the effect of temperature/humidity on moth populations.

Expected outputs: Develop a protocol for sentinel monitoring of PTM populations

Task 1: Determine the incidence of PTM males in Mali

Task 2: Determine the incidence and abundance PTM in select plots in Mali

Task 3: Determine the effect of trap density on the number of male PTM trapped

Task 4: Correlate environmental temperature and humidity on the number of males trapped with pheromone-baited traps

Country: Senegal

Status: On going

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

Progress to date: Trap data from experimental plots sited in Notto Guouye Diama, a town that is about 30 miles north of Dakar, indicates that potato tubermoth males were caught between February 12, 2011 and May 7, 2011. Moths per trap averaged between 0.5 and 1.1. The tuber moth exhibited high incidence between the months February and April. The lowest incidence was in May, by which time potatoes had been harvested.

Description: In Senegal, potatoes are considered to be one of the most economically important vegetable crops and are becoming more important because of their high nutritional value, high value as a cash crop, and potential export 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, from 17,044 metric tons in 1992 to 2006 level of 6,649 metric tons; 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 pheromone lures will be used in monitoring moth populations in Senegal. This study will provide information on periods of peak infestation of potato by PTM, phenological stages of potato that are most susceptible, and the effect of temperature/humidity on moth populations. Trapping will be continued in storage to determine if infestation by the tubermoth is carried into storage or moths are attracted from outside the stores.

Expected outputs: Develop a protocol for monitoring the populations of PTM; Establish the identity of parasitoids associated with the tubermoth

Task 1: Determine catches of PTM males in potato plots in Senegal

Task 2: Determine catches of PTM males in potato stores and warehouses in Senegal

Task 3: Determine the effect of trap density on the number of male PTM trapped

Task 4: Correlate environmental temperature and humidity with the number of males trapped

Task 5: Determine the parasitoids associated with PTM

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

Country: Mali

Status: Planning

Scientists involved: Don Mullins & Pat Hipkins/VT; Seriba Katile/IER

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

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

Activity 2h: Plan for institutional capacity-building and long-term training

Country: Mali

Status: Planning

Scientists involved: Don Mullins & Pat Hipkins/VT; Kadidiatou Gamby & Issoufou Kollo/IER

Description: Using research recommendations, produce training materials for field agents.

Progress to date: Ongoing

Expected outputs: Training materials and methods and techniques for field agents will facilitate adoption of IPM potato packages

Task 1: Begin to collect and assimilate materials and procedures for package development

Country: Senegal

Status: Planning

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

Description: Using research recommendations, produce training materials for field agents.

Progress to date: Ongoing

Expected outputs: Training materials and methods and techniques for field agents will facilitate adoption of IPM potato packages

Task 1: Begin to collect and assimilate materials and procedures for package development

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

Activity 3a: Conduct surveys in each location for cabbage production practices, yields and disease and pest problems

Country: Mali

Status: Continuing

Scientists involved Doug Pfeiffer/VT; Kadidiatou Gamby/IER

Description: A survey instrument is being distributed that will include questions on farmers' practices, cabbage yield, and their perceptions of pest pressure and injury. Male and female farmers will be compared in terms of farm roles and knowledge.

Progress to date: Almost complete.

Expected outputs: Knowledge of pest pressure and damage will provide a baseline against which to compare progress of our project's research. Understanding the role and farm knowledge of both genders will facilitate appropriate technology transfer activities.

Task 1: A list of 30 farms for a cabbage pest management survey in Mali will be compiled.

Task 2: Farmers in 30 locations will be surveyed for cabbage pest management practices in Mali, including gender disaggregated questions (i.e. asking questions separately to male and female farmers to determine gender-related differences in farm role, expertise, and resources).

Country: Senegal

Status: Continuing

Scientists involved: Doug Pfeiffer/VT; Dieynaba Sall/ISRA-CDH

Description: A survey instrument is being distributed that will include questions on farmers' practices, cabbage yield, and their perceptions of pest pressure and injury. Male and female farmers will be compared in terms of farm roles and knowledge.

Progress to date: Almost complete.

Expected outputs: Knowledge of pest pressure and damage will provide a baseline against which to compare progress of our project's research. Understanding the role and farm knowledge of both genders will facilitate appropriate technology transfer activities.

Task 1: A list of 30 farms for a cabbage pest management survey in Senegal will be compiled

Task 2: Farmers in 30 locations will be surveyed for cabbage pest management practices in Senegal, including gender disaggregated questions (i.e. asking questions separately to male and female farmers to determine gender-related differences in farm role, expertise, and resources).

Activity 3b: Identify farmers for participating in the IPM program

Country: Mali

Status: Continuing

Scientists involved: Doug Pfeiffer/VT; Kadidiatou Gamby/IER

Description: A subsample of the survey forms will be selected that will be (a) representative of Malian cabbage production, and (b) practical for visit by CRSP scientists. These farms will serve as the base for our research projects and preliminary technology transfer efforts.

Progress to date: A partial list of research sites is in place.

Expected outputs: A practical set of research farms will be in place, and consequently a nucleus of farmers to test appropriate IPM technology.

Task 1: Ten farmers from the survey list in Mali will be selected to participate in cabbage IPM field trials.

Country: Senegal

Status: Continuing

Scientists involved: Doug Pfeiffer/VT; Dieynaba Sall/ISRA-CDH

Description: A subsample of the survey forms will be selected that will be (a) representative of Senegalese cabbage production, and (b) practical for visit by CRSP scientists. These farms will serve as the base for our research projects and preliminary technology transfer efforts.

Progress to date: A partial list of research sites is in place.

Expected outputs: A practical set of research farms will be in place and consequently a nucleus of farmers to test appropriate IPM technology.

Task 1: Ten farmers from the survey list in Senegal will be selected to participate in cabbage IPM field trials.

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

Country: Mali

Status: Continuing

Scientists involved: Doug Pfeiffer/VT; Kadidiatou Gamby/IER

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 Mali.

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 Mali research farms, serviced weekly, to determine patterns of phenology.

Country: Senegal

Status: Continuing

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

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: 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.

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

Country: Mali

Status: Continuing

Scientists involved: Doug Pfeiffer/VT; Kadidiatou Gamby/IER

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 Mali.

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 Mali research farms, serviced weekly, to determine patterns of phenology.

Country: Senegal

Status: Continuing

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

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: 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.

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

Country: Mali

Status: Continuing

Scientists involved: Doug Pfeiffer & Pat Hipkins/VT; Safiatou Dem/ETQCL; Kadidiatou Gamby/IER

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 Mali to assure pesticide safety.

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

Country: Senegal

Status: Plan pesticide use patterns

Scientists involved: Doug Pfeiffer & Pat Hipkins/VT; Baba Gadji/ CERES-Locustox; 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.

Activity 3f: Collect larvae and pupae for rearing of natural enemies

Country: Mali

Status: Continuing

Scientists involved: Doug Pfeiffer/VT; Kadidiatou Gamby/IER

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 will start 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: At each research site in Mali, lepidopteran larvae and pupae will be reared in small containers to determine presence of parasitoids. Parasitoids will be preserved in ethanol for later identification.

Country: Senegal

Status: Continuing

Scientists involved: Doug Pfeiffer/VT; Dieynaba Sy 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: Continuing

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: At each research site in Senegal, lepidopteran larvae and pupae will be reared in small containers to determine presence of parasitoids. Parasitoids will be preserved in ethanol for later identification.

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

Country: Mali

Status: Continuing

Scientists involved: Doug Pfeiffer/VT; Kadidiatou Gamby/IER

Description: This activity will employ alternating rows of tomato with cabbage as a means of controlling population development of diamondback moth. These plots will have standard practice plots nearby to allow comparison.

Progress to date: This activity will start in 2011.

Expected outputs: If successful, this approach could allow management of diamondback moth without insecticides, using a crop that is economically profitable.

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

Country: Senegal

Status: Continuing

Scientists involved: Doug Pfeiffer/VT; Dieynaba Sy 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 will start 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 3h: Plan for technology transfer and short-term training

Country: Mali

Status: Planning

Scientists involved: Don Mullins & Pat Hipkins/VT; Kadidiatou Gamby/IER

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: 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 cabbage packages to identify training needs; plan training as appropriate

Activity 3i: Plan for institutional capacity-building and long-term training

Country: Mali

Status: Planning

Scientists involved: Don Mullins & Pat Hipkins/VT; Kadidiatou Gamby/IER

Description: Using research recommendations, produce training materials for field agents.

Progress to date: Ongoing

Expected outputs: Training materials and methods and techniques for field agents will facilitate adoption of IPM cabbage packages

Task 1: Begin to collect and assimilate materials and procedures for package development

Country: Senegal

Status: Planning

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

Description: Using research recommendations, produce training materials for field agents.

Progress to date: Ongoing

Expected outputs: Training materials and methods and techniques for field agents will facilitate adoption of IPM potato packages

Task 1: Begin to collect and assimilate materials and procedures for package development

Activity 3j: Conduct initial weed surveys.

Country: Mali

Status: Continuing

Scientists involved: Jim Westwood/VT; Kadidiatou Gamby/IER

Description: Identification of weeds in cabbage production and evaluating weeds as alternate hosts for pests are important aspects of managing the crops.

Progress to date: Activity is just starting

Expected outputs: Inventory of weed associated with cabbage production, photographs and descriptions of the weeds added to the Weed Guide.

Task 1: At each research site in Mali, the weeds occurring in and around cabbage fields will be recorded and photographed. This will be repeated periodically during the cabbage-growing season.

Activity 3j: Conduct initial weed surveys.

Country: Mali

Status: Continuing

Scientists involved: Jim Westwood/VT; Kadidiatou Gamby/IER

Description: Identification of weeds in cabbage production and evaluating weeds as alternate hosts for pests are importants aspect of managing the crops.

Progress to date: Activity is just starting

Expected outputs: Inventory of weed associated with cabbage production, photographs and descriptions of the weeds added to the Weed Guide.

Task 1: At each research site in Mali, the weeds occurring in and around cabbage fields will be recorded and photographed. This will be repeated periodically during the cabbage-growing season.

Country: Senegal

Status: Continuing

Scientists involved: Jim Westwood/VT; Souleymane Diallo/ISRA/CDH+DPV+ CERES-Locustox

Description: Identification of weeds in cabbage production and evaluating weeds as alternate hosts for pests are an important aspects of managing the crops.

Progress to date: Activity is just starting

Expected outputs: Inventory of weed associated with cabbage production, photographs and descriptions of the weeds added to the Weed Guide.

Task 1: At each research site in Senegal, the weeds occurring in and around cabbage fields will be recorded and photographed. This will be repeated periodically during the cabbage-growing season.

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.

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: Mohameth Kane
Sex: Male
Nationality: Senegal
Discipline: Plant Pathology
Site/Country: Senegal
Degree: Masters of Science
Start date: ongoing
Completion date: December 2012
Advisor/PI: R. Gilbertson
Thesis topic: Pending
University: Univ. of Thies

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 Mali, Ghana & Senegal)

Publications planned:

Research articles: 2

Extension articles 4

Posters 5

Bulletins 2

Integrated Pest Management: Science for Agricultural Growth in South Asia

PIs: **Dr. Ed Rajotte,** Penn State University

Dr. George Norton, Virginia Tech

Bangladesh Site

1. Activity Title: Demonstration of IPM package for eggplant production (third year).

Brief description: Farmers' practice of indiscriminate pesticide applications to control fruit & shoot borer, jassids, soil-borne diseases including bacterial wilt disease, and root-knot nematode is ineffective, highly uneconomical, and hazardous to human health and the environment. Several IPM component technologies (such as use of BW-resistant grafted seedlings, resistant varieties, Tricho-compost, NSKE, pheromone traps, and bio-control agents) have been developed in recent years; these are highly effective against most of the pests and are also cost effective. Integrating the IPM technologies in to a package will not only solve the pest problems, but also reduce pesticide use.

Objectives: To demonstrate the performance of the eggplant IPM package in farmers' fields.

Scientists: Shahabuddin Ahmad, M. Nazim Uddin, Harunor Rashid, S. N. Alam, and Mafruha Afroz.

Status: continuing

Progress to date: IPM package for eggplant has been demonstrated

Expected outputs: Development of an IPM package for eggplant cultivation that will control the eggplant pests effectively and economically without the use of pesticides. Adoption of this package at the field level will ensure availability of healthy eggplant in domestic as well as export markets.

2. Activity Title: Demonstration of IPM package for the production of cucurbit crops (bitter gourd, sweet gourd, ash gourd, teasel gourd) (third year).

Brief description: In Bangladesh, the cucurbit fruit fly (*Bactrocera cucurbitae*) attacks as many as 16 kinds of cucurbit crops, causing 30-70% yield losses. Recently, a few Lepidopteran pests (e.g., *Spodoptera*) have also been identified as causing considerable damage to bitter gourd. IPM packages (use of Tricho-compost, poultry refuse, mustard

oil-cake, pheromone traps, bio-control agents and others) have been found to be highly profitable for effective control of various pests of the cucurbit crops. Demonstrations of IPM strategies with farmers' participation will allow them to know and learn about the IPM package. Adoption of IPM practices will help produce healthy cucurbit crops without pesticide use. Demonstrations will be set up in Gazipur, Jessore and Ishurdi (Pabna) during the summer season, and in Jessore & Ishurdi during the winter season.

Objectives: To demonstrate the performance of the IPM package at the farm level.

Scientists: S. N. Alam, Debasish Sarker, M. Kafil Uddin, Fatema Khatun, M. A. Goffer, M. S. Nahar, and Ed Rajotte.

Status: Continuing

Progress to date: Demonstrations are on-going at two locations in Bogra (Sadar & Sherpur upazila) & another in Magura (Sadar upazila) district. Performance of the plots treated with IPM package treatments look better than the non-IPM plots.

Expected outputs: Development of an IPM package for production of healthy cucurbit crops without the use of pesticides, which will be more profitable and environmentally safe.

3. Activity Title: Demonstration of IPM package for cabbage/cauliflower production (third year).

Brief description: Leaf-eating caterpillars (*Spodoptera litura)* and the Diamond back moth (DBM) are the most damaging pests of cabbage and cauliflower in Bangladesh. In an effort to control these and other pests, the farmers apply various toxic pesticides indiscriminately without achieving satisfactory control. An effective IPM package has been developed for controlling the leaf-eating caterpillars and other pests. The package consists of (a) use of Tricho-compost and poultry refuse for controlling various soil-borne disease pathogens; (b) for July-August planting (early planting), use of pheromone trapping, release of *Trichogramma bactrae* and *Bracon hebetor*, and destruction of Spodoptera and DBM caterpillars by hand-picking; and (c) for November planting (optimum planting), use of pheromone trapping, and destruction of *Spodoptera* and DBM caterpillars by hand-picking. Adoption of the IPM package will ensure production of healthy cabbage and cauliflower without pesticide use and bring about higher economic benefit to the farmers.

Objectives: To demonstrate IPM package for the production of healthy and profitable crops of a cabbage and cauliflower at the farm level.

Scientists: M. A. Rahman, M. S. Nahar, N. K. Dutta, Shahidul Islam, M. Golam Kibria, Mafruha Afroz, and Ed Rajotte.

Status: Continuing

Progress to date: Demonstrations with farmers' participation are on-going in farmers' fields in Bogra district.

Expected output: Availability of an effective IPM package for the production of pesticide-free, healthy cabbage/cauliflower crops that will bring about higher profits to the farmers.

4. Activity Title: Demonstration of IPM package for production of country bean (third year).

Brief description: Country bean (*Dolichos lab lab*), a very popular and high value vegetable in Bangladesh, is attacked by a number of highly damaging pests, such as *Maruca vitrata* and *Helicoverpa armigera*, aphids, bean yellow mosaic virus (BYMV), and bean common mosaic virus (BCMV). Farmers' practice of indiscriminate use of pesticides largely fails to control the pests successfully. An economically profitable IPM package has been developed to effectively manage these pests. The package consists of (a) use of Tricho-compost & poultry refuse for disease management; (b) use of soap water and botanicals for aphid control; (c) use of sanitation to destroy the pest-infested twigs and flowers; (d) use of *Trichogramma* and *Bracon* parasitoids, Chrysopa, lady beetles, spraying of HNPV and MNPV for controlling *Helicoverpa* and *Maruca* pod borers and other pest insects; and (e) roguing of plants infected with BYMV & BCMV. Adoption of this package will greatly reduce pesticide use and produce healthy crops of country bean that will be safe for the consumers as well as the environment. Demonstrations will be set up in Jessore & Ishurdi (Pabna) during the summer season, and in Gazipur, Jessore & Ishurdi during the winter season.

Objectives: To demonstrate the performance of the IPM package for production of country bean at the farm level.

Status: Continuing

Progress to date:, A demonstration trial is on-going in farmers' fields in Jessore.

Expected output: Availability of a cost-effective IPM package for the production of healthy and pesticide-free country bean crops that will increase farmers' profits.

5. Activity Title: Development of an IPM package for the production of cucumber and pointed gourd (third year).

Brief description: Cucumber (*Cucumis sativa*) and pointed gourd (*Trichosanthes anguina*) are two very popular and high value cucurbit crops which are mainly attacked by the cucurbit fruit fly (*Bactrocera cucurbitae*) as well as by various soil-borne disease pathogens. Cucumber mosaic virus is also a very damaging virus disease of the cucumber. To offer alternatives to farmers' present practice of indiscriminate pesticide use, there is urgent need to develop an IPM package that can effectively manage the pest problems without pesticide use and also increase yield and economic returns. The IPM tactics that will be tested for developing the IPM package are: (a) use of Tricho-compost, poultry refuse, or mustard oil-cake for controlling soil-borne disease pathogens; (b) use of virus-resistant cucumber varieties or seeds collected from virus-free plants; (c) use of cuelure pheromone for cucurbit fruit fly control; (d) roguing of virus-infected plants; and (e) use of NSKE for mite control.

Objectives: To develop an effective and economically profitable IPM package for the production of cucumber and pointed gourd.

Scientists: G. M. A. Halim, M. S. Nahar, A. Muqit, and M. S. Hossain.

Status: Continuing.

Progress to date: The trial for developing the IPM package is on-going at BARI farm, Gazipur. Final harvest may be completed in September.

Expected outputs: Development of an IPM package for the production of pesticide-free, healthy cucumber and pointed gourd crops that will produce higher yields and fetch higher profits to the farmers.

6. Activity Title: Development of an IPM package for the production of Tomato (third year)

Brief description: Tomato is an exportable high value crop in Bangladesh. Presently, it is grown in the winter (optimum season) as well as summer (off-season). Pest problems that cause low yields and less profit to the farmers include virus diseases, various soil-borne diseases including bacterial wilt (BW), root-knot nematode (RKN), and fruit borer. A number of IPM tactics have been developed to manage the pest problems effectively and economically. The tactics include (a) use of virus-resistant varieties/lines, such as BARI Tomato-15, or TLB-182 for the winter season, and BARI Hybrid Tomato-3 or 4 for the summer season; (b) netting of seedbed for non-virus resistant varieties; (c) use of Tricho-compost; (d) use of grafted seedlings for BW & RKN; and (e) use of parasitoids. An IPM package will be developed by integrating the above IPM tactics. Use of an IPM package at the farm level will greatly reduce pesticide use and help produce healthy and better tomato crops with higher yields and economic returns.

Objectives: To develop a cost effective IPM package for the production of tomato crops in both winter and summer seasons.

Scientists: Shahabuddin Ahmad, Shahidul Islam, M. A. Goffer, N. K. Dutta, and M. A. Rahman.

Status: Continuing

Progress to date: A trial for the summer tomato is on-going in Bogra district.

Expected outputs: Development of an IPM package that will be available to the farmers for growing tomato crops in both the winter and summer seasons, and farmers will be highly benefited with higher yields and higher economic returns.

7. Activity Title: Development of an IPM package for the production of okra (third year)

Brief description: Okra production in Bangladesh is seriously constrained due to infection by yellow-vein-mosaic virus (YVMV) that is transmitted by white fly, various soil-borne disease pathogens, root-knot nematode (RKN), aphids and jassids. Pesticide use is largely ineffective, and the farmers lose money due to poor yields. A few okra lines have been found to be moderately resistant or less susceptible to YVMV. Some IPM tactics, such as the use of Tricho-compost, have been highly effective for controlling soil-borne disease pathogens and RKN. Similarly, use of sanitation, bio-control agents, soap water, and botanicals are useful for controlling okra borers, jassids and aphids. Trials integrating the above IPM tactics are necessary for developing an effective IPM package that will increase yields of okra producing higher economic returns.

Objectives: Development of an IPM package for producing healthy and economically profitable okra crops.

Status: Continuing

Progress to date: Field trials integrating the IPM tactics for controlling the diseases and the pest-insects were conducted. Crops on IPM treated plots were healthier than the non-IPM ones.

Expected outputs: Development of an effective IPM package for the production of healthy okra crops with higher yields and higher economic returns.

8. Activity Title: Production of Tricho-compost and Tricho-leachate for standardization of their application rates, effects on soil-brne pathogens, use

of Tricho-leachate for production of Tricho-compost at farmers' level. (third year)

Brief description: BARI scientists associated with IPM CRSP programs have developed an organic compost fertilizer fortified with a strain of *Trichoderma harzianum* (a fungus bio-control agent) known as "Tricho-compost", which is highly effective for controlling various soil-borne fungus pathogens as well as bacterial wilt (BW) pathogen and root-knot nematode (RKN). Moreover it adds fertility to the soil and enhances plant growth. Tricho-leachate, which is a liquid by-product of Tricho-compost, is also effective for controlling various terrestrial fungus pathogens of vegetable crops.

In order to use Tricho-compost and Tricho-leachate effectively at the field level the following trials/experiments will be conducted both at the research station and farmers' fields: (a) replicated experiments for standardizing the application rates of the Tricho-products in sweet gourd, Indian spinach, cabbage, tomato, and eggplant crops; (b) in-vitro efficacy test tests of Tricho-leachate on *Sclerotium* & *Fusarium* pathogens; and (c) use of Tricho-leachate as an alternative to Trichoderma suspension for production of Tricho-compost, so that the farmers can produce Tricho-compost in their farmyard by themselves. Moreover, enough quantity of Tricho-compost and Tricho-leachate will be produced for their use in different IPM trials and demonstrations.

Objectives: To produce Tricho-compost and Tricho-leachate for conducting experiments on (a) standardization of application rates on different crops; (b) in-vitro efficacy test of Tricho-leachate for controlling *Sclerotium* and *Fusarium* pathogens; and (c) use of Tricho-leachate as an alternative of Trichoderma suspension for production of Tricho-compost.

Status: Continuing

Scientists: M. A. Rahman, M. S. Nahar, M. Golam Kibria, Mafruha Afroz, Arefur Rahman (MCC), Ed Rajotte & Sally Miller

Progress to date: About three tons of Tricho-compost have been produced and supplied for conducting different demonstrations and trials.

Expected output: (a) Standardization of the production of Tricho-compost and leachate; (b) standardized application rates of the Tricho-products on major vegetable crops; and (c) development of a protocol for maintaining their quality and use of Tricho-leachate for production of Tricho-compost at the farm level instead of the use Trichoderma spore suspension.

9. Activity Title: Development of mass-rearing protocol and field efficacy tests of larval parasitoids of *Epilachna* beetle and lady bird beetle and syrphid fly predators. (third year)

Brief description: Populations of different predators and parasitoids have decreased drastically in the vegetable fields due to injudicious use of pesticides by the farmers. Research has shown that pesticides applications can be avoided if populations of predators and parasitoids are conserved and augmented.

Lady bird beetle and syrphid fly are the two important insect predators that can control different vegetable pest-insects effectively. Recently, techniques have been developed to rear lady bird beetle and syrphid fly on the eggs of *Corcyra/Sitrotoga* species. In the present activity, a protocol will be developed for mass production of the predators, and their effectiveness for controlling different vegetable pest-insects, such as aphids, jassids and white fly in eggplant, cucurbit, and bean crops will be tested in the greenhouse as well as in the field under micro-plot conditions.

Recently the parasitoid *Pediobius foveolatus* has been found parasitizing the larvae of *Epilachna* beetles.

Objectives: (a) To develop a suitable protocol for mass production of lady bird beetle and syrphid fly predators, and the parasitoid of *Epilachna* beetle; (b) To evaluate the efficacy of the predators and the parasitoids both in the greenhouse and field; and (c) determine the seasonal abundance of the natural hosts of the predators and parasitoids to understand the natural control systems.

Scientists: S. N. Alam, M. Mahamunnabi, Fatema Khatun, and Ed Rajotte

Status: New

Progress to date: Mass rearing of lady bird beetle and syrphid fly has been completed. The parasitoid *Pediobius foveolatus* on *Epilachna* beetle has been collected and reared.

Expected output: (a) Development of an easy and economical protocol for the mass production of lady bird beetle and syrphid fly predators, and parasitoid of *Epilachna* beetle**;** and (b**)** Determination of the efficacy of the predators and parasitoids for their use in controlling the vegetable pest-insects.

10. Activity Title: Assessment of the adoption and impacts of IPM technologies in vegetable crops at the farm level. (third year)

Brief description: A number of IPM technologies developed by BARI scientists through IPM CRSP project have become popular among the farmers in different areas mainly

because of their excellent effectiveness for controlling pest-insects and diseases, higher crop yields and high cost-effectiveness. In several areas of the country, the farmers have switched over from their conventional use of pesticides to practicing IPM technologies for growing various vegetable crops. As a result, farmers are earning premium price by producing pesticide-free vegetables. Presently, a number of private firms are engaged in the production and supply of different bio-control agents, bio-fertilizers and sex pheromones. The Bangladesh government has also recently approved the commercialization of different bio-rationals (e.g., pheromones, bio-pesticides) ensuring their production, import and marketing at the local market. Assessment of these developments are necessary to record the impacts on the adoption and spread of IPM practices among the larger vegetable farming community, that has an important role to make healthy and pesticide-free vegetables available at the domestic and export markets.

Objectives: To identify the factors and assess the adoption and impact of IPM technologies in vegetable crops in different areas.

Scientists: Q. M. Shafiqul Islam, Mahmuda Akter, Sadique Rahman & George Norton.

Status: Continuing

Progress to date: Baseline surveys for assessment of adoption and impacts of IPM technologies have been targeted in three sites of three districts. Surveying in one site of Jessore district has been completed and the second one is on-going in Narsingdi district. The third one will be completed during the first week of August.

Expected output: (a) Identification of positive and negative factors responsible for adoption of IPM technologies; (b) determination of adoption rates of IPM technologies and assessment impacts at the farm level; and (c) identification of possible technology refinement and policy guidelines.

11. Activity Title: Survey and diagnosis of pest-insects and diseases of vegetable crops under the the International Plant Diagnostic Network (IPDN) (second year)

Brief description: Nearly 100 varieties of local and exotic vegetables are grown in Bangladesh. Because of the tropical and sub-tropical agro-climate of the country, which is highly conducive to the proliferation of numerous pest-insects, nematodes and diseases, all the vegetable crops are attacked by various damaging pests throughout their growing season. Records of all the pest species attacking all the vegetable crops are not available. A complete list of all the pests with their characteristics will be highly useful to (a) know their incidence and abundance patterns; (b) research and develop

their management strategies and practices; (c) develop diagnostic laboratory and clinical services for the farmers; (d) develop a regional network on pest distribution and available management tactics; and (e) exchange technical information on pest diagnostic issues among the networking countries.

Objectives: To document a dependable list of different pest species attacking the vegetable crops with their diagnostic characteristics that can serve as a repertory for reference as well as for developing management strategies.

Scientists: M. A. Rahman, S. N. Alam, M. S. Nahar, N. K. Dutta, M. M. Islam, K. E. Jahan, Mafruha Afroz, M. Nabi, and Sally Miller

Status: Continuing

Progress to date: Surveys for collection of samples and their diagnosis will be started soon.

Expected output: (a) Documentation of all the pest species (insects, disease pathogens and nematodes) attacking the vegetable crops with diagnostic characteristics; (b) development of a repertory for pest management research & development; and (c) establishment of a pest diagnostic and pest management network in the region.

12. Activity Title: Survey and diagnosis of virus diseases attacking vegetable crops in Bangladesh under the International Plant Virus Disease Network (IPVDN) (second year)

Brief description: Many of the 100 varieties of vegetables grown in Bangladesh are infected by different species of viruses causing large crop losses. Unfortunately, only a few virus diseases of some vegetable crops have been identified and documented so far. Managing virus diseases is a formidable task all over the world. As a prerequisite, it is therefore highly important to document all the virus diseases of the vegetable crops with their symptomatic and molecular characteristics so that meaningful research programs can be developed for their management. Documentation of the virus diseases will help establish diagnostic centers in order to help farmers with appropriate cultivation and management practices. It will also help establish a regional network for exchanging scientific information and probable solutions.

Objectives: To document the incidence and abundance of virus diseases attacking the vegetable crops in Bangladesh with their diagnostic characteristics and establish a network for virus disease management research & development.

Scientists: A. Muqit, Z. Karim, Mujahid-e-Rahman, Mahfuzur Rahman, Mafruha Afroz, T. K. Dey, and Rayapati Naidu.

Status; Continuing

Progress to date: Surveys have been completed and virus infected samples have been collected from three districts. More surveys will be carried out and the diagnostic characteristics of the infected samples will be recorded based on symptoms and ELISA tests.

Expected outputs: (a) Documentation of virus diseases attacking vegetable crops with their symptomatic and molecular diagnostic characteristics; (b) establish a regional network for diagnostic as well as management purposes; (c) establish a repertory of virus diseases that can be used for research & development purposes.

13. Activity Title: Role of women in vegetable cultivation and IPM technology adoption under the Global Gender Program

Description: In Bangladesh, gender plays an important role in agriculture and pest management. Farm activities are usually gendered based on their nature of tasks, which is also related to access to various resources that include land, labor, education and credit. Moreover, farm tasks are also gendered based on knowledge, aptitude and practice which influence the adoption of a particular agricultural practice or IPM strategy. Bangladesh is a multi-religious country having varied cultures. Muslim women as well as the women of the higher caste Hindu religion do not work in open fields, but they do cultivate and maintain vegetables in homestead gardens and take care of animals (mainly cattle & poultry). The women of lower caste Hindu religion and those of tribal sects sometimes work in open fields. In many cases of agricultural and IPM practices, based on the nature of the tasks, women play a leading part in decision making and execution of the tasks including handling financial aspects of household management. Earlier studies in some IPM CRSP sites showed that women played important roles in pest management issues. In recent years, IPM practices have become very popular in many districts of Bangladesh and many women have become involved in IPM practices. More studies however are needed to understand the present status of women's role in agriculture, particularly vegetable cultivation and adoption of IPM practices.

Objectives: To survey and document the role of women in vegetable cultivation and adoption of IPM practices.

Scientists: Shahnaz Huq-Hussain, Tahera Sultana, Umme habiba (DU), Sadique Rahman (BARI), K. A. Uma (TNAU, India) & Maria Elisa Christie

Status: Continuing

Progress to date: Two graduate students (Ms. Tahera Sultana and Ms. Umme Habiba) are carrying out the research survey at the field level at Jessore and Narsingdi sites under the supervision of Dr. Shahnaz Huq-Hussain (Professor of Geography & Environment, Dhaka University)**.** Ms. Tahera Sultana is working on "women's role in adoption of IPM inputs in vegetable cultivation", and Ms. Umme Habiba on "women's role in vegetable cultivation".

Expected output: A documented record of women's role in Bangladesh with regard to vegetable cultivation and IPM adoption that will depict various aspects including planning, decision making, nature of tasks including execution, marketing, handling of financial matters, and socio-economic impact**s.**

Nepal Site

Regional Project:

Project Title : The South Asia Regional IPM CRS Program, Nepal

Names: PI : Dr. Luke A. Colavito

Co PI : 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 without any adverse effect on health, environment, and bio-diversity.

This workplan details the third year's activities under the objectives stated in the full proposal.

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

Activity 1: Tomato IPM package development

Major pests include whitefly, *Helicoverpa*, *Spodoptera*, leafminer and thrips. Major diseases include bacterial wilt, rootknot nematode, tomato yellow leafcurl virus, tomato spotted wilt virus, TMV, CMV and Sclerotium.

Task 1: Deploy and evaluate package

Similar to Bangladesh, a range of tactics will be used in the tomato IPM package, including use of plants resistant to bacterial wilt, RKN, and TYLCV. Soil amendments, including Trichoderma compost, mustard oil cake and VAM, will be used against soil pests. Pheromone traps will be set to monitor major insect pests. Packages will be tested in at least three sites, including two mid-hills and one flat land terai in Nepal.

Task 2: Evaluate new components

While the initial component studies will be done in Bangladesh and India, Nepal will contribute its own research input. IPM tools such as pheromones, traps, biopesticides and biofertilizers have been found to vary in quality depending on their source. Products purchased from different vendors or produced in different countries may or may not be dependable. The Nepal project will test IPM tools against standards purchased in the U.S. or Europe. These products will be tested in farmers' fields in Kaski, Palpa, Rupandehi, Lalitpur, and Illam districts. Five farmers will be selected in each district to participate.

Slow release of nutrients is required for the sturdy growth of plants; this helps the selected crop plants tolerate pathogenic diseases and phytophagus insects. In a well-managed system, the selected crops' yields should be higher than those with chemical fertilizer applications. Farmers will apply equivalent doses of compost as well as bio-fertilizers such as Nitrofix-B, P sol-B and K sol-B on tomato, coffee, and tea. Each bio-fertilizer will be mixed with well-decomposed compost in separate slots.

On tomato, an initial application of *Verticillium leacanii* (at 5g per liter of water to the point of drenching) will be made; this will be done during evening hours at flower initiation stage. A second spray—*Beauvaria bassiana* (at 5g per liter of water to the point of drenching)—will be made during evening hours 15 days after the first spray. A third spray—*Bacillus thuringiensis* var. *kurstaki* (at 1.5g per liter of water to the point of drenching)—will be made during evening hours 15 days after second spray. An unsprayed check will be used for comparison.

There are different types of pheromones available in the Nepalese market. Nepalese smallholders and poor farmers are facing problems in pheromones and trap quality. There is no consistency in technical support from service providers. Quality control is not institutionalized. Poor quality pheromones are expensive and easily available through local marketing networks. Poor quality pheromones and traps have caused serious damage to the on-going value chain approach.

Five major insect pests (fruit fly [*Bactrocera* spp.] in cucurbits and tomato, eggplant shoot and fruit borer [*Leucinodes orbonalis*], tobacco caterpillar [*Spodoptera litura]*, tomato fruit worm [*Helicoverpa armigera])* are targeted on four crops (cucurbits, tomato, eggplant, and cole) in farmers' fields for evaluation of effective pheromones. Five project districts, Rupendehi, Palpa, Kaski, Lalitpur and Illam, are selected for field testing. Adult insects attracted to the pheromone traps needs to be monitored once a week, if possible twice a week. Frequent monitoring helps participating farmers to protect polyethylene sleeves of the traps from bird damage. For effective "lure and kill method", soapy water needs to be replaced on every 4th. day.

For cucurbit fruit fly trapping, U.S. purchased Cue-lure will be tested in locally made versus purchased traps, with and without soapy water, and with and without mashed sweet gourd.

Activity 2: Eggplant IPM package development

Key pests are similar to those in Bangladesh. They include eggplant fruit and shoot borer, jassids, *Epilachna* and spider mites. Diseases include bacterial wilt, phomopsis, little leaf, RKN and Sclerotium. Weeds will be addressed by testing various hand weeding frequencies.

Task 1: Deploy and evaluate package

Nepal will adapt IPM package elements from the Bangladesh site. They will be tested in mid-hills in Kaski and Lalitpur districts and flat land terai in Rupandehi district.

Task 2: Evaluate new components

Nepal will evaluate bio-pesticides and bio-fertilizers in each crop designed for IPM package; we will also evaluate locally developed pheromones to initiate need-based application rather than time-based application. These will be tested in Rupendehi, Palpa, Illam, Lalitpur and Kaski districts.

Activity 3: Socioeconomic Analyses

Task 1: Initiate new components for impact assessment and budget analysis

Objective 2: Technology transfer

Technology transfer in Nepal involves a collaboration among government, NGOs and IPM CRSP personnel. As research results are obtained and IPM packages developed, IPM CRSP scientists interact with these groups to begin the transfer process.

Activity 1: Government activity

IPM CRSP partners with the Department of Agriculture and the Nepal Agricultural Research Council. One of the main research sites is in Pokhara, Kaski District at a NARC station. Local farmers are linked to the station and allow experiments to be done in their fields. These fields then become demonstrations for the local farming community. Government scientists will join the annual planning meeting to offer their expertise.

Activity 2: NGO activity

Our main partner in Nepal is IDE, a social enterprise dedicated to ending poverty in the developing world not through handouts, but by helping poor farmers invest in their own success. IDE has an extensive training network throughout the country working mainly on water projects, leading in micro irrigation technology. The IDE will sub-contract with a National NGO called CEAPRED to run its field activities.

Task 1: By training IDE staff about IPM, the network is used as a technology transfer mechanism.

Activity 3: Private sector activity

The private sector has also become involved in Nepal. Some technologies are saleable, such as bio-pesticides, bio-fertilizers, and pheromones. The success of grafting has stimulated some nurserymen to supply grafted seedlings to local farmers in western Nepal.

Task1: Maintain contact with the private sector during technology transfer activities.

Objective 3: Institutional capacity building

Capacity building includes collaborative working relationships between host country and U. S. scientists, inter-country collaborations, scientist short term training and student training.

Activity 1: Inter-country collaboration activity

Task 1: Planning and review meeting

Annual planning and evaluation meetings that draw the site coordinators to one place to meet with U.S. scientists will be used to encourage close and mutually beneficial working relationships and transfer of information.

Activity 2: Scientist training

Task 1: Funds will be set aside for intra-regional scientist training and a short term training plan developed.

This has worked well in the past with host country scientists traveling to other countries to give or get training.

Task 2: Graduate student training

Each U.S. institution has funds for graduate assistantships at the U.S. universities. In addition, as part of Penn State's match, two additional assistantships will be available. One Graduate student candidate has been selected (Mr. Sulav Paudel) this year for a Masters Degree in Penn State University. In Nepal, a former OSU graduate student will be rejoining OSU to complete his PhD as a part of IPM CRSP long term training program.

India Site

<u>Regional Project:</u>

Project Title:	The South Asia Regional IPM CRS Program, India
Names: PI(s):	Dr. S. Mohankumar
Co PI(s):	Dr. G. Karthikeyan, N. Kaushik
Administrative Co-PI(s):	Dr. R. Samiyappan, E. I. Jonathan

IPM CRSP III year Annual Workplan –
Integrated Pest Management: Science for Agricultural Growth in South Asia- India site - TNAU

Regional Projects:

Project Title:
Integrated Pest Management: Science for Agricultural Growth in South Asia-India site (TNAU, Coimbatore, and TERI, New Delhi)

Institution Administrative Co-ordinators	Dr. R. Samiyappan and Dr. E. I. Jonathan Directors
Names: PI(s)	S.Mohankumar and G. Karthikeyan
Co PIs	G. Chandrasekar, P. Karuppuchami, L. Pugalendhi, C. Durairaj, S. Ramakrishnan, G. Gajendran, D. Dinakaran and N. Kaushik
Objective - 1	**Development and validation of IPM modules for major vegetables in Tamil Nadu and New Delhi**
Activity - 1	**IPM in tomato, brinjal, okra, onion**
Country(ies)	India
Status: New or continuing	Continuing
Scientists involved	G. Karthikeyan, C. Durairaj, S. Ramakrishnan, S. Mohankumar, G. Gajendran, D. Dinakaran, N. Kaushik
Description	IPM module developed will be validated in larger plots and IPM technologies will be popularized
Progress to date	IPM modules in different crops developed
Expected outputs	Validation of cost-effective IPM package, awareness for adoption of different components and reduction of pesticide usage is expected
Task - 1	Conducting large scale IPM trial at different locations
Task - 2	Organizing field days
Activity - 2	**IPM in Chilies, cabbage, cauliflower and gourds**
Country(ies)	India
Status: New or continuing	Continuing

Scientists involved	C. Durairaj, G. Karthikeyan, S. Ramakrishnan, S. Mohankumar and N. Kaushik
Description	The following IPM Components as a package will be evaluated in farmers field: Cabbage and Cauliflower ❖ Seed / nursery treatment with *Pseudomonas* @ 10 g/ kg of seed / lit of water ❖ Seedling root dip with *Pseudomonas* @ 10 g/ lit of water ❖ Soil application of neem cake @ 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 Chilies ❖ Seed treatment with *Trichoderma viride* @ 4g/kg of seeds or ❖ Seed treatment with *Pseudomonas fluorescens* @ 10g/kg of seeds ❖ Nursery application with *Trichoderma viride* or *Pseudomonas fluorescens* after multiplication with FYM ❖ Growing castor as border trap crop ❖ Application of neem cake @ 250kg/ha ❖ Soil application of *Pseudomonas fluorescens* @ 2.5kg/ha ❖ Selection of good and virus disease-free seedlings for planting ❖ Roguing out of virus infected plants up to 45 days of transplanting ❖ Grow marigold as a trap crop in irrigation channels ❖ Set up *Helicoverpa* / *Spodoptera* pheromone traps @ 12 numbers / ha ❖ Release *Trichogramma chilonis* @ 50000/ha ❖ Install yellow sticky traps ❖ Spraying neem formulations / neem seed kernel extract

	❖ Need based application of eco-friendly nematicide / insecticides/fungicide Gourds ❖ Seed treatment with *Trichoderma viride* @ 4g/kg of seeds or ❖ Seed treatment with *Pseudomonas fluorescens* @ 10g/kg of seeds ❖ 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 @ 12 numbers / ha ❖ 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 were laid out and the trials are in progress
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
Activity - 3	**Breeding for pest resistance**
Country(ies)	India
Status: New or continuing	Continuing
Scientists involved	L. Pugalendhi, C. Durairaj, G. Karthikeyan, S. Ramakrishnan, S. Mohankumar
Description	The resistance in identified germplasm will be confirmed under bombarded conditions both in field and glasshouse
Progress to date	Germplasm were assembled from various national and international agencies in four different (brinjal/ okra/ tomato/ chilies) crops and resistant sources were identified for various pests.

Expected outputs	Pest resistant donors will be identified and exploited in breeding programs.
Task - 1	Evaluating the performance of germplasm (brinjal/okra/tomato/chilies) for pest resistance under bombarded conditions both in field and glasshouse
Task - 2	Crossing and hybridization with desirable parents
Activity – 4	**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	The IPM strategies as a package will be evaluated under polyhouses/shade net conditions
Progress to date	Survey on the occurrence of major pests in vegetables cultivated in polyhouses/shade nets were done. Studies on IPM module suited to polyhouse vegetable cultivation were conducted
Expected outputs	IPM module suited to polyhouse will be available
Activity - 5	**Popularization of different components of IPM**
Country(ies)	India
Status: New or continuing	continuing
Scientists involved	G. Karthikeyan, G. Gajendran and D. Dinakaran, S. Ramakrishnan, S. Mohankumar, C. Durairaj, N. Kaushik
Description	Popularization of biocontrol agents in IPM - *Pseudomonas, Trichoderma, Trichogramma, Acerophagus papayae*; soil organic amendments in IPM; fencing brinjal fields with mesh, botanical formulations, monitoring of insect pests through pheromone traps and yellow sticky traps will be done through large scale demonstrations

Progress to date	Popularization of various strategies depending upon the crop, pest and local situations were done. Major efforts were carried out onion IPM as a package and popularization of biocontrol agents like *Pseudomonas, Trichoderma,* and *Acerophagus papayae*, pheromone traps and yellow sticky traps as components in other crops.
Expected outputs	Large scale adoption of non-chemical eco-friendly IPM components will be popularized
Activity - 6	**Collaboration with IAMWARM (World Bank-funded scheme) for popularization of IPM in vegetables**
Country(ies)	India
Status: New or continuing	continuing
Scientists involved	S. Mohankumar, G. Karthikeyan, C. Durairaj, S. Ramakrishnan
Description	Large scale adoption of non-chemical eco-friendly IPM components in vegetables will be popularized
Progress to date	-
Expected outputs	Large scale adoption of non-chemical eco-friendly IPM components will be popularized
Activity - 7	**IPM for vegetable nursery**
Country(ies)	India
Status: or continuing	continuing
Scientists involved	L. Pugalendhi, S. Mohankumar, G. Karthikeyan, C. Durairaj, S. Ramakrishnan
Description	Large scale production of healthy seedlings from vegetable nurseries with bio-inputs to reduce pests and diseases
Progress to date	Initial experiments were conducted with biocontrol agents
Expected outputs	Large scale production of healthy seedlings from vegetable nurseries is possible.

Activity - 8	**Development of indigenous pheromone blends for vegetable pests**
Country(ies)	India
Status: New or continuing	New
Scientists involved	C. Durairaj, P. Karuppuchami, S. Mohankumar, G. Karthikeyan
Description	Identification of pheromones for ecotypes of vegetable pests will be done
Progress to date	-
Expected outputs	Identification of pheromones for local vegetable pest populations will be done
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, N. Kaushik
Description	Research articles on earlier research findings will be published; Tomato, okra and brinjal IPM books are planned for third year; publishing extension articles through dailies/ magazines (English/ vernacular language) on IPM is planned; Posters will be displayed in different conferences/ seminars/ symposium.
Progress to date	Onion IPM book is in preparation; Two book chapters are published; Twenty extension articles through dailies/ magazines (English/ vernacular language) on IPM were published. Around 15 posters were displayed in different conferences/ seminars/ symposium are planned; Five plant protection bulletins were prepared for the benefit of farmers
Expected outputs	Large scale adoption of non-chemical eco-friendly IPM components will be popularized

Graduate Students and Post Doctoral Research Associates:	
Name	will be decided based on discussion with Dr. Doug Pfeiffer/ Dr. Ed Rajotte/ Dr. Sally Miller
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 on insect pest identification is planned
Seminars:	Two farmer seminars on vegetable IPM during two different seasons

Field days:	Five field days for demonstrating IPM technologies in major vegetable crops
Mass media events	10 different talks through ALL INDIA RADIO about pest management; Two events through national telecasting channel, Doordarshan
Annual meetings	One workshop cum annual meeting with all IPM-CRSP scientists and research scholars of TNAU and TERI is planned
Others	Field visits for pest diagnosis and providing solutions to farmers: 100 visits

IPM CRSP work plan for Year 3-TERI

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.

Activity- 1: IPM trials on Okra, Tomato, Eggplant, Cucurbits and Cabbage in Meerut, Kolar and Chittoor.

Status: Trials will be carried out during October 2011-September 2012.

Scientists Involved: Dr. Nutan Kaushik, Mr. Vivek Sharma, Mr. Vister Joshi, Mr. T M Manjunathaiah and Ms Monika.

Description: Minimum 10 trials each for Okra, Tomato, and Eggplant and 5 trials each for Cabbage and Cucurbits will be conducted according to their respective season in all the three states. Thus a minimum of 40 trials will be conducted.

Progress to date: In Meerut region 4 Okra trials are in progress while 6 Tomato, 3 Eggplant and 5 cucurbits trials will be completed.In Southern region i.e. Kollar and Chitoor, 7 Okra trials, 22 tomato and 1 egg plant trial were laid down during 2010-2011, out of which 2 have been completed.

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: Trials will be carried out during October 2011-September 2012.

Scientists Involved: Dr. Nutan Kaushik, Mr. Vivek Sharma, Mr. Vister Joshi, Mr. T M Manjunathaiah and Ms Monika.

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 Botanicals against viruses – TERI will provide extracts to TNAU for viral efficacy.

Status: New activity

Scientists Involved: Dr. Nutan Kaushik, Ms Rishu Kalra and Mr. Vikram Kumar.

Description: TERI will provide extracts to TNAU for viral efficacy and efficacy of Botanicals against viruses will be assessed by TNAU scientists.

Progress to date: 10 extracts have been prepared and 2 samples from North and 5 samples from South have been sent to TNAU in the month of June for identification of viruses.

Expected outputs:

1. Efficacy of Different Botanicals against viruses will be assessed by TNAU scientists.

2. Identification of virus in the field.

Task 1: Assessment of Efficacy of Botanicals against viruses.

Task 2: Provision of Extracts to TNAU.

Task 3: 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, Mr. Vister Joshi, Mr. Manjunathaiah, Ms Monika 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.

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.

Ecologically-based Participatory IPM for Southeast Asia

PI: **Dr. Michael Hammig;** Clemson University, Clemson, SC.

CO-PIs: **Dr. Merele Shepard;** Clemson University, Clemson, SC.
Dr. Gerry Carner; Clemson University, Clemson, SC.
Dr. Eric Benson; Clemson University, Clemson, SC.
Dr. Guido Schanbel; Clemson University, Clemson, SC.

Clemson University

Objective 1: to develop IPM knowledge with smallholder farmers producing vegetables and selected other high-value crops in Southeast Asia.

Activity 1. Support field activities of collaborators in Indonesia, Cambodia, and the Philippines.

Task. Travel to research sites, meet with collaborators, and develop innovative IPM tactics for key crops/pests.

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.

Task. Continue data collection in the Philippines with samples from trained and untrained farmers to improve understanding of project success and to guide future activities.

Task. Adapt the Philippines survey instrument to Indonesia with collaboration of IPB and UNSRAT social scientists to improve cross-country comparisons of IPM strategies.

Activity 2. Conduct gender impact surveys.

Task. 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 a host country scientist on identification and management of plant virus diseases.

Task. A host country scientist will travel to Dr. Naidu Rayapati's laboratory in Washington State for training to possibly include short visits to UC Davis and Univ. of Arizona.

Activity 3. Conduct a regional workshop in SE Asia for collaborators.

Task: Conduct the regional workshop in Cambodia where collaborators will share experiences to learn from one another and invited international scientists.

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.

Task: 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.

Activity 2. Expand collaborative network to include the Institute for Coffee and Cocoa Research and the Indonesian Vegetable Research Institute.

Task: Meet with staff and organize research and training activities.

Workplan Year 3. University of the Philippines Los Baños

Objective 1: To develop IPM knowledge with smallholder farmers producing vegetables and selected other high-value crops in Southeast Asia.

Activity 1. Development and utilization of IPM strategies for management of soil-borne diseases (bacterial wilt)

Crops: Tomato, eggplant, bitter gourd (new), hot pepper (new)

Location: UPLB CES (with field demonstration plots in Sariaya, Quezon)

1. Use of *Pseudomonas fluorescens*
2. Use of vesicular arbuscular mycorrhiza (VAM)
3. Use of *Trichoderma* (UPLB isolate)
4. Use of guava leaves

Activity 2: Evaluation of biological control agents against insect pests (fruit and shoot borer, leafhopper, fruitworm, fruitfly):

Crops: Tomato, eggplant, bitter gourd (new), hot pepper (new)

Location: UPLB CES (with field demonstration plots in Sariaya, Quezon)

1. Use of *Trichogramma chelonis* or *T. evanescens* against FSB
2. Use of earwig (*Euborellia annulata*) and another species of earwig, *Labiduria riparia*
3. Use of mulching for insect pest and weed control

Activity 3. Evaluation of mulching, stale-seedbed technique and inter-row cultivation for control of weeds in ampalaya (bitter gourd) and hot pepper

Crops: Hot pepper, bitter gourd

Location: UPLB CES (with field demonstration plots in Sariaya, Quezon)

Objective 2: To improve IPM communication and education leading to widespread adaptation, adoption, and impact of IPM approaches in Southeast Asia

Objective 3: To enhance the capability of smallholder farmers to produce and market high quality products for local, national, and international markets.

Activity 1. Dissemination of promising IPM technologies in partnership with the Department of Agriculture and NGOs

Location: Sariaya, Quezon (5 villages) and Region IV (Laguna area)

Task 1. Implement IPM technology transfer to farmers and extension workers

1. Field demo plots in 5 villages in Sariaya, Quezon
2. One-day seminar workshop to farmers, extension workers in Sariaya, Quezon

Task 2. Implement IPM technology transfer to staff of state colleges and universities (SCUs) in Region IV (Laguna area)

1. Field demo plots at UPLB Central Experiment Station for observation by SCUs in Region IV (Laguna area)
2. One-day seminar workshop on IPM strategies at UPLB for SCUs

Task. 3. Provide expertise to the participants of the Department of Agriculture-Gawad Kalinga project in performing IPM technologies like grafting eggplant seedlings and use of earwigs to control pests in their vegetable garden program and providing them with IPM materials such as earwigs, *Trichogramma,* and *Trichoderma.*

Task 4. Writing and printing of leaflets and training materials such as leaflets or posters about the use of mature IPM technologies

Workplan Year 3. Philippine Rice Research Institute (PhilRice)

Objective 1: to develop IPM knowledge with smallholder farmers producing vegetables and selected other high-value crops in Southeast Asia.

Activity 1. Development and utilization of IPM tactics for the management of soil-borne diseases of rice-based vegetables

Crops: onion. garlic, eggplant, tomato, pepper, okra, bittergourd, and melon.

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 2. Use of rice straw and stale seedbed techniques to reduce weeds and provide refuge for predators

Crop: - onion

Location: - Guimba, Nueva Ecija

IPM Tactics: - Rice straw mulch for the management of weeds and increase population of predators

Activity 3: Development and utilization of IPM tactics for the management of insects in rice-based vegetables

Crops: onion. garlic, eggplant, tomato, pepper, okra, bitter gourd, and melon.

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 *Metarrhizium* 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 (ESFB)
g. Use of resistant varieties of eggplant for ESFB management
h. Field sanitation

Objective 2: to improve IPM communication and education leading to widespread adaptation, adoption, and impact of IPM approaches in Southeast Asia.

Objective 3: to enhance the capability of smallholder farmers to produce and market high quality products for local, national, and international markets.

Activity 1. Technology Transfer, Promotion and Dissemination of Pest Management Technologies In Rice -Vegetable Cropping Systems.

a. Promotion of IPM tactics/technologies developed
b. Development of information and extension campaign materials
c. Short trainings, technical briefings, establishment of PTDs
d. Season-long farmers field schools (FFS)
e. Media publicity
f. Farmers educational tours
g. 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.

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 biological control agents (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.

a. Collection and identification of diseases of different vegetable crops

b. Description of the signs and symptoms of each disease

c. Development of the diagnostic kit

d. Pre-testing of the kit – evaluation by farmers

e. Modification of the kit based on the farmers' evaluation and finalization of the kit.

f. Mass production of the disease diagnosis kit.

Workplan Year 3. Bogor Agricultural University (IPB)

Objective 1: to develop IPM knowledge with smallholder farmers producing vegetables and selected other high-value crops in Southeast Asia.

and

Objective 2: to improve IPM communication and education leading to widespread adaptation, adoption, and impact of IPM approaches in Southeast Asia.

A. Development of IPM tactics for high value crops

A.1. IPM knowledge/tactics for Crucifers

a. Screened-beds to prevent early infestation by insects,

b. Use of plastic mulch to maintain soil moisture and to prevent weed infestation,

c. Pouring bokashi (compost) mixed with *Trichoderma* into planting holes,

d. Dipping seedlings in *Bacillus subtilis* and *Pseudomonas fluorescens* for 12 hours before transplanting,

e. Reduce rates of synthetic fertilizers,

f. Hand picking caterpillars from infested plants, and

g. Spot-spraying with *Bacillus thuringiensis* or botanical extracts

A.2. IPM knowledge/tactics for chili pepper

a. Screened-beds to prevent early infestation by insect vectors,

b. Use of plastic mulch to maintain soil moisture and to prevent weed infestation,

c. Pouring bokashi (compost) mixed with *Trichoderma* into planting holes,

d. Dipping of seedlings in *Bacillus subtilis* and *Pseudomonas fluorescens* for 12 hours before transplanting,

e. Lower rate of synthetic fertilizers,

f. Need-based botanical extract applications.

A.3. IPM knowledge/tactics for tomatoes

a. Screened-beds to prevent early infestation by insect vectors,

b. Use of plastic mulch to maintain soil moisture and to prevent weed infestations

c. Pouring bokashi (compost) mixed with *Trichoderma* into planting holes,

d. Dipping of seedlings in *Bacillus subtilis* and *Pseudomonas fluorescens* for 12 hours before transplanting,

e. Reduce rates of synthetic fertilizers,

f. Need-based applications of HaNPV and fungicides.

A.4. IPM tactics for green onion

a. Use of plastic mulch to maintain soil moisture and to prevent weed infestations,

b. Pouring bokashi (compost) mixed with *Trichoderma* into planting holes,

c. Dipping seedlings in *Bacillus subtilis* and *Pseudomonas fluorescens* for 12 hours before transplanting,

d. Reduce rates of synthetic fertilizers,

e. Yellow sticky traps to monitor/reduce leafminer infestations,

f. Hand picking of egg mass and caterpillars from infested plants, and

g. Need-based botanical pesticide applications

A.5. IPM knowledge/tactics for potato (NEW ACTIVITY)

a. Use of plastic mulch to maintain soil moisture and to prevent weed infestation,

b. Pouring bokashi mixed with *Trichoderma* into planting holes,

c. Pouring *Bacillus subtilis* and *Pseudomonas fluorescens* into planting holes,

d. Reduce rates of synthetic fertilizers,

e. Need-based fungicide applications

A.6. IPM knowledge/tactics for papaya

a. Assessment of impact of parasitoid *Acerophagus papayae* on suppression of papaya mealybug populations.

b. Evaluate the effect of hyperparasitoids.

B. IPM Dissemination

a. Produce various VCDs/DVDs relevant to IPM.

b. Talks through community radio Edelweis about various aspects of IPM.

c. Mobile diagnostic plant clinic

C. Farmer level production of biotic agents

a. Improve capability of farmer-level bioagent production centers and quality control of biotic agents produced.

Workplan Year 3. Sam Ratulangi University (UNSRAT)

No	Crop	Location	IPM Tactic
01	Tomato	Toure	1.*Liriomyza sativae* and *N. tenuis* -Bioinsecticides (use of plant extract) -Optimization of natural enemies 2.Bacterial and fungal diseases -Use of *Trichoderma* sp -Use of Plastic Mulch -Application *Pseudomonas fluorescens*
02	Chili	Toure	1. Viral and Bacterial diseases -Use of Plastic Mulch -*Trichoderma* sp Resistant varieties 2. Survey important pests and natural enemies - survey vectors of viral diseases
03	Cabbage	1.Rurukan 2.Modoinding	1. *Plutella xylostella* - use of *B. thuringiensis* and local strain of *M. anisopliae* to conserve and enhance natural enemies such as the parasitoid *Diadegma semiclausum* 2. *Crocidolomia binotalis* - Use of *B. thuringiensis* - Use of local strain of *M. anisopliae*
04	Spring Onions	Modoinding	1.*Spodoptera* spp. - Use of *B. thuringiensis* - SENPV and SLNPV -local strain of *M. anisopliae*
05	Cacao	1.South Minahasa 2.Bolaang 3.Mongondow	1. *Conopomorpha cramerella* - Determine distribution of CBB - Survey of natural enemies -Continue evaluation of plastic sleeves
06.	Potato	Modoinding	Bacterial and Fungal Diseases -Use of *Trichoderma* sp -Use of *Pseudomonas fluorescens*
07	Egg Plant	Langowan/Toure	Grafting

Workplan Year 3. FIELD/Indonesia

CROPS	LOCATION	MAIN PEST / DISEASES	IPM TACTICS
Sweet Potato	Sungai Sariak village (Baso sub- district, Agam district, West Sumatera province)	*Cylas formicarius*	• Sanitation of the remains of the harvest in the field • Use of bioagents (*Metarrhizium and Beauveria*)
Bitter Gourd	Kayu Gadang village (Padang)	Fruit Fly	• Sanitation • Sleeving • Protein bait
Chili	• Guguk village (2 x 11 Kayu Tanam sub-district, Padang Pariaman district, West Sumatera province). • Ulakan village (Ulakan Tapakis sub-district, Padang Pariaman district, West Sumatera province) • Batu Layang village (Sibolangit sub-district, Karo district) • Doulu village (Berastagi sub-district, Karo district)	Antracnose Viruses *Fusarium* wilt Fruitfly	• Sanitation • Use of mulch • Use of bioagents (*Trichoderma*) • Healthy seedling • Eradication of infected plant • Use of botanical pesticide and ash solution for controlling vectors • Virus surveys and identificaton • Eradication of infected plant • Use of *Trichoderma* • sanitation • Botanical pesticide • Protein bait
Citrus	Tangkidik village (Barusjahe sub-district, Karo district, North Sumatera)	CVPD (citrus vein phloem degeneration)	• Pruning • Organic fertilizing • Ash solution spraying (to reducce vector insect) • Sanitation • Survey for parasites of citrus psylid

Broccoli	Tangkidik village (Barusjahe sub-district, Karo district, North Sumatera)	*Crocidolomia sp*	• Egg / 1st instar larvae collecting • Use of bioagents • Use of botanicals

Workplan Year 3. 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.

Activity Cam-1/1. Set up experiments to investigate the use of *Trichoderma harzianum* to control soil borne diseases for selected vegetable crops.

Task 1. Establish field tests of *Trichoderma harzianun* at Kbal Koh Vegetable Research Station.

Task 2. Conduct field trials on *Trichodermna harzianum* with farmer groups in Kandal, Kampong Cham and Siem Reap Provinces.

Activity Cam-1/2. Introduce farmer production of *Trichoderma.*

Task 1. Train selected farmers in Kandal, Kampong Cham, and Siem Reap provinces on on-farm production techniques.

Activity Cam-1/3. Test impact of grafting of tomato on eggplant.

Task: Establish field tests for grafted tomato in selected provinces.

Activity Cam-1/4. Maintenance of *Cotesia* populations by sequential plantings of cabbage.

Task: Conduct farmer participatory field tests for maintenance of *Cotesia* populations at the Kbal Koh vegetable research station.

Activity Cam-1/5. Organize farmer field days in selected provinces to demonstrate IPM tactics to farmers.

Task: Conduct field days in selected provinces.

Objective 3: to enhance the capacity of host country institutions to support research and extension of IPM systems.

Activity Cam-3/1. Host SE Asia IPM CRSP regional workshop in 2012.

Development and Delivery of Ecologically-Based IPM Packages for Field and Vegetable Cropping Systems in Central Asia

PI: Dr. Karim Maredia, Michigan State University, East Lansing, MI.

Project Management

Dr. Jozef Turok, Coordinator, CGIAR/ICARDA-Project Facilitation Unit, Tashkent, Uzbekistan

Wheat IPM Package

Dr. Nurali Saidov, IPM CRSP Coordinator/Research Fellow, Tajikistan

Dr. Doug Landis, Michigan State University

Dr. Mustapha El-Bouhssini, ICARDA, Aleppo, Syria

Dr. Megan Kennelly, Kansas State University

Tomato IPM Package

Dr. Barno Tashpulatova, IPM CRSP Coordinator/Research Fellow, Uzbekistan

Dr. Frank Zalom, University of California-Davis

Dr. Ravza Mavlyanova, AVRDC/World Vegetable Center

Potato IPM Package

Dr. Murat Aitmatov, IPM CRSP Coordinator/Research Fellow, Kyrgyzstan

Dr. George Bird, Michigan State University

Dr. Walter Pett, Michigan State University

Dr. David Douches, 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 and Dr. Zahra Jamal, Michigan State University and Dr. Maria Elisa Christie, Virginia Tech University

Socio-Economic Impact Assessment**:** Dr. Mywish Maredia and Richard Bernsten, Michigan State University, Ms. Tanzila Ergasheva, Agricultural Economics Division of Tajik Academy of Agricultural Sciences, and Dr. George Norton, Virginia Tech University

Description

Michigan State University (MSU) in partnership with the University of California-Davis, Kansas State University, ICARDA, AVRDC, and several local research and academic institutions and NGOs is implementing a regional IPM program in Central Asia. The three host countries include Tajikistan, Uzbekistan and Kyrgyzstan.

The technical objectives of the Central Asia Regional IPM Program are as follow:

1. Develop ecologically-based IPM packages for wheat, tomatoes and potatoes 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 "Central Asia IPM Knowledge Network" encompassing a cadre of trained IPM specialists, trainers, IPM packages, information base, and institutional linkages.

The proposed activities for the period covering October 1, 2011 to September 30, 2012 are linked to the above five technical objectives.

Objective 1. Develop ecologically-based IPM packages for wheat, tomato and potato cropping systems through collaborative research and evaluation of new technologies and approaches.

Activity 1: Establish IPM Applied Research and Demonstration Sites for testing and evaluating the existing and new approaches and technologies for IPM packages for wheat, potatoes and tomatoes in three host countries (Tajikistan, Kyrgyzstan, and Uzbekistan).

This work will include cultural practices, botanicals and biopesticides, biological control agents/products, resistant varieties, pheromone traps, sticky traps, chemical pesticides, etc. The locations for the research and demonstration sites have been selected and detailed plans have been developed (see more description in the following sections). For Wheat IPM, the project is focusing in Tajikistan; for Potato IPM, in Kyrgyzstan; and for Tomato IPM, in Uzbekistan.

Participating scientists/institutions: N. Saidov, B. Tashpulatova and M. Aitmatov, IPM CRSP project coordinators in Central Asia with collaborators from ICARDA, AVRDC, and the United States. In addition, collaborators include local scientists from research institutions and universities in host countries.

Expected output: IPM applied research and demonstration sites will be established and IPM Packages demonstrated to local farmers in host countries for wheat, tomato, and potato crops.

Time line: October 2011 – September 2012

Activity 1A: Wheat IPM Research/Demonstration in Tajikistan

In the year 2011-12, the wheat IPM project will focus in Tajikistan. The framework that is developed in Tajikistan can be extended to colleagues in Uzbekistan and Kyrgyzstan through workshops, trainings, printed materials, etc. There will be one site in the northern part of Tajikistan where yellow rust, Sunn Pest and cereal leaf beetle are the key pests, and two sites close to Dushanbe, for example in Hissor, where yellow rust and cereal leaf beetle are the key pests. All three sites will be used both for research and for demonstration (farmer field schools). At each site we will compare an IPM Package and the local farming community standard practices (i.e. two treatments).

IPM Package:

- Variety resistant to yellow rust (Ormon, from ICARDA and local breeder collaboration)

- Appropriate seeding rate
- Planting date (north: early to avoid Sunn Pest)
- Fertilizer (rate and timing)
- Weed control (timing, before competition)
- Harvest date (harvest early for Sunn Pest avoidance)

Farmer Standard Package:

- All of the characteristics above to be determined by a pre-season meeting with the land owner and local farming community.

Plot lay-out: At each site we will compare the IPM package with the farmers' standard package (FSP) in randomly assigned replicated plots (see example below, each site to separately randomized). The wheat plots will each be 10 x 10 meters in size with 1 meter of bare (maintained by hoeing) alleyway in between for access.

Replicate 1	**Replicate 2**	**Replicate 3**	**Replicate 4**
IPM	FSP	FSP	IPM
FSP	IPM	IPM	FSP

Wheat Research Data Collection in the South

In the south the data will be collected by a local graduate student supervised by Anvar and Nurali Saidov.

- In mid-April and again in mid-May, we will assess yellow rust damage, using a visual severity scale, on 50 plants per plot (all four reps in the IPM plots and all four reps in the farmer standard, n=400 plants).

- On the same 50 plants per plot, we will collect any cereal leaf beetle eggs or larvae and bring them to the lab to rear for parasitoids. We will record the number of eggs, larvae (total) and the total number with parasitoids.
- We will harvest each of the four IPM and Grower Standard plots to obtain the average yield.
- We will run statistics to compare IPM yield versus the farmer standard.

Wheat Research Data Collection in the North

The data will be collected by a local graduate student.

- In mid-April and again mid-May, we will assess yellow rust damage, using a visual severity scale, on 50 plants per plot (all four reps in the IPM plots and all four reps in the farmer standard, n=400 plants).
- On the same 50 plants per plot, we will collect any cereal leaf beetle eggs or larvae and bring to lab to rear for parasitoids. We will record the number of eggs, larvae (total) and the total number with parasitoids.
- In each of the four IPM plots and each of the four grower standard plots, we will establish one 1x1 meter area to assess Sunn Pest egg masses. This will occur two weeks after insects migrate to the field. In May, we will go back and estimate parasitism of the eggs (by color).
- We will harvest each of the four IPM plots and get an average yield. Also, we will determine the percent of grain infested by Sunn Pest. This will be done separately for each of the four IPM plots.
- We will harvest each of the four IPM and Grower Standard plots to obtain average yield.
- We will determine the percent of grain infested by Sunn Pest for each of the four reps and take an average.
- We will run statistics to compare IPM yield versus farmer standard.

Additional Research: Shahlo Safarzoda's Graduate Research at MSU

Due to the direct overlap of MSU's spring semester classes with the critical periods of cereal leaf beetle and Sunn Pest development in Tajikistan, the team has determined it unfeasible for Tajik graduate student, Ms. Shahlo Safarzoda, who is currently at MSU, to conduct her research in-country. Given this situation, we are developing a US-based

research project for Ms. Safarzoda that is directly applicable to the Sunn Pest and cereal leaf beetle systems in Central Asia. At present, we are exploring options to investigate parasitoid use of floral nectar to enhance parasitism. This topic is applicable to both pest systems and knowledge/technologies; developments in Ms. Safarzoda's project would be transferable to other crop/pest systems in the region.

Activity 1B: Potato IPM Research/Demonstration in Kyrgyzstan

Our potato IPM research sites include one location in the Alay region of the Osh area in Kyrgyzstan and another location in Chui Oblast of the Sokuluk region, Scientific Research Institute of Livestock and Pasture of the KNAU named after K.I. Skryabin, Kyrgyzstan.

At these sites the project will focus on the Colorado potato beetle (*Leptinotarsa decemilineata*), late blight *(Phytophthora infestans)* and potato cyst nematodes (*Globodera* spp.). Weeds in potatoes at these sites include various weeds such as swine's-bane *(Chenopodium rubrum L.)* and houndsberry (*Solanum nigrum L.).*

IPM Package Components

At these research and demonstration sites we will test the following IPM package components:

- Test three local potato varieties and U.S. potato varieties for resistance to late blight (*Phytophthora infestans*). Additionally, evaluate potato varieties from Michigan (USA) for resistance to insect pests and *Globodera* spp. (April – August 2012)
- Continue to evaluate the agronomics of U.S. potato varieties brought from Michigan (in 2011) in seed-trial ground of the Ministry of Agriculture of the Kyrgyz Republic in Issyk-Kul region. (April – August 2012)
- Biological control of potato fungal pathogens will include the use of potato seed inoculation with the biopesticide Thrichoderma. (April – August 2012)
- Application of immune-response nodulating agents Baikal, Fosstim-3 (bacterial fertilizer), and Serhosil to enhance root development. These preparations will be used with a reduced (50%) amount of mineral fertilizers. (April – August 2012)
- Monitoring of potato pests will be conducted at both research/demonstration sites throughout the growing season and during post-harvest storage.
- Evaluation of trap crops and polyethylene-lined trenches will be tested at both sites in side-by-side rotated potato plantings for control of Colorado potato beetles.

Names of local scientists and collaborators: Dr. M Aitmatovo (IPM CRSP/ICARDA), D. Douches, G. Bird, W. Pett from MSU, and Dr. Anara Chakaeva from the Laboratory of Phytopathology Scientific Research Institute of Livestock and Pasture of the KNAU named after K.I. Skryabin, and MSDSP-Aga Khan Foundation in Kyrgyzstan.

Additional Research: Sultanat Mambetova's Graduate Research at MSU

Ms. Sultanat Mambetova, who is currently at MSU, will receive training in potato tissue culture, greenhouse seed production, seed certification, and potato breeding variety testing. Her research topic will include late blight and virus resistance in Kyrgyzstan potato production.

Activity 1C: Tomato IPM Research/Demonstration in Uzbekistan

Tomatoes are grown in the open field in summer and in protected culture such as greenhouses in winter. Research will be divided into greenhouse and open field studies.

GREENHOUSE - Participating scientists and institutions: Collaborative research will be conducted with the Institute of Microbiology, Uzbek Academy of Sciences.

There are three plantings a year. We will select the winter-spring term to conduct demonstrations at two sites for greenhouse cultivation.

- Selection of seedlings - remove infected seedlings.
- Preventative cultural practices for disease control - water management.
- Biological control of soil diseases with 4 replicates + control.
- Treat transplants with *Bacillus subtilis* suspension (concentration: $3x10^7$titre of spores).
- Experiment with use of biological preparation - "Serhosil": foliar treatments
- Insect monitoring - yellow sticky traps for whiteflies and aphids; blue sticky traps for thrips; pheromone traps for tomato fruitworms.
- Biological control of whiteflies with *Encarsia* releases.
- Botanical or microbial pesticides as needed.
- Grafted tomato lines study (AVRDC)
- Monitoring of virus diseases

Expected outputs for the year:

- Improved method for transplant treatments with *Bacillus subtilis* and "Serhosil."
- Develop technique for "Serhosil" preparation foliar use on tomatoes in both open field and greenhouses.
- Develop methods for rearing and releasing the whitefly parasitoid *Encarsia formosa*, and identify how to integrate it with other means of biological control.
- Publish articles on use of gossypol-related compounds in local agricultural journals.
- Prepare a guide on rearing of *Encarsia formosa.*

OPEN FIELD - Participating scientists and institutions: Collaborative research will be conducted with the Uzbek Research Institute of Plant Protection and the Institute of Microbiology, Uzbek Academy of Sciences.

We will conduct research/demonstration at one open field cultivation site.

- Selection of seedlings - remove infected seedlings.
- Preventative cultural practices for disease control - water management.
- Biological control of soil diseases.
- *Bacillus subtilis* treated transplants.
- Experiment with use of biological preparation - "Serhosil" foliar treatments with 4 replicates + control.
- Insect monitoring - yellow sticky traps for whiteflies and aphids; blue sticky traps for thrips; pheromone traps for tomato fruitworms.
- Biological control of whiteflies with *Encarsia* releases and fruitworms with *Trichogramma* releases.
- *Trichoderma lignorum* release on soil before tomato planting (*4 replicates + control);
- Grafted tomato lines study (AVRDC).
- Disease resistance lines study (AVRDC).
- Monitoring of virus diseases.

Expected outputs for the year:

- Improved method for transplant treatments with *Bacillus subtilis* and "Serhosil."
- Develop technique of "Serhosil" preparation foliar use in tomatoes for both open field and greenhouses.
- Develop rearing and release methods for the whitefly parasitoid *Encarsia Formosa*, and integrate with other means of biological control.
- Improved method of soil treatments with *T. lignorum*. Develop technique for *T. lignorum* use on tomato crops in the open field and greenhouses (in vivo and in vitro).
- Determine presence of virus disease.

Collaborative research will be conducted with the Uzbek Research Institute of Plant Industry (UzRIPI) to screen tomato varieties/lines to primary diseases. We will obtain permission to collect, quarantine (if needed), and ship disease-resistant tomato varieties and lines from AVRDC gene bank and breeding unit to the partner institute in Uzbekistan. Introduced germplasm seeds will be sown in greenhouses in January - February 2012 to produce seedlings for a varietal trial that will be initiated in May 2012. Screening of germplasm will be conducted during the 2012 field season.

With the Tashkent State Agrarian University, AVRDC tomato germplasm seeds will be sown in a greenhouse in November 2011. Tomato seedlings will be grafted in December 2011 and planted in a greenhouse in January 2012. Research of this method will be conducted in a greenhouse in January-May 2012.

The study of grafted tomato varieties will also be conducted at an open field site. Seeds will be sown in greenhouses in January - February 2012 to produce seedlings for additional grafting. Screening of grafted tomato varieties will be conducted in an open field during the field season in 2012. This will be the first time innovative research of tomato grafting and its adoption will be conducted in Uzbekistan for further introduction into vegetable production in the republic and to neighboring countries.

We will collaborate with the Uzbek Research Institute of Plant Protection and Tashkent State Agrarian University to develop a method for rearing *Encarsia Formosa* in the greenhouse.

A greenhouse will be equipped to make favorable conditions for growing whitefly host plants. Whiteflies will be multiplied on tobacco plants and used for rearing *Encarsia Formosa*. An experiment on integrating the use of *Encarsia formosa* together with

yellow sticky traps will be conducted. The method for using *Encarsia formosa* on tomato crops in both the open field and greenhouses together with other means of biological control will be developed.

Additional Research: Graduate Research

- Master's thesis research on whitefly control in tomato greenhouses.
- Master's thesis research on tomato grafting.
- Present scientific program on tomato grafting for postgraduate students in Tajikistan and Kyrgyzstan.
- Initiate Master's thesis on tospovirus survey (in conjunction with Naidu Rayapati).
- Mr. Bahodir Eshanov, will continue graduate studies at MSU and will work jointly with Drs. Frank Zalom (UC Davis) and George Bird (MSU). His research will be linked to the tomato IPM package by contributing identification and IPM-compatible controls for nematodes and leafminers.

Objective 2: Disseminate IPM packages to farmers and end-users through technology transfer and outreach in collaboration with local NGOs and government institutions.

Activity 2: Establish Farmers Field Schools (FFS) at IPM Demonstration sites in each country to transfer knowledge and demonstrate existing and new IPM technologies to local farmers.

Participating scientists/institutions: N. Saidov, B. Tashpulatova and M. Aitmatov in collaboration with local agriculture ministries, local NGOs, universities, ICARDA regional program, AVRDC regional program, and U.S. Collaborators. As outlined in Objective 1, the sites have been selected in each country and plans are being developed for the next planting season. FFS will be established at each site/country. These farmers will meet regularly to learn about how to produce a good wheat, potato or tomato crop. 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, tomato and potato in each of the three countries, and information shared with local farmers and NGOs (20 -30 farmers per FFS).

Timeline: October 2011 – September 2012.

Activity 2A: Wheat IPM Outreach in Tajikistan

The wheat research sites will be used for farmer field schools where we will hold several meetings per year, such as:

- Pre-plant (August or September) to discuss varieties, planting rate, etc.
- At planting to see planting rate, method of site preparation and planting.
- Two or three times in spring to see insects, rust, flowering plants, etc.

We will hold separate trainings for men and women and use a female trainer or translator.

In conjunction with the Ministry of Agriculture, local farmers will be trained and encouraged to remove overwintering sites of Sunn Pest, a group of insects that causes damage by feeding on leaves, stems and grains. Along with reducing yields, the insects also inject chemicals that greatly reduce the baking quality of the dough made from the wheat.

Activity 2B: Potato IPM Outreach in Kyrgyzstan

Eight farmer field schools will be launched in the Alay region in the Osh area of Kyrgyzstan (April 2012). These schools will address IPM, the project research and production practices that support IPM and a healthy potato crop.

A manual on Potato IPM will be developed for trainers (September 2011 – May 2012).

Activity 2C: Potato IPM Outreach in Uzbekistan

We will train students and young specialists on tomato grafting (August 2011 or March 2012).

Farmers Field Day will be conducted in the demonstration field with grafted and non-grafted tomato lines in July 2012. We will also train farmers, students and young specialists on biological control of tomato diseases using the soil and foliar biological agents *Bacillus subtilis,* "Serhosil" and "Baikal" M1.

In partnership with the Uzbek Research Institute of Plant Industry, Tashkent State Agrarian University, AVRDC-CAC, and MSU-IPM-PFU-Uzbekistan, we will develop these publications:

- A booklet and leaflet on tomato grafting.

- Booklets on botanical pesticides; biological control of tomato diseases; biological control of whiteflies.
- Articles on tomato grafting; biological control of diseases; biological control of whiteflies.
- Guides for tomato grafting; rearing and applying *Encarsia Formosa*.

Objective 3: Build institutional capacity through training and human resource development.

Activity 3A: Graduate student training in IPM in wheat, tomato and potato:

In collaboration with local agrarian universities in Tajikistan, Kyrgyzstan and Uzbekistan, opportunities will be provided to at least 6 graduate students for collaborative research at IPM CRSP sites in the three host countries.

The three graduate students who are currently at MSU – Ms. Shahlo Safarzoda from Tajikistan for Wheat IPM, Mr. Bahodir Eshchanov from Uzbekistan for Tomato IPM, and Ms. Saltanat Mamabetova from Kyrgyzstan for Potato IPM – will continue their graduate program. More details are included in the research section of this plan (Objective 1).

Participating scientists/institutions: D. Landis, F. Zalom, D. Douches, G. Bird, W. Pett, M. Kennelly, K. Maredia, M. Bohssini, R. Mavlyanova, B. Tashpulatova, N. Saidov, M. Aitmatov, and faculty members of local universities in Central Asia.

Expected output: Masters and Ph.D Degree training for Central Asian young scientists.

Timeline: October 2011 – September 2012.

Activity 3B: **Pest Diagnostics and Viruses**

In collaboration with two global theme programs, Dr. Naidu Ryapati will conduct a two-week regional survey for viruses in potatoes and tomatoes for the Central Asia region. This will be carried out in collaboration with host country institutions in Tajikistan, Kyrgyzstan and Uzbekistan. 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, Kyrgyzstan and Uzbekistan.

Participating scientists/institutions: N. Saidov, B. Tashpulatova, and M. Aitmatov in collaboration with global theme programs in pest diagnostics and viruses (Sally Miller-OSU, N. Rayapati-WSU, Sue Tolin-Virginia Tech).

Expected output: Enhance viruses and pest diagnosis skills of local scientists and NGOs, and efficient diagnosis of viruses in potato and tomato.

Timeline: January 2012 – September 2012.

Activity 3C: Gender Issues in IPM: Addressing gender issues is an important component of the IPM CRSP project. Given that the Project is focusing on developing specific IPM packages and on building local capacities to carry out demonstration sites and use of IPM packages, the work of the gender team will be limited to three dimensions.

First, the IPM Central Asia team will endeavor to take gender into account as they develop the IPM packages and will continue to try to locate a gender specialist in Tajikistan who can work with the country coordinator to integrate gender into the research and outreach.

Second, a paper on gender and food security will be developed for publication; it will draw on bibliographical research and visits to Tajikistan in years one and two of the project.

Third, Dr. Linda Racioppi will oversee the completion of an undergraduate student thesis on women and agricultural development in Tajikistan.

Participating Scientists and Collaborators: L. Racioppi, Z. Jamal, M. Elisa Christie.

Expected Output: Increased awareness on gender issues and gender equity in IPM programs in Central Asia.

Time Line: October 2011 to September 2012.

Activity 3D: Impact assessment of IPM CRSP project activities in Central Asia: Given the early stages at which the project is on the "research-to-development" continuum, the impact assessment component of this project will focus on the following activities in FY 2012. We will conduct and complete a baseline survey in Tajikistan in collaboration with the Tajik Academy of Agricultural Science, Institute of Agricultural Economics (Dr. Tanzila Ergasheva). The component PIs plan to implement a baseline

survey of farm households in locations representative of the IPM pilot sites in Tajikistan. The survey will help assess the status of wheat production conditions and constraints in Tajikistan. The size, scale and scope of the survey will be a function of the potential adoption sites and resources available.

The baseline data to be collected will include:

- Data on input, output, and price;
- Crop management practices including the use of biological, cultural, chemical, etc. and their associated costs;
- Farm household characteristics and demographic data;
- Farmer perspective on potential constraints to adoption of IPM technologies;
- Gender role in the cropping systems of focused commodities.

Baseline data (primary and secondary) will be also collected in the other two countries, Kyrgyzstan and Uzbekistan, with a focus on potatoes and tomatoes.

Collaborating Scientists and Institutions: R. Bernsten and M. Maredia, Michigan State University; T Ergasheva, Agricultural Economics Division of the Tajik Academy of Agricultural Sciecnes; Host Country PIs/Research Fellows (B. Tashpulatova, M. Aitmatov, and N. Saidov) and other U.S. and host country collaborators.

Expected Outputs: Data and preliminary analysis of the baseline assessment.

Start and end-date: October 2011 to September 2012.

Activity 3E: Participation of five local scientists from host countries in International IPM short courses organized by MSU and ICARDA.

Participating scientists and institutions: Scientists and NGO representatives from Central Asia, MSU and ICARDA.

Expected output: Increased knowledge in ecologically-based IPM and design and management of IPM research and demonstration sites.

Timeline: October, 2011 – September 2012.

Activity 3F: Organize local workshops and training programs for trainers and local farmers in host countries on IPM in wheat, tomatoes and potatoes during the growing season.

Participating scientists/institutions: IPM CRSP Team members, local NGOs, Government research institutions, local Universities

Expected output: At least 50 farmers and 5 trainers trained in IPM in wheat, potato and tomato production.

Timeline: October 2011 – September 2012.

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 4: Participation in International Meetings and workshops: 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.

Participating scientists and institutions: N. Saidov, B. Tashpulatova and M. Aitmatov

Expected output: Enhanced linkages and collaborations with IPM CRSP regional programs, and other international programs.

Timeline: October 2010 – September 2011.

Activity 2: Participate in International IPM Symposium: Dr. Karim Maredia (PI of Central Asia IPM CRSP Project) will attend the 7th International IPM Symposium "IPM on the World Stage" in Memphis, Tennessee from March 27 – 29, 2012 and moderate a session on Development of IPM Packages for Vegetables Crops in Developing Countries.

Participating scientists and institutions: K. Maredia and J. Landis, MSU.

Expected output: International outreach and sharing of information on IPM CRSP experiences with the global IPM community

Timeline: March 2012.

Objective 5: Create a "Central Asia 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 Central Asia regional IPM program in collaboration with project team members. 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

Participating scientists/institutions: J. Landis, MSU.

Expected output: Enhanced communication with stakeholders, expanded access to resources and knowledge developed in other activities, greater publicity for IPM CRSP project impacts.

Timeline: October 2011 – September 2012.

Activity 2: Develop communication pieces about the Project's work and activities. Develop flyers about components of the project such as gender issues, success stories, or other communication resources

Participating scientists/institutions: J. Landis, MSU, and U.S. and Central Asia collaborators.

Expected output: Enhanced communication with stakeholders, increased awareness of the Project's impact.

Timeline: October 2011 – September 2012.

Activity 3: Develop flyers on IPM Packages. One-page flyers that explain the key pests being addressed in wheat, tomatoes and potatoes.

Participating scientists/institutions: J. Landis, MSU, and U.S. and Central Asia collaborators.

Expected output: Project information will be shared more broadly with Central Asian farmers and stakeholders.

Timeline: October 2011 – September 2012.

Activity 4: Prepare and Display Project Poster with an overview of the project and its activities.

Participating scientists and institutions: J. Landis and U.S. and Central Asia collaborators.

Expected output: A poster highlighting the Central Asia Regional IPM Program activities for presentation at multiple events where others working in IPM will network.

Timeline: January 2012.

Activity 5: Update the Directory of IPM Specialists and Stakeholders in Central Asia to include recent participants in workshops, seminars and other events where groups interacted.

Participating scientists and institutions: J. Landis and U.S. and Central Asia collaborators.

Expected output: Increased ability for those working in IPM to network and share information.

Timeline: November 2011 - January 2012.

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

PI: **Dr. Wondi Mersie;** Virginia State University, Petersburg, VA

Co PIs: **Jenipher Bisikwa;** Makerere University - Uganda
Krissie Clarke; PAMS Foundation - Tanzania
Emily Wabuyele; East African Herbarium - Kenya
Kassahun Zewdie; Ethiopian Institute of Agricultural Research (EIAR)
Yeshi Chiche; EIAR - Ethiopia
Sintu Alemayehu; EIAR - Ethiopia
Lisanework Nigatu; 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 biodiversity, 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 – I: 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 will be conducted in Kenya, Tanzania and Uganda, annually at least for two consecutive years.

Activity - 1: Survey the distribution of parthenium in Kenya, Tanzania and Uganda.

Task- 1 – Compile, analyze, and present data at the annual meeting in Addis Ababa Ethiopia in December 2011. Prepare a manuscript on the distribution of parthenium in Kenya, Tanzania and Uganda.

Country(ies): Kenya, Tanzania and Uganda.

Status: survey is being completed for Kenya, Tanzania and Uganda

Scientists involved: Jenipher Bisikwa (Makerere University - Uganda), Krissie Clarke (PAMS Foundation - Tanzania), Emily Wabuyele (East African Herbarium - Kenya).

Description: The distribution of parthenium in Eastern Africa is not clearly determined. This activity will attempt to answer the following question. How extensive is the spread of parthenium in Kenya, Tanzania and Uganda? Initially, participating countries will enter all known parthenium localities into a spreadsheet. The spreadsheet will be sent to Kenya. Locality data from the spreadsheets will be plotted using the program Mapviewer 7. A baseline map of known distribution will be generated for each of the participating countries. The climatic modeling program CLIMEX will be used to generate predictive maps of areas in each of the participating countries that are most climatically suitable for parthenium to occur. CLIMEX is a multiparameter, dynamic simulation model, which, in addition to using temperature parameters, also includes humidity and precipitation to estimate potential distributions of animals and plants. The known distribution of parthenium will be overlaid on the CLIMEX predictive outputs in order to generate a list of localities for researchers in each country to survey for parthenium. Surveys will be conducted along road networks in quarter degree squares (QDS) (25 km x 25 km) immediately surrounding baseline localities and areas which were predicted by the CLIMEX model to be suitable for the growth of parthenium. The surveys will be conducted during a 2-3 week period at the end of the summer growth season. In QDS where parthenium was observed and had not been previously recorded, the following data will be recorded: date, geographical coordinates altitude, locality name, and description of infestation with regard to land use. The abundance of parthenium at each site will be recorded as either low (1 plant/m^2), medium (2-3 plants/m^2) or high (>3 plants/m^2). Locality data will be plotted using the mapping programme MAPViewer 7.

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- II: To 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 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 and Uganda.

Status: Continuing.

Scientists involved: Lisanework Nigatu and Jenipher Bisikwa.

Description: Experiments on the effectiveness of various native plants and cultural methods against parthenium will be conducted in Ethiopia and Uganda. 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 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.

Objective- III: To 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, Objective III: 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: Continuing.

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 listronotus.

Progress to date: The host range test for listronotus is underway in the quarantine facility.

Expected outputs: Information on the safety, establishment and effectiveness of biocontrol agents for parthenium management becomes available.

Task – 2: Culture listronotus and assess damage to the test plants and look for any oviposition by the bioagent.

Objective - IV: 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 permit 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: Permit from USAID is needed before Zygogramma is reared and released in fields to control parthenium.

Progress to date: Application for permit 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 Obej. I	Survey the distribution of parthenium in Kenya, Tanzania and Uganda	09-30-12	Jenipher Bisikwa, Krissie Clarke, Emily Wabuyele
Task - 1	Conduct survey, compile, analyze, and interpret parthenium survey data	09-30-11	Jenipher Bisikwa, Krissie Clarke, Emily Wabuyele
Activity – 1 Obej. II	Evaluate native forage species for their ability to suppress parthenium	09-30-12	Lisanework Nigatu Jenipher Bisikwa,

Task – 1	Compile and interpret data from greenhouse and field trials.	09-30-12	Lisanework Nigatu Jenipher Bisikwa,
Activity – 1 Obej. III	Improve/update quarantine facility	09-30-12	Sintu Alemayehu Kassahun Zewdie
Task 1	Develop specific tasks and hire a contractor start making the improvements	09-30-12	Sintu Alemayehu Kassahun Zewdie
Activity – 2 Obej. III	Conduct host range test of the stem-boring weevil *Listronotus setosipennis* and other bioagents (if permit is secured for the other agents) under quarantine	09-30-12	Sintu Alemayehu Kassahun Zewdie Million Abebe
Task 2	Culture listronotus and assess damage to the test plants and look for any oviposition by the bioagent.	09-30-11	Sintue Alemayehu Kassahun Zewdie Million Abebe
Activity -1 Obej. IV	Apply to USAID for a permit to release the leaf-feeding beetle, *Zygogramma bicolorata* against parthenium	11-30-11	Wondi Mersie
Task 1	Hold meeting of stakeholders on the release of Zygogramma	12-31-11	Wondi Mersie Million Abebe
Activity -2 Objec. IV	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

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

PI: Sally Miller; Ohio State University, Wooster, OH

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.

Tasks

1. Analyze survey data (new and with previously collected) and prepare publication.
2. Administer follow-up surveys for professionals working in labs already part of the network to both assess capacity and gauge adoption of the DDIS-CIMS and other IPDN Phase I products.
3. Follow up list of professionals working in diagnostics labs in Central America, and expanded regions Ecuador and Dominican Republic.

Objective 2: Expand networks and implement digital diagnostics

Activity 2A. Expand the network in the IPDN regions (East and West Africa, Central America and Asia) to include additional laboratories in participating countries and new laboratories in new countries.

Tasks

1. Expand list of subject matter experts and add to DDIS-CIMS system.
2. Train new participants in DDIS-CIMS at workshops (see below).
3. Meet goal of 50 digital samples per region through DDIS in Year 3; 100 digital samples for South Asia.
4. 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.

Tasks

1. Expand list of experts at the Year 3 training programs (see below).
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). This task will be continued in Year 3.

Objective 3: Develop diagnostic assays and protocols.

Activity 3A. Prioritize needed diagnostic protocols, assays, etc.

Task

1. Work with IPVD to identify and test virus diagnostic protocols.
2. Develop pictorial guides to diagnosis of target pathogens in priority crops.
3. Work with Regional Programs to identify needed diagnostic assays/protocols and begin implementation of protocols if available.

    LAC – Continue work focus in Clavibacter, *Phytophthora* spp, Candidatus liberibacter and some viral diseases.

Objective 4: Report new diseases and pests and develop incidence maps.

Activity 4A. Prioritize pathogens or pests to be surveyed/mapped.

Tasks

1. Continue prioritization in cooperation with host country NPPOs, APHIS and IPM CRSP RPs (and IPVD for viruses).
2. South Asia: Perform joint surveys and document the pest species (insects, disease pathogens and nematodes) attacking selected vegetable crops with diagnostic characteristics in India, Nepal and Bangladesh.
    a. Document the pest species (insects, disease pathogens and nematodes) attacking selected vegetable crops with diagnostic characteristics.
3. West Africa: Document disease and insect pest problems as part of production surveys being conducted by the WA RP for potatoes and cabbage (Mali and Senegal), and tomatoes (Mali, Senegal and Ghana).
4. LAC: 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.
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

Tasks

1. East Africa: Train selected project partners on the use of priority standard operating procedures (SOPs) for passion fruit, tomato and/or onion in East Africa (joint with IPM CRSP EA Regional Program – see EA Workplan).
2. West Africa: Develop or adapt two SOPs for priority pests/diseases.
3. South Asia: Publish insect pest and disease identification guides developed in Year 2 for target vegetable crops.
4. LAC: Plan a meeting/workshop in June-July 2012 to develop SOP'S for *Ralstonia solanacearum, Clavibacter michiganensis michiganensis* and *Candidatus* Liberibacter.

Technology Transfer and Training Objectives

Objective 6: Write IPM recommendations

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.

Tasks

1. Write one recommendation in the appropriate format per target crop (up to three crops) in each region, with cooperation of RPs.
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 Workplan).

Objective 7: Train pathologists and entomologists in targeted methodologies or pathogen or pest identification.

Activity 7. Conduct hands-on professional diagnostic training programs in East Africa, Central America, and South Asia.

Task

1. (Regional coordinators) Organize the training programs, recruit local resource persons, provide supplies, equipment and reference materials, and identify participants. Coordinate with IPVD for training in all regions.

    a. LAC – Conduct workshop for DDIS technology planned for April-May 2012 in cooperation with University of Florida.
    b. East Africa: Conduct workshop based on SOP utilization (see Objective 6).
    c. South Asia : Conduct focused workshop on priority pest or disease identification.

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.

Activity 8. Select individuals for host countries in each region to attend OSU short course.

Task (optional)

1. 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

Activity 9. Conduct one hr webinars on prioritized subjects.

Task

1. Identify subjects for 1-3 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.

2. Conduct at least 2 webinars on disease or pest diagnostics.

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.

Activity 10A. Training farmers and extension staff on diagnosis and management of common diseases of tomato and passion fruit (East Africa and South Asia).

Tasks

1. LAC: Organize at least two extension meetings with potato/tomato growers in Quetzaltenango (Western highlands-potato growing area) and Salama (North-Eastern-tomato growing area) in Guatemala. Cooperation with Universidad Del Valle, Universidad Rafael Landivar and Univ. San Carlos.
2. East Africa: Train farmers and extension staff on diagnosis and management of priority diseases of tomato and passion fruit (joint training with E.A. Regional Project)
3. South Asia: Train individuals on the diagnosis of the main diseases affecting eggplant, okra and tomato and cucurbits.

Graduate Students (None)

Short-Term Training planned

	US co-PIs	SA	SEA	CA	LAC	EA	WA
Workshops	2	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						

Publications planned:

Research articles/notes	4
Books and book chapters	
Extension articles	12
Posters	3
Bulletins	
Website contributions	4

International Plant Virus Disease Network (IPVDN)

PI: Dr. Sue A. Tolin; Virginia Tech, Blacksburg, VA

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 the lack of chemical controls for viral diseases. Activities are new or continuing from years 1 and 2. The total annual budget for the PVD Global Theme is distributed to five US institutions and over half of the 19 host countries in the IPM-CRSP. Host countries and some PVD collaborating US institutions also receive funding from regional projects. Regional project funding in support of the PVD global theme mostly goes to host countries.

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 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:

1. Information packages for viruses of tomato, pepper (including chillies and hot peppers), and other priority crops according to interests of regions and host countries.
2. Information packages for aphid, thrips, and whitefly-transmitted viruses for priority crops.

3. 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 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 Mali, Ghana and Senegal for virus diseases in collaboration with the West Africa Regional Project.

Status: Continuing.

Scientists involved: R. L. Gilbertson, T. Kon (UC-D), I. Kollo (Senegal), M. Noussourou, K. Gamby (Mali), M. Osei, S. Diao (Ghana).

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. Two surveys of peppers and other crops (okra) have been conducted in Mali and viruses infecting pepper, okra and other crops identified. Results indicate that a complex of insect-transmitted viruses can infect peppers in Mali and that management strategies will have to take into account both aphid- and whitefly-transmitted viruses. In Year 3, activities will expand to include okra and pepper in Ghana and Senegal, and cucurbit viruses in Mali and other countries.

Task 1.1.2: Survey pepper, tomato, potato, and sweetpotato for virus diseases in Dominican Republic, Guatemala and Honduras, and identify viruses and virus-like agents, in collaboration with the Latin America and Caribbean Regional Project.

Status: Continuing.

Scientists involved: M. Palmieri (UVG, Guatemala), Mauricio Rivera (FHIA, Honduras), R. T. Martinez (IDIAF, Dominican Republic), J. K. Brown (UAZ); S. Tolin (VT), R. L. Gilbertson, T. Kon, T. Melgarejo (UC-D), LAC (Dominican Republic, Guatemala, Honduras, Peru)

Description and progress: This work involves continuing document viruses and virus-like agents infecting peppers and tomatoes in countries in the LAC region. In Honduras potyvirus and closterovirus positive samples of sweet potato have been documented, but the source of these viruses -- introduced in planting material or by in-field transmission – is not yet known. Progress has been delayed on this objective in Honduras since one FHIA collaborator was reassigned to new location that has no screen house for grafting,

and another took a 6 month out of country sabbatical. Sampling will resume in Honduras, and will be initiated in Guatemala. Potato has been confirmed positive for *Ca*. Liberibacter solanacearum infection and incidence and distribution studies are underway in Honduras and Guatemala during 2011, and will continue during 2012. A survey of tomato and pepper was conducted in Guatemala and of tomato in Peru. A virus infecting Jatropha in the Dominican Republic (DR) was found to be a bipartite begomovirus and not TYLCV. Further characterization will demonstrate whether Jatropha is a reservoir for viruses of tomato. Samples of additional noncultivated plants as potential begomovirus reservoirs were collected in tomato- and pepper- growing areas. DNA has been extracted in the DR lab and will be sent to Arizona for PCR, cloning, and sequencing to determine virus identity in relation to those in cultivated species. In Guatemala surveys are underway to identify begomoviruses in wild hosts that are important in virus spread and management in tomato and pepper crops. Potyviruses and Tospoviruses, when symptoms are present in plants in field and greenhouse cultivation, are being detected and identified using Agdia immunostrips or ELISA. TYLCV-specific primers and positive control (cloned fragment) have been supplied and are in use in Guatemala.

Task 1.1.3: 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.

Status: Continuing.

Scientists involved: N.A. Rayapati (WSU), G. Karthikeyan (India), A. Muquit (Bangladesh), T.A. Damayanti and S. H. Hidayat (Indonesia), C. Cheythyrith (Cambodia), Nurali Saidov (Tajikistan), Murat Aitmatov (Kyrgyzstan), Barno Tashpulatova and Z. Kadirova (Uzbekistan).

Regions/Countries: South Asia (Bangladesh, India), Southeast Asia (Indonesia and Cambodia), Central Asia (Tajikistan, Kyrgyzstan, Uzbekistan)

Description and progress: 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, 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 UCD.

Documentation of viruses in tomato and potato in Central Asian countries was initiated during a trip to the CA regional workshop. (Tajikistan, Kyrgyzstan and Uzbekistan). We have documented the presence of two distinct strains of *Potato virus Y* in potato in Tajikistan and *Tomato spotted wilt virus* (TSWV) in tomato in Uzbekistan. In Tajikistan, peas and beans planted adjacent to a potato field in Muminabad area showed mosaic symptoms and tested positive for potyvirus in RT-PCR. In addition, seed onion fields that were monitored for viruses were observed to have some plants showing chlorotic spindle-shaped lesions on scapes. These symptoms are similar to those produced by *Iris yellow spot virus* (IYSV) in other onion-growing regions. Further studies are in progress to confirm the presence of IYSV by RT-PCR, cloning and sequence analysis. During year 3, further molecular analyses of samples imprinted on FTA cards will be conducted by RT-PCR assays and cloning and sequence analyses to precisely identify the virus(es) present in potato, onion, pea and bean samples. Further surveys are planned in all three countries in collaboration with Central Asia regional program and symptomatic samples will be tested by serological and molecular methods to gather region-wide information on viruses in potato and tomato. These results provided a foundation for a better understanding of the spectrum of viruses in select vegetable crops across the Asia regions and helped with the development of field-based assays for their monitoring in multi-location varietal evaluations and IPM trials in host countries.

Task 1.1.4. Initiate collaborations with scientists in East Africa and plan for surveys and research on virus diseases of pepper, tomato and passion fruit. (Deom, UGA; Gilbertson, UC-D; P. Sseruwagi, NaCRRI, Uganda, and other host country scientists associated with EA-RP, IPDN)

Status: New

Description and progress: At the East Africa region meeting, which no one from the PVDN team was able to attend, P. Sseruwagi presented plans for integration with the PVD, and described activities for priority crops tomato, passionfruit, onion, and scotch bonnet pepper. Fact sheets and SOPs have been drafted for some tomato viruses, and need to be completed. There has been work on passion fruit in Kenya by a student, in conjunction with Ohio State and the East Africa regional project, on developing and

validating primers for virus detection, and on assessing the diversity of the virus in different agroecological zones. There have been tomato variety trials to assess performance under virus pressure in Kenya. Identity of viruses in pepper needs to be documented. Uganda is looking to develop a system for small-holder virus-free seed production. These activities can be augmented by better linkage with the PVDN, to include capability assessment in virus diagnosis and management.

Activity 1.2. Develop diagnostic methods and capacity for detecting sweetpotato (LAC) and potato (CA) viruses and virus-like agents.

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 will consist 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.

Expected outputs: Management of virus diseases of sweetpotato and potato through reduction of viruses in seed pieces, enabling production of a local supply of clean seed.

Task 1.2.1. Establish 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.

Status: Continuing

Scientists involved: Brown, Rivera , LAC RP.

Zamorano initiated activities in Yr 1 but no progress was made during Yr 2 toward establishing a system that could be transferred to FHIA. FHIA has expressed concern about the lack of resources and space to accomplish this task; substantial funds would need to be leveraged to accomplish this task and establish a working tissue culture laboratory.

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 (J. Abad, USDA; L. Salazar; J. Vetten).

A 96-well plate assay has been developed in the AZ laboratory for detecting *Ca*. Liberibacter solanacearum in individual psyllids and plant samples, with detection employing DIG-labeled probe. DNA was extracted from infected and non-infected psyllids and plants using the bead beater and CTAB buffer followed by ethanol precipitation. DNA was applied undiluted and diluted 1:10, 1:100 to a nylon membrane. Results of the hybridization 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 will be tested using field-collected psyllids from Honduras 2011 (currently underway). PCR primers and a positive control have been provided to Guatemala for Ca. Liberibacter detection in plants and in psyllids.

Task 1.2.2: Conduct diagnostic assays for viruses in potato in Tajikistan, Kyrgyzstan and Uzbekistan in collaboration with host country scientists, international agencies and NGOs (Rayapati, Nurali Saidov, Murat Aitmatov, Barno Tashpulatova and Z. Kadirova).

Description and progress. Rayapati conducted field surveys in Tajikistan (Dushanbe and Muminabad) for virus diseases in vegetable crops, with emphasis on potatoes. In several farmers' fields, potatoes showing a range of symptoms (chlorotic spots, mild mosaic, leaf curling and up-ward rolling of leaf margins) were observed and symptomatic plants showed poor vigor and growth. Testing of symptomatic plant samples with immunostrips revealed the presence of Potato virus Y (PVY). Some samples were imprinted on FTA cards and brought to WSU for virus detection by RT-PCR. Initial results indicated the presence of two distinct strains of PVY, one of which appears to be a recombinant necrotic strain. Further diagnostic assays are in progress to identify other potato viruses.

Last year, we have documented the presence of two distinct strains of Potato virus Y in potato in Tajikistan and tomato spotted wilt virus in tomato in Uzbekistan. . Further surveys are planned in all three countries in collaboration with Central Asia regional program and symptomatic samples will be tested by serological and molecular methods to gather region-wide information on viruses in potato and tomato.

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. Etiology and ecology of tomato, pepper and potato virus and virus-like diseases in various countries.

Status: Continuing. Scientists involved: Several.

Sub-Tasks:

Task 1.3.1a. Etiology of Pepper yellow vein disease and a virus-like tomato diseases in Mali. (Gilbertson/Kon, UCD; WA-RP)

Description and progress:

Samples of peppers were taken from a variety trial conducted in Baguineda. The peppers showing mottle/mosaic symptoms were infected with *Cucumber mosaic virus* (CMV) and the potyvirus, *Pepper veinal mottle virus*, whereas those showing leaf curling, distortion and stunting were infected with a begomovirus, which was subsequently determined to be *Tomato yellow leaf crumple virus* (ToLCrV). Peppers with severe stunting and distortion were found to be infected by all three viruses. These results indicate that a complex of insect-transmitted viruses can infect peppers in Mali. Sorting out this complex will define the management strategies as they will have to take into account both aphid- and whitefly-transmitted viruses. Etiology of a virus-like agent associated with leaf curl and necrosis of tomato in Ghana West Africa will be continue to be characterized.

Task 1.3.1b. Tomato and pepper begomoviruses and other viruses in Guatemala. (Palmieri, Brown, LAC;)

Description and progress:

This year we will continue to focus on potatoes, peppers and tomatoes. We will work in the three regions of Guatemala: Salamá (north central region), Sololá (Occidental region) and Chiquimula (Oriental region). We will evaluate symptomatic plants as well as weeds and vectors, if possible, for selected viruses such as begomoviruses, potyviruses, and tospoviruses. If suspicious symptoms appear, other viruses will be evaluated; an example would be 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 the Zebra chip amplicon for validation of the diagnostic assay transferred to the University del Valle laboratory, and similarly, cloning of PCR products and sequencing for begomoviruses and other viruses, as needed.

Task 1.3.1c. Tomato and pepper viruses in Dominican Republic (Tolin, Deom, Brown, Gilbertson, Martinez)

Samples of symptomatic (for begomovirus) wild and cultivated species have been and will continue to be collected seasonally near/in the Ochoa vegetable growing area. DNA has been extracted from 12 samples collected from wild species, and will be PCR amplified, cloned, and sequenced in the AZ lab as soon as it is received from the Martinez lab. . Monitoring for aphid-transmitted (CMV, PVY, TEV) and thrips-transmitted (TSWV) viruses will continue by using immunoassays. Collections and vector identification will be done collaborative with the LAC Regional Project.

Task 1.3.1d. Tomato and pepper viruses in Honduras (Brown, Tolin, Rivera)

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 last year.

Task 1.3.1e. Sweetpotato viruses in Honduras and Guatemala (Brown, Rivera; Palmieri)

A survey of sweet potato plantings for virus-like symptoms and associated insect vectors will be undertaken in Guatemala during 2012 by M. Palmieri, J. Brown and graduate student Andrés Avalos Figueroa. 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 1.3.4. Verify and document the identity of virus (es) associated with necrosis diseases of tomato.

Status: Continuing. Scientists Involved: Karthikeyan (India) and Rayapati, WSU.

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*.

Task 1.3.5. 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)

Description and progress: 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 2011 and 2012 principally in one location in 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.

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.

Activity 2. 1: Assess virus detection and diagnosis capacity, and vector expertise, in regions and host countries.

Description and Status: This activity was begun in the last phase under the two previous global theme projects on viruses, and collaborated with the IPDN Global Theme. Countries in the Asia regions were not included in the last IPDN.

Progress to date: Rayapati participated in the regional Pest Diagnostics Training Workshop "Pest Problems and Diagnostic Techniques" in June 2011 in Tajikistan and delivered lectures on viruses, diagnostics and management and demonstrated diagnosis of potato virus Y in the field samples using immunostrips. Activities for capacity building in virus research and teaching are being initiated in the region for enhanced capacity to address virus disease problems.

Expected outputs: The result of this objective will be enhanced institutional capacity to enable timely diagnosis of viral disease problems, and monitoring tools for conducting research on viruses in specific cropping systems.

<u>Tasks</u>

1. Continue identification of scientists and institutions in host countries as collaborators.

2. Assess needs and appraise capability and constraints for virus research, particularly in countries of the Asian regions, in cooperation with the IPDN-GT.

3. Summarize virus diagnostic capability surveys from in previous phase and expand to new host country participants, in collaboration with IPDN-GT.

4. Continue to work with IPDN GT to integrate virus diagnostics into the East Africa-RP program, and conduct a workshop in Year 3.

5. Follow up on workshops in Year 2 in Central Asia and in West Africa.

6. Plan for and conduct a virus workshop in India in Year 3.

7. Identify level of expertise in host countries for conducting lab and field research (ecological, vector, resistance, impact) on virus diseases.

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: We participated in joint workshops with regional projects in Central Asia and West Africa to develop linkages and assess the current research and need for capacity building activities. Host country scientists were exposed to 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. We also participated in a workshop for producers and technicians in Honduras entitled: Management of viral diseases of vegetable crops. This workshop was directed toward IPM practitioners to give them a better understanding of viruses and virus-like agents causing diseases in Honduras and Central America.

Tasks

1. Conduct workshops within host countries and regions.

2. Prioritize short-term and long-term training needs and activities.

3. Conduct short-term training for faculty members, professionals, and students.

4. Conduct long-term graduate student training if funding can be obtained.

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 they allocate 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 assessment of impact, as indicated in region and country work plans.

Activity 3.1a– Monitoring the host-free period for tomato virus management

Regions/Country(ies): LAC (Dominican Republic, Guatemala); WA (Mali, Ghana, Senegal)

Status: Continuing

Scientists involved: A. Almanzar, T. Martinez, M. Palmieri , I. Kollo, M. Noussourou, K. Gamby, M. Osei, S. Diao and R. Gilbertson.

Tasks

1. Continue to maintain the successful TYLCV IPM program in the Dominican Republic.

   Description and progress: We continue to monitor whiteflies on a monthly basis using PCR and TYLCV primers to assess the build-up of TYLCV in the Dominican Republic and the effect of the host-free period. We are receiving and processing the whitefly samples from the Dominican Republic as part of the IPM project. We are

also characterizing some TYLCV strains from the Dominican Republic that are suspected of infecting TYLCV-resistant varieties.

2. Continue to work to establish IPM programs for insect-transmitted viruses in tomato in Guatemala.

   In Guatemala, we continue to work toward the implementation of the tomato IPM package for whitefly-transmitted begomoviruses. The general package has been developed, the challenge now is implementation. Additional challenges are in continued funding by the government, with recent political changes in Guatemala.

3. Continue to expand the tomato IPM program for whitefly-transmitted viruses into countries in West Africa, especially those in the WA-RP.

   Description and Progress: Continue to develop and extend the IPM program for whitefly-transmitted viruses to other areas in Mali and to Ghana and Senegal. This will include implementation of the host-free period, use of improved varieties and regional sanitation. The IPM program has been successfully implemented in Baguineda Mali and is being evaluated in Kati. We are in the process of expanding it to other areas in Mali and to Ghana and Senegal.

Activity 3.1b. Management of necrotic viral diseases in tomato through clean seedling production, roguing, and variety selection.

Regions/Country(ies): South Asia (India); Scientists involved: G. Karthikeyan, Nutan Kaushik, Naidu Rayapati

Expected outputs:

Information on roguing for reducing Peanut bud necrosis virus (PBNV) spread made available. Information on field response of tomato varieties and hybrids against PBNV made available.

Tasks

1. Conduct roguing trials in three locations in Tamil Nadu and two locations in Karnataka (Kolar area) during the main cropping season (January-June) and gather yield data.

2. Conduct field trials in three locations in Tamil Nadu and two locations in Karnataka to evaluate 25 tomato varieties and newly released hybrids and gather yield data.

3. Conduct IPM trials for PBNV management in four locations (two locations per season)

4. Continue developing a list of nurseries in major tomato-growing areas of Tamil Nadu and document methods of raising tomato seedlings (open field vs. shade house), and assess relative risk level for early infection of plants with PBNV in selected nurseries.

5. Compare marketable quality of tomato fruits produced by healthy and PBNV-infected tomato varieties and hybrids.

Activity 3.1c. Epidemiology of psyllid vector/Liberibacter and whitefly vector/virus in potato and other crops to design management practices.

Status: New Scientists involved*:* Brown, Rivera. Countries involved: Honduras, Guatemala

Description and expected outputs: Viable 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. (H. Espinosa). 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. 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.

Tasks

1. Determine psyllid dispersal and transmission times by yellow sticky trap catches.

2. Recommend targeted insecticide use to avoid continuous sprays by farmers.

Activity 3.2. Conduct trials to evaluate germplasm for resistance to viruses.

Status: Continuing. Scientists involved: Several.

Tasks

1. Conduct germplasm field-testing within the solanaceous crop cluster (pepper, potato, tomato) in Honduras (Rivera. LAC-RP).

2. Evaluate commercial and noncommercial seed having resistance to potyviruses to begin determining the efficacy of the resistant germplasm. (Martinez, Deom, LAC-RP).

3. Continue to evaluate tomato varieties for resistance to begomoviruses in WA (Mali) and begin programs in EA (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.

Status: Continuing

Scientists involved: Several.

Task 1. Conduct one field day and two seminars on vegetable IPM in Tamil Nadu for farmers and nurseries

Regions/Country(ies): South Asia (India)

Scientists involved: G. Karthikeyan, S. Manoranjitham, N. Balakrishnan, N. Rayapati

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' seedling s to farmers.

Task 2. Develop a plan for inclusion of virus disease management as part of IPM field days. (Host country scientists)

IPM Impact Assessment for the IPM CRSP

PI: **Dr. George Norton;** Virginia Tech, Blacksburg, VA

Co PIs: **Dr. Jeffrey Alwang;** Virginia Tech, Blacksburg, VA
Dr. Daniel Taylor; Virginia Tech, Blacksburg, VA

Brief description of the project: This global theme project provide leadership and coordination on impact assessment for each regional IPM program on the IPM CRSP. It uses a common set of methods for impact assessment of IPM packages in the regional programs to assess economic and environmental impacts of the IPM practices and packages developed and extended on the IPM CRSP. It also conducts specialized in-depth assessments of poverty, environmental, and nutritional impacts of IPM packages. It builds institutional capacity in IPM impact assessment among regional and national partners. It coordinates with IPM programs at IARCs and with other USAID-supported agriculture and natural resource management programs. It also disseminates impact assessment methods beyond the CRSP.

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 surveys and summarize the data in reports

Regions/Country(ies): India, Nepal, Uganda, Ecuador, Indonesia, Dominican Republic , Guatemala, Ghana

Status: Continuing

Scientists involved: Norton, Alwang, Taylor

Description: Some surveys already completed are still being written up and will be finished in Year 3 (India, Dominican Republic, Ecuador, and Ghana). Others will be started in year 3 such as Uganda, Guatemala, Nepal and the data summarized.

Progress to date: The surveys in Bangladesh, Mali, and Senegal have been completed. Ones in India, Ghana, Dominican Republic, and Ecuador will have been completed by

the end of year 2 but the reports are not finished. New ones will be completed in Uganda, Guatemala, and Nepal in Year 3.

Expected outputs: Reports with baseline data on adoption of IPM practices disaggregated by gender, perceptions of pest problems, etc

Task – 1: Finish surveys and reports in India, DR, Ecuador, Uganda, Guatemala, Ghana, and Nepal.

Activity 2: Short term training on impact assessment

Regions/Countries: Guatemala, Ghana, Uganda

Status: Continuing

Scientists involved: Taylor, Norton, Alwang

Description: Short term training at Virginia Tech for an economist from Ghana. 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, Honduras, Ecuador, Uganda, and the Dominican Republic in collaboration with regional planning meetings. Short term training for economist from DR took place at Virginia Tech

Expected outputs: Increased understanding by host country scientists of impact assessment methods

Task – 1: Organize and complete three-week training for economist from Ghana at Virginia Tech.

Task – 2: Provide training materials to economists in regional programs so they can conduct their impact assessments in other host countries.

Task – 3: Provide short term training in Guatemala 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 variety of impacts such as poverty impacts, general equilibrium effects, intra-household impacts, the value of impacts on institutional changes, and more detailed health, environmental, gender, and nutritional impacts.

Activity - 1: Revise manuscript preparation out of West Africa tomato IPM impact assessment

Regions/Countries: Mali, Senegal, and complete simple impact analyses for at least 2 other IPM CRSP technologies that have been adopted elsewhere.

Status: Continuing

Scientists involved: Norton, Alwang, Taylor

Description: Working with Theo Nouhoheflin from the West African site to revise manuscript out of his thesis. Economic surplus analysis completed for technologies already adopted and manuscripts prepared.

Progress to date: First draft of journal article manuscript from Masters thesis completed with data from Mali and Senegal.

Expected outputs: Journal article submitted and accepted for publication from tomato work in West Africa

Task – 1: Revise manuscript and submit from West Africa tomato work

Task – 2: Complete analysis and prepare manuscripts for at least 2 other technologies already released on the IPM CRSP

Activity 2: Assessment of IPM CRSP impacts in LAC

Regions/Countries: Honduras, Ecuador, DR, Guatemala

Status: New

Scientists involved: Norton, Alwang, Taylor

Description: Conduct an impact assessment of IPM packages in LAC with a new graduate student.

Progress to date: Impact assessment conducted in Honduras and article manuscript has been drafted

Expected outputs: Thesis and Journal articles

Task – 1: Prepare thesis proposal and collect data.

Activity 3: Assessment of optimal mix of IPM dissemination approaches

Regions/Countries: Bangladesh and Nepal

Status: Continuing

Scientists involved: Norton, Alwang, Taylor

Description: Prepare and revise as needed a 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 with a new graduate student.

Progress to date: Ms. Harris has finished her thesis in Bangladesh and Nepal and is drafting a journal article manuscript.

Expected outputs: Journal article on modeling approach for assessing optimal dissemination approaches for different types of IPM practices (with results for Bangladesh).

Task – 1: Prepare manuscript for Bangladesh.

Task – 2: Conduct data collection and analysis for Nepal

Graduate Students and Post Doctoral 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. Name: To be selected in August
Sex: Female or male
Nationality: U.S.A.
Discipline: Agricultural Economics
Site/Country:
Degree: Masters
Start date: August 16, 2011

Completion date: August 1, 2013
IPM CRSP funds: 100%
Advisor/PI: George Norton
Thesis topic:
University: Virginia Tech

Short-Term Training planned

Annual meetings: South Asia, Latin America, East Africa

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

Publications planned:

Research articles: 2

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 2012	Norton
Task - 1	Survey reports complete	Sept 2012	Norton, Alwang, and Taylor
Activity - 2	Short term training	Sept 2012	
Task – 1	Ghana economist trained	November 2011	Norton
Task – 2	Revised training materials sent to regional program economists	Sept 2012	Norton
Task - 3	Guatemala short term training	September 2012	Norton

Obj 2: Activity - 1	West Africa tomato manuscript sent to journal and other papers prepared	Sept 2012	Norton
Task - 1	Tomato manuscript sent to journal	October 2011	Norton
Task - 2	Analyses completed and manuscripts prepared for two additional IPM technologies	Sept 2012	Norton
Activity 2	Assessment of IPM CRSP impacts in LAC	September 2012	Norton and Alwang
Task 1	Prepare thesis proposal and collect data	September 2012	Norton and Alwang
Activity 3	Optimal mix of dissemination approaches	Sept 2012	Norton and Harris
Task - 1	Prepare manuscript for Bangladesh	October 2011	Harris and Norton
Task - 2	Conduct data collection and analysis for Nepal	September 2012	Norton

Gender Equity, Knowledge, and Capacity Building

First the US managed objectives are listed, followed by regional workplans. Objective 1 is not listed independently for RPs, as all will be completing activities listed under US managed objective, listed immediately below.

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 four 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: C Asia: Racioppi and Jamal SE Asia: Lestari S. Asia: Uma LAC: Cruz W Africa: TBD E Africa: Mangheni	Provide guidance with GGT workplan for RPs and compile CRSP-wide GGT workplan.	All	July 2012
2	Prepare gender components of the annual report for Regional Program.	Gender components included in annual report	RP Gender Coordinators as above	N/A	All RPs	September 2012
3	Prepare GGT annual report to be submitted to GGT PI using GGT format.	GGT specific annual report	RP Gender Coordinators as above	Compile information for GGT annual report	USA	September 2012

Objective 2: Capacity building: Empowering teams to integrate gender

Task	Description and purpose	Output	Responsible Party	Specific Regional Activity	Location
1	Training in data gathering workshops to increase gender awareness and integration into pesticide research; understand and practice participative methodologies and strategies to better include women; scale up impact of FY1 workshop, if applicable.	RP: Gender workshop (in second country if a workshop was carried out in FY 1 or 2) GGT PI: Planning and guidance documents	RP with GGT PI support DR: Cuevas Kenya: Mangheni Ghana: Haleegoah; D.R.: Valenzuela	Support regional workshops	Dominican Republic or Honduras, Kenya
2	Long term training: select, advise, and support student working on IPM gender research.	Student name, level, program, university, progress and research abstract in report.	GGT PI for American student working in Ghana; Bangladesh: Karim and Huq Hussein; India: Uma; Indonesia: Puspitawati; Uganda: Mangheni; Philippines: Dayo	Theses: Laura Zscelecky (VT), Tahera Sultana & Umme Habiba (University of Dhaka), Robert Ochago & Robinah Atukunda (Makerere University), Indonesia TBD (Bogor University)	USA, Bangladesh, Philippines, India, Indonesia, Uganda

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	Research proposal, field report or thesis	GGT PI for student working in Ghana; Bangladesh: Karim and Huq Hussein; Indonesia: Puspitawati; Uganda: Mangheni; possible student in TNAU with. Uma	Masters Theses, Research abstracts, Articles	USA, Bangladesh, Indonesia, India, Uganda
2	Analysis of sex-disaggregated data from baseline survey.	Article for regional publication	RP Gender Coordinators	Laura Zseleczky in coordination Impact Assessment and Global Theme collaborators in Ghana; Robert Ochago with Dr. Mangheni in Uganda	USA, Ghana, Uganda
3	Qualitative research on the gendered dimensions of pesticide use, knowledge and activities linked to the productive and reproductive sphere.	Collection of case studies for publication	RP Gender Coordinators and their students (If applicable)	Baseline survey and field work	India, Ghana, Mali, Indonesia, Cambodia, Philippines, Dominican Republic

Task	Description and purpose	Output	Responsible Party	Specific Regional Activity	Location
4	Analysis of data from Rapid Gender Assessment in FY 1 to include methodological notes on the use of the 4 Gender Dimensions framework.	RP: Revised case study report for publishing as research note on IPM CRSP website and for local publication GGT PI: Case studies online Cross-cutting research article use of 4 Gender Dimensions framework in IPM research	RP & GGT PI	1. Case studies online 2. Cross-cutting research article use of 4 Gender Dimensions framework in IPM research 3. Second article based on case studies for value chain analysis and/or kitchenspace	Philippines, Indonesia, India, Ghana, Mali
5	Present research results of FY 1 and 2 at local, regional, or international forum to increase visibility of gender work in IPM CRSP.	Conference presentation PowerPoint of same presentation to post on IPM CRSP website	RP Gender Coordinators; GGT PI and student Laura Zselecky	1 presentations at Women in International Development discussion series at VT; presentation at the Annual Conference of the Southeastern Division of the Association of American Geographers (SEDAAG); other presentation in region	USA, Ghana and others TBD

Travel Matrix and Justification for the Trips

		Regional Projects						Global Themes						
Destination	**Number of travelers per trip**	**LAC**	**EA**	**WA**	**SA**	**SEA**	**CA**	**Parthenium**	**IPDN**	**IPVDN**	**Impact**	**Gender**	**ME**	**Total**
Bangladesh	1				8				5	1	1	1	2	18
Brazil	1	2												2
Cambodia	1					32				1		1	2	36
China	1							1						1
Costa Rica	1	2												2
Ecuador	1	5								1	1	1	2	10
Ethiopia	1							6					2	8
Ghana	1			5						2		2	3	12
Guatemala	1	15							10	2	1		2	30
Honduras	1	10							2	2	1	1	1	17
India	1	2	2	2	4	4	1			10	1	1	4	31
Indonesia	1					10				1		1	2	14
Kenya	1		5						5	3		1	3	17
Mali	1			10					2	3	2	2	3	22
Nepal	1				8				2	1	1	1	3	16
Nicaragua	1	2												2
Philippines	1					10						2	2	14
Senegal	1			20					2	2			3	27
South Africa	1							2						2
South Korea	1				2								1	3
Tajikistan	1						10		5	1		1	3	20
Tanzania	1		5						5	4	2		3	19
Uganda	1		15						5	4	2	2	3	31
USA	1	10	3	10	10	5	4		5	4	1			52
Total	1	48	30	47	32	61	15	9	48	42	13	17	44	**406**

Destination	Total	Justification for the Trips
Bangladesh	18	**Planning meeting for the SA region**; IPDN workshop.
Brazil	2	International Agricultural Economics meeting.
Cambodia	36	**Planning meeting for the SEA region**; site planning.
China	1	Present a paper at the International Weed Science Society meeting
Costa Rica	2	Attend a short bacteriology course.
Ecuador	10	Review of research progress; site planning.
Ethiopia	8	Site planning and project monitoring.
Ghana	12	Site planning; IPDN workshop.
Guatemala	30	**Planning meeting for the LAC region**; IPDN Workshop
Honduras	17	Review of research progress; workshop.
India	31	**Virology workshop at TNAU**; site planning.
Indonesia	14	PIs for SEA; IPDN; IPVDN; ME to visit for planning and surveys.
Kenya	17	Site management; field assessment; IPDN; workshops.
Mali	22	Site management; field assessment; IPVDN planning; short term training.
Nepal	16	Site management, field assessment, and workshops.
Nicaragua	2	Attend IPM meeting.
Philippines	14	PIs for SEA; IPDN; IPVDN; ME to visit for planning and surveys.
Senegal	27	**Planning meeting for the WA region**;
South Africa	2	Attend a training program in biological control of weeds
South Korea	3	Attend the International Entomology Congress;
Tajikistan	20	**Planning meeting for the CA region**; site planning; IPDN workshop
Tanzania	19	Site management, field assessment, and workshops.
Uganda	31	**Planning Meeting for the EA region.** Site management; field assessment; IPVDN planning.
USA	52	**Attend the 7th International IPM Symposium**; short-term training.
Total	**406**	