IPM CRSP Accomplishment Report - FY 2007

IPM in Latin America and the Caribbean: Crops for Broad-based Growth and Perennial Production for Fragile Ecosystems

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Ecuador:

Fusarium control techniques and other technologies for naranjilla

- The intimate association of vascular wilt caused by *Fusarium oxysporum*, and the root knot nematode (*Meloydogine incognita*) has been established and its control is the key point for an integrated control strategy in naranjilla. Seed disinfection was then developed to control the pathogen and avoid it in new areas for common naranjilla cultivation and also manage the pathogen in nurseries. Plant resistance is a complementary approach. Similar resistance studies were conducted for *M. incognita*. Six accessions with good levels of resistance to both, *Fusarium oxysporum* and *M. incognita* are being evaluated successfully during the 2006-2007 year. Four of them (*S. sessiliflorum, S. tequilense, S. hirtum* and *S. pectinatum*) produce between 350 to 550 Kg more fruits than the control.

- Whenever resistant rootstock to Fusarium is used, longevity of the crop is extended and control of late blight and fruit borers become economically feasible.

- Technology to efficiently control vascular wilt (*F. oxysporum* f. sp. *quitoense*), root knot nematode (*M. incognita*), late blight (*P. infestans*) and bruit borer (*Neocidones elegantalis*) are at present available. A study to quantify the benefits of individually or combining technologies is being taking place in an area conducive to these pest and diseases.

- Several promising means of controlling naranjilla late blight have been identified and tested. Biological means of control are showing significant promise. The combined presence of late blight, the fruit borer, and soil diseases makes it necessary to integrate more holistic ICM techniques.

Cocoa resistance to frosty pod and witches´ broom

- Three of the five methods originally tested for early evaluation of Witches´ broom in cacao were repeated this year with a reduction of the inoculum concentration (from 10^5 to $7{,}5 \times 10^3$) to account for the aggressiveness of the Ecuadorian pathotipe of the fungus: the modified Holliday test, the semiautomatic system of inoculation-infection (SAI) or “Belt Spray Method”, and the agar drop method.

- Seedlings presented a range of symptoms for Witches broom infection. Controls non infected, were symptomless. Despite a reduction in the amount of spores, all materials tested presented 100% incidence of the disease and differences for the parameters used for testing were not statistically significant. However results indicate that resistant materials will have larger incubation periods.

- The variable permanence of cotiledons (%) measure as the difference in days between the inoculated and the corresponding non inoculated control, gave statistical significance, with the resistants showing larger permanence period (> 90 days difference), against 30 to 45 days in non inoculated seedlings and with shorter permanence (around 60 to 85 days) in susceptible inoculated cultivars.

- An exploratory trial was conducted to test spore germination on three cocoa clones with wide range of resistance to *M. roreri* (EET 233, resistant; EET 387, tolerant; EET 19, susceptible); the suspension used (500,000 spores/ml) for the test was prepared with yeast extract solution. Results produced significant results given the expected order, with larger germination (85%) on the susceptible and the lower (59% spore germination) for the resistant. Following this technique a range of clones will be tested both from National and Forastero cocoa type.

Pathogens in cocoa/plantain-producing areas

- Observations continue on an experimental plot to compare phenology, type and amount of diseases and pests affecting the cocoa/plantain system under three spatial arrangements and monoculture of plantain and cocoa. For plantain, monoculture shows increasing populations of pests and diseases.

- Nematode populations (*Radopholus* and *Meloydogine)* in monoculture plots are double than any of the other designs. Banana stem borer populations are also greated in the monoculture plots.

- The incidence of Witches broom in cocoa is larger (statistically significant) in monoculture and lowest in the diamond design.

- Misidentification of sanitary problems affecting either single or mixed cultivation crops is common in the area.

- Besides Witches broom and Moniliasis, the genus *Lasiodyplodia* causing damage on fruits, trunks and branches of cacao, obtained the higher percents of incidence, followed by *Colletotrichum, Cladosporium* and *Pestalotia*.

- In high and humid areas it is common to see serious problems caused by parasitic algae (*Cephaleurus* sp),epiphytes and aerial parasitic plants.

- Fifty percent of farmers think that problems of plantain may pass over to cacao, mainly ants and root groovers and even the Black sigatoka.

IPM package for mixed cultivation in plantain

- Several techniques for control of main pests have been developed and technology transfer is ongoing.

Honduras

Several promising IPM strategies for pest control in horticultural crops were developed by our partners in Honduras.

- Canavalia, Dolichus, Mucuna and Cowpea cover crops suppressed purple nutsedge (*Cyperus rotundus*) and harbored Chrysomelidae, Formicidae, Cicadellidae and Coccinellidae insect familes.

- Cowpea and Canavalia reduced nematode populations in the soil and were the most effective cover crops for fixing soil nitrogen.

- The predatory mite *Neoseiulus californicus* resulted in reduced leaf chlorosis damage by the *Tetranychus urticae* mite in papaya.

- *Trichoderma harzianum* inoculation of bell pepper seed prior to transplanting stimulated plant development however, inoculation of tomato and cucumber seeds or of tomato roots had no effect.

- Root-knot nematode *Meloidogyne* spp. infection in eggplant (*Solanum melongena*) was reduced when plants were treated with Vesicular Arbuscular Micorrhiza (VAM), *Trichoderma harzianum*, *Paecilomyces lilacinus* or grafted on a nematode-resistant root stock

- *Trichoderma harzianum* **c**an be applied as a biological pesticide through irrigation systems which may result in easier application under field conditions.

- *Trichoderma harzianum* **a**pplication to onion seeds and again at transplanting or only at transplanting resulted in higher yields than untreated plants.

- Biological control was obtained of the root knot nematode *Meloidogyne* spp. in cucumber (*Cucumis sativa*) with Vesicular Arbuscular Micorrhiza (VAM), *Trichoderma harzianum* and *Paecilomyces lilacinus*.

- Control of *Meloidogyne* spp. in Americana Okra (*Abelmoschus esculentus*) was obtained with Vesicular Arbuscular Micorrhiza (VAM), *Trichoderma harzianum, Pochonia chlamydiosporia*, *Paecilomyces lilacinus* but not when plants were grown in association with Marigold (*Tagetes erecta*).

Regional IPM Program for East Africa

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The Regional IPM Program for East Africa (RP/EA) focuses on Uganda, Kenya, and Tanzania. The two main complementary objectives are to develop a regional model of collaborative IPM research, training, and knowledge dissemination that focuses on improving the productivity of higher-value marketed horticultural crops. The Regional Technical Committee met twice over the past year in Kampala, Uganda in March and September of 2007. There were 12 visits made to the EA Site by Co-PIs from OSU, VT, University of Wisconsin and AVRDC. The IPDN Global Theme in collaboration with the EA Regional Program launched its first activity, a Stakeholder Meeting and workshop on plant disease diagnostic technology training, in Nairobi, Kenya on March 5-8, 2007, and this was followed by two-week pest diagnostic workshop in late August at OSU's Wooster Campus in which 8 scientists from the EA region participated. Two co-PIs from the EA who participated in this workshop, Mrs. Mildred Ochwo-Ssemakula, Uganda and Mr. Hossea Mtui, Tanzania, also conducted additional research work at OSU laboratories. Over the past year 583 farmers in the region participated in various IPM CRSP East Africa activities conducted by 21 co-PI scientists and graduate students.

Tomato:

Uganda

A. Economic analysis of dry season tomato production using on-farm demonstration trials compared three IPM practices (staking, mulching and 3 sprays per season) with farmer practices of no staking, no mulching, and 12 sprays per season. Although IPM practices resulted in reduced incidence of Bacterial wilt (*Ralstonia solanacearum*), aphids, thrips and white flies, and yield differences between the two IPM practices – staking and mulching – did not have significant yield differences from farmer practices. However, at 12 sprays per season farmer practices cost 1,004,884 Ugsh ($546 US) versus the IPM practices at 251,211 Ugsh ($146 US) per hectare. Thus based on reduced sprays, profitability can increase by $500 US per hectare for tomato producers. A rough estimate of the extent of tomato production in the agro-ecological zone where the trials were conducted is 2,000 hectares. Given the cost savings from the reduced sprays, the potential increase in profits is $ 1 million US if all the framers in the agro-ecological zone adopted the IPM practices.

B. On-station field trials were conducted to assess the performance of bacterial wilt susceptible tomato grafted onto three indigenous solanaceous *(Solanum* spp*)* rootstocks. A randomized complete block design was used with 3 replicates, and the tomato varieties 'MT 56'and 'Onxy' were used as bacterial wilt resistant and susceptible checks, respectively. 'Onxy' and rootstock *S. indicum* exhibited the highest bacterial wilt incidence of 100% and 83%, respectively. Rootstock

S. complycanthum was the most tolerant with only 13% incidence, although this was not significantly ($P<0.05$) different from that of tomato variety MT 56 with 33% and *Solanum spp (Katengotengo)* with bacterial wilt incidence of 53% . There was no significant ($P<0.05$) difference in the girth of all the rootstocks. Tomato variety MT 56 produced the highest yield of 2.84 kg/plant, which was more than three times and significantly ($P>0.05$) higher than that of the rootstocks. These results indicate that although the indigenous solanaceous rootstocks, S. *complycanthum* and *Solanum spp. (Katengotengo)* can confer bacterial wilt resistance to commercial tomato varieties through grafting, they seem to have a negative effect on tomato yields. Grafting onto these rootstocks is, therefore, recommended as an economically viable IPM practice for areas where soils are infested with bacterial wilt disease and bacterial wilt tolerant or resistant tomatoes are not readily available because under these conditions grafting would permit some yield.

Kenya

A. Tomato biological monitoring was conducted on a weekly basis with six farmers in Nyagati and Wanguru sub-location, Mwea Division in Kirinyaga District. The farmers were interviewed weekly on their pest management practices. Information on the variety being grown, cropping systems and the pesticide used was noted.

Fungal blights (early and late blight) were the dominant diseases. Post-bloom pests included thrips, whiteflies, mites, lygus bugs, aphids and bollworms, but their population was low on the five farms examined. Natural enemies were not recorded probably due to the frequent use of broad spectrum pesticides. Fungal (early and late blight), bacterial wilt, symptoms of nematode attack, and begomoviruses were common in all the farms despite regular spraying. The whitefly transmitted begomoviruses were observed and recorded with an incidence of 20 – 70% among the farms while the fungal blights ranged from 10 – 30%. The major weed species on the tomato farms included; *Amaranthus hybridus, Commelina bengalensis, Datura stramonium, Pencum maximum, Bidenspilosa, Digitaria sp., Oxygonium sinatum, Galinsoga sp. Cynodon doctylon, Setaria vertiullata* and others less important. Physiological diseases such as blossom end rot, fruit cracking and sun scotching resulted in yield losses ranging from 7-50%. Fruit losses due to bollworm damage ranged from 7-18% while fungal blights caused fruit damage ranging from 3-75%. Fungicides were the major pesticides used. Foliar feed fertilizer (Easy grow®) was applied by most (5) farmers. Hand weeding ranging from 2 to 4 weedings/ crop season.

Highlights: 1) All farmers used pesticides for pest management. However, they lacked knowledge of alternative pest control options and did not practice pest scouting. 2) Farmers incurred high production costs due to routine fungicide application. However, none of them had knowledge of or attempted to carry out cultural management practices such as crop rotation and irrigation methods that do not promote disease transmission. 3) Marketable yield of tomato was reduced significantly due to avoidable physiological diseases such as Blossom end rot and fruit cracking. 4) There is urgent need to train the farmers on appropriate tomato production technologies. 5) There is need to develop/introduce Bacterial wilt tolerant varieties as

well as varieties that are tolerant to Begomoviruses for production in this area.

B. Tomato trials were conducted at KARI-Thika to assess the efficacy and economic benefits of five tomato pest management options. The five treatments were (i) grass mulch application without insecticide application, (ii) Grass mulch application at two weeks from transplanting and need-based pest control using bio-pesticides, (iii) farmers' practice involving staking bi-weekly insecticide application, (iv) staking and need-based insecticide application using bio-pesticides, and (v) untreated control without insecticide application.

Highlights: 1) Insecticide application in tomato production significantly reduced pests and increased yield; 2) Need based pesticide application would be environmentally friendly and increase the economic benefits of tomato production; 3) Organic mulching greatly reduced the occurrence of weeds and pest infestation in the tomato plots. However farmers rarely use mulch. There is a need to further investigate the advantages of staking determinate tomatoes in Kenya.

Kenya & Uganda: Identification of begomoviruses associated with tomatoes.

In March 2007, six tomato fields in the irrigated agricultural area near Mwea Kenya and four tomato fields near Kampala, Uganda were visited. Tomatoes that had typical viral symptoms were collected, as well as tomatoes that showed wilting characteristic of bacterial wilt caused by *Ralstonia solanacearum*. The extension agents and growers thought that the main viral problem was caused by *Tomato mosaic virus*, which is an RNA virus. Immunostrips form Agdia, which are specific for this virus, were used to test multiple samples. All samples tested negative. Samples with symptoms consistent with whitefly-transmitted geminivirus (begomovirus)viral infection were squashed onto nylon membranes in Kenya and Uganda and these samples sent to the Dr. Maria Rojas, Department of Plant Pathology, University of California-Davis for processing. The five samples from Kenya and three samples from Uganda tested positive for the presence of a whitefly-transmitted geminivirus using both DNA hybridization with a general probe and polymerase chain reaction (PCR) with two different sets of general primers. Samples were tested with PCR specific primers for three geminviruses: Pepper yellow leaf curl virus (PYLCV), Tomato yellow leaf curl Morondava virus (TYLCMV), and Tomato leaf curl virus (ToLCV). PYLCV was detected in all the samples from both Kenya and Uganda. TYLCMV was not detected in any of the 8 samples and one sample from Kenya had ToLCV. Two other samples from Uganda were only tested with degenerate PCR primers and these samples were negative for begomoviruses with this one set of primers.

Highlight:

1) There was a positive identification of begomovirus infection as one of the main problems in the sampled areas of Kenya and Uganda. Pepper yellow leaf curl virus was detected in all samples; 2) All samples tested negative for *Tomato mosaic virus*.

Tanzania

A. An on-station experiment to evaluate seven tomato management techniques effect on pests was conducted from October 2006 to February, 2007 and repeated May - September, 2007 at SUA.

Highlights: 1) Reduced pesticide application under IPM (3X) gives results similar to growers standards where application is 12 to 24 times; 2) From field observations it is possible to improve the performance of some of the techniques evaluated by adding other components, e.g., mulching with application of pesticides as needed; 3) Formulation of what will constitute IPM demonstration plots in the target villages has been done and initial on station evaluation is in progress; 4) Though weeds were ranked lowest as pests, nutsedges were singled out to be the most problematic. An on station trial on yield loss assessment due to weeds is in progress using 5 test vegetables.

B. Several experiments were conducted to assess seed biology based interventions for enhanced integrated crop management in tomato production by small scale farmers in the Morogoro region-Tanzania.

1) Seed germination and vigor tests for four tomato (*Lycopersicon esculentum* Mill) seed sources (commercial 'Tanya' and 'Cal J', and farmer-saved seeds 'Tanya G_1' and 'Tanya G_2') were conducted. **Highlights:** i) Cal J cultivar produce fewer seeds per unit fruit weight than Tanya cultivar; ii) Farmer–saved seeds had higher germination % than commercial seedlots; iii) Commercial seedlots produced seedlings with higher vigor; iv) Chlorine and hot water treatments were the most efficient treatments in hastening germination and improving seedling vigor.

2) Experiments were conducted to assess the presence of seedborne bacteria in four different tomato seedlots and evaluate the efficacy of seed treatments in reducing bacterial contamination. Results showed that all the seedlots assessed were contaminated with Clavibacter michiganensis subsp. michiganensis (CMM), Xanthomonas campestris pv. vesicatoria (XCV) and Pseudomonas syringae pv. tomato (PST). Highlights: i) Both commercial and farmer-saved seedlots were highly contaminated with seedborne bacterial pathogens; ii) Farmer–saved, Tanya G2, seedlots had the highest contamination with bacterial speck pathogen; iii) Chlorine and hot water seed treatments reduced significantly bacterial populations.

3) A field experiment conducted to evaluate four tomato seed sources was subjected to four different seed treatments (hot water, chlorine, Ridomil and untreated check) and two mulch levels for subsequent incidence of bacterial leaf spot (BLS), bacterial speck (BS) and bacterial canker (BC), along with post transplanting vigor and survival. **Highlights:** i) Seedlings from commercial 'Tanya', 'Cal J' and 'Tanya G_1' seedlots had both superior vigor and survival index compared to 'Tanya G_2'; ii) Chlorine and hot water seed treatments reduced bacterial disease

incidence in the field; iii) Organic mulch reduced bacterial speck severity and enhanced plant vigor.

4) Yield differences encountered by farmers using four different tomato seed sources were assessed. **Highlights:** i) Commercial 'Tanya' and 'Tanya G_1' had a higher yield compared to 'Cal J' and 'Tanya G_2'; ii) Chlorine and hot water treated seeds led to higher number of fruits per plant; iii) Plants from hot water treated seeds produced less sunscald fruits; iv) Mulched plots produced higher fruit number per plant, fruit weight and marketable yield per acre; v) Mulching reduced sunscald fruit disorder.

Scotch bonnet hot peppers

Uganda

Four different treatments were used to assess four different IPM technologies for key pests and diseases of scotch bonnet hot peppers. **Highlights:** i) Intercropping reduced infestation of pepper by aphids, but did not affect thrips and whitefly population; ii) Neem application did not significantly affect the population density of aphids and thrips, but affected whiteflies; iii) Incidence of viral disease was very high and was not influenced by either cropping system or pesticide application suggesting that the infection might have been from the seeds. Therefore farm-generated hot pepper seed will be analyzed for viruses and other seed born diseases; iv) Field trial assessing some IPM options to be repeated for conclusive results; more improved tactics to be tested to create a 'packed basket' of options.

Managing *Helicoverpa armigera*

Uganda

In developing cost-effective biologically-based interventions for managing Helicoverpa armigera (tomato fruitworm/cotton bollworm) a survey of important tomato growing districts of Wakiso, Kayunga and Masaka, was conducted to determine the incidence and damage by bollworm. Sampling for bollworm on tomato was conducted during flowering and fruiting. Sampling for bollworm was also done on possible alternate host plants within a 30m radius of the focal tomato field. First year Highlights: 1) Higher tomato fruit damage in one field coincided with the presence of an unsprayed maize field that was seriously affected by bollworms and hence acted as a bollworm refuge; 2) Major crops grown near tomato gardens include cassava, pineapple, banana, maize, green pepper and eggplant, while non-crop plants include Lantana, spear grass, and couch grass. Among all these crops/plants, bollworm presence and damage was only observed on maize.

Passion Fruit: Research efforts in **Uganda and Kenya** have been focused on developing an integrated disease management strategy for passion fruit.

Uganda:Results: i) Preliminary analysis indicates some genetic diversity among passion fruit types; ii) Yellow passion fruit types with tolerance to viruses have been identified in Central Uganda; iii) The complete coat protein gene for the prevalent potyvirus species infecting passion fruit in Uganda has been sequenced. Phylogenetic analysis confirms this potyvirus as a distinct species from other potyviruses so far reported on the crop worldwide; iv) Four primer pairs have been identified that can be used to detect the potyvirus species infecting passion fruit in Uganda, and discriminate between the two sub groups of this potyvirus; v) Aphids were not found on passion fruit. Aphid species from alternate hosts in Central Uganda are under investigation. **Highlights:** i) Confirmed occurrence of a novel potyvirus on passion fruit; ii) Detected tolerance in local passion fruit that may be useful in resistance breeding.

Kenya: Results: Two studies were conducted in year two, (A) isoloation of the fungal disease of passion fruits and (B) screening passion fruit root stocks for resistance to fusarium root rot as part of a larger study to develop an integrated disease management program for the control of *Fusarium* wilt of passion fruit in Kenya.

A. Plant samples (leaf root and stems) were colleted from approximately 40 farms selected from major production areas in Western, Nyanza, Central and Rift Valley Provinces. Morphological characterization was done through microscopy. **Highlights**: i) There are multiple fungal pathogens attacking passion fruit in Kenya, and there is need to characterize and evaluate their impact on yield; ii) The most prevalent diseases were the *Fusarium* wilt and woodiness viruses. They should therefore be given high priority.

B. Multiple studies are being conducted to develop an integrated disease management program for the control of *Fusarium* wilt of passion fruit. **Highlights**: i) Screening 8 passion fruit root stocks for resistance to fusarium root rot indicates that *Passiflora subrosa* is as tolerant as *Passiflora flavicarpa* in the laboratory. *Flavicarpa* is still susceptible in the field; ii) Passiflora species screened for compatibility with the purple passion fruit indicated that the most compatible rootstock was *Passiflora flavicarpa.* Species like *Passiflora mollisima* and *Passiflora ligularis* provided a success rate of between 40% and 60%, providing a window for possible alternatives; iii) The most drought tolerant Passiflora species were *Passiflora subpeltata, Passiflora mollisima, Passiflora subrosa* are as tolerant as *Passiflora flavicarpa. iv)* To suppress fusarium a combination of soil treatments and irrigation levels were tested indicating that STEP mulch with Rodozim as the most effective combination for suppressing fusarium wilt under field production. Step Pot tends to slow down growth but has better water economy than basin, Step mulch, and no irrigation.

Banana: Uganda

This effort has focused on developing diagnostic tools for *Xanthomonas campestris* pv. *musacearum* the causal pathogen for banana bacterial wilt disease. **Highlights:** i) A semi-

selective medium, CCA has been developed for isolation of *Xanthomonas campestris* pv. *musacearum*. This medium will allow easy isolation of the bacterium and facilitate detection of new outbreaks, monitoring of disease spread and epidemiological studies; ii) No genetic variation was detected in the *Xanthomonas campestris* pv. *musacearum* population. This implies a highly uniform population of the bacteria (clonal in nature), This is good for breeding for resistance to BBW as resistance break down is unlikely should resistant materials be developed; iii) A molecular diagnostic tool for *Xanthomonas campestris* pv. *musacearum* has been developed and tested. It is very promising because it can detect the pathogen in infected tissue without need to extract bacterial DNA.

Coffee: Uganda and Tanzania

Grower surveys conducted in Uganda and Tanzania established that the following are the priority insect pests, diseases, and weeds. These results are being validated through biological monitoring activities in both countries.

Priority Insect Pests and Diseases of Arabica coffee (*Coffea arabica* L.) as defined by various sources in East Africa.

Pests & Source	Growers Uganda	CORI Uganda	Growers Tanzania	Kenya *
Insects				
Antestia bug (*Antestiopsis spp*. Ghesq. and Carayon)	2	1	2	2
White stem borer (*Anthores leuconotus*)			1	1
Coffee Stem borer (*Bixadus seirricola* White)	1	5		
Coffee berry borer (*Hypothenemus hampei* Ferr.)	3		3	
Scales (*Gascardia brevicauda* and/or *Coccus alpinus* De Lotto)	5	2		
Coffee leaf miner (*Leucoptera meyricki* and *L. caffeina)*		3	4	
Coffee root mealy bug (*Planococcus ireneus* De Lotto)	6			
Coffee mealybug (*Planococcus kenyae* Le		4		3

Pelley)				
Coffee lace bug (*Habrochila* ssp.)	4			
Diseases				
Leaf rust (*Hemileia vastatrix*)	2	2	2	2**
Coffee berry disease (*Colletotrichum kahawae* Waller and Bridge)	1	1	1	1
Red blister disease	4			
Armilleria, wilting root rot (*Armillaria melea* Vahl)	3			
Fusarium, (*Fusarium stilboides* Wollenw)	5			
Elgon die back (*Pseudomonas syringae* Van Hall*)*	4			
Weeds				
Digitaria scalarum	1		1	
Cyperus rotundus			2	
Oxalis latifolia	2			
Bidens pilosa	3			

Rankings range from 1 – most important, to 6, lower in importance.

* Kenyan results come from Kenyan Coffee Research Institute

** In Kenya, leaf rusts have been recently controlled by grafting a Ruiru III onto resistant root stock. Copper-based fungicides are also used to control leaf rusts.

Continuing evaluations of the potential for using *Pseudomonas fluorescence* to control *Fusarium xylarioides* (coffee wilt disease=CWD) and other fusarium wilt diseases of coffee indicates the following: i) 25 *Pseudomonas spp.* were isolated from the 30 soil samples. 5 were confirmed as pure *P. florescence* by PCR analysis; ii) Cell-free metabolites produced by the bacterial antagonists reduced the colony area of *F. xylarioides* isolate by up to 90%, and growth of *F. solani* and *F. oxysporum* by up to 60%; iii) The result showed that the antibiotics including pyoluteorin (Plt), and 2,4-diacetylphloroglucinol (Phl) are also produced in agar and was able to diffuse restricting the growth of the pathogens. This provides a positive indication of the potential of the bacteria as a bio-control of Fusarium root pathogen; iv) In the screen house the suppression of CWD incidence was 30% over a period of 90 days. Under field condition, no

incidence of CWD was recorded one year after establishment of the trial. Data collection shall continue up to the first change of cycle of the planted coffee.

In order to characterize Ugandan isolates of coffee berry disease (CBD) *Colletotricum kahawae***,** 21 arabica coffee fields were randomly selected and visited to assess disease damage an subsequently collect isolates, during the month of July2007, in Mt. Elgon districts of Mbale, Sironko, Kapchorwa and Manafa**.** CBD was only prevalent at three fields in Sironko districts and all were at altitudes above 1800 metres above sea level (Masl). However, the disease was not observed in the other three districts even at higher altitudes (>1800 masl). The absence of CBD in most parts of Elgon region was probably due to the less conducive warm and drier environment that prevailed during the time of the survey as opposed to that at the high altitudes in Sironko. In all cases, incidence of the disease remained below 30%.

Coffee berry disease infection and disease development is influenced by several factors: temperature and moisture. Optimal temperatures for germination and lesion development of the pathogen are 17^0 C, although the germination optimum could be increased to 22 ^{0}C if nutrients were present. Maximum temperature for germination is 30 ^{0}C (and 35 C with nutrients) with a minimum of 10^0C. In practice, as with most *Colletotrichum* pathogens, germination and infection requires free water from rain, mist, or dew. Water is also required for dispersal of spores. Studies with alternating cycles of desiccation indicate that infectivity is generally reduced with desiccation and is completely lost after 10-12 days. It is therefore possible that the required field conditions for pathogen development were not conducive to elicit the disease in the region during the survey and could have affected disease development in the region.

Accomplishment Summary for the IPM CRSP South Asia Site

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The IPM CRSP in South Asia focuses on vegetable crops in three countries: Bangladesh, India, and Nepal. In Bangladesh the program works with a consortium of host country institutions (Bangladesh Agricultural Research Council (BARC), Bangladesh Agricultural Research Institute (BARI), Bangladesh Rice Research Institute (BRRI), Department of Agricultural Extension) (DAE), BSMR Agricultural University, CARE-Bangladesh, Mennonite Central Committee (MCC), Practical Action, and Action Aid). In India, it works with Tamil Nadu Agricultural University (TNAU) and The Energy and Resources Institute (TERI). In Nepal, it works with Winrock and with the Nepal Agricultural Research Council (NARC).

Bangladesh -- BARI is the lead institution in Bangladesh for the IPM CRSP. Vegetable IPM technologies were not available to the farmers before the initiation of IPM CRSP. Thus far, seven IPM technologies have been developed through the IPM CRSP program:

1. *Pest-resistant eggplant and virus-resistant pumpkin varieties* -- Three pest-resistant eggplant varieties were released in 2006 and two virus-resistant pumpkin varieties in 2007. The resistant varieties have resistance to fruit and shoot borer (FSB), bacterial wilt (BW), jassids and root knot nematodes (RKN). Presently, the eggplant varieties are being demonstrated in farmers' fields by BARI and DAE in different districts.

2. *Grafting of eggplant and tomato for controlling BW disease* – Grafting has proven to be highly effective in reducing BW incidence by more than 95%. It increases yield 2-3 times in eggplant and 1.5-2 times in tomato. It increases farmer income from those commodities 1.5 – 3 times.

3. *Soil amendment with poultry refuse and mustard oil-cake for managing soil-borne pathogens* – Soil amendments have proven to be cost effective in improving soil fertility, reducing soil-borne disease pathogens by 70-80%, reducing seedling mortality by more than 85%, increasing crop yields by 30-50%, and increasing farmers' income by 156-192%.

4. *Sex pheromone bait traps for controlling fruit fly in cucurbit crops* – Pheromone traps have become the most popular IPM technology among farmers because of their high cost effectiveness. They reduce the cost of fruit fly control by more than 85%, reduce fruit fly damage by 80-95%, and increase yield and farm income by 150-200%. The IPM CRSP not only developed and spread the technology but worked with the government to change the rules to allow the import of the pheromones.

5. *IPM methods for controlling leaf-eating pests of cabbage/cauliflower* – Hand picking of leaf-eating pests of cabbage/cauliflower has allowed for the reduction of pest damage by about 95%, reduction of pest control costs by more than 50%, and 1.6 times higher farm income.

6. *Biological control of eggplant and cabbage pests through exploitation of natural biological control by reducing pesticide use* -- Several egg and larval parasitoids (*Trichogramma* spp., *Trathala* spp., *Bracon* spp.) are abundant in vegetable fields. Indiscriminate pesticide use has destroyed their populations. Trials have shown that these parasitoids are highly efficient in parasitizing 50-70% eggs/larvae of various pests and can contribute effectively to controlling them. Trials have shown that natural enemy populations can increase 3-fold in a year if pesticide use is reduced.

7. Ha*nd weedings at critical crop growth stages* – It has been shown that 2 hand weedings instead of the farmers' practice of 4-6 hand weeding has been shown to reduce weeding costs by 50% with no crop losses and with 10-52-% higher economic returns.

Technology transfer --The above IPM technologies have been transferred to farmers at different sites in the country by BARI, DAE and NGOs. Technologies are transferred at the field level primarily through two means. The first is by the US-funded and BARC coordinated PL480 project "Facilitating the development and spread of IPM CRSP" and the second is by NGOs. BARI and DAE have carried out technology transfer activities in 13 sub-districts for the last two years. Training programs for DAE field level extension officers and farmers were also carried out. All of the technologies were successful but the most successful were fruit fly control by pheromone baiting and soil amendment by poultry refuse. 318 extension officers and 120 farmer trainers were trained in IPM technologies during the last two years. Four international NGOs (CARE-Bangladesh, MCC, Practical Action-Bangladesh and Action Aid-Bangladesh) along with their partner NGOs (PNGO) have transferred IPM technologies through demonstrations and pilot production programs. In 2004-2005, CARE-Bangladesh demonstrated IPM technologies in 4107 farmers' fields through their PNGOs. CARE also facilitated 5600 farmers through demonstrations. In 2006-2007, the four NGOs demonstrated and disseminated IPM technologies in 15 districts involving 548 farmers. Those farmers obtained 163-211% higher yields and roughly 180% higher income from adopting the various IPM technologies.

Training, Education and Capacity Building -- IPM CRSP supported training of 19 BARI scientists, 80 NGO officers (in training if trainer programs), and 95 farmer trainers (in six target farmer training programs) to build their capacity in IPM research and technology transfer. Six scientists at BARI were supported for their PhD in agronomy, entomology, plant pathology and horticulture, one for an MS in horticulture, and three for an MS in agricultural economics. Nine BARI scientists received short term training in agronomy, entomology, plant pathology, plant virology, molecular biology, agricultural economics, and biotechnology.

Networking -- Within the south Asian region, IPM CRSP scientists in Bangladesh collaborated with scientists in India and Nepal. As a part of the technology exchange program, IPM CRSP-BARI trained one Philippine scientist in grafting of eggplant and three scientists of Nepal Agricultural Research Council (NARC) on grafting of eggplant and tomato.

Enterprise Development – Due to the popularity of the IPM technologies developed for vegetable crops on the IPM CRSP, the demand of various inputs required for adopting the technologies has increased and local entrepreneurs have started businesses for their production and marketing. One entrepreneur has established a small factory for producing and marketing small plastic clips needed for grafting of eggplant and tomato. Several nurserymen have started nurseries to raise grafted eggplant and tomato seedlings in large numbers to sell to farmers. One farm is producing bait traps (3-liter capacity transparent plastic containers and lure dispensers for baiting synthetic pheromone) for control of fruit fly in cucurbit crops. A private firm is now producing and marketing egg and larval parasitoids and predators to control various vegetable insects. Farmers are selling poultry refuse needed for soil amendment to control various soil-borne pathogens in vegetable crops

Environmental and livelihood success stories -- Farmers of Gaidghat and adjacent villages in Jessore have produced pesticide-free vegetables since 2005, receiving a premium price for their produce. They have declared their area a "*pesticide-free zone for vegetable production.*" About 150 farmers of Chandiara village of Comilla district have been producing pesticide-free cucurbit crops since 2005. Fifty farmers produced pesticide-free eggplant and cucurbit crops in 2007 in Sirajgonj district. Farmers in two sites in Pabna and Bogra districts are producing pesticide-free vegetables. The livelihood patterns of the farmers have improved in all sites, particularly in Comilla and Jessore sites, where several hundred farmers have been practicing IPM for growing various vegetables. In interviews they expressed their satisfaction of having better food, clothing, and housing. The farmers of Gaidghat village in Jessore district and Chandiara village in Comilla district informed that all of their children now attend schools. The children are now well fed, well dressed and have the required number of books and study materials for schooling. Farmers in Gaidghat and Nangarpur no longer become sick from applying pesticides. One young farmer Mr. Abdul Halim of Chandiara village (Comilla) expressed it, *"I used to feel giddy every time after spraying pesticides in my field. Now, I have got rid of that problem after adopting pheromone baiting technology."* Several farmers of Gaidghat and Nangarpur and In Chandiara (Comilla District) said that their personal status in the society has improved after having increased income from practicing IPM technologies. People in their villages look at and talk with them with respect.

India – At TNAU, eggplant fruit and shoot borer resistant eggplant germplasm was tested in green house and evaluated for gene expression in different stages. A regional meeting with IPM experts was held on integrated management of pests in eggplant and virus-vectors in okra. IPM experts from TNAU and from Virginia Tech attended. Field trials were conducted in farmers' field on management of eggplant and Okra pests okra using cultural methods, botanicals, and bio-

pesticides. A participatory appraisal was conducted with vegetable farmers in October 2006 to collect information (perceptions and facts) to be used as a guide in formulating the IPM CRSP vegetable project at the India site of the South Asia. A survey was also carried by the expert team. An IPM training sessions was conducted by TNAU scientists for 60 eggplant and okra farmers from Theethipalayam village. A visit was made by TERI to an okra field trial in that village. In order to study the insecticide resistance among the population of *Leucinodes orbonalis* and *Bemisia tabaci*, populations of insects were collected from eight districts of Tamil Nadu and were reared under artificial natural diets. Bioassays were initiated and after finalizing an insecticide resistance study, the distinctly varied population will be taken for molecular studies.

At TERI, demonstration plots were set up in 5 villages in UP, 5 villages in AP, and 4 villages in Karnataka. Targeted farmers population in these villages is nearly 20000 including woman farmers. Farmers were very pleased with the results. The IPM packages employed at all TERI sites included: (1) Brinjal: for whiteflies and leafhoppers (jassids): yellow sticky traps and neem; for acetamiprid *Earias fabia* (borer): pheromone and *Bt* for control; for bacterial diseases *Pseudomonas:* streptomycin as a seed treatment; for fungal diseases: *Trichoderma* as a seed treatment; for fruit and shoot borer (*L. orbonalis*) pheromone (only used for monitoring and not control), neem, Spinosad, *Bt;* (2) Tomato: Fruit worm (*Helicoverpa armigera*): neem and *Beauveria bassiana* and pheromone for monitoring and control; mealy bug: neem and *Beauveria bassiana;* bacterial wilt: *Pseudomonas* seed and seedling treatment; fungal diseases: *Trichoderma* seed and seedling treatment, mancozeb, (3) Okra: whiteflies and leafhoppers (jassids): yellow sticky traps and neem sprays; *Earias fabia* (fruit borer): neem sprays, *Bt* and pheromone for control; for bacterial diseases: *Pseudomonas* as a seed treatment; for nematodes: neem cake broadcast in soil, carbofuran; for sucking insects: *Beauveria bassiana* and neem sprays; for fruit worm (*Helicoverpa armigera*): neem and *Beauveria bassiana:* for yellow vein mosaic virus: varietal resistance, rouging.

Nepal – Several IPM technologies were developed, tested and transferred to farmers including (1) pheromone traps for cucurbits, tomato, and eggplants, (2) bio-pesticides for tomato fruit worm and shoot and fruit borer of eggplant and bio-fungicide, *Trichoderma viride*, was used against soil borne diseases of cucurbits, tomato and eggplants. Nepal-IPM CRSP imported the graft technology from Bangladesh through a team of research scientist from NARC. They achieved a 100% success rate in grafting tomato and egg plant in less than 4 months and have successfully disseminated the grafting technology through nursery growers, agriculture officers, and agriculture technicians. The project led a value chain training for poverty alleviation for 20 participants from MoAC, DOA, NARC, NCPA, BDS MaPS, SIMI and CRRN, Nepal and eight participants from Bangladesh. It also conducted IPM training for 200 participants including field staff and farmers in Rupandehi, Palpa and Kaski on pheromones and traps. Research scientists from NARC organized a two day training on grafting technology for fifteen (five female) agriculture officers and agriculture technicians at Khumaltar.

Ecologically-Based Participatory IPM for Southeast Asia

Mike Hammig
Clemson University

Indonesia

There are four major sites of IPM CRSP activity in Indonesia: North Sumatra with vegetables and citrus producers, West Java with vegetables, North Sulawesi with vegetables and cacao, and South Sulawesi with cacao.

North Sumatra

The IPM CRSP works in close collaboration with the USAID/Jakarta funded Environmental Services Project in an upland area at the headwaters of a watershed that provides water to Medan, the Provincial capital. Vegetable producers in the area raise tomatoes, cabbages, onions, and others for markets in Medan and for some export markets to other islands of Indonesia and neighboring countries in SE Asia. Insect and disease problems are chronic problems in the area. The IPM CRSP has provided resources for farmer training in two villages. The farming area for these two villages encompasses an entire valley in the upper part of the watershed. Our major objective is for all farmers in the valley to practice IPM in their vegetable production. To this end, two Farmer Field Schools have been conducted each year of the project by training experts from the ESP project and the local District Department of the Environment.

Citrus is a major cash crop in North Sumatra. Citrus farmers confront problems with fruit fly, fruit borer, and other insects and diseases. The IPM CRSP supported workshops for farmers in the area and the organization of farmer workgroups to conduct field studies on these problems. Field sanitation (disposal of dropped fruit), fertilization, and experiments with plant extracts for disease and insect control were conducted. A new sprayable fruit fly bait is being developed and will be tested in growers' orchards. Results indicate that these approaches improve farmers' ability to obtain a quality crop.

West Java

The IPM CRSP works in collaboration with the Bogor Agricultural University (*Institut Pertanian Bogor*) which is the leading agricultural university in the country, located near Jakarta. Activities of the IPM CRSP include networking,capacity building, farmer training, and farmer participatory research. Networking and capacity building involves close collaboration with District agricultural services agencies (Extension agents, IPM Field Leaders, and the Crop Protection Section), providing them with technical support and involving them in IPM field studies and demonstrations. Independent efforts by farmers to establish on-farm bio-agent

laboratories are an important contribution of the IPM CRSP team at IPB. Selected farmers are producing Trichoderma, SeNPV, and bokashi (an organic fertilizer) for distribution to members of local farmer groups. On a larger scale, the Institute for Healthy Agriculture is a newly formed NGO whose director is a PhD student at IPB and a former technician working with an earlier USAID-funded Clemson IPM project based in Bogor. The Institute propagates, packages, and sells biocontrol agents to farmers in West Java. They also market organic rice produced by cooperating farmer groups. The IPM CRSP provides technical support.

Farmer training activities are focused on propagation of biocontrol agents. Local production of these products enables easy access for cooperating farmers. Demonstration plots comparing usual farmer practice to the IPM approach are used to showcase the efficacy of biocontrol as compared to chemical-based practices.

Farmer participatory research is focused on several vegetable crops grown in the highlands in the Bogor and neighboring Districts. Most of the production goes to Jakarta markets. Traditional farmer practice involves heavy applications of chemical pesticides. Farmer cooperators work with IPB scientists to conduct IPM tests in their fields. Pak Choi, broccoli, onion, and carrots are the crops currently being studied. For each crop, four farmers establish random plots of IPM and farmer practice in their fields. Daily maintenance is provided by the farmers and periodic monitoring is done by District government staff and IPB scientists.

An additional activity is underway as a collaboration with the SANREM CRSP program. A national park area in Bogor District is the locale for study of income generating agricultural activities for local residents that will not involve harm to nearby forest resources. IPB scientists from the IPM CRSP are collaborating with colleagues from the SANREM CRSP to do field studies of vegetable production systems with potential to provide high income crop production serving Jakarta and local markets.

North Sulawesi

The IPM CRSP in North Sulawesi in collaboration with scientists from Sam Ratulangi University (Unsrat) is focused on vegetable production in the Modoinding area. Vegetables from Modoinding provide for markets in North Sulawesi and neighboring islands. Farmer participatory research efforts involve students from Unsrat conducting thesis research. These have included studies of mass rearing of parasitoids of insect pests of cabbage, surveys of insect pest damage on tomatoes, and use of pesticides in the area. Use of Trichoderma to control disease of cabbage was also completed. Most of these studies have resulted in a student thesis. In addition to field research studies, six farmer field schools have been completed with the cooperation of the provincial Bureau of Plant Protection.

As part of the IPM CRSP program, but with independent funding from Masterfoods and DPPI (a manufacturer of biodegradable plastics) studies have been conducted of the efficacy of using biodegradable plastic sleeves to protect cocoa pods from the cocoa pod borer (CPB). These

studies are conducted in cocoa plantations that have been largely abandoned, or receive little pest control, due to the difficulty of control of the CPB. Biodegradable sleeves are tested as a possible replacement for common plastic sleeves used frequently in Indonesian cocoa plantations which are discarded after each season leaving large amounts of non-degradable plastic trash. Results show that the degradable sleeves provide effective control and they do degrade within a reasonable time frame.

South Sulawesi

The IPM CRSP has provided technical assistance, but no funding from the CRSP except for small amounts for travel, to efforts in South Sulawesi to improve cocoa production in the area. In collaboration with Hasanuddin University (Unhas) and Masterfoods, studies are on-going to improve cocoa production in the most important cocoa growing region of Indonesia. Key pest problems include the cocoa pod borer and vascular streak dieback (VSD). Studies are underway to test the use of biodegradable sleeves for CPB control – similar to the studies in North Sulawesi – and selection of resistant clones to control VSD. The role of the IPM CRSP has been to facilitate the DPPI involvement in the project. Currently, three Unhas junior faculty are preparing to begin PhD studies at Clemson University in Entomology and Plant Pathology. Funding for these students will come from Indonesian government sources.

Philippines

The IPM CRSP is involved in four projects in the Philippines. Collaborations with PhilRice in Nueva Ecija and Nueva Viscaya, and the University of the Philippines, Los Baños in Laguna focus on vegetable production on Luzon. A collaboration with Washington State University and local government units in Benguet is working on spider mite control on strawberries. A collaboration with Kansas State University, the International Rice Research Institute, and the University of Southern Mindanao is investigating cash crop production in newly established rubber plantings on Mindanao.

PhilRice / Nueva Ecija, Nueva Viscaya

PhilRice was one of the principal collaborators on the Phase I IPM CRSP and, as such, has several activities that are outgrowths of earlier IPM CRSP work. These include the use of vesicular arbuscular mycorhiza (VAM) for the management of soil-borne diseases and as a soil amendment, the use of sex pheromone traps for management of insect pests in tomato and eggplant, yellow sticky board traps to manage leafminers, blue sticky board traps to manage thrips, and stale seedbed techniques to manage weeds. Large numbers of farmers and agricultural technologists have been trained through farmer field schools and specialized workshops in the use of these techniques. Dissemination of IPM strategies has been implemented by providing training materials to local extensionists and local media outlets, and by conducting farmer participatory demonstrations in key growing areas. Much of the work of the IPM CRSP has long-term benefits and often the impacts are not realized during the period of

project funding. PhilRice's experience with the IPM CRSP has resulted in noticeable benefits for individual farmers. Anecdotal evidence of these impacts can be observed by farmers whose living standards have been significantly improved, evidenced by their ability to obtain household items such as TVs, furniture, power equipment, and education for children that were previously beyond their means.

PhilRice has maintained a continuing research agenda addressing important issues for farmers in their region. They are conducting a feasibility study of the marketing potential for mass produced biocontrol agents as a commercial venture. Crop research includes study of the management of whiteflies in rice-vegetable cropping systems; the effect of no-tillage and use of rice straw mulch on the incidence of pests and natural enemies in onion production; a survey of larval parasitoids of leafminers on vegetables and weeds; management of tomato fruitworm using sex pheromone traps; and study of the role of women in IPM in the Philippines. These studies have all contributed to the development of IPM strategies for use in outreach and technology transfer activities of the program.

UP, Los Baños / Laguna

IPM CRSP activities in collaboration with scientists from UPLB are concentrated on production of eggplant and tomato in farmer participatory research, and research and demonstrations of IPM approaches at the UPLB Agri-Park site located near the university campus. Participatory field research is studying the benefits of grafting varieties of eggplant with desirable marketing qualities to an eggplant rootstock that is resistant to soil borne diseases and that fares well under wet conditions. Local tomato varieties are also grafted to the same eggplant rootstock . Field research shows clear evidence of the benefits of the grafting approach. Weed management is also a focus of farmer participatory research using the stale seedbed technique which reduces farmers' use of herbicides and the intensity of weeding that is usual farmer practice.

A 10 hectare "Agri-Park" has been established on UPLB land near the campus. The Agri-Park is used to showcase IPM and organic approaches to agriculture. Many crops are grown in small plots to demonstrate the new techniques to visitors who include students, farmers, urban dwellers, agricultural workers, scientists, and others who may have an interest. Biocontrol products are being produced and marketed through the Agri-Park, and as they are available, crops are sold to university personnel. The Agri-Park is envisioned as a central location for education programs related to IPM and organic agriculture. The IPM CRSP supports demonstration activities conducted at the Agri-Park.

Washington State University / Benguet

Washington State University has established a collaboration with local government entities in La Trinidad, Benguet to conduct a research and training program to address the problems of spider mite infestations on strawberries. The La Trinidad area is the site of concentrated strawberry production that supplies markets throughout the Philippines. The WSU effort is concentrated on

the use of predatory mites as a natural control of the spider mite pest. Research has focused on identifying indigenous predacious mites to incorporate into a managed control program, rearing and release of predacious mites, and enhancing habitat for predacious mite populations. Farmer training and workshops are an integral part of the program. The mayor and other local residents have contributed significant resources to the project, which addresses a very important constraint to a major segment of the local economy.

Kansas State University/International Rice Research Institute/Univesity of Southern Mindanao / Cotabato

The collaboration including KSU, IRRI, and USM uses IPM CRSP funding to study approaches by farmers in a remote region of Mindanao who are engaged in establishing smallholder rubber plantations. Because the rubber trees take several years to reach productive size, it is necessary for farmers to plant other crops to support their families while they wait for the rubber trees to mature. The research of this project is an augmentation of an on-going project supported by the Asian Development Bank. The IPM CRSP component is an investigation of cropping systems of rice and mungbean that can provide income without requiring heavy use of chemical inputs. A community seed bank is used to support farmers who engage in a mixed cropping system using a local variety of rice that is less productive but which demands a relatively high price in the market with an improved rice variety that is a higher producer, and mungbean that provides an alternative income source and that enhances soil fertility. The area where this effort is underway is one where chemical inputs have not been commonly used, so it is important to maintain that component while devising workable systems for income producing crop production.

Other notable accomplishments

Project workshops

In each of the first two years of the IPM CRSP, a regional workshop was held for all collaborators in the SE Asia program. Each time the workshop was held in a highland vegetable growing area near Bogor in Indonesia. Participants included representatives of all collaborating institutions in Indonesia and the Philippines, as well as IPM experts from the World Vegetable Center, Taiwan and colleagues from the IT Global Theme component of the IPM CRSP. The EEP member with responsibility for the SE Asia program attended the second workshop. Local NGO technicians, farmers, representatives of the USAID ESP project, and a representative of USAID/Jakarta also came to the workshops. The purpose of the workshops was to enhance communication among collaborators on the project, to review past accomplishments, and to present plans for the following year activities. Special activities included field visits to vegetable production sites near the workshop venue and farmer demonstrations of grafting techniques and production of biocontrol agents at on-farm laboratories. The workshops provide an opportunity for discussion of issues related to IPM programs and for team building in the region. Similar workshops will be planned for each remaining year of the project.

USAID Mission interaction

Each year of the project the Clemson PIs have visited the USAID Mission in Manila to apprise the Mission staff of our activities. Our primary contact is Mr. Oliver Agoncillo who works in the Office of Energy and Environment. Oliver has accompanied us on one occasion to Los Baños to visit with our collaborators there. In 2006, the Clemson group (Hammig, Shepard, and Carner) were invited to visit the U.S. Embassy in Manila for a meeting with Ambassador Kristie Kenny, a Clemson graduate. We invited her to visit some of our field sites and we hope that sometime in the future that will happen.

In Indonesia our primary contact is Mr. Prijanto Santoso a Program Specialist who has been a close associate with IPM in Indonesia for many years. He attended the 2007 workshop and has always been supportive of IPM activities, even when Mission priorities move in other directions.

Ecologically-Based participatory and Collaborative Research and Capacity Building in IPM in the Central Asia Region

Dr. Karim Maredia and Dr. Dieudonné Baributsa
Michigan State University

Central Asia region was isolated for more than four decades under the former Soviet Union. This project under the IPM CRSP has helped to break the isolation by building collaborative linkages between the Central Asia region and the global IPM community. This regional IPM CRSP project was launched in October 2005 by Michigan State University and UC-Davis in close collaboration with ICARDA regional office in Tashkent, Uzbekistan. Currently, the project focuses on three major components (Enhancing efficiency and product lines of biolaboratories, Landscape ecology and biological control of pests, and Strengthening IPM outreach and educational programs) in three countries in the region—Tajikistan, Kyrgyzstan and Uzbekistan. Three research fellows from the Central Asia region (Dr. Nurali Saidov, Dr. Murat Aitmatov, and Dr. Barno Tashpulatova) representing each of these three countries are based at ICARDA regional office in Tashkent to implement the project activities.

Following are some of the achievements of this project over the last two years.

1. Ecologically-based approaches and thinking have been introduced in this region through this project. During the former Soviet Union era, the emphasis was on monoculture with little emphasis on crop diversification.

2. The IPM CRSP project is building a team of IPM specialists from the region so that they can serve as resources and build ecologically based IPM programs locally. Towards this goal, MSU and UC Davis have provided training to more than six participants from Central Asia region on ecologically based IPM and sustainable agriculture. These trainees are serving as resource faculty in national and regional IPM training programs and workshops in Central Asia region.

3. The collaborative research program on landscape ecology under the IPM CRSP project has introduced a new way of thinking, a new way of looking at enhancing biological control of pests through conservation biology. For the first time, through the IPM CRSP project, native plant species have been screened for their attractiveness to beneficial organisms. The ultimate goal of introducing these plant species into Central Asian agricultural landscape is to enhance biological control of pests into vegetable and other cropping systems.

   An IPM CRSP Research fellow led teams of collaborators to collect Central Asian native plants for testing and use in agricultural system for attracting beneficial insects. Participants covered more than 3000 km^2 and collected more than 60 local nectar plants in Tajikistan and Kyrgyzstan. Research plots were established in Tajikistan to test 24 known native plants (Table 1) and in Kyrgyzstan to test 10 native plants (Table 2). Several of the plants tested in this preliminary trial were very attractive to a variety of natural enemy taxa. Initial tests revealed that seven plant species were most attractive to natural enemies of pests in Tajikistan, whereas five were most attractive in Kyrgyzstan. The concept of Landscape

Ecology has been introduced to FFS through testing of nectar plants into vegetables crop in Tajikistan and results published as chapter in two modules of IPM in FFS.

Table 1. List of plant species screened at the research plot in Tajikistan, 2006.

##	Family	Genus and species	Common Name	Plant Type
1	Tamaricaceae	*Tamarix arceuthoides Bunge*	Tamarix	shrub
2	Rosaceae	*Rosa canina L.*	Dog rose	subshrub
3	Asteraceae (Compositae)	*Silybum marianum l.*	Silybum	forb
4	Lamiaceae (Labiatae)	*Ziziphora interrupta Juz.*	Interrupta	forb
5	Lamiaceae (Labiatae)	*Mentha asiatica Boriss.*	Horse mint	forb
6	Fabaceae (Papilionaceae)	*Glycyrrhiza glabra L.*	Licorice	forb
7	Malvaceae	*Alcea nudiflora (Lindle) Boiss.*	Alcea	forb
8	Apiaceae (Umbelliferae)	*Dacus carota L.*	Wild carrot	forb
9	Lamiaceae (Labiatae)	*Salvia sclarea L.*	Clary or Europe sage	forb
10	Apiaceae (Umbelliferae)	*Conium maculatum L.*	Poison hemlock	forb
11	Scrophulariaceae	*Verbascum songaricum Schrenk*	Mullein	forb
12	Capparaceae (Capparidaceae)	*Capparis spinosa L.*	Caperberry, caperbush	shrub
13	Cruciferae	*Barbarea vulgaris*	Barbarea	forb
14	Asteraceae (Compositae)	*Pyrethrum carneum*	Pyrethrum	forb
15	Asteraceae (Compositae)	*Achillea filipendulina Lam.*	Fernleaf yarrow	forb
16	Asteraceae (Compositae)	*Calendula officinalis L.*	Marigold	forb
17	Apiaceae (Umbelliferae)	*Anethum graveolens L.*	Dill	forb
18	Apiaceae (Umbelliferae)	*Coriandrum sativum L.*	Coriander	forb
19	Apiaceae (Umbelliferae)	*Foeniculum vulgare Mill.*	Sweet fennel	forb
20	Guttiferae	*Hypericum scabrum L.*	Hypericum	forb
21	Lamiaceae (Labiatae)	*Hyssopus seravschanicus (Dubjan)* Parij	Hyssop	forb
22	Lamiaceae (Labiatae)	*Ocimum basilicum L.*	Sweet basil	forb
23	Balsaminaceae	*Impatiens balsamina L.*	Balsam	forb

24	Lamiaceae (Labiatae)	*Melissa officinalis L.*	Melissa	forb

Tableb 2. List of plant species screened at the research plot in Kyrgyzstan, 2007.

	Family	**Genus and species**	**Common Name**	**Plant Type**
1	Rosaceae	*Rosa Sp.*	Dog rose	subshrub
2	Lamiaceae (Labiatae)	*Mentha silvestris L.*	Horse mint	forb
3	Malvaceae	*Alcea nudiflora (Lindle) Boiss.*	Alcea	forb
4	Lamiaceae (Labiatae)	*Salvia sclarea L.*	Clary or Europe sage	forb
5	Lamiaceae (Labiatae)	*Origanum vulgare L.*	Oregano	forb
6	Apiaceae (Umbelliferae)	*Conium maculatum L.*	Poison hemlock	forb
7	Liliaceae	*Eremurus Sp.*	Eremurus	forb
8	Asteraceae (Compositae)	*Achillea filipendulina Lam.*	Fernleaf yarrow	forb
9	Lamiaceae (Labiatae)	*Hyssopus seravschanicus (Dubjan)* Parij	Hyssop	forb
10	Lamiaceae (Labiatae)	*Melissa officinalis L.*	Melissa	forb

4. The Central Asia region has more than 800 bio-laboratories that are producing beneficial organisms through mass rearing techniques for release in crop fields as biological control agents. The IPM CRSP project is enhancing the efficiency of the product lines of these bio-laboratories by introducing new techniques for mass rearing and conservation of biological control agents during winter time and screening native organisms for expanding the product line.

5. The extension and outreach system in the Central Asia region is broken. Most of the extension is carried out by NGOs and/or private sector. The Outreach Component of the IPM CRSP Program in Central Asia has established working relation with the following institutions: Kyrgyz Agrarian University, Tashkent State Agrarian University, Samarkand Agricultural Institute, Institute of Microbiology of the Uzbek Academy of Sciences, Kazakh National Agrarian University, Tajik Research Institute of Plant Protection and Quarantine, Andijan Agricultural Institute of Uzbekistan, Biology-Soil Institute of the Kyrgyz Academy of Sciences, Institute of Zoology and Parasitology in Tajikistan, Institute of Zoology of the Uzbek Academy of Sciences. Through the outreach, the IPM CRSP in Central Asia works with these institutions in implementing FFS, Student Field School, developing IPM

Extension Bulletins or other materials (see publications).

In partnership with the Advisory Training Center (ATC) of the Rural Advisory Services in Kyrgyzstan, the IPM CRSP project has introduced IPM component in farmer field schools in Kyrgyzstan and has set up the first Farmer Field School (FFS) in Tajikistan. The IPM CRSP project has assisted the ATC in developing pest calendars for vegetable crops for introduction into FFS educational programs.

Based on the feedback received when implementing the FFS in Tajikistan, a booklet for FFS has been developed. It covers topics such as seeds preparation and conservation, seeding, ecological analysis of vegetables in the field, botanic pesticides, ecological analysis of nectariferous plants in the field, etc. All these mentioned topics are new for FFS in Kyrgyzstan as well as in Tajikistan.

In Collaboration with the AVRDC-CAC of the World Vegetable Center, a pocket guide on weeds in vegetable crops in Central Asia has been developed by the IPM CRSP. Various photos of 35 most common weeds have been taken and described, and will be published in Russian.

In collaboration with the Tajik Agricultural Academy of Science, the IPM-CRSP has opened a Farmer Field School (FFS) where 13 women and 2 men have been trained. Six faculty members from the Tajik State Agrarian University have been selected to become the Master-trainers through the IPM-FFS.

A summary leaflet/flyer in Russian covering the ecologically-based IPM approach with highlights of IPM CRSP regional project was developed and sent to more than 40 private and government institutions in Tajikistan and Kyrgyzstan. Discussions are underway with the Tajik to introduce IPM in their agricultural education curriculum. State Agrarian University

In collaboration with TSAU, the IPM-CRSP has developed a manual on creation and training of ToT and FFS. In addition, both partners will be conducting a training of trainers of scientists from various universities including the Andijan Agriculture Institute, Namagan and Fergana Universities and the Nunkun. TSAU in collaboration with the IPM-CRSP developed special brochures of pest calendars during vegetable production. Three pest calendars were developed for cabbage, carrot and tomato.

In addition, a manual on pest management in organic agriculture is being developed and will be widely distributed to agricultural universities and NGOs in the Central Asia region. In collaboration with the Advisory Training Center in Kyrgyzstan (Ms. Petra Geraedts and Ms. Gulnaz Kaseeva) a manual on FFS management has been developed and published. This document will be useful to government institutions, NGOs and International agencies planning to open FFS.

6. The IPM CRSP project is conducting a systematic inventory of the existing university IPM curriculum in Central Asian. The goal is to introduce ecologically based IPM modules into the existing curriculum.

7. The IPM CRSP project has held two regional IPM forums in Central Asia region to foster networking and share information on ecologically-based IPM approaches that are relevant for the Central Asia region. A "proceedings" of the recently held IPM forum in Tajikistan will be published and distributed to various stakeholders through electronic and print materials.

   The three IPM CRSP team members regularly attend regional meetings/conferences to present the USAID IPM-CRSP project activities.

   - In March 2007, Dr. Tashpulatova attended a two-week training course on sunn pest in Tajikistan.

   - Dr. Nurali Saidov attended a joint workshop of ICARDA, the Central Asia and Caucasus Association of Agricultural Institution (CACAAI) and the Global Forum on Agricultural Research (GFAR). The goal of the forum was to design and develop a research need program for Central Asia and Caucasus in the area of genetic resource management, natural resource management and socio-economic, policy and capacity building.

   - Dr. Barno traveled to Samarqand to visit a private Biolab for initiating research collaboration and Drs. Aitmatov and Saidov visited the Samarqand Agrarian Institute for future research collaboration.

   - Three participants from Tajikistan, Kazakhstan and Kyrgyzstan attended the International Short Course IPM at MSU. The objective of the training is to build human capacities of institutions collaborating with the Central Asia IPM-CRSP Program. Below is the list of the three participants and their affiliation:
   - Dr. Abdussator Saidov, Institute of Zoology and Parasitology of the Tajik Academy of Agricultural Science in Tajikistan
   - Ms. Gulnaz Kaseeva, Advisory Training Center of the Rural Advisory Services (ATC-RAS)in Kyrgyzstan
   - Dr. Zhanna Issina, Kazakh Institute of Plant Protection in Kazakhstan

   N. Saidov, Barno Tashpulatova and Murat Aitmatov attended the Tenth Meeting of the Steering Committee of the CGIAR Program for Central Asia and the Caucasus. May 29-30, 2007. Dushanbe, Tajikistan.

8. To foster networking and information access from the global IPM community, the project has provided membership to more than 10 IPM specialists from the Central Asia region in the International Association of Plant Protection Sciences (IAPPS).

9. Directory of IPM specialists in the Central Asia Region: A database of IPM scientific in Central Asia (Kazakhstan, Uzbekistan, Kyrgyzstan and Tajikistan) has been developed. This database is available in electronic version both Russian and English and has been sent to Tashkent State Agrarian University, Kyrgyz Biology-Soil Institute, Kazakh National Agrarian University, Kazakh Research Institute of Plant Protection, and Andijan Agricultural Institute.

10. The IPM CRSP project team has leveraged more than $12,000 from external agencies towards the collaborative research, training and participation in various workshops.

11. In collaboration with two agricultural economists from Michigan State University, the IPM CRSP Project in Central Asia will conduct a base-line survey of the current IPM practices and socio-economic aspects of IPM in the Central Asia region.

12. The partnership with ICARDA has helped expand ICARDA's IPM research and outreach programs in the region.

13. Publications and Presentations:

Publications:

- Barakanova, N., U. Sultanbekov, P. Geradts, and F. Zalom. 2007. Determination of cucumber pests and diseases. Advisory Training Centre of Rural Advisory Service. Bishkek, Kyrgyzstan, 30 pp. (in Russian)

- Barakanova, N., U. Sultanbekov, P. Geradts, and F. Zalom. 2007. Determination of tomato pests and diseases. Advisory Training Centre of Rural Advisory Service. Bishkek, Kyrgyzstan, 30 pp. (in Russian)

- Saidov, N., B. Tashpulatova, M. Aitmatov, D. Baributsa and K. Maredia. 2007. Directory of Integrated Pest Management Specialists and Stakeholders in Central Asia.

- Aitmatov, M. 2007.
    - Calendar of insect pests development and damage to cabbage
    - Calendar of insect pests development and damage to tomato
    - Calendar of insect pests development and damage to carrot

- Aitmatov, M. et al. 2007. Terminological dictionary of the main diseases, pest of the cotton and vegetable crops was published in Latin, Russian and Tajik.

- Aitmatov, M. et al. 2007. Organization and Management of the Farmer Field School on IPM.

- Aitmatov, M., P.Geraedts and N. Saidov. 2007. IPM in Farmers Field School:
  - Module 1. Introduction of FFS, 93 pages. (Russian).
  - Module 2. Biological Control Methods of Main Insect Pest and Disease of Tomato, 104 pages (Russian).

- Maredia, K. and D. Baributsa. 2007. Integrated Pest Management Forum for Central Asia, Dushanbe Tajikistan. CD of Forum Power Point Presentations.

- Aitmatov, M., N. Saidov et al. 2007. Weeds in Vegetable Crops.

Presentations:

- Maredia, K., F. Zalom and R. Paroda. Ecologically-Based Participatory and Collaborative Research and Capacity Building in IPM in Central Asia Region. CGIAR Meeting, Washington, D.C. December 4, 2006.

- Maredia,K. and D. Baributsa. May 2007.Integrated Pest Management Collaborative Research Support Program (IPM-CRSP), Central Asia IPM Stakeholders Forum, Dushanbe-Tajikistan.

- Maredia, K. and N. Saidov. 2007. IPM CRSP Program in Central Asia. Tenth Meeting of the Steering Committee of the CGIAR Program for Central Asia and the Caucasus. May 29-30, 2007. Dushanbe, Tajikistan.

- Aitmatov, M., G. Bird and W. Pett. May 2007. Strengthening IPM Outreach/ Education in the Central Asia Region,Central Asia IPM Stakeholders Forum, Dushanbe-Tajikistan.

- Saidov, N. and D. Landis. May 2007. Landscape Ecology and Biological Control. Central Asia IPM Stakeholders Forum, Dushanbe-Tajikistan.

Tashpulatova, B. and F. Zalom. May 2007. Enhancing the Efficiency and Product Lines of Biolaboratories in Central Asia. Central Asia IPM Stakeholders Forum, Dushanbe-Tajikistan.

West African Regional Consortium of IPM Excellence

Donald Mullins
Virginia Tech

1. Development of an online whitefly monitoring system:

During 2006-07, Drs. Jim Westwood and Carlyle Brewster, and local scientists, identified potential sites for the whitefly study in Senegal and Mali. Based on information gathered during the visit, They developed a generic protocol for area-wide sampling of whitefly populations in the West African countries. The protocol had the advantage of ensuring that sampling of whitefly populations among the different countries was consistent, but also was developed so that it could be adapted easily by local scientists to suit the specific landscapes in each of the regions where plans were made to conduct the studies.
In December 2006, Dr. Brewster traveled to Senegal to work with Kemo Badji, Chief Entomologist Crop Protection Directorate at DPV, to begin survey studies in Gorom, Mboro, and Kolda. They also traveled to the Gambia where they worked with local collaborators (Lamin Jobe and Momodou Jabang) to identify a suitable region for the whitefly study.

During the December trip, Dr. Brewster conducted interviews for training students. One Ph.D. student has been identified (Kemo Badji- Senegal) and a plan for developing the research training program is being developed. Recruitment of a second Ph.D. student (Djibril Badiane-Senegal) is currently underway.

Development of GIS-based maps of the whitefly population surveys has been initiated and work to place them on the WA IPM web site is underway.

2. Develop and implement IPM strategies for viral diseases of tomatoes:

In order to understand socioeconomic and agroeconomic aspects of tomato production a tomato baseline survey and impact assessment of research to reduce tomato viruses in Mali and Senegal was undertaken to provide guidance on the nature of the tomato virus problem in Mali. This study will also provide an assessment of the potential impacts of technologies and management practices aimed at reducing the virus problem. Results of the studies have implications for other West African countries as well. The Mali study was completed under the auspices of the USAID-funded IPM-CRSP and ABSPII projects. The first step of the study consisted of a baseline survey of tomato producers in Mali using a structured questionnaire. It included questions on attitudes and perceptions of tomato insects and diseases and information collected from 343 tomato producers from 15 villages as well as professional support personnel. The results of the baseline survey are currently being analyzed. Details of the Senegal survey are not yet available.

Efforts of finalize and implement plans for collaboration with the Global Themes projects on plant disease diagnosis plant including insect transmitted viruses in tomatoes and other vegetable crops are still underway These include discussions on planning the development of disease diagnosis centers and satellite labs as well as the plans for the development of protocols for disease diagnosis.

3. **Influence of agroecosystem biodiversity on virus levels**:

Our efforts to build a database and compile geographic and temporal data on weeds in the region and their propensity to host whiteflies and viruses continue. The resources and mechanisms to facilitate the identification of weeds by project personnel who may lack experience with weed ID have been explored. To this end we have explored available electronic databases and determined that no satisfactory resources exist. Therefore, we have begun to acquire and implement a system of weed collection and digital photography that will be used to develop our own weed identification website that will reside within the West African IPM web site. Collection of data on whitefly incidence on weeds has been initiated in Senegal in cooperation with Kemo Badji, Brewster, and coworkers. Dr. Gilbertson has sampled many weeds from throughout West Africa and is assaying them for the presence of virus. To date, no Tomato Yellow Leaf Curl virus has been positively identified from these weeds.

4. Prioritize regional needs through a participatory planning process:

Information has been obtained from a socio-economic study of the villages of Balandou, Tintioulenkoro, Karfamoriah and Bankalan in Guinea. The main objective of this study was to gather initial information about village cropping systems in order to support the research initiatives. The results contain historical data on the installation of the populations, the characteristics of the physical environment, husbandries and their evolutions, the agronomic problems and a comparison of the production and farming systems.
An agronomic study of cabbage was conducted and involved representatives of vegetable growers in Karfamoriah (3 associations) and Soumankoï. Constraints of cabbage production were identified and consist of 1) poor production techniques, 2) damage by various pests, and (3) very low prices.

5. Investigate pests of potato in storage and propagation:

We have conducted surveys to determine the incidence and abundance of potato tuber moths in Senegal and Guinea. In both countries, potato is cultivated twice a year, the early season commences in November and the crop is harvested about February, while the late season crop is cultivated in March and harvested between May and June. Infestation of the early crop by the potato tuber moth (PTM) is light. Infestation of the late crop by the same moth is quite heavy. Infestation commences in the field and infested tubers are carried into storage where infestation continues. The PTM attacks all the phenological stages of potato, from vines to tubers. The

shoot of the potato crop is attacked first. Eggs are laid in the soil and hatched larvae burrow into the ground where they locate and burrow into tubers to complete their development. The incidence and abundance of the potato moth has also been obtained for Guinea. During the summer months of 2007, the data on the dynamics of potato tuber moth was generated through a survey. Following this, a West Africa regional map of potato cultivating areas and diseases or pests associated with potato will be produced.

Details on the biology, life history and food preference of the potato tuber moth has been obtained from laboratory studies.

6. Develop, coordinate, and expand quality assurance and pesticide safety education:

In May-June of 2007, the IPM CRSP (Integrated Pest Management Collaborative Research Support Program) sponsored a professional development workshop for pesticide safety educators in West Africa. Pesticide safety trainers (agricultural scientists and educators) gathered at this first-of-its-kind workshop to: 1) share information, experiences, ideas, materials and methods, successes, and "lessons learned", 2) identify and prioritize pesticide safety program needs and target audiences; 3) discuss collaborative/cooperative efforts to ensure food safety in general and export crop quality involving residue chemists, field researchers, and pesticide safety educators, and 4) share techniques for measuring program impact. Participants and presenters included trainers sponsored by the West African Cotton Improvement Project (WACIP) from many agencies in Benin, Burkina Faso, Tchad, and Mali; Malians from the Institut d'Economie Rurale (IER), Office of the Office de la Haute Vallée du Niger (OHVN), Laboratoire Central Vétérinaire (LCV), Office de Protection des Végétaux (OPV), and Peace Corps; a representative of PAN Africa who is based in Senegal; and IPM-CRSP team members from Benin (International Insitute of Tropical Agriculture/IITA) and the USA (Virginia Tech/VT).

7. Quality Assurance: Pesticide Residue Training:

A five-day professional training workshop was held for pesticide residue chemists at Bamako, Mali in August 2007. Announcements were distributed to contacts at USAID missions in West Africa, the USDA-ARS/FAS, FAO, and invitations were sent to 40 chemists and other stakeholders in West Africa. Chemists representing 9 laboratories in 5 West African countries (Mali, Niger, Nigeria, Burkina Faso, Senegal) attended – 24 chemists in all. The opening ceremony was attended by 43 individuals and included televised speeches by the USAID-Mali Director, the Secretary General of the Malian Ministry of Livestock and Fisheries, and the Permanent Secretary of CILSS. USDA-Agricultural Research Service (ARS) Lead Scientist Dr. Steven J. Lehotay designed and led hands-on training of the Quechers method that was developed by him and other researchers. The Quechers method is in worldwide use for routine monitoring of pesticides in fruits and vegetables and other food commodities. The West Africa IPM CRSP funding was leveraged to obtain additional support (~$12,000) from the USDA-Foreign Agricultural Service (FAS) and the Food and Agricultural Organization (FAO) who

sponsored Dr. Lehotay's travel to the workshop and a total of 6 chemists from the West Africa region.

Integrated pest management of specialty crops in Eastern Europe

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Virgina Tech
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Virginia tech is the lead institution for this project. The first phase CRSP project centered in Albania; the focus has shifted to tomato, cucumber, apple and grape in Albania, Ukraine and Moldova.

Progress to date:

Participatory Appraisal

The participatory Appraisal was completed for the second phase Eastern European regional project. The Albanian PA was performed in August 2004, and for Ukraine and Moldova in May 2006. Results were reported initially at the National IPM Symposium in St. Louis MO and the Eastern Branch of the Entomological Society of America.

Pfeiffer, D. G., A. D. Bratsch and J. Tedeschini. 2006. Participatory appraisal in expanding the Eastern European IPM CRSP. 5th National IPM Symposium, St. Louis MO. Apr. 4-6.

Pfeiffer, D. G. 2007. A participatory appraisal of IPM in high-value horticultural crops in Albania, Moldova and Ukraine. Entomol. Soc. Am. Eastern Branch, Harrisburg PA. Mar 18-20.

Baseline Survey:

A survey instrument was developed and translated into Albanian, Ukrainian, Russian and Romanian. Sixty farms were surveyed in Moldova and in each of the three oblasts in Ukraine (Lviv, Odesa and Dnipropetrovsk). Three hundred were surveyed in Albania. Results from Albania and Moldova have been translated back into English; translation of Ukrainian results is in progress. Preliminary results were presented at the International Plant Protection Congress in Glasgow Scotland.

Pfeiffer, D. G., J. Tedeschini, B. Stamo, M. Bregasi, D. l Panajoti, D. Pertena, O. Cholovska, G. Shestopal, M. Ishchuk, K. Maslikova, M. Kharytonov, O. Pleshko, V. Todirash, T.

Tretiakov, A. D. Bratsch, S. M. Miller, and M. E. McGiffen. 2007. Status of IPM, pesticide use and misuse and information transfer in horticultural crops in Albania, Ukraine and Moldova: Participatory appraisal and baseline survey for tomato, cucumber, grape and apple. Proc. 16th Internat. Plant Protection Congress 2: 774-775. A summary of an invited 20-minute talk. Glasgow Scotland. 15-18 Oct.

Capacity Building:

Support for Albanian scientists to participate in the National IPM Symposium, and the International Plant Protection Congress was provided. These scientists presented results of our work to these international audiences. Computer resources are being provided to host country scientists. We supported construction of a plastic tunnel greenhouse for research at the Institute for Plant Protection and Ecological Agriculture in Moldova.

Field research:

Albania:

Mite management in greenhouse vegetables:

Twospotted spider mite *(Tetranychus urticae.)* represents one of the main arthropod pests affecting cucumber in greenhouses. Mite infestations are difficult to control due to the lack of satisfactory control measures, either old chemical or other. New miticides are tested to improve control. The effectiveness of several botanicals was compared to the standard farmer approach to control this pest. Treatments were replicated five times in a randomized complete block design. *Tetranychus* counts were twice, once before the treatment and again a week later. Results indicate that significant differences were found in *Tetranychus* populations between the different treatments and untreated control. The control effect of botanicals was similar to that of chemical treatment.

Whiteflies in greenhouse vegetables:

This study was conducted during the first season of tomato crop cultivation in greenhouses in Kemishtaj (Lushnja Region). The objective was to evaluate if entomopathogenic fungi and other botanicals exhibited control on whitefly adults and nymphs. A randomized block design was used with 5 replications and 6 treatments, consisting of applications of Naturalis (Beauveria Bassiana), Neemazal – T/S (Azadirachtin), UFO (ultra fine oil) and Keniatox (Natural Pyrethrin), compared with a standard insecticide (Ramplan) and untreated control. The number of adults and nymphs per leaf was similar in treatments using entomopathogenic fungi as with treatments using natural pesticides, both of which showed less than absolute control. The efficacy of Ramplan 20Sp (a.i. acetamiprid), compared with Plenum 50WG (a.i pymetrozine), Ronin 25WP (a.i. buprofezin) and Actara (a.i. thiomethoxam) in greenhouse control of whitefly

(*Trialeurodes vaporariorum*) on tomatoes, was investigated. All investigated insecticides significantly decreased the number of whitefly adults and nymphs, compared with untreated plots where population density grew during the trial. Plenum controlled the adults very well with the lowest population level of adults. Ronin and Ramplan were less effective. Based on the data obtained, the best efficacy on whitefly nymphal control has provided by Ronin followed by Ramplan.

Aphids in greenhouse vegetables:

This study was conducted on greenhouse' tomato plants in Durres with the aim to test several plant protection products (ppp), some of which are of natural origin (bio-insecticides). Two experiments were carried out: firstly, aphid monitoring by counting aphids on color traps; secondly, tomato plants are analyzed for the intensity of infection before and after the treatments, 3 days and 7 days after.

The results show that aphid population reaches its peak during April and the intervention threshold was surpassed. The natural compounds, which offer several benefits in terms of product safety for human health and environment, show a good control against aphids. These results can be used as a basis for the effective implementation of a IPM strategy for the control of aphids attacking tomatoes in greenhouses.

Nematodes in greenhouses:

Field experiments were conducted to evaluate the effect of bio-nematicide BioNem and two other products: Nemafung and Softguard (bio-stimulant and repellent) against root-knot nematode on pepper grown in unheated plastic greenhouse. Initial results indicate that in the plot treated with BioNem the population of nematodes in soil has a reduction of 25%. The other treatments with bio-fertilizers do not seem to have any significant effect on nematode population. The experiment is underway and will end in November.

The nematicide Fenamiphos and two other products Ethoprophos 10% granules and Ethoprophos 19% liquid were applied to limit the damage of root-knot on tomato grown in unheated plastic greenhouses. The results revealed that the treatment by drip irrigation were efficient in controlling the nematode. Fenamiphos and Ethoprophos !9% liquid caused significant reduction in the nematode population in the soil compared with Ethoprophos 10% granules; The treatments by drip irrigation significantly suppressed root gall index on tomato crop. The root gall index at the final harvest was 0.5, 1.2 and 1.7 for Fenamiphos, Ethoprophos 19% liquid and Ethoprophos 10% granular, respectively.

Field experiments were performed in sandy soil, naturally infested by *Meloidogyne incognita* in Durres Region to assess the effectiveness drip applied soil nematicides and bio-nematicides for the control of root-knot nematodes in cucumber and tomato crop in heated Israeli-type greenhouses. The results of trials showed that Fenamiphos and Ethoprophos used by drip

irrigation system were effective in controlling nematode populations and reducing cucumber and tomato damage. The treatment with Ethoprophos incorporated in soil was less effective. Good results were obtained by application of bio-nematicide BioNem.

A field experiment was performed in heavy clay soil, naturally infested with *Meloidogyne incognita* to evaluate the effectiveness of soil solarization and combination of this treatment with grafting for the control of root-knot nematode and soil borne diseases on tomato in second crop. Initial results indicate that compatibility of solanaceous rootstocks showed different compatibility with the tomato scions. Percentage catch of grafted tomato on Beaufort rootstock was higher then in Interga rootstock. Soil solarization reduces the incidence of damping off in both grafted and ungrafted tomato seedling compared with un treated control. The experiment is underway and will end in December.

Botrytis management in greenhouse tomatoes:

A fungicide trial was established in a commercial unheated plastic greenhouse at Lushnja region to evaluate efficacy of several fungicides for control of botrytis on tomato. Treatments included Teldor SC 500 (Fenhexamide a.i.), Botrilan 500 SC (Iprodione a.i.) and Daconil 72 SC (Chlorothalonil a.i.). applied as single treatments every 7- 10 days to each of five replicates. In samples to determine the percentage of leaf area affected by botrytis and the number of fruits infected within different treatments, Teldor and Daconil were significantly different from non-treated control. Although Botrilan was different from the control this treatment had more number of leaves and fruits infected than other treatments.

Integrating fungicides in cucumbers and tomatoes

This research project evaluated the performance of cucumber disease control under three different disease control programs ranging from a minimally acceptable to a highly intensive program. These three diseases control spray programs were compared on the basis of cost and disease management as well as the environmental impact.

Ukraine - Lviv
April-May. Purchase of cucumbers seeds (from Co Numens) to plant on the test fields for test on IPPM: farmer B. Drobota, v. Zhovtantsi Kamyanka-Buska Distr., farm Revera in v. Ozhynevychi Zhydachiv Distr., farm "Zorya" v. Zorotovychi Staro-Sambirskyi Distr., farm "Lotivka Elit" Shepetivskyi Distr. Khmelnytsk Reg.

Farmer Education:

Lviv-Odesa

June 2007: A workshop on integrated growing of cucumbers was organized at the farm "Revera" in the v. Ozhynevychi Zhydachiv Distr. 50 participants were present, among them 40 farmers

July 2007: A workshop on Integrated growth of grapes was organized in Odessa Oblast v. Sofiivka Byelgorod-Dnistrovskyi Distr. 25 participants were present, among them 20 farmers

September2007: A workshop "Integrated protection of agricultural crops and importance of autumn monitoring and prognosis for the prevention of the development of insects and diseases" was organized in v. Zhovtantsi Kamyanka-Buska Distr., Farm "Driada", 50 participants were present, among them 40 farmers.

September2007: A workshop "Discussion and analysis of the tests on integrated growing of cucumbers " was organized on the farms with test fields of cucumbers in Kamyanka-Buska distr. and Zhydachiv distr. 35 participants in each , 25 among them farmers.

Management of *Parthenium hysterophorus* in Eastern and Southern Africa using Integrated Cultural and Biological Measures.

Wondi Mersie
Virginia State University

The project is funded by USAID Integrated Pest Management Collaborative Research Support Program (IPMCRSP). The project runs from Oct 2005 till Sept 2009, and is funded to a total value of $519,000 for the four years duration.

Collaborating Countries and Institutions in this Regional Project are:

Ethiopia:

- Ethiopian Institute of Agricultural Research
- Amhara Regional Agricultural Research Institute
- Haramaya University
- Mekelle University

South Africa:

- Agricultural Research Council-Plant Protection Research Institute

Botswana:

- Department of Agricultural Research

Uganda:

- Makerere University

CABI, IITA, CIMMYT, University of Queensland Australia, and the Indian Agricultural Research Institute also participated by providing advisors.

Goal of the 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 whole region of eastern and southern Africa.

The project objectives are to:

1a) collect accurate information on the distribution, and spread of parthenium in eastern and southern Africa and 1b) assess its socio-economic impact in Ethiopia;

2) determine the effect of parthenium on plant diversity;

3) evaluate and release insect agents for the control of parthenium;

4) evaluate and demonstrate pasture management systems for the control of parthenium;

Ethiopia and South Africa are focal countries.

- A parthenium distribution survey has been conducted in Ethiopia, Uganda, Botswana, Swaziland, and South Africa.
- Objectives 1b, 2 and 4 are being conducted in Ethiopia.
- Objective 3 is being conducted in Ethiopia and South Africa.

In Ethiopia, the survey has been completed for Amhara, Somali, Tigray, most parts of Oromiya and Afar Regional States.

The survey data will be compiled to develop an up to date and accurate map showing the distribution and spread of parthenium in Ethiopia, as well as for the whole region. The avialability of such information is crucial for area wide planning for parthenium management and control.

An upgrade to EIAR facility at Ambo Plant Protection Research Center has been undertaken. The quarantine facility is the first of its kind in the country and is very important for future biological control studies. The leaf feeding beetle (*Zygogramma biclorata*) which is widely used in India and Australia against parthenium is being evaluated in Ethiopia in this quarantine facility.

Evaluation of several agents, specificity, suitability and impact is already done in South Africa.

Studies on the impact of parthenium on socio-economics (formal survey via questionnaire) have been completed for three Ethiopian localities and a manuscript on the subject is under preparation.

The impact of parthenium on below and above ground plant diversity is underway in two locations in Ethiopia.

Studies to determine best management practices (mowing, burning, oversowing) that that can reduce the adverse impacts of parthenium on beneficial pasture species are also underway in northern and eastern regions of Ethiopia.

The USAID/IPM-CRSP Project supports three graduate students at Haramaya University studying for their M.S. One student, Ms. Shashie Ayele has already graduated after conducting her thesis on parthenium. The project plans to train additional graduate students and all are expected to conduct their thesis work on parthenium.

Three EIAR employees have been trained on the evaluation and handling of biocontrol agents in South Africa.

Many have been trained on the management of parthenium during three workshops conducted in Addis Ababa, Bahir Dar, and Ambo.

Recent contacts with USAID Mission in Addis Ababa, Ethiopia

Dr. Wondi Mersie from VSU, Dr. Andrew McConnachie, ARC-PPRI, South Africa and Dr. Lulseged Gebrehiwot, VSU, Ethiopia met with Dr. Belay Demissie, Senior Ag. Advisor and Head of Rural Productivity Division, at the USAID Mission in Addis Ababa, Ethiopia to discuss the progress on the upgrade of the quarantine facility at Ambo on October 11, 2007.

On Tuesday October 16, 2007, the upgraded quarantine facility at Ambo Plant Protection Research Center was opened. Dr. Belay Demissie traveled from Addis Ababa to Ambo to participate at this opening ceremony. He spoke on the importance of controlling parthenium in Ethiopia and the role the quarantine facility will play in the evaluation of bioagents to control this and other invasive species.

Integrated Management of thrips-borne tospoviruses in vegetable cropping systems

Naidu A. Rayapati
Washington State University

Activity: Develop formal linkages with other Global and Regional IPM-CRSP projects to initiate project activities in South and Southeast Asia.

Rayapati has expanded his project linkages with PI Karim Maredia and other members of the regional project “Ecologically-based participatory and collaborative research and capacity building in IPM in the Central Asia Region” to explore possible collaborations on virus diseases in vegetables in Central Asia region. He participated in the "Central Asia Regional IPM Stakeholders Forum" meeting at Dushanbe, Tajikistan (May 27-29, 2007) to build collaborative relationships with host country scientists in the region. Rayapati’s project sponsored Dr (Mrs). Zarifa Kadirova, a Virologist at Institute of Genetics and Plant Experimental Biology, Academy of Sciences of Uzbekistan, Tashkent, Uzbekistan, to participate in the Stakeholders Forum meeting at Dushanbe and develop potential collaborations on virus disease problems in vegetables in the Central Asia region. Rayapati established linkages with PI Mark Earbaugh of the Regional IPM Program for East Africa: Kenya, Tanzania and Uganda to explore possible collaborative activities on tospoviruses in vegetables in the region. As part of strengthening these collaborations, he provided practical training on tospoviruses to Dr (Mrs). M. K. N. Ochwo-Ssemakula, a Virologist in the Department of Crop Science, Faculty of Agriculture, Makerere University, Kampala, Uganda.

Activity: Reconnaissance studies for the occurrence of tospoviruses in vegetables.

The reconnaissance studies conducted during the past 2 years have indicated wide spread distribution of *Peanut bud necrosis virus* (PBNV) in tomato, *Watermelon bud necrosis virus* (WBNV) in watermelons and *Iris yellow spot virus* (IYSV) in onion in several vegetable growing states in India. Using molecular techniques, a new tospovirus (*Capsicum chlorosis virus*, CaCV) was reported for the first time in tomato in India. This finding has implications in tomato crop improvement against tospoviruses, since PBNV and CaCV produce similar symptoms in tomato. Our studies have also shown the expansion of the host range of WBNV to cucurbits, besides watermelon.

Activity: Molecular analysis of Watermelon bud necrosis virus (WBNV) genome

Cloning and sequencing of the small RNA segment of WBNV genome has been completed. This enabled to establish precise relationships between WBNV and other tospoviruses. The information will help to gain a better understanding of the virus genome and to facilitate the development of improved diagnostic tools and an integrated pest management system consisting of transgenic plants and improved strategies of thrips vector control.

Activity: Identification of thrips species infesting vegetables

Five species of thrips *(Thrips palmi, T. tabaci, T. hawaiiensis, Scirtothrips dorsalis* and *Frankliniella schultzei*) have been documented in vegetables in India. One of the significant findings of this study is the identification of *T. hawaiiensis* for the first time in vegetables in India. The vectoring capacity of *Thrips hawaiiensis*, however, is to be determined. The survey has already provided a better idea of what thrips taxonomic groups are expected to be encountered in vegetable crops India. This knowledge is a foundation for further studies to document the current thrips vector situation in different vegetable production regions in India with the ultimate goal of developing and testing an integrated management plan for thrips-borne tospoviruses in vegetables in India.

Activity: Develop diagnostic methods for the detection of tospoviruses in plants and thrips vectors

We have optimized various parameters (type of nitrocellulose membrane, buffers, blocking agents and antibody dilutions) for the detection of PBNV by tissue blot immunoassay. Cloning of nucleocapsid (N) protein of IYSV in to a protein expression vector and expression of N protein in *E. coli* has been completed. The expressed protein is being used to produce high quality antibodies for diagnostic purposes.

Activity: Facilitate international exchanges of knowledge through long-term and short-term training programs

As part of capacity building, a faculty member from Tamil Nadu Agricultural University, India, is undergoing long-term practical training in plant virology in Rayapati's lab at Washington State University. Three graduate students (two female and one male) are being supported for PhD. A scientist from Uganda has undergone one week of practical training in tospoviruses in Rayapati's lab at Washington State University.

Activity: Conduct technology dissemination to various stakeholders on tospovirus diseases in vegetables

We have developed leaflets on *Peanut bud necrosis virus, Watermelon bud necrosis virus* and *Iris yellow spot virus* is being produced. Each leaflet provided brief description of the disease and pictures of symptoms, virus and thrips vectors for the benefit of farmers and extension personnel. The leaflets are being printed for distribution. Four journal articles are published in peer-reviewed scientific journals and four articles are in press.

No interactions with USAID missions, except a visit to USAID mission in New Delhi in June 2007.

IPM CRSP Regional Diagnostic Labs Global Theme: International Plant Diagnostic Network (IPDN)

Sally Miller
Ohio State University

The focus in the first two years has been to identify current plant disease diagnostic capacity and needs, recruit laboratories into the network, develop the necessary software for distance digital diagnosis and laboratory management, and to train plant pathologists in modern and classical diagnostic technology. Three hub laboratories, responsible for regional coordination, were identified: Agroexpertos, Guatemala; Kenya Agricultural Research Institute (KARI), Kenya; and IITA – Benin. The IPDN is closely linked to IPM CRSP regional programs and other Global Theme programs in selected countries by sharing resources and scientists and by developing joint research programs. Collaborating U.S. institutions are The Ohio State University, Virginia Tech, the University of Florida, The University of California-Davis, and the University of Wisconsin. Faculty from each institution participate in at least one "Operation Committee" for a regional diagnostic site, providing assistance to the sites including expertise and training. In addition, participants from these institutions provide specific inputs into program areas. The Ohio State University is the lead institution, provides leadership for the program, is developing diagnostic assays, and organized an intensive training program carried out in 2007. The University of Florida is responsible for development of the Digital Distance Diagnosis and Clinic Information Management System. Virginia Tech and the University of California-Davis provide expertise in virus diagnostics, assay development and linkages with the Insect-Transmitted Viruses Global Theme. Host country institutions are responsible for implementation of the regional networks and development of disease diagnostic capacity through infrastructure support and training.

Central America/Caribbean Site – The hub lab for this site is AgroExpertos, a private plant disease diagnostics and consulting laboratory in Guatemala City.

1. A stakeholder meeting was held in Antigua, Guatemala, June 28, 2006, hosted by site coordinator Agroexpertos. Approximately 30 participants, including plant pathologists from six

countries and representatives of grower organizations, government (Sanitary-Phyosanitary, SPS), and USAID Guatemala Mission attended the stakeholder meeting on June 8. The IPDN and IPM CRSP were introduced, and the purpose of the IPDN was described. Participants were also given the opportunity to describe their capabilities and needs in diagnostics. A baseline survey (in Spanish or English) of capacity and needs was completed, results of which were published in a poster presented at the Annual Meeting of the American Phytopathological Society in Quebec City in July 2006.

2. The Central America site formally established its system of spoke labs. The following cooperators and organizations were invited by the IPDN to become part of this international effort in the Central American and Caribbean region: Marco Arevalo, Agroexpertos private clinic and HUB lab, Guatemala; Laureano Figueroa, 4 Pinos Cooperative (small farmers), Guatemala; Maria Mercedes Roca, Zamorano, Honduras; Mauricio Rivera, FHIA, Honduras; Margarita Palmieri, Universidad del Valle, Guatemala; Lisa Myers, Ministry of Agricultura, Jamaica; Charles MacVean, Universidad Rafael Landivar, Guatemala; Reina Guzman, CENTA, El Salvador; and Gustavo Alvarez, Universidad de San Carlos, Guatemala.

West Africa Site – The hub lab for this region is the International Institute for Tropical Agriculture (IITA) in Benin.

1. A stakeholder meeting was held September 5-6, 2006 in Cotonou, Benin, hosted by IITA. This meeting was attended by 40 West Africans and included representatives from government (SPS, NARs), USAID, FAO, CABI (UK) and universities. The format was similar to that of the Central America meeting, although extended to 2 days of stakeholder interactions. The baseline survey (in French) indicated a lower level of diagnostic lab capacity in West Africa than in Central America, and a great need for training in all areas of diagnostics.

2. IITA Benin was established as the hub for West Africa following the stakeholder meeting and capacity building in September 06. The coordinator of the West Africa site, Dr, Fenton Beed, was transferred to IITA Uganda, and the position has not been replaced in Benin. We have designated a new coordinator from West Africa, Dr. Ranajit Bandyopadhyay, IITA-Nigeria, who will coordinate activities in the region. The physical hub will remain in Benin with assistance from Dr. Rachidatou Sikirou and a recent Ph.D. graduate working with IITA. Spoke countries have been designated: Mali (AVRDC), Cameroon and Burkina Faso.

3. Identification of *Ralstonia solanacearum* on tomato in Benin during the workshop led to initiation of surveys across Agro-Ecological zones of Benin to determine incidence and severity of the diseases in tomato growing areas. Isolates were recovered and tested for virulence and biovar characterization at IITA Benin. New Disease Reports submitted for five pathogens newly diagnosed in Benin (and sometimes the continent) or on a new host. Tremendous publicity for IPDN was generated via BBC World Service, SciDev.net, New Agriculturist, National TV and newspapers in Benin.

East Africa Site – The hub lab for this region is the Kenya Agricultural Research Institute (KARI, in Nairobi.

1. An East African Regional Disease Diagnostics Stakeholder Meeting was held at the National Agricultural Research Laboratories (NARL) of the Kenya Agricultural Research Institute (KARI) from the 5th to 6th March, 2007. This was jointly organised by KARI and The Ohio State University for the purpose of assessing the existing plant disease diagnostic needs in Eastern Africa in consultation with stakeholders and to provide hands-on training to improve disease diagnostic capacity. Ninety participants, who were drawn from the East African region, comprised of researchers, technicians/technologists, plant health regulatory agencies, farmers, exporters, and providers of plant health services. The main stumbling blocks/hindrances to the provision of effective plant disease diagnostics services were listed as insufficient manpower, lack of requisite skills, infrastructure inadequacy, poor access to chemicals/reagents, shortage of basic diagnostics tools (identification manuals, quick and effective kits, taxonomic literature), lack of modern diagnostic equipment, laboratory space limitation, poor communication systems and lack of linkages to other stakeholders (farmers and diagnostics laboratories).

2. Results of the baseline surveys conducted in West and East Africa were compiled and presented at a Bill and Melinda Gates Foundation/Rockefeller Foundation meeting on "Developing a Road Map for Plant Disease Diagnostics in Sub-Saharan Africa" (S. Miller) in April 2007 and during its follow-up meeting in Zanzibar, Tanzania in October, 2007 (F. Beed). We continue to search for opportunities for additional funding for plant disease diagnostics in Africa.

3. In order to ameliorate the problem of low disease diagnostic capacity, it was considered necessary to encourage institutional recognition and support for disease diagnostic activities, and to build linkages and partnerships locally, regionally and internationally. As a starting point, the following commodity-based common-interest groups were formed: Potato, Seed Health, Maize, Banana, Tomato, Indigenous Vegetables; Citrus; Post-Harvest. These groups will be charged with developing standard operating procedures for diagnosis of key diseases in their groups, among other activities. Additionally, a training committee was suggested in order to plan and make appropriate decisions on regional plant disease diagnostic training courses.

4. The countries that will comprise the East Africa network of the IPDN, in addition to Kenya, were determined: Tanzania, Uganda and Rwanda.

Development of Communications and Networking Systems:

1. Units for the Polycom system have been purchased and set up in most of the U.S. Universities and host country institutions. Operations Committees and the full IPDN group also communicate by email and by Skype (Http:www.Skype.com), the free internet communication system that also allows inexpensive phone calls and both internet and combined internet/land line coference calls.

Listserves have been established for individual Operation Committees and for the group as a whole.

2. The IPDN website was developed at The Ohio State University and is now available at http://www.IntPDN.org. This website contains details of the stakeholder meetings and training workshops in Central America and West Africa, links to related sites, publications and images. A "Member Communication" list is being developed that will be closed to the general public and password protected. The website is meant to be a networking tool in all of the IPDN regions. The website will continue to be populated throughout this project.

3. The development of Distance Diagnostic and Identification System (DDIS) and Clinic Information Management System (CIMS) was started in May 2007. The following tasks were accomplished: 1) System requirement analysis; 2) Database scheme design with revisions to include countries; 3) Web user interface design (most part of the user interface); 4) IPDN home page design; 5) Setup a testing server for the website at (http://ipdnt.ifas.ufl.edu); and 6) IPDN Country implementation (13 countries). The targeted release date is January, 2008.

Training Programs:

1. A plant disease diagnostics training workshop was held in Antigua, Guatemala, June 29, 2006, hosted by site coordinator Agroexpertos. Participants (about 20) were plant pathologists from Guatemala, El Salvador, Honduras, Nicaragua, DOminican Republic and Jamaica. The workshop covered plant disease diagnostics topics including bacteriology, molecular and serological virus detection, nematology, and bacterial wilt diagnosis and management. Presenters were IPDN members from Agroexpertos, Ohio State University, University of Florida and Virginia Tech. The Workshop agenda, photos and Powerpoint presentations are posted on the IPDN website: http://www.IntPDN.org.

2. A diagnostics training workshop was held September 7-8 in Cotonou, Benin, hosted by site coordinator IITA. This workshop was attended by 40 West Africans, including representatives from government (SPS, NARs), USAID, FAO, CABI (UK) and universities. The program extended to 2 days of training. Topics included bacterial, fungal and viral diagnostics, and sessions on digital distance diagnosis and the Global Plant Clinic (by CABI). Presenters carried out 6 mini-workshops each over the 2-day period, with 8-10 participants each. Presenters included IPDN members from IITA, Ohio State University, University of Florida and University of California-Davis. The Workshop agenda, photos and Powerpoint presentations were posted on the IPDN website: http://www.IntPDN.org. The workshop for East Africa will be held in East Africa in early 2007.

3. The IPDN East Africa Training Diagnostice Training Workshop was held March 7-9, 2007 at KARI NARL. Resource persons were drawn from KARI, the Ohio State University, University of Florida, IITA, Central Science Laboratory-UK (CSL), Kenya Plant Health Inspectorate Service (KEPHIS), Kenya Flower Council, University of Nairobi and Jomo Kenyatta University

of Agriculture and Technology (JKUAT). The lab-based training covered aspects such as symptom identification, isolation, ELISA, PCR, digital diagnostics and clinic information management systems. Areas of coverage included diagnosis of bacterial, fungal, viral diseases and nematodes. In addition, there was an introduction to the International Plant Diagnostic Network, which aims to facilitate the establishment of a database and promote communication and private sector involvement in plant disease diagnosis.

4. An intensive training course in plant disease diagnostics ("Advanced Plant Disease Diagnostics for International Partners") was held at The Ohio State University – OARDC in Wooster, OH, August 26-September 8, 2007. A total of 25 participants from 14 countries were trained (14 female, 11 male) in advanced classical and modern diagnostics, including microscopy, selective media, PCR and serology. Intensive training in development of Standard Operating Procedures (SOPS), the DDIS-CIMS under development, and Sanitary/Phytosanitary issues was accomplished. Eleven participants were from countries already part of the IPDN (Guatemala, El Salvador, Honduras, Jamaica, Kenya, Uganda, Tanzania and Benin), and were funded all or in part by the project (attendance of several was cost-shared by their institution). Fourteen were funded by other programs: USDA APHIS (5), USDA APHIS/SPS program (3), the IPM CRSP East Africa region al site (2), the Cochran program (2) and the Mexican government (2). Resource persons (teaching) were from The Ohio State University, University of Florida, Va Tech, USDA APHIS, North Carolina State University, IITA, KARI, and AgroExpertos. The program included a 2-day bus trip to the USDA APHIS lab in Beltsville, MD. .

Diagnostic Assay Development.

1. PCR primers based on the Hrp gene and specific to the causal agent of banana xanthomonas wilt have been developed at OSU with the cooperation of the IPM CRSP East Africa regional site, IITA and Makerere University. A large collection of strains from Uganda and Rwanda, as well as strains of other bacteria, were screened at OSU. The strains of Xcm show very little molecular diversity by repPCR, RFLP or rapid analyses. A PCR assay was developed and tested against more than 30 strains of Xcm. The assay is highly specific for Xcm, detecting all Xcm strains and no strains of other Xanthomonas pathovars or other bacteria. The PCR assay is currently being tested at Makerere University with plant samples. Two monoclonal antibodies generally specific for Xanthomonas spp., developed by Dr. Anne Alvarez (Univ. of Hawaii) and currently under license with Agdia, Inc. (Elkhart, IN USA), have been obtained for evaluation. The specificity of the antibodies will be evaluated during Year 2 and if acceptable will be further tested in East Africa.

2. Tomato samples were collected in Kenya (Thika) and Uganda (near Kampala) during a 2-day survey conducted in March, 2007; leaf samples from plants with virus symptoms were blotted on

nitrocellulose membranes and sent to Bob Gilbertson's lab (UC-Davis). Geminiviruses were detected in all of the samples from symptomatic tomato leaves using nucleic acid hybridization techniques. Work is underway to identify the viruses involved. This activity was cost-shared by the IPM CRSP East Africa Regional Program.

Insect Transmitted Viruses

Sue Tolin

Virginia Tech

The program is led by US-based researchers at Virginia Tech, University of Arizona, University of Georgia, and University of California at Davis, and by scientists in tropical countries and islands of the Western hemisphere (Guatemala, Honduras, Dominican Republic, Jamaica) and in arid lands of West Africa (Mali, Burkina Faso, Cameroon), and in AVRDC-The World Vegetable Center and with IITA in Tanzania. Within the IPM-CRSP, we have linked with other Global Themes and Regional Centers.

This Global Theme addresses viruses of vegetable crops that are transmitted by aphid and whitefly vectors. Previous work suggests the most problematic viruses in vegetables are DNA viruses in the family Geminiviridae transmitted by whiteflies (begomoviruses), and RNA viruses in the families Potyviridae and Cucumoviridae transmitted by aphids. Designing and validating IPM systems for minimizing losses from viral diseases requires proper virus identification, knowledge of virus and vector ecology and diversity, and a rapid means of virus detection in plants and vectors for efficient monitoring. If all components of the virus/vector/crop ecosystem can be identified, integrated disease management can be devised to identify virus source(s) and interfere with virus spread by vectors. Additionally, genetically resistant crops can be developed through collaborative research of virologists, molecular geneticists, and plant breeders.

Overall Impact

A crop-based database with information on viral diseases and specific viruses and vectors, and available diagnostic methods, will accelerate rapid identification of disease outbreaks and provide information to be used by IPM researchers to develop management strategies. The techniques, infrastructure, and capacity to use diagnostic methods varies between collaborating countries, and can be used as models for capacity development in other countries. Host-free periods and resistance can be successfully employed as ecologically-based management practices to reduce viral infection.

Accomplishments – Information Collection and Distribution

We continue to expand the virus and vector inventory database with information from both external sources, and from our work to detect and characterize new viruses. Included, for example, are digitized records from FHIA for over a thousand plants in Honduras assayed for

viruses and diagnosed in the last seven years, and several newly described viruses. Linkages have been established with Central American and West Africa IPDN hub labs of the Diagnostics Global Theme, as well as with the Thrips-transmitted Virus Global Theme. Discussions are under way with the IT Global Theme to make this information available on an IPM-CRSP designed website.

Accomplishments - Diagnostic Capacity, Ecosystem Analysis and Management

Sub-Saharan Africa

- The three African countries in which work has been focused during the first two years of the project are Burkina Faso, Cameroon, and Tanzania. African project participants met as an organizational meeting in Tanzania in October 2006, and in Cameroon in September 2007. In-country scientists (Koutou - Burkino Faso; Leke - Cameroon) are currently receiving advanced training in virus diagnosis in laboratories in Sweden, United Kingdom and United States, funded by other sponsors, thus leveraging funding for training to benefit the IPM-CRSP. These young scientists are using for their laboratory studies selected plant virus-vector complexes from their home country. Collaborators in IITA/Tanzania and U Arizona are assisting them, as they have other active projects on whitefly-transmitted viruses, particular in the cassava/vegetable production systems. Although it was planned to train a student at IITA with J. Legg (Brown, co-advisor) to focus on cropping systems in Tanzania, this was not possible because of funding constraints. Our activities are also being linked with the East African IPM Center, which is planned to begin in Year 3 for RNA virus diagnosis.
- Labs have been identified, including linkage with the AVRDC lab in Mali selected as the West African hub for the IPDN, and discussions are on-going with the West African Regional IPM Center on cooperative research to assess whitefly vector biology and diversity, and geminivirus identification, and plans have been made to establish these collaborations in Year 3. Emphasis will be placed on in-region capacity building to process samples and detect geminiviruses and their whitefly vector species and biotypes.
- The virus inventory database for sub-Saharan Africa has been expanded and updated with information from both our identification and characterization studies and external sources. Viruses that have been identified include: whitefly-transmitted geminiviruses *Tomato yellow leaf curl Mali virus, Tomato leaf curl Mali virus, Pepper yellow vein Mali virus, Pepper veinal mottle virus, African cassava mosaic virus;* the aphid-transmitted potyviruses *Papaya ring spot virus* (PRSV), *Potato virus Y*, and *Cowpea aphid-borne mosaic virus*; and *Potato virus X*. In Mali, *Okra leaf curl Mali virus* has been identified in UC-Davis work and occurs, perhaps, with a complex of other viruses such as *Okra yellow crinkle virus* described by AVRDC.
- AVRDC has screened about 150 entries of bottle gourd, cucumber, okra and pepper for response to natural infection of virus at their station in Mali, testing for geminivirus (GV) presence by PCR, and a potyvirus, *Zucchini yellow mosaic virus* (ZYMV) by ELISA. Some resistant lines were identified, although the incidence of GV was high in okra and pepper and ZYMV was high in the cucurbits.

Central America and the Caribbean

Guatemala

- The University del Valle research group has developed outstanding capacity to conduct PCR-based detection of geminiviruses in host plants and identification and biotyping of whitefly vectors, and has trained many students to assist in these tests. Viral loads in single whiteflies can be detected, which has been used to design a host free period for geminivirus management in the Salamá Valley. A wide range of symptoms seen in tomato can be attributed in large part to begomovirus infection, although the mechanically transmitted and seed-borne tobacco/tomato mosaic is also widespread . The main geminiviruses have been found to be *Tomato severe leaf curl virus*, *Tomato Havana virus*, and *Tomato yellow leaf curl virus* (TYLCV), but a number of other less common viruses are also present.
- Good progress has been made, in cooperation with UC-Davis, to discover that the chocolate-spot disease of tomato is associated with a new spherical, mechanically transmitted, RNA virus. Reports of similar tomato necrosis-associated viruses have appeared recently from Mexico and Spain. The vector is not yet known for this virus, nor is it know how extensive it is in Central America.
- UC-Davis has also collaborated in a project, supported in part from in-country funds, to design a host-free period for the Salamá Valley. Whiteflies have been collected monthly and identified to species, and for viral load carried in this valley and another one.

Honduras

- Collaborators in Honduras have digitized results of 1,048 samples tested for virus at FHIA and Zamorano as an Excel spreadsheet. Samples were from symptomatic plants of vegetable crops collected over the last 7 years. Additions to the spreadsheet this year were 131 samples from FHIA for the current year, and 302 samples from Zamorano analyzed in previous years.
- Honduran collaborators (FHIA and Zamorano University) have the capacity to conduct serological tests using commercially available diagnostic kits, and through a subcontract from a Millenium Challenge Fund Grant to FINTRAC. Both labs can also perform PCR with core coat protein primers for begomovirus (Geminiviridae), as well as for phytoplasma. One of the major constraints identified to diagnosis, however, was the difficulty in acquiring such testing materials in a timely manner because of delays and restrictions in shipping and importing. An alternate sequence-based hybridization method to replace PCR is under development with U AZ. Tissue blot immunoassays a
- The ELISA kits and immunostrips were used to test samples from extensive surveys conducted by both FHIA and Zamorano for viruses in vegetables. Aphid-transmitted potyviruses and *Cucumber mosaic virus* (CMV) were both detected at 10-30%, TMV was as high as 20% of tomato samples. Geminivirus incidence was surprisingly low. Many samples from plants showing classical viral disease symptoms tested negative to all assays, suggesting new viruses or strains are present, and that additional research approaches are needed.

- Germplasm from local seed suppliers and from AVRDC are being tested for response to endemic viruses. Experiments are being coordinated by C. M. Deom (U Ga), who is also exploring and seeking approvals to test genetically-engineered resistance to TMV in tomato.

Dominican Republic

- A new diagnostic laboratory has been constructed and equipped in CEDAF in Dominican Republic, and the potyvirus *Tobacco etch virus* (TEV) and CMV have been identified by ELISA. Over 500 samples of tomato and pepper were tested and shown to be 25% positive for TEV and 8% for CMV.
- Training was received in Jamaica on methods to detect virus in large numbers of survey samples by tissue immunoblot assays, developed at Virginia Tech, for testing TEV and CMV. Methodology for following aphid vectors in association with disease development, and impact of management practices, was also acquired.
- The success of implementing a host-free period for minimizing TYLCV in tomato, first applied in Dominican Republic, was monitored by periodic sampling of virus incidence in whitefly vectors and crop plants over the year in the north and south, as well as the Ocoa Valley where it has not yet been used. This demonstrated that viral loads were diminished significantly by the end of the period.
- Squash blot-PCR (SB-PCR), or PCR off of a membrane, was shown to be more sensitive than squash blot hybridization. This test was used to detect TYLCV in a symptomless weed.
- A meeting was held with stakeholders in the Ocoa Valley to convey information about the main viral diseases and to learn of their interest in the host-free period .

Jamaica

- A tissue blot immunoassay (TBIA) for a geminivirus, adapted by S. McDonald from a TEV assay, permitted temporal sampling of tomato in Jamaica by an affordable method not requiring PCR.. The progress of infection with TYLCV followed a logistic model, and showed that expressing tomato plants was correlated with increase in whitefly incidence. This rapid method will be used to address whether management methods can decrease infection rate.
- Extensive sequence data has been obtained of TEV from hot peppers in Jamaica by a graduate student at UWI. Training is planned in Jamaica for a Dominican Republic scientist to improve her molecular diagnostic skills.
- A Jamaican Ministry of Agriculture plant pathologist is studying for her Ph. D. at Virginia Tech, focusing on diagnosis and diversity of CMV in tropical countries. In addition to further developing TBIA for use in all collaborating countries if a good antiserum is available, potentially replacing ELISA, she has optimized a membrane-based PCR assay for RNA viruses.
- A survey of farmer practices indicated that many used at least one tomato variety resistant to TYLCV, and that they had instigated a period of time in areas in which they did not grow tomato. The majority of those interviewed said they would be willing to employ one, but some said it would be ‘giving in to the pest’ and would not consider it.

IPM CRSP Impact Assessment

George Norton
Virginia Tech

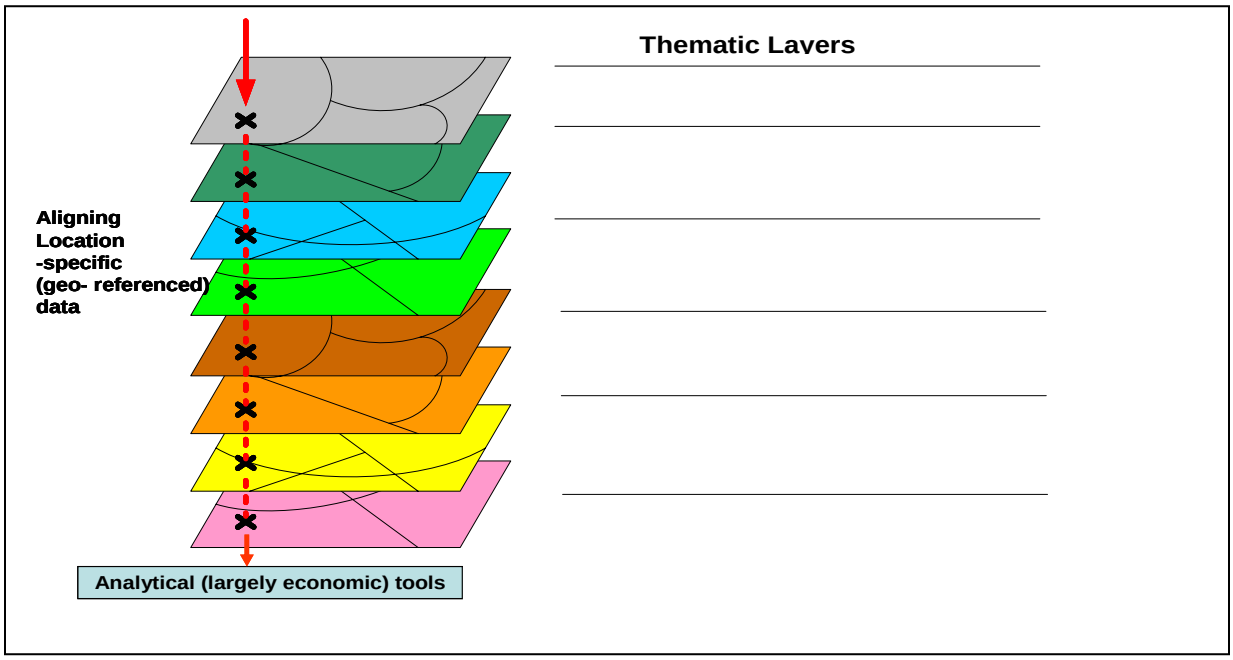
The global theme on IPM impact assessment is a collaborative program lead by researchers at Virginia Tech, IFPRI, and the University of Minnesota to guide and coordinate economic and gender impact assessment programs of the regional and other global theme programs on the CRSP. The Virginia Tech component also includes a faculty member who is a gender specialist at the University of Denver. The IPM impact assessment program works with the site chairs and coordinators to standardize the approaches used for impact assessment and to help with analyses in some cases. The program is developing consistent and integrated, spatially-referenced datasets to support IPM impact assessments at multiple scales and to facilitate the projection of which IPM interventions are likely to have the greatest impacts locally, nationally, regionally, and globally. It coordinates with other IPM programs at IARCs and with other USAID-supported agriculture and natural resource management programs on developing and applying assessment methods that provide the most relevant and strategic information in consistent and appropriate formats for specific target audiences.

A standardized set of methods were refined for impact assessment working with graduate students at Virginia Tech. One student completed a thesis examining the impacts by gender of higher yielding pest resistant varieties in Bangladesh. Another student examined the impacts of the Pheromone IPM research in Bangladesh. A third student (partially funded) assessed the regulatory costs of *Bt* eggplant in the Philippines. Baseline surveys were completed and drafts of reports completed Bangladesh, Mali, and Ecuador in coordination with regional programs. Data are being used for further analyses. With guidance, budget data were gathered for the experiments in most regions by the regional programs. Budget and survey data were collected in the South Asia and West Africa sites by research assistants.

Economists at Minnesota and IFPRI have collected geo-spatially recorded data on crop production, prices, trade, and potential versus actual yields on 20 commodities to use in an analysis of strategic priorities of pest problems globally. A PhD student at Minnesota is working to gather information on crop-pest losses at a disaggregated level for this large set of major crops. Support from the IPM-CRSP to IFPRI and the University of Minnesota is being leveraged with funding from the Bill and Melinda Gates Foundation to the *HarvestChoice* project co-led by IFPRI and the University of Minnesota. The *HarvestChoice* project is tackling the following set of issues (with special reference to sub-Saharan Africa and South Asia): (a) Where are the poor and what is their welfare status? (b) On what cropping systems do the poor most depend? (c) What are the constraints to the productivity of those systems? (d) What existing or potential technologies might best address those constraints? Under what scenarios? (e) What is the magnitude and distribution of potential payoffs to the poor from different investment targeting

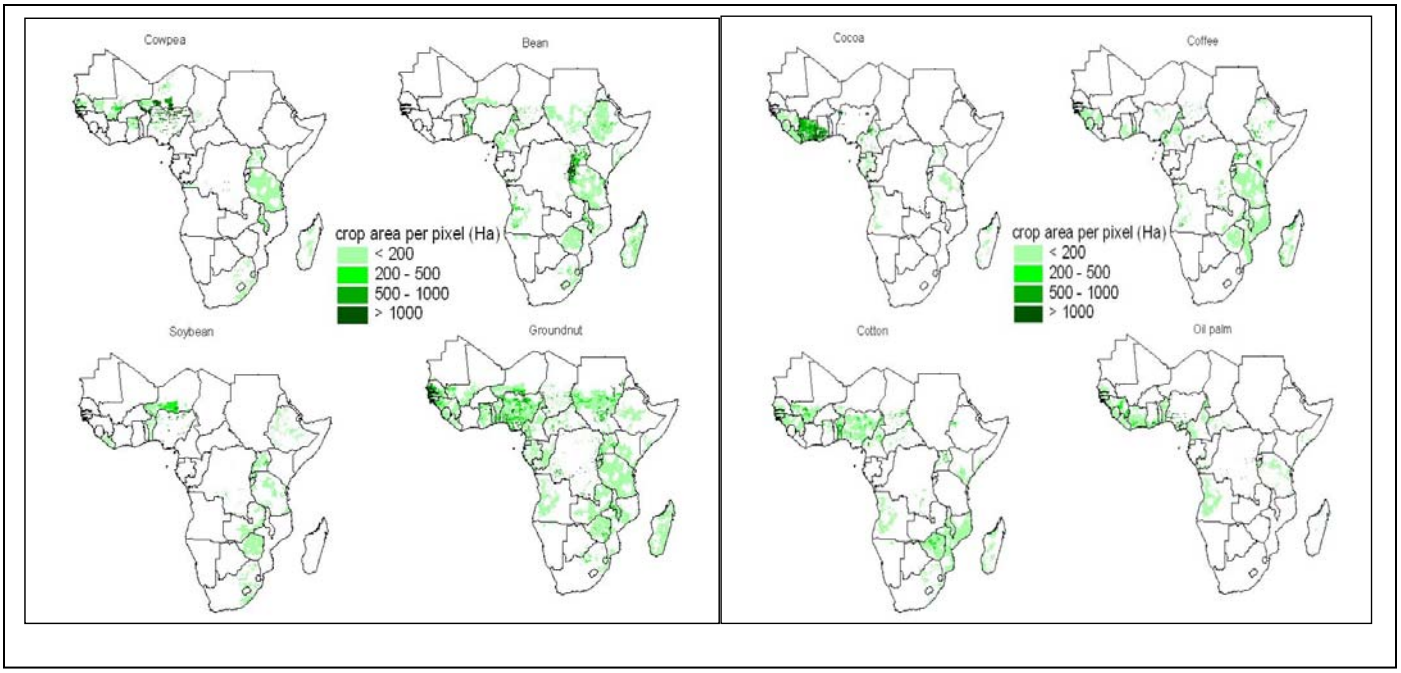
strategies (by districts, AEZs, production systems, crops, constraints, technologies)? The IPM-CRSP funds are focused on efforts to assess the likely global economic returns from ameliorating key biotic constraints from among the world's 20 principal crops. During the past year spatial data were complied and harmonized from a range of data sources including FAO, national agricultural census, and other (sub-) national sources. Agricultural production, consumption and infrastructure data have been compiled into a spatial data base and juxtaposed with numerous other climate, topography, soil and irrigation extend data sets (Figure 1).

Figure 1: *Compiling and Spatially Harmonizing Different Themes of Data*



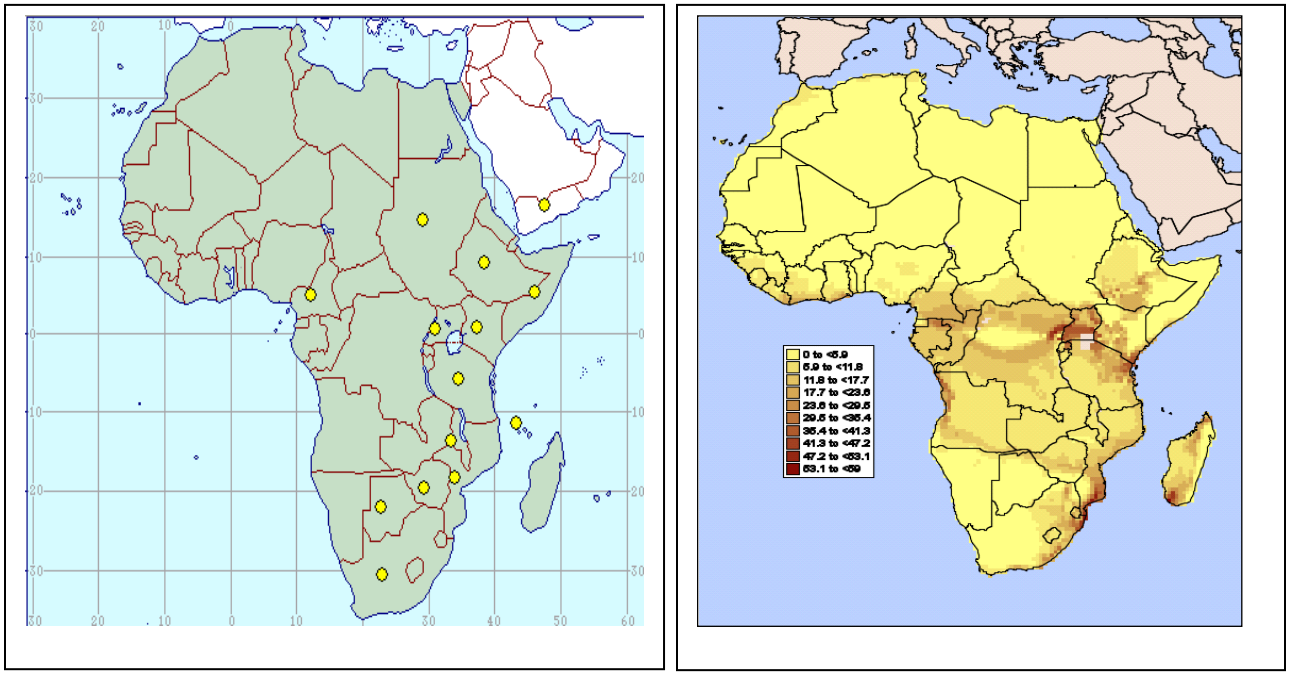
systematic review. Feedback from this review process is being introduced into a second round of crop allocations (along with additional statistical data obtained from efforts listed above) and this second version of global crop allocation data sets and their associated mapped representations will be released in the next several months.

Figure 2: *Spatial Distribution of Crop Production*



A critical step in assessing the global economic consequences of crop pests is to improve our understanding of their spatial occurrence. A survey of available global data sets revealed comparatively sketchy data. For example, the left hand panel in Figure 3 shows the CAB international occurrence data for Sub-Saharan Africa for *Chilo partellus* (maize borer). A project workshop was held in CIMMYT, Mexico (DATE) to assess options for estimating the likelihood of occurrence of key pests worldwide. The CLIMEX model was chosen as the modeling framework to be used for this purpose and some pilot assessments were undertaken (for example, *Chilo partellus* in the right hand panel of Figure 3 represents the Eco-climatic Index estimates for Africa generated by an initial run with the CLIMEX model).

Figure 3: *Reported Occurrence and Estimated Ecoclimatic Index for Chilo partellus (Maize Borer) in Africa*



Improved pest occurrence estimates are dependent on calibrations made possible by access to better observed occurrence data. To that end, a Virtual Survey Instrument (a spatially explicit, web-based tool for primary data collection) using a grid overlaid on Google Earth is in the final stages of development. After initial testing, an invitation only global survey of occurrence patterns for key pests on selected food crops for the past 10 years will be administered via the internet with the assistance of colleagues at CGIAR centers and the IPM CRSP.

Coordination occurred with both social and biological scientists at the IARCs (IITA, IFPRI, ICARDA, CIMMYT, and IRRI) working on IPM and impact assessment. In addition, three MS students and one PhD student were partially funded on the IPM impact assessment program. One student from India (at VT) helped summarize the baseline survey in Bangladesh and with the assessment of the pheromone IPM program in Bangladesh. Another (at VT) from the Philippines completed her MS thesis on gender impacts of high yielding pest resistant varieties in Bangladesh. Another (PhD student at Minnesota) is compiling the datasets for strategic IPM impact assessment and completing a literature review for his dissertation. Finally, one graduate student (at VT) assessed the regulatory costs associated with *BT* biotechnology as part of her MS thesis. Oneresearch assistant from the West Africa site spent two months at Virginia Tech for training on impact assessment methods.

Publications

Ricker-Gilbert, Jacob, George W. Norton, Jeffrey Alwang, Monayem Miah, and Gershon Feder, "Cost Effectiveness of Alternative IPM Extension Methods: An Example from Bangladesh," *Review of Agricultural Economics*, 30 (2008): (in press).

Mauceri, Maria*, Jeffrey Alwang, George W. Norton, and Victor Barrera, "Adoption of Integrated Pest Management Technologies: A Case Study of Potato Farmers in Carchi, Ecuador, *Journal of Agricultural and Applied Economics*, December 2007: (in press).

Victoria, Melanie, "Agricultural Technology in Bangladesh: A Case Study on Non-farm Labor and Adoption by Gender," M.S. thesis, Virginia Tech, June 2007.

Bayer, Jessica, "Biotechnologies in the Philippines: The Cost of Regulation," MS thesis, Virginia Tech, June 2007.

IT and Database Global Theme

Yulu Xia
North Carolina State University

Our major accomplishments can be briefly summarized as followings, based on the major tasks

Global IPM Technology Database. Main objectives of this task is that by the time of completion, 1) this database will be the most comprehensive IPM technology database in the world; 2) in addition to IPM technology database, this system will be a prime site for searching pest management information based on pest, crop, and region; 3) providing linkage to USDA and other US and international pest management web sites.

Accordingly, our main achievements during the year can be summarized as: 1) completed information collection and indexing IPM technology literatures in Biological Control, Chemical Control, and Host Plant Resistance. Users can now search pest management technology based on each of the technologies above. We are in the process hiring a part-time employee dedicated for collecting pest management information; 2) partial completion of searchable IPM databases based on crop, pest, and region; 3) providing linkage to a number of USDA and other major pest management information sites.

Southeast Asia IPM Information System. The main goals of this task are to 1) provide pest management information for the region; and 2) share pest information among the countries, especially for Indonesia and Philippines.

Our major accomplishments for the year are 1) redesign the website to focus on providing information on Cocoa Pod Borer (CPB), a major insect pest in the region; 2) writing literature reviews of CPB biology, ecology, distribution, damage, etc. These reviews have been uploaded to the site; 3) collected close to 100 IPM documents and images in related to CPB and other major pests in the region. These literatures and images are available online; 4) a short training about using IT and Database for pest information sharing at the regional meeting held in August 2007.

Web, database, and GIS/ interactive cartography integration and applications in the Caribbean. The long term goal of this task is to develop capacity for interactive cartography of pests in the Caribbean. We will use fruit flies, an economically important pest group for the Caribbean Basin, as a model system to develop a surveillance and reporting program in IPM

Major accomplishments for the year: 1) hosted a training and planning meeting. Over 40 people attended the meeting, including the representatives from USDA, USAID mission, the regional pest management organizations, a number of government ministries of Jamaica. Jamaica minister of Agriculture attended the meeting too. The main achievements of the meeting is coming out a workplan and timeline. 2) Field and system/programming works done so far:

System/programming:

a) wrote requirements document and worked with Caribbean scientists to update it (latest version attached)
b) created preliminary web forms for collector and site information as well as submitting trap count data. This was done in close collaboration with Phillip Chung, and further iterations are continuing.
c) c) began making map pages for the initiation screen capturing the full geographic extents of the Caribbean basin, and shaded relief base maps of Jamaica upon which the trap catch data can be superimposed.

Field

a) Survey instrument refined
b) All extension staff trained in survey and protocol
c) All sampling locations identified
d) All trapping supplies procured (except Mcphail traps, lure, strainers)
e) Information and feedback supplied to Jon Voortman to facilitate web database development

West Africa IPM Information System. This system shares the similar goal as the Southeast Asia IPM Network. Major accomplishments for the year include 1) finalize the system based on the type of information the system is going to provide. 2) work with the host country institution and the regional program on data collection, online upload system.

This GT also provide a training and presentation at the Central Asia regional IPM CRSP coordination meeting.

A number of presentations and publications were made during the year.