Integrated Pest Management Collaborative Research Support Program (IPM CRSP)

Annual Workplan for Year Four

Office of International Research and Development
Virginia Tech
1060 Litton Reaves Hall
Blacksburg, VA 24061-0334

TABLE OF CONTENTS

Project Objectives....................1

Summary of Progress and Achievements in Year 3....................1

Fourth-Year Workplan for the Asian Site....................4

Fourth-Year Workplan for the Caribbean Site....................38

Fourth-Year Workplan for the SubSaharan African Site....................59

Fourth-Year Workplan for the Latin American Site....................83

Cross-Cutting Activities in the Fourth Year....................113

Biotechnology Statement....................115

Intellectual Property Rights....................115

Degree Training....................115

Response to AID Requests for IPM Technical Assistance....................116

Globalization....................116

External Evaluation....................116

Prepare Fifth-Year Workplan....................117

Technical Committee Meetings....................117

Board Meeting....................117

Budgets 118

IPM CRSP Annual Workplan (Year 4 September 29, 1996-September 28, 1997)

This workplan describes the research and other activities to be undertaken during the fourth year of the IPM CRSP, including their timing, person months required, expected status and outputs at the end of year 4, and budget allocation. The relationship of these activities to the project objectives and priorities is noted. Activities in this workplan are directly related to (a) the technical proposal for the project, and (b) the five-year logistical framework for each site. Prior to describing the activities for year4 a summary statement of progress and achievements in year 3 is presented.

Project Objectives from Proposal

Objective 1. Identify and describe the technical factors that influence pests and pest management practices.
Objective 2. Identify and describe the social, economic, political, and institutional factors affecting pest management.
Objective 3. Work with participating groups to design, test, and evaluate appropriate, holistic IPM strategies.
Objective 4. Work with participating groups to promote education, training, and information exchange on IPM.
Objective 5. Work with participating groups to foster policy and institutional changes.

Summary of Progress and Achievements in the Second Year

The IPM CRSP project was fully operational in all four primary sites (Jamaica, Mali, the Philippines, and Guatemala) and globalization activities were undertaken in Uganda, Eritrea, Nepal and elsewhere in Africa. A two-day workshop was held to share information across sites and to plan future IPM CRSP research. An IPM CRSP annual report and newsletter were produced.

The following is a brief summary of progress by site for year three: Additional progress reports for continuing activities are found within the workplan activities described for each region.

Asia

Reducing herbicide treatments for onions from two to one followed by one handweeding provided adequate weed control for more than 15 days, but longer term control required the addition of mulch unless an additional herbicide treatment and one more handweeding occurred. Formulation of a local Bt isolate, LEP-22, has been completed and is available in powder form for field testing for *spodoptera* a control in onions.

Of the 26 crops tested against the nematode, *M. graminicola*, peanut, mungbean, and stringbean have been identified as non-hosts and will be field tested in rotations with onions and rice during Year 4. Eggplant and pepper will also be included in the rotations as they do not appear to be preferred. A nematode screening lab was set up and PhilRice employees were trained in nematode detection.

A survey of 100 households in six barangay was completed on household decision making with respect to pest management, segregated by gender and age. Seventy five farmers were also surveyed in the vegetable season with the data added to those from other seasons to prepare for a cost function analysis of pesticide productivity in Year four.

IPM CRSP representatives participated in an IPM workshop in Nepal and met with scientists at the National Agricultural Research Council (NARC) and at USAID/Nepal to discuss a possible collaborative project in that country.

Caribbean

Resistance to root-knot nematode was confirmed in three accessions of Scotch Bonnet peppers (*C.. chinensis)* and in the *C.annuum* pepper Carolina Cayenne. Some sweet potato clones were demonstrated to be allelopathic to yellow nutsedge, purple nutsedge. Several advanced dry-fleshed sweet potato clones were confirmed to be resistant to root-knot nematode and *fusarium* wilt and to have excellent culinary quality.

Training was held for pest management specialists in Jamaica for callaloo, hot pepper, and sweet potatoes. Training was also held for extension personnel in pest identification and preclearance inspection. A computer training workshop for project personnel was also held.

Analysis of pesticide residues in callaloo, hot pepper, and sweet potato found diazinon as the primary contaminant but other organophosphates were also present.

Pest and natural enemy monitoring identified the key pests for each crop and found that callabo production was reduced 2.5 to14% by pests and sweet potato production was reduced 6 to 42%. Analysis of soils found phosphorous to be the most limiting nutritional constraint for the crops targeted by the IPM CRSP.

Africa

Results of light trap monitoring indicate that a new potentially damaging meloides insect, *Rhinyptin infuscata* has entered Mali from Niger and therefore will be the focus of future IPM efforts. New extracts have been found to give superior control of Blister Beetles (*Psalydolytta spp.)* compared to the no neem control. No differences were found between Azatin and village-extracted neem. Preliminary interviews were conducted in four project villages to determine characteristics of new technologies desirable to farmers.

Latin American

Intercropping methods have been developed for broccoli and snowpeas production that have resulted in reduced pest numbers and pesticide use compared to monoculture. Research has found that *Gallina Ciega* populations are higher in areas where corn is grown as the rotation crop prior to broccoli and where chicken manure is used. Extracts of hot pepper and mirnsol have shown excellent potential in greenhouse studies for control of broccoli insect pests. The effectiveness of several commercial Bt products have been tested for *Lepidoptera* control in broccoli and all tested were found effective. Some areas of bramble production in Guatemala have been found to have *Botrytis cinerea* resistance to the fungicides dicarboximide and benZimidazale.

A list of practices that traditional farmers in the Highlands of Guatemala use to control pests has been compiled after interviewing 50 farmers. Practices most common are preventative, including soil management with organic fertilizers. In experimental plots of corn and beans, populations of aphids were higher in plots fertilized with synthetic fertilizers compared to composted cow manure. However, no other soil borne or leaf pests varied in the two fertilizer treatments.

The IPM CRSP sponsored a regional IPM workshop in Guatemala. Over 155 researchers, field managers, NGO representatives, and others attended from Guatemala, Honduras, Costa Rica, El Salvador and Jamaica. A preceedings was produced in Spanish and English.

Fourth Year Workplan for the Asian Site

Fourth-year IPM research activities in the Asia site will include four major topics for the Philippines with subactivities within each one. These four activities include (a) crop monitoring, (b) multidisciplinary field experiments, (c) multidisciplinary laboratory, greenhouse, and microplot experiments, and (d) socioeconomic analysis and training. Research activities in year four are primarily structured around issues rather than disciplines in order to facilitate interdisciplinary research. Also, the proportion of time devoted to crop monitoring is much reduced relative to field experiments compared to year three. Most of these field experiments are conducted on-farm. A fifth activity in addition to the four research activities listed above involves developing linkages to other institutions, networks, and CRSPs.

I. Crop monitoring (AS 97-1)

The objective of this research activity is to conduct systematic assessment of pest and natural enemy occurrence and abundance in relation to crop phonology of onions, eggplant, and string beans. Although crop monitoring of pests and natural enemies will occur during each of the field experiments listed in research topic II, there will be two separate and specific monitoring sub-activities, one for arthropods and one for weeds, for which the primary focus is monitoring and which bring to closure activities begun in previous years.

I.1 **Arthropod Community Structures** (AS 97-1-a-3)

a. Scientists: K.L. Heong, G.S. Arida - IRRI; V. Gapud, E. Martin - PhilRice; E. Rajotte, Penn State

b. Status: Continuing research

c. Objective: To assess arthropods/arthropod community structure as affected by cropping systems (rice-onion and mixed vegetables) and farmers' pest control practices.

d. Description of research activity: Regular samples of arthropods will be taken from both field and bunds, using the modified blower/vac suction machine. Temporal composition changes, species diversity and abundance will be analyzed. Farmers' pest control practices will also be monitored. Two sites will be selected for this study, Sto. Tomas (rice-onion) and Abar 1st (rice-vegetables). Four farms from each site will be sampled at monthly intervals. For arthropod sampling, a modified blower-vac machine will be used. On each sampling occasion, four samples inside the field and four samples from the bunds will be obtained.

e. Justification: This activity will add to information gathered on the dynamics of arthropods between crops and cropping systems and pest control practices.

f. Relation to other research activities at the site: Results of monitoring activities have and will feed directly into other research activities described below with the same scientists working on both.

g. Projected outputs: Outputs from this activity will include: (a) an updated list of insect pests and their natural enemies in the rice-vegetable cropping system, (b) descriptions of the seasonality of pests and natural enemies in the cropping cycle, (c) a report on how cultural practices carried out in one crop affect pest and natural enemy abundance in the following crop, (d) a description of management practices that will sustain natural enemy abundance through cropping cycles, and (e) a description of management interventions based on surveillance knowledge to impact pesticide use.

h. Progress to date: Monthly sampling of arthropods across farmer cooperators' fields, including the bunds, showed peak populations of phytophages, predators, and parasitoids during August - September, coinciding with the period when rice crops were at the late vegetative and early reproductive stages. Phytophage species in bunds were dominated by leafhoppers and planthoppers and by *Nephotettix*, *Nilaparvata*, and *Sogatella* hoppers in rice fields. Predator density was also observed to be high during the fallow period, May. Saprophyte populations started increasing in July when most farmers were preparing their land for the rice crop, with collembolans dominating the saprophyte composition. Predators were dominated by spiders, crickets, and *Cyrtorhinus.* Parasitoids mostly consisted of braconids, scelionids, mymarids, and trichogrammatids. Density changes of arthropods were presented in graphs and histograms. Thrips densities in onion fields were generally low, less than one per enclosure (covering 4-6 onion plants), during the onion growing season.

i. Projected impacts: Reduced pesticide use in the region within three years.

j. Start: September, 1994

k. Projected completion: September, 1997

l. Projected person-months of scientist time per year: 2 person-months; 250 days of field labor

m. Budget: PhilRice/IRRI - $10,340 (See Appendix Table 4a for a breakdown)
Penn State - $7,200 (See Appendix Table 4c for a breakdown)

I.2 Weed Survey in Rice-Onion Fields in Palestina, San Jose, Nueva Ecija (AS 97-1-b-3)

a. Scientists: M.C. Casimero, E. Martin, S.R. Obien - PhilRice; A.M. Baltazar, F.V. Bariuan - UPLB (NCPC); A. Watson, M. Mabbayad - IRRI; S.K. DeDatta - Virginia Tech

b. Status: Continuing research

c. Objective: To identify major weed problems in rice, onions and other vegetable crops in Barangay Palestina, San Jose, N. Ecija.

d. Description of research activity: Weed survey using the quadrant method will be conducted in the farmer-cooperators' fields in Palestina. Weeds from 1 x 1 m quadrant will be identified and counted by species. Samples will be taken from each crop (rice and onions, other vegetables) at early, mid-, and late-seasons and also during the fallow period. Weed dominance will be expressed as the summed dominance ratio (SDR) of weed density and weed weight.

e. Justification: The first step in the development of control strategies against weeds is to identify the major problem weeds in the area and their infestations at various stages of the crop life cycle. This will determine priorities on what weeds should be controlled and at what times during the cropping season.

f. Relation to other research activities at the site: This is a continuation of a Year 3 activity. Samples have been taken and major problem weeds identified in Barangays Sto. Tomas and Abar 1st. Barangay Palestina was included as additional site only much later, leaving the weed studies in this barangay unfinished. In Year 3, three grasses, three broadleaf weeds and one sedge species that grow in each crop and about five species that grow in both crops have been identified.

g. Projected output: Identification of problem weeds in Barangay Palestina for prioritizing and development of control strategies.

h. Progress to date: Weed surveys conducted from late 1994 through the fallow period of 1995 showed that broadleaf weeds predominated both rice and onion fields in Abar 1st. In Sto. Tomas, broadleaf weeds at early season and grasses at mid to late season predominated in rice, while sedges predominated in onion fields. In both villages, the most dominant broadleaf weeds were *Ludwigia* spp., *Sphenoclea zeylanica,* and

Monochoria vaginalis in rice and *Cleome viscosa* and *Trianthema portulacastrum* in onion. The most dominant grasses were *Echinocloa colona, Eleusine indica,* and *Digitaria ciliaris* in onion. The most dominant sedge was *Cyperus rotundus* in both rice and onion fields.

i. Projected impact: More efficient weed control methods, resulting in reduced weed control inputs.

j. Start: September, 1994

k. Projected completion: September, 1997

l. Projected person-months of scientist time per year: 1-2 person-months

m. Budget: PhilRice/NCPC/UPLB/IRRI - $3,520 (See Appendix Table 4a for a breakdown)
Virginia Tech - $894 (See Appendix Table 4b for a breakdown)

II. *Multidisciplinary Field Experiments* (AS 97-2)

Field experiments with farmer cooperators in our six villages and at PhilRice will be completed under nine subactivities. Each of these subactivities is multidisciplinary in that at least two and up to five disciplines are involved in each one. The nine subactivities are: (1) appropriate use of pesticides, (2) NPV and Bt for Spodoptera control in onions and string beans, (3) impact of straw mulch on insects, diseases, and weeds, (4) effect of planting date manipulations on onion thrips, (5) effects of rice hull burning on soilborne diseases, weeds, and nematodes, (6) effects of crop rotations on diseases and nematodes, (7) effects of soil amendments on nematodes, (8) effectiveness of trap cropping for *Spodoptera litura* and mating disruption for *Leucinodes Orbonalis.*, and (9) composting in a livestock-rice-vegetable system. Some of these subactivities involve multiple experiments.

II.1 Appropriate Use of Pesticides

II.1.1 Field Evaluation of Insecticide Treatments Against Onion Thrips, Bean Pod borer (*Maruca testulalis*), Eggplant Leafhopper (*Amrasca biguttula*), and Eggplant Shoot and Fruit Borer (*Leucinodes orbonalis*) (AS 97-2-a)

a. Scientists: V. Gapud, R. Suiza, E. Martin - PhilRice; E. Rajotte - Penn State

b. Status: New Research

c. Objectives: (1) Determine appropriate frequency of application of commonly used insecticides against *Thrips tabaci, Amrascsa biguttula* and *Leucinodes orbonalis*, and (2) evaluate the most effective and least hazardous insecticides against these insects.

d. Hypotheses: (1) Frequency of insecticide applications on the target pests can be reduced while maintaining or improving yields of target crops, and (2) cabamates provide better control than pyrethroids or organophosphates on the target pests.

e. Description of research activity: Farmers' and experimental fields will be used to evaluate the effectiveness of commonly used insecticides against *Thrips tabaci, Amrasca biguttula* and *Leucinodes orbonalis.* The appropriate frequency of application of these chemicals will be tested against farmers' practices. Onion and eggplant fields will be laid out in 2x5 m^2 plots in an RCBD pattern, with four replications for each treatment per crop. Chemicals to be tested at recommended rates are: a) Brodan and Hopcin, and farmers’ practice against *Thrips*; b) Brodan and Treban and farmers' practice against *Amrasca*. Treatments will be 30 days after transplant and then bi-weekly. For *Leucinodes*, chemical treatment will be compared with infested shoot tip and fruit removal.

For frequency experiments, on onions, one treatment will be farmer's practice (weekly), a second will be 30 days after transplant and then bi-weekly, and a third will be no spray. For eggplant, one treatment will be farmer's practice (2 times per week), and a second will be no spray for first 30 days and then bi-weekly and a third will be no spray.

f. Justification: Monitoring of farmers' use of insecticides for the past two years consistently showed very high application levels, with up to 11 treatments per season against onion thrips and *Spodoptera* and 32 treatments against *Amrasca* and *Leucinodes* in eggplant during the growing season. If these frequencies can be reduced while maintaining effective control, assuming less hazardous insecticides are applied at the right time, one of the goals of the project would be achieved.

g. Relation to other research activities at the site: A related activity involving collection and testing of potential microbial pathogens of *Amrasca* and *Empoasca* will be initiated in the laboratory and later tested in the farmers' and experimental fields. Other tactics for *Spodoptera* control are currently being explored, which will result in a comprehensive management for this insect. Separate activities will also explore parasitoids for *Maruca, Leucinodes,* and *Spodoptera.*

h. Projected outputs: (1) Most effective and less hazardous insecticides evaluated against thrips, *Amrasca*, and *Leucinodes*, (2) appropriate frequency of insecticide application identified for the different insects, and (3) effective control of *Amrasca*, thrips, and *Leucinodes* established.

i. Projected impacts: (1) Substantial reduction in insecticide use, and (2) use of less hazardous insecticides.

j. Start: September 29, 1996

k. Projected completion: September 28, 1997

l. Projected person-months of scientist time per year: 3 person-months

m. Budget: PhilRice: $4,180 (See Appendix Table 4a for a breakdown)
Penn State: $4,200 (See Appendix Table 4c for a breakdown)

II 1.2 Complementary Weed Control Strategies in Rice-Vegetable Systems (AS 97-2-b)

a. Scientists: M.C. Casimero, E.C. Martin, R. Camacho, S.R. Obien - PhilRice; A.M. Baltazar, F.V. Bariuan - UPLB (NCPC); A. Watson, M. Mabbayad - IRRI; S.K. DeDatta - Virginia Tech

b. Status: Continuing research

c. Objective: To determine effects of herbicides on growth of weeds infesting rice-vegetable systems.

d. Hypotheses: (1) Herbicide in onions injure string beans, eggplant, tomato, and peppers, (2) fine tuning the rates and times of herbicide use will reduce herbicide use while maintaining or increasing vegetable yields, and (3) herbicides combined with hand-weeding is more cost-effective in controlling weeds than herbicides alone.

e. Description of research activity: Bentazon, MCPA, 24-D, and glufosinate, alone and in combination with hand weeding, will be evaluated for their efficacy against weeds in rice, onions, eggplants, and string beans. Most promising treatments identified from the greenhouse herbicide evaluation studies will be compared with farmers' weed control practices in onion field (on-site) studies. Crop injury ratings will be taken at 7, 15, and 30 days after seeding. Visual weed control ratings will be taken 7, 15, 22, 30, and 60 days after seeding and at harvest. Weed counts and weights will be taken at 45 days after seeding and at harvest. Crop yields will be recorded at harvest. Plants will be grown following recommended cultural practices in 4x5 m plots replicated three times in a RCBD lay-out.

f. Justification: Weeds can cause yield losses by 50% or more of potential yields if left uncontrolled. Some farmers spend almost one-third of total production costs on hand weeding and/or herbicides. Herbicides will continue to be a major weed control method until other alternative cultural or biological methods are developed. In continued efforts to reduce the frequency of herbicide treatments, there is a need to identify the most efficient field use rate(s) and time(s) of application, especially when these are combined with other control practices.

g. Relation to other research activities at the site: Promising rates and times of treatment identified from the greenhouse evaluation studies will be used in this study.

h. Projected outputs: (1) Identification of existing and potential herbicide treatments alone and in combination with other cultural practices, and (2) a publication/booklet of herbicides evaluated or recommended for weed control in vegetables.

i. Progress to date: Efficacy of existing herbicides for vegetables (oxyfluorfen, oxadiazon, fluazifop, and glyphosate) and their selectivity to the crops have been determined in greenhouse and field (on-site) studies in year 3, together with a new herbicide (bensulfuron). A field study was conducted from December 1995 to March 1996 (dry season) to compare cultural and chemical methods of weed control in onion in Sto. Tomas and Palestina. The farmers' practice of two sequential herbicide applications followed by two handweedings was compared with only one herbicide application followed by one handweeding. An additional cultural control method of mulching was practised in Sto. Tomas but not in Palestina. In Sto. Tomas, all the treatments provided adequate to excellent control until 15 days after treatment but control did not last until 30 days after treatment. Mulching in Sto. Tomas helped suppress weed growth markedly such that the use of only one herbicide followed by one handweeding provided comparable control with that of two herbicides followed by two handweedings. In Palestina, absence of mulch caused profuse weed growth such that even two herbicide applications followed by two handweedings did not provide adequate weed control.

j. Projected impacts: (1) Reduced rates and/or frequency of herbicide treatments, and (2) herbicide booklet will provide farmers more options to avoid repeated use of the four existing herbicides for vegetables.

k. Start: September, 1996

l. Projected completion: September, 1997

m. Projected person-months of scientist time per year: 2-3 person-months

n. Budget: PhilRice/UPLB/NCPC/IRRI: $2,420 (See Appendix Table 4a for a breakdown)
Virginia Tech: $894 (See Appendix Table 4b for a breakdown)

II.2 Potential of Nuclear Polyhedrosis Virus (NPV) and *Bacillus thuringiensis* (Bt) for *Spodoptera* Control in Yellow Granex Onions (AS 97-2-c-3)

a. Scientists: L.E. Padua - UPLB; V.P. Gapud, R. Suiza, E. Martin - PhilRice; N.S. Talekar - AVRDC; E. Rajotte - Penn State

b. Status: Continuing research

c. Objectives: (1) To evaluate commercially available *B. thuringiensis* (Dipel, Thuricide, Agree) and LEP-22 against *Spodoptera litura*, (2) to mass produce NPV-CRSP for field trials in combination with selected commercial Bt, (3) to evaluate the efficacy of 3 NPV's (LB, AVRDC and CRSP) against *S. litura*, (4) to start field trials using the most promising Bt and NPV-CRSP as microbial control agents against *S. litura*.

d. Hypotheses: (1) Bt is an effective and economically viable control measure for *Spodoptera litura* on onions, and (2) NPV is an effective and economically viable control measure for Spodoptera litura when combined with Bt and is more effective than Bt alone.

e. Description of research activity: The common cutworm will be mass-reared in the laboratory using natural food and possibly artificial diet. The effectiveness of four commercially available *B. thuringiensis* (Dipel, Thuricide, Agree), as well, as its local isolates such as LEP-22, and three NPV's will be tested against *S. litura* in the laboratory. The most promising Bt will be tested in farmers' fields and in combination on onions and compared with farmers' practice (insecticide treatment), each with four replications, using RCBD. Plots will be 150 m^2.

f. Justification: The polyphagous common cutworm, *S. litura,* is currently controlled by intensive insecticide spraying (11 times for Yellow Granex onions) but with little success because of its ability to remain concealed inside onion leaves. The use of NPV and Bt as microbial control agents, being renewable, safe, effective and highly specific to target pests, would be more economical and practical alternatives to insecticide use.

g. Relation to other research activities at the site: Other management tactics, such as pheromones, trap plants (castor), and parasitoids, are being tested against *S. litura* in onions and string beans.

h. Projected outputs: (1) Effectiveness of commercially available and local isolates of Bt evaluated, (2) efficacy of the three NPV's tested, (3) most promising Bt and NPV selected for field evaluation, and (4) mass production of selected local Bt and NPV for field use.

i. Projected impacts: Development of Bt formulations and NPV inocula as viable alternatives to *S. litura* control, and, as a result of their use, reduction in insecticide application.

j. Progress to date: Formulation of a local Bt isolate, LEP-22, has been completed and is available in powder form for field testing. *Spodoptera litura* is currently being mass-reared for the production of NPV. Two hundred, fifty grams of infected larvae have been produced and suspended in 500 ml Tris+EDTA. NPV-infected larvae were retrieved from farmer cooperators' onion fields, macerated and suspended in Tris+EDTA. They were used for the mass production of the NPV strain which has now been labelled NPV-CRSP, which generated 110 gm of infected cutworms, currently maintained in 660 ml Tris+EDTA. Initial field tests for LEP-22+NPV in three farmer cooperators' fields were not adequate for quantitative analysis. Experimental fields will be established in San Jose and Bongabon in the next season. The NPV-CRSP preparations are currently being bioassayed against *S. litura* larvae and will be used for field tests in the next onion growing season. Castor plants obtained from PhilRice were grown in UPLB to provide a constant supply of *S. litura* larvae for laboratory use.

k. Start: September 29, 1994

l. Projected completion: September 28, 1997

m. Projected person-months of scientist time per year: 3 person-months

n. Budget: PhilRice/UPLB/AVRDC: $4,847 (See Appendix Table 4a for a breakdown)
Penn State: $6,600 (See Appendix Table 4c for a breakdown)

II.3 Impact of Rice Straw Mulch on Thrips Population, Seedling Damping-off Disease, and Germination and Growth of Weeds in Vegetables After Rice (AS 97-2-d)

a. Scientists: V.P. Gapud, R. Suiza, E. Martin, L. Sanchez, M.C. Casimero, and S.R. Obien - PhilRice; A.M. Baltazar, F.V. Bariuan - UPLB (NCPC); A. Watson, M. Mabbayad - IRRI; E. Rajotte - Penn State; S. Miller - Ohio State; S.K. DeDatta - Virginia Tech

b. Status: New research

c. Objectives: To (1) evaluate the influence of rice straw mulch on movements of thrips population in onion fields, (2) determine direct effect of straw mulch on the incidence of seedling damping-off in onion, (3) determine if straw mulch serves as source of pathogen inoculum in the field, and (4) determine the effect of straw mulch on weed growth and/or weed populations in fields grown to onion.

d. Hypotheses: (1) Straw mulch reduces thrips population, (2) straw mulch reduces damping off due to presence of *Trichoderma* sp., and (3) straw mulch reduces weeds in onions.

e. Description of research activity: Onion will be grown in replicated plots with two treatments and five reps: 1) with rice straw mulch; and (2) without rice straw mulch, using farmer-cooperators' fields. The population densities of thrips will be compared in both treatments with sampling schedules beginning one month after transplanting and every two weeks thereafter.

   Using the same plots, the severity of damping-off/bulb rot will be determined in both treatments. The survival of pathogens, *R. solani*, *Sclerotium rolfsii* and *Fusarium* spp. will be determined throughout the growing season, with samplings every two weeks.

   The growth of weeds will be assessed by: 1) counting the number of weeds by species at 3-7, 15, and 45 days after transplanting (DT) and at harvest using quadrat sampling method; 2) taking visual control ratings at 15, 30 and 60 DT and at harvest; and 3) recording the weights of onion bulbs at harvest.

f. Justification: It is not known whether straw mulch in onion crops increases or decreases the population of thrips. The possibility that straw mulch favors the buildup of natural enemies of thrips must be explored. Moreover, the past two years of monitoring have shown that straw mulch may carry certain pathogens which can inflict serious damage to onion. However, straw mulch may foster development of *Trichoderma* spp. which may suppress the pathogens. While mulching has been long practiced by vegetable farmers as a weed control strategy for onion, garlic, eggplant, and other crops, the extent to which the practice really suppresses weed growth and which species are effectively suppressed need to be well evaluated and documented.

g. Relation to other research activities at the site: This activity integrates pest, disease weed components as they are affected by the rice straw mulch. The integration should identify interactions among them within the straw mulch regime and, in the process, strengthen working relationships among the scientists of various specializations.

h. Projected outputs: Analysis and documentation of the: (1) effect of mulching on thrips population, (2) extent of disease spread and survival through mulching, (3) extent of reduced weed growth and/weed species, and (4) yield effects of straw mulching.

i. Projected impacts: (1) Improved pest, disease and weed management through improved mulching practices, and (2) reduced frequency of hand weeding and/or herbicide treatments.

j. Start: September, 1996

k. Projected completion: September, 1998

l. Projected person-months of scientist time per year: 4 person-months

m. Budget: PhilRice/UPLB/NCPC/IRRI: $5,720 (See Appendix Table 4a for a breakdown)
Penn State: $6,600 (See Appendix Table 4c for a breakdown)
Ohio State: $1,411.30 (See Appendix Table 4d for a breakdown)
Virginia Tech: $894 (See Appendix Table 4b for a breakdown)

II.4 The Effect of Planting Date on Onion Thrips Population (AS 97-2-e)

a. Scientists: V.P. Gapud, R. Suiza, E. Martin - PhilRice; E. Rajotte - Penn State

b. Status: New research

c. Objective: To determine the influence of planting date on onion thrips population buildup.

d. Hypotheses: Early planting reduces thrips damage in onions.

e. Description of research activity: The best planting time for onion will be explored, using three planting schedules, representing the months of November, December and January. Farmers representing each planting date from Barangays Sto. Tomas, Abar 1st and Palestina will be identified. The thrips populations will be sampled one month after transplanting and every two weeks thereafter up to harvest time by removing ten plants per plot. Thrips densities will be compared among the planting dates to determine the best planting time which avoids the high populations of thrips. Temperature, humidity and rainfall data will also be gathered from the Weather Station nearest to the study site. Yield data will be gathered at harvest.

f. Justification: Observations made in the past two years indicate that thrips populations tended to increase rapidly and drastically during February and March, appearing to be more abundant toward the warmer months of the dry season. Knowledge of the best time to plant onion would be a simple tactic to avoid buildup of high thrips populations at the early vegetative stages of the plants.

g. Relation to other research activities at the site: This activity will be synchronized with insecticide tests against onion thrips and the effect of rice straw mulch on thrips populations.

h. Projected output: Best time to plant onion in relation to thrips populations determined.

i. Projected impact: Reduced thrips population and minimal damage due to thrips feeding.

j. Start: September, 1996

k. Projected completion: September, 1997

l. Projected person-months of scientist time per year: 2 person-months

m. Budget: PhilRice: $1,100 (See Appendix Table 4a for a breakdown)
Penn State: $8,400 (See Appendix Table 4c for a breakdown)

II.5 Effects of Rice Hull Burning on Soil-Borne Diseases, Weed Survival and Growth, and the Rice Root-knot Nematode, *Meloidogyne graminicola* in a Rice-Onion Cropping System (AS 97-2-f)

a. Scientists: R.T. Alberto - CLSU; L. Sanchez, E. Martin, M.V. Libunao, M.C. Casimero, S.R. Obien - PhilRice; A.M. Baltazar, F. Bariuan - UPLB (NCPC); A. Watson, M. Mabbayad, J.C. Prot, E. Gergon - IRRI; J. Halbrendt - Penn State; S.K. DeDatta (Virginia Tech); S. Miller - Ohio State

b. Status: New research

c. Objectives: To (1) determine the effectiveness of rice hull burning (RHB) in controlling soil-borne diseases, (2) determine the effectiveness of (RHB) in suppressing weed populations and reducing their survival and regeneration and growth, (3) assess the effect of RHB on root-knot population levels, and (4) determine the contribution of RHB to onion yield.

d. Hypotheses: (1) Rice hull burning reduces soil-borne diseases, (2) rice hull burning reduces weed populations, (3) rice hull burning reduces nematode infestations, and (4) rice hull burning increases onion yields.

f. Description of research activities: Experimental plots will be set up in farmers' fields in an RCBD, with six replications in San Jose and six in Bongabon for each of the following treatments: 1) rice hull burned beforeplowing; and 2) without rice hulls. In each field, adjoining burned and unburned plots (4x5 sq m/plot) will be laid out. Data for diseases, weeds and nematodes will be taken from the same farmers' fields to acquire insights on the overall effect of RHB. Yield samples will be taken at harvest.

Soil-borne diseases, particularly damping-off, bulb rot and pink root, will be monitored in San Jose and Bongabon, Nueva Ecija one month after transplanting and every two weeks thereafter to determine the rate of their recovery. At least 10 onion plants will be removed from each plot and examined for disease infection. Cultures of the pathogens will be prepared and maintained in the laboratory.

Weed data to be gathered from the same plots are: 1) weed species and number per species that emerge at 3-7, 15, and 45 days after transplanting and at harvest; 2) visual weed control ratings at 30 and 60 DT; and 3) weights of onion bulbs at harvest. Weed counts will be done by quadrant sampling method.

Nematode populations will be assessed on previous rice crop prior to burning and in onion one week after transplanting, and bi-weekly thereafter until harvest. At sampling time, five root systems will be collected at random from each plot. The samples will be brought to the Nematology Laboratory at IRRI for nematode extraction. The yield of onion will be measured on 6 m^2 in the center of each plot.

Also, the effective soil depth level of RHB on nematode mortality will be determined by burying small canisters at specific depths in farmers' fields. The canisters will contain soil with a known infestation of *Meloidogyne graminicola* prepared from a greenhouse population. Following RHB, the canisters will be recovered and the nematode population determined. All treatments will be replicated four or five times.

In a separate experiment, eight 2x2 m plots will be marked in a nematode-infested field with upright metal rods. Soil samples will be taken from the center 1x1 m and the nematode population level determined. Four of the plots will remain free of rice hull and have a border of corrugated galvanized sheet which will serve as a heat shield. The remaining plots will be covered with rice hull as will the rest of the field. Following RHB, the corrugated galvanized sheet will be removed but all plots will remain marked by upright rods. Onions will be transplanted according to farmers' standard practice. At the end of the growing season, nematode population levels will once again be determined. In addition, onion yield and quality will be determined from burned and unburned plots. This experiment will be repeated fields.

f. Justification: Onion is a major source of income for many farmers in many areas of Nueva Ecija, especially San Jose and Bongabon and is the most preferred vegetable crop after rice. Both the root-knot nematode, *Meloidogyne graminicola* and pink root disease caused by the fungus, *Phoma terrestris*, have been identified as very serious onion problems, which can readily reduce the yield and quality of onions. Most of the known crops resistant to root-knot nematodes and probably pink root disease are unacceptable to San Jose farmers who grow onions for export, because the former have much lower market value or none at all. Chemical control is both uneconomical and environmentally unsound in a rice-based system. It is hoped that RHB, which is economical, practical and less hazardous to the environment, would be sufficient to at least delay the buildup of *M. graminicola* and *P. terrestris* to allow onion plants to gain a head start to advanced bulb formation after which the latter's effects would be rendered insignificant. Thus, RHB, originally targeted specifically for weed control, might very well contribute substantially to reduction in disease incidence, especially pink root disease and delay in nematode population increase. These supposed effects, therefore, require careful and precise documentation.

g. Relation to other research activities at the site: In theory, RHB appears to be a useful tool for control of nematodes, weeds, pink root, and other soil-borne disease/pest problems. However, replicated experiments intended to demonstrate its effectiveness have not been performed. This integrated activity may also be related to crop rotation and soil amendments as components of disease and nematode management. The use of the same experimental plots in gathering data for diseases, weeds and nematodes allows for possible correlation studies among them in relation to a management option as RHB. Arthropod samples can also be taken from the same plots in relation to the study of arthropods/arthropod community structure in the first activity.

h. Projected output: Documentation and validation of the effectiveness of RHB in suppressing incidence of soil-borne diseases, e.g., pink root, weed populations, and rootknot nematode populations. Data on onion yields effects will also be obtained.

i. Projected impacts: (1) Identification of a cost-effective cultural practice as RHB which can effectively contribute to simultaneous control of seed-borne diseases, weeds and nematodes, (2) reduced damage to onion due to diseases, weed competition and nematodes, and (3) potential yield and increased income realized.

j. Start: September, 1996

k. Projected completion: September, 1998

l. Projected person-months of scientist time per year: 8 person-months

m. Budget: PhilRice/UPLB/NCPC/CLSU/IRRI: $10,347 (See Appendix Table 4a for a breakdown)
Penn State: $12,000 (See Appendix Table 4c for a breakdown)
Ohio State: $1,411 (See Appendix Table 4d for a breakdown)
Virginia Tech: $894 (See Appendix Table 4b for a breakdown)

II.6 Effects of Crop Rotation on Incidence of Pink Root Disease in Onion and *Meloidogyne graminicola* in Onion and Rice (AS 97-2-g)

a. Scientists: J.C. Prot, E. Gergon - IRRI; R.T. Alberto - CLSU; L. Sanchez - PhilRice; S. Miller - Ohio State; J. Halbrendt - Penn State

b. Status: New research

c. Objectives: To (1) determine the effects of different rice-based cropping patterns on the incidence of pink root disease of onion and *Meloidogyne graminicola* population in onion and rice, and (2) identify the most effective crop rotation scheme for suppress nematode population and pink root disease incidence in the rice-vegetable system.

d. Hypotheses: (1) Multi-year rice-onion rotations which include groundnuts or mungbean will reduce nematode populations; (2) multi-year rice-onion rotations which include groundnuts or mungbean will reduce pink root disease incidence.

e. Description of research activities: Different 2-year crop sequences - (a) rice-onion-peanuts-rice-onion-pepper; (b) rice-peanut-pepper-rice-onion-pepper; (c) rice-mungbean-pepper-rice-onion-pepper; (d) rice-onion-fallow-rice-onion-fallow will be grown in 4x5 m plots, with six replications, in a randomized complete block design (RCBD) under farmers' field conditions. The pink root incidence and nematode population from each plot will be assessed at the beginning of the experiment and at harvest of each crop. At each sampling time, five 200-cc soil samples and five root systems will be collected at random from each plot. The samples will be brought to the Nematology Laboratory at IRRI for nematode examination. Similar samples will be taken for assessment of pink root disease incidence in the roots. Yields will be measured on 6 m^2 in the center of each plot.

f. Justification: The use of nematicides to control *M. graminicola* in rice or onion is un-economical and environmentally unsound. So far, no rice or onion variety has been found truly resistant to this nematode. The same may be said for the pink root disease, which is the most serious disease of onion in the tropics. Crop rotation using poor or non-host plants is one possible method of reducing the nematode population during the initial development of the plants without additional cost to the farmers. In contrast, very little is known about the host range of the pink root pathogen. If the same crop rotation will work against both the nematodes and pink root pathogen, this would be a preferred scheme.

g. Relation to other research activities at the site: This is an integrated activity of crop rotation effects on pink rot disease incidence and *M. Graminicola* population, as part of cultural/biological control. It will likewise relate to the experiments on rice hull burning and soil amendmentsj on soil-borne diseases, weeks, and *M. Graminicola.*

h. Projected outputs: (1) Improved knowledge of pink root disease dynamics and population dynamics of *M. graminicola* in the rice-vegetable system, and (2) identification of most promising rotational cropping scheme that can reduce incidence of pink root disease and *M. graminicola* in the soil.

i. Projected impacts: (1) Improved understanding of the pathosystem of rice-vegetable rotation schemes, (2) reduced incidence of pink root disease and suppression of nematode population, and (3) improved yields of rice and onion, translated into increased farmer income.

j. Start: September, 1996

k. Projected completion: September, 1998

l. Projected person-months of scientist time per year: 4 person-months

m. Budget: PhilRice/IRRI/CLSA: $4,620 (See Appendix Table 4a for a breakdown)
Ohio State: $4,619 (See Appendix Table 4d for a breakdown)
Penn State: $7,200 (See Appendix Table 4c for a breakdown)

II.7 Effects of Soil Amendments on Populations of *Meloidogyne graminicola* in Rice-Onion System (AS 97-2-h)

a. Scientists: L. Sanchez, M.V. Libunao, E. Martin - PhilRice; M. B. Castillo - UPLB; J. Halbrendt - Penn State

b. Status: New research

c. Objective: To evaluate different soil amendments for possible suppression of nematode population.

d. Hypotheses: (1) *M. graminicola* populations are suppressed by biofertilizers and green manure, nematode-antagonistic crops.

e. Description of research activities: Different soil amendments, such as biofertilizer, green manure and plants with nematicide properties will be evaluated for possible suppression of *M. graminicola* populations.

Four farmer cooperators in Bongabon will be selected to test the effect of biofertilizer (VAM and BION) on nematode populations. In field of each cooperator, four plots will be divided into eight subplots, half of which will be treated with biofertilizer and the other half as control check. Soil samples will be taken from subplots to determine the nematode population level. One-month old Yellow Granex onion seedlings will be transplanted into the subplots. Sampling for nematodes will be done two weeks after transplanting and at harvest time.

The effectiveness of nematode-antagonistic crops, *Tagetes erecta*, and *Cosmos caudatus*, green manure crops, will be investigated. The plants will be grown in farmers' fields in Palestina during the fallow period after rice and then turned under and incorporated with the soil. Each of the nematode-antagonistic crops and a check will be replicated four times in 5x4 m plots. Root samples will be taken three times, at the end of the previous rice crop, at the middle of the onion season and at onion harvest. Yield samples will also be taken at harvest.

f. Justification: Soil amendments, when they are effective, are economical, environmentally safe and practical compared with expensive and hazardous nematicides. The right combination of such amendments can help improve the organic matter content of the soil. Also, during fallow periods between rice- onion and onion-rice sequences, green manures can be grown in the fields and turned under prior to crop establishment. On the whole, these amendments may be beneficial to both the crop and the soil.

g. Relation to other research activities at the site: The use of soil amendments as possible suppressants of nematode population can be integrated into rice hull burning, crop rotation and possibly biological control strategies. The options for nematode management are promisingly diverse.

h. Projected outputs: (1) identification of the most practical and effective green manure for use in nematode-infested fields, and (2) identification of the best combination of management options for rice-onion nematodes.

i. Projected impacts: (1) Establishment of an integrated management approach for *M. graminicola*, (2) reduced yield losses of onion due to nematodes in Central Luzon, and (3) higher onion yield and quality, translated into increased farmer income.

j. Start: September, 1996

k. Projected completion: September, 1998

l. Projected person-months of scientist time per year: 4 person-months

m. Budget: PhilRice/UPLB: $3,520 (See Appendix Table 4a for a breakdown)
Penn State: $6,000 (See Appendix Table 4c for a breakdown)

II.8 The Effectiveness of Trap Plants and Pheromone Traps for *Spodoptera litura* and *Leucinodes orbonales* Management (AS 97-2-i)

a. Scientists: N.S. Talekar - AVRDC; V.P. Gapud, R. Suiza, E. Martin - PhilRice; E. Rajotte - Penn State

b. Status: Continuing research

c. Objectives: To (1) determine the use of castor as trap plants for *Spodoptera litura*, and (2) evaluate pheromone mating disruption techniques for Spodoptera litura/exiqua.

d. Hypotheses: (1) Castor beans can be effectively used to attract *Spodoptera litura* where it can then be sprayed so it will not damage onions; (2) mating disruption is a cost-effective solution to *Spodoptera* control.

e. Description of research activities: Castor seeds will be sown in individual black soil-filled plastic bags. When seedlings are a month old, they will be transplanted into strategic areas of farmer-cooperators' fields and set apart from each other by 1 m in two staggered rows around each field. The plants will be observed every two to three days. When larvae of *S. litura* congregate on the plant, the number of egg masses and larvae per plant will be recorded and removed as soon as they appear. Also, the number of infested plants with respect to the total number of plants will be recorded. The egg masses will be collected and taken to the laboratory for observation on level of parasitism. Larvae will be either sprayed with insecticide or killed. The performance of castor plants will be evaluated accordingly.

New formulations of a possible mating-disruption pheromone for *Leucinodes Orbonalis* are being developed at AVRDC. Traps will be set up in farmer's and experimental fields in the next onion growing season.

f. Justification: The difficulty of regulating populations of *S. litura*, a polyphagous pest, has led to the search for as many management options as available. The use of traps, especially when they contain insecticides, is relatively easy to manipulate and is environmentally safe. Should castor prove to be an effective trap plant, more seeds will be secured and seedlings grown at the edges of farmers' fields, making sure that they are constantly monitored and *S. litura* immediately killed when they occur. If the pheromone experiments are successful, a major pest would be controlled with reduced use of insecticides.

g. Relation to other research activities at the site: These activities are compatible with the search for effective natural enemies of *S. Litura*. Voucher samples of this pest can be used by collaborating scientists working on parasitoids of *S. Litura*.

h. Projected outputs: (1) Evaluation of castor as a trap plant for *S. Litura*, and (2) evaluation of effectiveness of pheromone traps for mating disruption for *Leucinods orbonalis*.

i. Projected impacts: (1) Reduction in population of *S. litura* due to trap plants and pheromones, and (2) availability of an effective pheromone for *Leucinodes orbonalis*.

j. Progress to date: Indian-based castor plants were grown around onion fields at the PhilRice experimental station and in three farmer cooperators' farms to observe their ability to attract *Spodoptera litura* during the onion growing season. Initial results showed that a few plants attracted larvae of *S. litura* during the first month after transplanting but they were too few to assess the plants' trapping capability. In the experimental field, castor plants attracted *Helicoverpa armigera* larvae, instead of *S. litura*, after the first month. *Helicoverpa* was apparently coming from the nearby corn field. These results were not sufficient to assess the castor plants' potential as trap plants for *S. litura* on onion. Such assessment will be made more extensively and systematically during the next onion growing season. At least 1000 seeds were generated during the season, which will be used to continue the research. Pheromones for *Spodoptera litura* have been tested in farmers' onion fields but not enough to allow for quantitative analysis.

k. Start: September, 1995

l. Projected completion: September, 1997

m. Projected person-months of scientist time per year: 2 person-months

n. Budget: PhilRice/AVRDC: $1,980 (See Appendix Table 4a for a breakdown)
Penn State: $6,000 (See Appendix Table 4c for a breakdown)

II.9 Designing a composting system involving livestock manure and rice sraw for vegetable disease and nematode control.

a. Scientists: M. B. Castillo - UPLB; S. Miller and H. Hoitink - Ohio State; G. Norton - Virginia Tech; J. Halbrendt - Penn State

b. Status: New Research

c. Objective: To (1) study feasibility of developing an integrated livestock-rice-vegetable system on a large scale in Nueva Ecija that utilizes animal manure and composts prepared with manure and rice straw and (2) field test selected components of such a system.

d. Hypotheses: (1) chicken manure provides control of *M. graminicola,* (2) a compost made up of rice straw and manure will provide improved disease control for onion and eggplant, (3) it is economically feasible to develop a livestock industry in Nueva Ecija that will supply meat and eggs, while providing large quantities of manure for application directly to fields and in composts

e. Description of research activity: This activity will provide the initial stage of a larger research project for which funds will subsequently be sought that will involve studying the feasibility of developing an integrated livestock-vegetable-rice system. Research will be conducted on the efficiency of poultry manure for controlling nematodes. A field experiment will be set up using the same methods described in research activity II.7. In addition, poultry manure and rice straw will be composted for testing during the following vegetable growing season. Finally, the current status of poultry and other livestock production in Nueva Ecija will be examined too as part of a preliminary assessment of the economic feasibility of producing enough manure for a viable integrated system.

f. Justification: Soil amendments such as poultry manure and compost hold promise for controlling nematodes and other diseases while providing a profitable outlet for wastes from poultry and other livestock operations. The demand for poultry and other livestock products is projected to grow in the future.

g. Relation to other research activities at the site: This activity will test one more possible tool for nematode and other disease control in addition to those described in other related activites. The poultry may also provide a market for the *tagetes* which are being tested in another activity.

h. Projected outputs: (1) identification of efficacy of chicken manure applied to onions to control nematodes and diseases, (2) identification of the major components and their interactions that would need to be researched in more detail in a larger research project aimed at designing a major integreated livestock-rice-vegetable system for Nueva Ecija.

i. Projected impacts: (1) improved control of M. *Graminicola*, (2) reduced yield losses on onions, (3) development of an integrated livestock-rice-vegetable system.

j. Start: September 1996

k. Projected Completion: September 1997

l. Projected person-months of scientist time: 4 months

m. Budget: UPLB: $3,000 (See Appendix Table 4a for a breakdown)
Ohio State : $12,000 (See Appendix Table 4d for a breakdown)
Virginia Tech: $7,000 (See Appendix Table 4b for a breakdown)
Penn State: $3,000 (See Appendix Table 4c for a breakdown)

III.Multi-disciplinary laboratory, greenhouse, and microplot experiments

Multi-disciplinary laboratory, greenhouse, and microplot experiments will be conducted for four subactivity topics: (1) biological control, (2) host susceptibility/resistance, (3) polymorphism analysis and pesticide evaluation, and (4) diseases carryover.

III.1 Biological Control

III.1.1 Effectiveness of Selected Parasitoids Against *Spodoptera litura, Maruca testulalis* and *Leucinodes orbonalis* (AS 97-3-a)

a. Scientists: P.A. Javier - UPLB/NCPC; V. Gapud, R. Suiza, E. Martin - PhilRice; E. Rajotte - Penn State; N.S. Talekar - AVRDC

b. Status: New research

c. Objectives: (1) Evaluate the effectiveness of egg and larval parasitoids against *S. Litura*, M. Testulalis and L. Orbonalis and (2) explore other natural enemies of *Spodoptera*, *Maruc*a, and *Leucinodes* within and outside the country.

d. Hypotheses: (1) Parasitoids of *Spodoptera litura, Maruca testulalis*, and *Leucinodes orbonalis* will be effective control agents for these pests.

e. Description of research activity: Of the known parasitoids of *Spodoptera litura*, an egg parasitoid *Telenomus* sp. and a larval parasitoid *Microplitis manilae* were previously reported in the literature to be promising but require extensive tests for their effectiveness. Eggs and larvae of *S. litura* will be collected from various vegetable farms, mainly in Laguna and Nueva Ecija and will be observed in the laboratory for emergence of these parasitoids. *S. litura* will be mass-reared in the laboratory for mass rearing of the parasitoids. These parasitoids will be evaluated in terms of searching efficiency, % parasitism, and % adult survival.

The previous two years of monitoring and surveillance of insects in rice-vegetable systems have resulted in the discovery of a braconid, *Dolichogenidea* sp., parasitizing larvae of *Maruca testulalis* despite the frequent spraying of insecticides against this pest. Bean-growing areas in Central Luzon will be sampled for other natural enemies of *M. testulalis*. *Dolichogenidea* will be recovered from the field and maintained in the laboratory for mass-rearing. Larvae of *Maruca* will be mass-reared on flowers of beans taken from the experimental fields of PhilRice. Bush sitao will continue to be grown in the field, without insecticide application, as a constant source of food (flowers and pods). Likewise, eggplant fruit damaged by larvae of *Leucinodes* will be collected and kept in cages for possible emergence of *Trathala.* This larval parasitoid will be mass-reared using damaged fruit containing *Leucinodes* larvae. The searching ability, reproductive potential, longevity and survival of adults of both parasitoids will be evaluated.

Other potential parasitoids will be introduced into the Philippines. Many parasitoid species have been reported in India since the 1960s and can be tested once the mass-rearing techniques for *Spodoptera, Maruca,* and *Leucinodes* have been perfected. Introduced parasitoids will be kept in the laboratory for a series of tests on their effectiveness.

f. Justification: Biological control (BC) of insect pests, when it works, is the safest, most economical and practical alternative strategy for managing *Spodoptera, Maruca,* and *Leucinodes.* Farm surveys and the PA showed the heavy use of insecticides by farmers as the only available option for managing these pests. BC is compatible with IPM CRSP goals of reducing pesticide use through IPM. Once such biological agents are established in the field, pest regulation is almost certain.

g. Relation to other research activities at the site: This activity complements other management tactics being developed for *Spodoptera, Maruca,* and *Leucinodes.*

h. Projected outputs: (1) Parasitoids effective for reducing *Spodoptera, Maruca,* and *Leucinodes* populations, and (2) discovery of more natural enemies of these pests in unsprayed farms.

i. Projected impacts: (1) Reduced insecticide application, (2) increased diversity of natural enemies of pests, and (3) improved vegetable yields and farmer income, once biocontrol practices are adopted.

j. Start: September, 1996

k. Projected completion: September, 1998

l. Projected person-months of scientist time per year: 8 person-months

m. Budget: PhilRice/UPLB: $8,975 (See Appendix Table 4a for a breakdown)
Penn State: $1,800 (See Appendix Table 4c for a breakdown)

III.1.2 Detection, Carryover, and Biocontrol of Soil-Borne Pathogens in Rice-Vegetable Systems (AS 97-3-b-2)

a. Scientists: L. Sanchez, G. Amar, M.V. Libunao, J. Rillon - PhilRice; R. Alberto - CLSU; S. Miller - Ohio State University

b. Status: New and continuing research

c. Objectives: To (1) identify potential biocontrol agents (BCAs) against soil-borne pathogens of vegetables, (2) demonstrate carry-over of rice pathogens into vegetable crops, and (3) develop and validate a system for rapid identification of interspecific groups of soil-borne pathogen *Rhizoctonia solani*.

d. Hypotheses: (1) Soil-borne pathogens of vegetable crops can be controlled by the use of antagonistic biocontrol agents; and (2) the soil-borne pathogen, *R. solani* can be detected rapidly and efficiently using immunoassays employing monoclonal antibodies.

e. Description of research activities: (1) *Trichoderma* sp. will be isolated from rice straw and also obtained from cooperators. Bacterial antagonists will also be obtained by isolation and from cooperators. Potential BCAs will be tested *in vitro* and in pot experiments (radish bioassay) for activity against *F. solani, Fusarium* sp. and *Sclerotium rolfsii*. An onion pink root bioassay will also be developed to test potential BCAs for this disease; (2) Soil-borne pathogens mentioned above, which have been isolated from rice or vegetables, will be tested for pathogenicity on rice, onion, eggplant, and string bean in greenhouse experiments; (3) Monoclonal antibodies developed in the U.K. will be tested for reactivity with Philippine and U.S. isolates of *R. solani*. These will then be used in a rapid, simple assay for use in detection, identification and differentiation of *R. solani* isolates.

f. Justification: *Rhizoctonia solani*, *Fusarium* sp., *S. rolfsii*, and *P. terrestris* are the principal fungi causing disease on target vegetable crops in this project. None of these pathogens can be controlled by fungicides and few resistant varieties acceptable to Philippine farmers are available. They are all soil-borne and good candidates for biocontrol. The extent to which these pathogens can attack rice and all three vegetable crops is currently unknown; however, this information is needed to determine the role of these pathogens and devise appropriate crop rotation strategies. *Phoma terrestris* is not known to attack rice; however, the possibility that it may serve as a symptomless host and permit increase of the pathogen in the soil must be determined. Development of a rapid diagnostic test for isolates of *R. solani* will assist in determination of the question of its carry-over from rice to vegetables.

g. Relation to other research activities at the site: This activity is related to experiments on pathogens in rice straw mulch used for vegetable production and to crop rotation experiments planned for onions in Bongabon.

h. Projected outputs: Dr. Sanchez will come to Ohio State for training (three months) in biocontrol strategies and disease detection techniques. The facilities at PhilRice will support this type of work when he returns. We will also identify potential BCAs against soil-borne pathogens and establish the importance of disease carry-over between rice and vegetable crops.

i. Progress to date: One *Trichoderma* sp. was isolated from rice straw (mulch) from a farmers field in San Jose, Nueva Ecija, and 20 sp. of bacteria were isolated from soil at the PhilRice experimental station. All were tested *in vitro* for biological control activity against *Rhizoctonia solani*, *Alternaria porri*, and several *Fusarium* sp. None of the bacterial strains nor the *Trichoderma* sp. isolate proved to have antifungal activity against the test pathogens in these assays.

j. Projected impacts: Results of these studies are expected to identify additional, nonchemical means of controlling soil-borne pathogens in onion, eggplant, and string beans, and to elucidate the role of *R. solani* carry-over in the rice-vegetable production system.

k. Start: September, 1995

l. Projected completion: September, 1997

m. Projected person-months of scientists time per year: 3 person-months for visiting scientist; 8 person-months for technical support

n. Budget: PhilRice: $5,055 (See Appendix Table 4a for a breakdown)
Ohio State: $16,294 (See Appendix Table 4d for a breakdown)

III.1.3 Augmentation of Natural Enemies for Control of *Cyperus rotundus* (AS 97-3-c)

a. Scientists: M.C. Casimero, E. Martin, S.R. Obien - PhilRice; A.M. Baltazar, F.V. Bariuan - UPLB (NCPC); A. Watson, M. Mabbayad - IRRI; S.K. DeDatta - Virginia Tech

b. Status: New research

c. Objectives: To (1) evaluate selected natural enemies of *C. rotundus* as potential biocontrol agents, and (2) monitor, collect, mass-rear, and evaluate *Athesapeuta cyperi* (curculionid) and *Bactra venosana* (tortricid), two natural enemies of *C. rotundus* as biocontrol agents.

d. Hypotheses: Natural enemies are cost-effective biological control agents against *Cyperus rotundus*.

e. Description of research activity: Natural enemies have been observed and collected from *C. Rotundus* in farmer-cooperators' fields. They will be mass-reared in the laboratory and evaluated for efficacy in field trials. Insects will be mass-reared on artifical diets as described in the literature. Reared larvae and adults will be released into caged potted *C. Rotundus* plants.

f. Justification: Successful augmentative biocontrol methods have been developed against *Cyperus* spp. in other countries. Use of biocontrol methods will broaden farmers' weed control options to help minimize continued reliance on single methods involving herbicides or hand weeding.

g. Relation to other research activities at the site: Data from the pest survey and monitoring activity show that weeds serve as alternate hosts of many insects, plant pathogens and nematodes. Of these, attention will be focused on mass-rearing of *Bactra* (a moth) and *Athesapeuta* (a weevil) for subsequent evaluation in field trials. This activity is part of the study on management of *C. rotundus.*

h. Projected outputs: (1) Establishment of mass-rearing techniques for *Athesapeuta* and *Bactra,* and (2) determination of the potential to augment these natural enemies to control *C. rotundus.*

i. Projected impact: Reduction in the use of direct control methods involving hand weeding and herbicides.

j. Start: September, 1996

k. Projected completion: September, 1997

l. Projected person-months of scientist time per year: 2-3 person-months

m. Budget: PhilRice/NCPC/IRRI: $2,750 (See Appendix Table 4a for a breakdown)
Virginia Tech: $894 (See Appendix Table 4b for a breakdown)

III.2 Host Suitability Studies in *Meloidogyne graminicola* (AS 97-3-d-2)

a. Scientists: J.C. Prot, E. Gergon - IRRI; R. Gapasin - PhilRice; J. Halbrendt - Penn State

b. Status: Continuing research

c. Objective: To determine the host status/suitability of different rice and vegetable cultivars to *M. graminicola*.

d. Description of research activity: Different rice and vegetable cultivars will be screened for their resistance or susceptibility to *M. Graminicola* under greenhouse conditions at IRRI. The plants will be grown in pots. Nematode inoculum using 24-hr old juveniles of *M. Graminicola* will be artifically applied into the soil. Plants will be evaluated 45-60 days after inoculation.

e. Justification: Knowledge of host suitability of different rice and onion cultivars would be useful for nematode control and crop selection in areas infested by *M. graminicola.*

f. Relation to other research activites at the site: This activity will be integrated into the other management strategies being tested for *M. Graminicola*, including rice hull burning, crop rotation, soil amendments and biological control.

g. Projected outputs: (1) Identification of possible sources of resistance for plant breeders and the development of resistant cultivars, and (2) identification of possible rotational crops.

h Progress to date: No rice variety has so far been found that is resistant to *M. graminicola*. Of the 26 other crops tested against *M. graminicola*, peanut, mungbean, and string beans have been identified as non-hosts. In addition, eggplant and pepper do not appear to be preferred. Of the 53 weed species studies, the majority of them appeared to be potential hosts of *M. graminicola,* especially *Cyperus, Echinocloa, Ischaemum, Monochoria, Protulaca, Sphenoclea, Trianthema, Amaranthus, Ageratum, Cleome*, and *Ludwigia*.

i. Projected impact: The use of host resistance for nematode control and a list of rotational crops in the rice-vegetable systems, giving farmers a choice of crop for their fields.

j. Start: September, 1995

k. Projected completion: September, 1998

l. Projected person-months of scientist time per year: 3 person-months

m. Budget: PhilRice/IRRI: $1,760 (See Appendix Table 4a for a breakdown)
Penn State: $1,200 (See Appendix Table 4c for a breakdown)

III.3 Characterization and Control of *Cyperus rotundus* Ecotypes (AS 97-3-e-2)

a. Scientists: M.C. Casimero, E. Martin, S.R. Obien - PhilRice; A.M. Baltazar, F.V. Bariuan - UPLB (NCPC); A. Watson, M. Mabbayad - IRRI; S.K. DeDatta - Virginia Tech

b. Status: Continuing research

c. Objectives: To (1) determine ecotypic variations in *Cyperus rotundus*, and (2) determine responses of *C. rotundus* ecotypes to herbicide treatments.

d. Description of research activity: Tubers of *C. rotundus* will be collected from farmer-cooperators' fields. They will be grown in pots from germination to maturity at two moisture levels: 1) flooded; and 2) saturated. Morphological, physiological and reproductive characteristics will be measured as follows: a) plant height; b) number of leaves, flowers, and tubers produced; and c) tuber sprouting and other characteristics related to fitness or adaptations of the ecotypes.

e. Justification: *Cyperus rotundus* has been identified from Activity 1 as one of the most serious weed problems threatening rice-onion fields for three reasons: 1) high densities (50 to 90%) of infestation in the vegetable rotation; 2) limited available control options in cropped fields; and 3) existence of increasing populations of a lowland ecotype in the rice rotation. Initial results from life cycle studies show that *C. rotundus* grown in flooded conditions are about 50% taller than those in saturated conditions. We need to know if these differences are merely morphological adaptations to changes in water management or if they represent two distinct ecotypes (lowland and dryland). If so, their fitness characteristics and their responses to control methods need to be studied.

f. Relation to other research activities at the site: In life cycle studies conducted in the previous year, a lowland ecotype of *C. rotundus* was found to grow much taller in flooded conditions, exhibiting morphological properties which differ from that of the existing dryland ecotype found in vegetable fields.

This study will characterize the properties of these ecotypes further in terms of growth, reproduction, and fitness. Data obtained will serve as basis for developing and evaluating control methods in the field studies.

g. Projected outputs: (1) Comparison of lowland and dryland ecotypes of *C. rotundus* in terms of growth and reproductive abilities, and (2) identification of potential control methods against *C. rotundus* ecotypes.

h. Progress to date: Initial results from life cycle studies show that *Cyperus rotundus* grown in flooded conditions were about 50% taller than those grown in saturated conditions (upland). Tubers of *C. rotundus* collected from four farmer-cooperators' fields were grown in pots at two moisture levels (saturated and with 3-5 cm standing water). Plants from two of the fields were taller by 47% when grown in saturated soil and by 62% when grown in flooded soil, than plants from the other two fields. Tubers from the taller plants were also 50% bigger and heavier. It appears that an ecotype of *C. rotundus*, which grows taller and with bigger tubers in flooded conditions than the upland ecotype, occurs in two out of four fields at the San Jose site. Differences in growth and morphology were more distinct when the plants were grown in flooded soil than when grown in saturated soil, implying that *C. rotundus*, previously confined to upland conditions, is increasingly adapting to flooded conditions.

i. Projected impact: Reduced populations of *C. rotundus* in both crops (rice-vegetable rotations), hence, reduced weed control inputs/expenses.

j. Start: September, 1995

k. Projected completion: September, 1997

l. Projected person-months of scientist time per year: 2-3 person-months

m. Budget: PhilRice/NCPC/IRRI: $2,415 (See Appendix Table 4a for a breakdown)
Virginia Tech: $1,532.40 (See Appendix Table 4b for a breakdown)

IV.1 An Analysis Inter-Generational and Gender Differences and Social Network that Impact Pesticide Use and IPM Adoption (AS 97-4-a-3)

a. Scientists: WID Director and G. Norton- Virginia Tech; I. Tanzo, T. Paris, K.L. Heong - PhilRice/IRRI

b. Status: Continuing research

c. Objectives: To conduct (1) data analysis of the 1995-96 survey on inter-generational and gender differences in pest management decision making and in knowledge and attitudes relevant to IPM and Pesticide use, and (2) focus group study of social networks and institutional linkages that influence gender differentiated pesticide and IPM use.

d. Hypotheses: (1) There is no difference between male and female decision making related to pest management, (2) age does not influence pest management decision making, (3) certain members of the community serve as centers of influence in spreading pest management information, and (4) credit institutions, cooperatives, and other institutions influence pest management decisions.

e. Description of research activities: Statistical analysis of social and gender data from inter-generational and gender differences survey will be completed. Differences between male and female and between young and old farmer decisions on pest management, in terms of how they decide on pest management practices and why they use particular practices, will be tested. Differences in knowledge and attitudes about pests, beneficials, and pest damage to rice and onions due to thrips, *spodoptera* and bulbrot will also be tested. For the study on social networks and institutional linkages, focus group and participatory appraisal methods will be used in each of the six San Jose barangay targeted by the IPM CRSP. A comparison will be made with selected barangay in Bongabon to explore why the latter have been more progressive, including the role of opinion leaders and the National Onion Growers Cooperative Marketing Association (Nogrocoma).

f. Justification: An important objective of the IPM CRSP is to identify the existing conditions with respect to village or local social structure, including the influence of gender, class, age and ethnicity that determine learning and adoption of IPM technology. Concern for inter-generational transfer of resources to ensure a sustainable natural resource base is reflected in the growing efforts to explore IPM alternatives to intensive pesticide use. It is essential to learn about local communities' inter-generational decision making, knowledge, and attitudes towards long-term impacts of pesticides as compared to other pest management approaches. Knowledge of the impacts of social networks and institutional linkages are important for designing training programs to increase adoption of IPM practices developed on the CRSP. Incentives and barriers to IPM adoption are shaped by the influence of key opinion leaders and of institutions that are operative in the social environment.

g. Relation to other research activities at the site: The proposed inter-generational/gender research activities will complement the on-going biological research by increasing likelihood of technology adoption. The social network and focus group analysis will provide information about the social dynamics and institutions influencing pesticide use and IPM.

h. Projected outputs: (1) Information on decision making by gender and age in San Jose, (2) information on the institutional influences on farmer decisions related to pesticide use and IPM adoption, (3) information to help market IPM among farmer groups.

i. Progress to date: Survey of 100 households in six barangay completed on household decision making with respect to pest management, segregated by gender and age during 1996.

j. Projected impacts: Increased adoption of IPM practices in Nueva Ecija.

k. Start: September, 1994

l. Projected completion: September, 1997

m. Projected person-months of scientist time per year: 2 person-months

n. Budget: PhilRice: $3,740 (See Appendix Table 4a for a breakdown)
Virginia Tech: $15,132 (See Appendix Table 4b for a breakdown)

IV.2 Effects of Pesticide Regulations, Credit, and Land Tenure on Farm Productivity and Pesticide Use (AS 97-4-b-2)

a. Scientists: D. Widowsky - IRRI; G. Norton - Virginia Tech; S. Francisco - PhilRice

b. Status: Continuing activity

c. Objective: To assess changes in farm productivity over the past six to eight years in the rice-onion system, the effects of pesticide regulations on that productivity, and changes in the marginal productivity of pesticides in that system. A second set of objectives is to examine the effects of borrowing and land tenure status on pesticide use.

d. Hypotheses: (1) Pesticide productivity on both rice and vegetables is declining over time, (2) total factor productivity has not declined despite selected pesticide bans, (3) increased use of credit through coops increases the demand for pesticides, and (4) the type of land tenure influences demand for pesticides.

e. Description of research activity: Seventy-five farmers were surveyed (1-3 parcels per farmer) over one rice and two vegetable seasons to gather information on all output and input quantities and prices as well as certain socio-economic characteristics. These data will be combined with five seasons of data collected in 1988-1990 and a cost function and input demand system estimated econometrically. A series of hypotheses will then be tested with this system.

f. Justification: The Fertilizer Pesticide Authority (FPA) has banned several pesticides. In addition, heavy use of pesticides may be influencing their efficacy and productivity. This study will provide information about farm and pesticide productivity that should be helpful to FPA in its deliberations on pesticide policy. If farm productivity remains the same despite the bans and if pesticide efficacy itself is declining, this implies that stricter pesticide policies may have environmental benefits without damaging farm productivity. The analysis of the effects of borrowing and land tenure on pesticide use will provide statistically valid information on whether institutional changes in the credit and land tenure areas might encourage reduced pesticide use and increased incentives to adopt IPM.

g. Relation to other research activities at the site: This activity will complement the activity on economic impact assessment because the data generated can be used to construct budgets in addition to estimating cost functions. Also, any information that will help in designing, incentive structures compatible with IPM adoption will complement the biologically-based IPM activities.

h. Projected output: Budgets calculated and cost function model estimated, hypotheses tested and article and report prepared.

i. Progress to date: Seventy-five farmers have been surveyed over one rice and two vegetable seasons and the data cleaned and files set up to run the cost functions.

j. Projected impact: Improved incentives to adopt IPM practices and reduced pesticide use.

k. Start: October, 1995

l. Projected completion: September, 1998

m. Projected person-months of scientist time per year: 8 person-months

n. Budget: PhilRice/UPLB/IRRI: $5,280 (See Appendix Table 4a for a breakdown)
Virginia Tech: $4,342 (See Appendix Table 4b for a breakdown)

IV.3 Economic Impacts of IPM Practices in the Rice-Vegetable System (AS 97-4-c- 2)

a. Scientists: G. Norton - Virginia Tech; S. Francisco - PhilRice

b. Status: Continuing activity

c. Objective: To evaluate and project impacts of IPM practices tested in multi-disciplinary field experiments (Section II) on household income and on society as a whole.

d. Hypotheses: (1) Each of the tested practices will be profitable for farmers; (2) each of the tested practices will generate net economic benefits to society as a whole once adopted.

e. Description of research activity: Budgets will be developed by crop for current and each of the alternative pest management practices being tested in field experiments on the CRSP. Changes in the cropping system will be assessed in determining changes in farm-household income with and without specific IPM practices being tested. Information generated on cost changes per unit of output will be combined with projections on the level and timing of adoption of the IPM practices and economic surplus analysis then used to project aggregate societal benefits.

f. Justification: Knowledge of farm-level profitability of IPM practices per hectare and per farm-household is essential in designing pest management recommendations. Knowledge of aggregate social benefits helps research directors and others assess the merits of specific IPM activities. If a specific IPM activity reduces pesticide use and has significant environmental benefits and is therefore socially profitable but is not privately profitable, this information can be useful to policy makers in designing tax, subsidy, or regulatory programs to encourage adoption of the IPM practices.

g. Relation to other research activities at the site: Other activities are underway to assess social and gender impacts of pest management activities. This activity complements those other activities as the estimated economic impacts can be distributed by family members and gender. The economic impact assessment provides feedback on the profitability of the practices being tested in the other workplan activities.

h. Projected outputs: Papers will be produced that summarize the economic impacts of the IPM activities.

i. Projected impacts: The results should influence decisions on which technologies to promote in training programs, on which IPM alternatives might justify further research, and on pest management policies and regulations.

j. Progress to date: A sample questionnaire for scientists has been developed but not yet administered.

k. Start: September, 1995

l. Projected completion: September, 1998

m. Projected person-months of scientist time per year: 2 person-months

n. Budget: PhilRice: $1,870 (See Appendix Table 4a for a breakdown)
Virginia Tech: $12,131 (See Appendix Table 4b for a breakdown)

IV.4 Environmental Impacts of IPM (AS 97-4-d-2)

a. Scientists: G. Norton - Virginia Tech; A. Rola - UPLB

b. Status: New activity

c. Objective: To estimate the economic value of the environmental benefits of IPM practices developed on the IPM CRSP.

d. Hypotheses: Filipinos place value on reducing environmental hazards associated with pesticide use.

e. Description of research activity: Hazard levels of the various pesticides used in Nueva Ecija will be identified for various categories of the environment (e.g. acute human health, chronic human health, ground water, surface water, etc.). Effects of IPM practices being tested in the field on pesticide use for those who adopt will be calculated. IPM adoption levels will be projected. A survey of households, stratified by income level will be used to estimate willingness to pay for hazard reductions for people with different levels of income. The results of the survey will be combined with information on pesticide use and hazard levels to calculate the economic value of the environmental benefits of IPM.

f. Justification: Environmental benefits are one of the two major reasons that IPM is being promoted in the Philippines. It is essential to estimate what the environmental benefits might be as we assess the impacts of the program.

g. Relation to other research activities at the site: The IPM technologies being developed through biological research will create the potential for significant productivity gains and reductions in pesticide use. The evaluation of the benefits of those technologies must be an integral part of their development. Consequently the IPM activities evaluated will be the same areas being tested in field trials on the project.

h. Projected outputs: Outputs expected are (1) tables that classify pesticides into hazard levels with respect to several environmental categories, (2) estimates of the willingness to pay to reduce environmental hazards, and (3) estimates of the economic value of the environmental benefits of specific IPM practices developed on the project.

i. Projected impacts: Changes in policies and regulations affecting pesticide use and encouraging IPM so that more environmentally-friendly pest management alternatives are encouraged.

j. Start: October 1, 1996

k. Projected completion: September, 1998

l. Projected person-months of scientist time per year: 6 person-months

m. Budget: PhilRice/UPLB: $4,910 (See Appendix Table 4a for a breakdown)
Virginia Tech: $27,456 (See Appendix Table 4b for a breakdown)

IV.5 Extension Agent and Farm Worker Training

a. Scientists: V. Gapud, L. Sanchez - PhilRice; A. Baltazar - NCPC; E. Rajotte, J. Halbrendt - Penn State.

b. Status: New Activity

c. Objective: To (1) develop training materials based on IPM CRSP results to date, and (2) conduct a workshop for agricultural technicians and farm leaders from the six project Barangay around San Jose.

d. Description of research activity: Training materials will be developed--overheads, slides, and handouts--to be used in a one-day workshop with key people who influence pest management behavior of farmers in the region. These materials will also be available for inclusion in small presentations in other training programs organized by PhilRice.

e. Justification: Training sessions can help spread the results of IPM CRSP research to farmers and provide feedback to project scientists. They also increase awareness among farmers about the project and the need for IPM.

f. Relation to other activities at the sitre: The training materials and presentation will draw upon the results of IPM discoveries during the first three years of the project.

g. Projected outputs: (1) IPM training materials, (2) completed workshop for roughly 20 participants.

h. Projected inputs: (1) increased awareness of IPM around San Jose, (b) increased application of IPM principles and practices, (c) reduced pesticide use and increased production of vegetable crops.

i. Start: September 1996

j. Projected completion: September 1998

k. Projected person-months of scientist time: 3 person-months

l. Budget: PhilRice/NCPC: $2,000 (See Appendix Table 4a for breakdown)
Penn State: $4,000 (See Appendix Table 4c for breakdown)

Fourth Year Workplan for the Jamaica Site

I. Monitoring and Analysis (JA 97-1)

a. Scientists: C. Edwards, J. Reid, H. Warren, R. Ravlin. S. McDonald, D. McGlashan, F. Eivazi, H. Harrison.

b. Status: Continuing research

c. Objectives: The Objectives of this activity are (a) to identify and monitor the insect pests and diseases of peppers, Callaloo, and sweet potato; (b) to analyze the soils and crops for pesticide residues.

d. Description of research activity: This is continuation of work started in 1995 and continued through 1996.

e. Justification: The pesticide residue assessment will provide base measurements which the success of progressive development of IPM on the crops can be measured. Introduction of vegetable-virus identification methods to Jamaican scientists through training will enhance their capability in this area. Investigation of possible relationships between pest incidence and cropping systems will aide in selection of proper farming systems which reduces pest incidence and pesticide use.

f. Projected outputs: (1)Data on pesticide residues in the target crops will indicate measures that should be taken to use IPM to decrease the levels of contaminants in food, (2) techniques developed in Jamaica will be applied to other sites where viruses are constraints to crop production, and (3) identification of proper cropping system for the growth of target crops will reduce dependance to pesticides, and will reduce costs which will make farming profitable and sustainable.

g. Projected impacts: Reduced pesticide use by farmers in in Jamaica, reduced loss of crop due to pests and viruses, and specific impacts by sub-activity are listed in the sub-activity descriptions below.

h. Start: October 1994

i Projected Completion: October 1997

j. Projected person-months of scientist time per year: Listed under sub-activities.

I.1 IPM in Hot peppers, Callaloo, and Sweet Potatoes to Minimize Use of Pesticides (JA 97-1-a)

a. Scientists: C. Edwards - OSU; J. Lawrence and J. Reid - CARDI

b. Status: Continuing research activity

c. Objectives: (1) to continue studies on pesticide residue in callaloo, hot peppers, and sweet potatoes and soils, (2) to advise on setting up a pesticide residue laboratory in Jamaica and prepare a proposal 3) to train Jamaican staff in pest and predator sampling methods and residue analyses 4) to continue collaborative studies of effects of nutrients on pest incidence.

d. Hypotheses: (1) pesticide residue in callaloo, hot peppers, and sweet potatoes are at levels that will lead to rejection in the market, (2) residue testing is hindered by absence of a residue testing laboratory and by lack of trained personnel, (3) levels of certain plant nutrients are exacerbating pest levels.

e. Description of research activity: Market samples of the three vegetables and soils will be analyzed for a range of commonly used pesticides. A proposal will be developed for equipping a pesticide residue lab in

Jamaica. A 2-day training workshop in Jamaica on plant and soil pest sampling methods for CARDI and other staff will be held. Three vegetables will be sampled for a range of pests and their enemies to assess the influence of nutrients on their numbers and effects.

f. Justification: The pesticide residue studies will provide an initial baseline for vegetable contamination by pesticides, and enable us to trace falling residue levels progressively, as the IPM CRSP continues and leads to decreased pesticide use. The training in pest sampling methods will facilitate ongoing on-site programs.

g. Relation to other research activities at the site: The pesticide residue studies are in collaboration with the studies on relationships between nutrient status and pest and natural enemy incidence.

h. Projected outputs: Knowledge of levels of contamination by pesticide residues in Callaloo, sweet potatoes and hot peppers. Provision of capability for residue analyses in Jamaica. Familiarity with appropriate pest sampling methods by CARDI and other local staff.

i. Progress to date: Pesticide residues in callaloo, hot pepper, and sweet potatoes were analyzed from 15 market basket samples taken in September 1995. The main contaminant found was diazinin, at comparatively high levels but other organophosphates were also present. Further basket samples taken in May 1996 have not yet been analyzed. A study was made to test the incidence of pests and predators in relation to the nutrient levels in callaloo and hot pepper. The soils from 11 fields were analyzed for the amounts and forms of nitrogen, phosphorus and potassium. There was a statistical significance between total pest numbers and N and between numbers of sucking pests and N for callaloo. In sweet potato, there were negative correlations between numbers of total pests and sucking pests and P.

j. Projected impacts: Lessen pesticide use in Jamaica. Promote IPM.

k. Start: September, 1995

l. Projected completion: September, 1997

m. Projected person-months of scientist time per year: 1.5 (plus graduate student 2.0).

n. Budget: Ohio State: $31,189
CARDI: None

I.2 Spatial and Seasonal Dynamics of Pest and Natural Enemy Complexes on Callaloo (Amaranthus sp.), Peppers (Capsicum spp.) and Sweet Potato (Ipomoea batatas) (JA 97-1-b)

a. Scientists: D. Clarke-Harris, J. Lawrence - CARDI; R. Martin, H. Reid, D. McGlashan - MINAG; P. Chung - RADA; D. Hutton, Althea Perkins - UWI; C. Edwards, M. Huelsman - Ohio State; L. Myers, S. Fleischer - Penn State

b. Status: Continuing research activity

c. Objectives: (1) Identify pest and natural enemy populations on callaloo, scotch bonnet peppers and sweet potato, (2) determine spacial and seasonal dynamics of pest and natural enemies on callaloo, peppers and sweet potato, and (3) assess economic loss attributed to pre- and post harvest factors.

d. Description of research activity: Collection and photographic documentation of pests, natural enemies and damaged symptoms/materials observed in the field will be continued. Insect specimens will be identified, preserved and immature reared where necessary. Soil and plant parts with possible nematode, fungal and viral infection will be isolated and identified. Monthly monitoring of pests and natural enemies by scouting and trapping mechanisms (traps, sticky, pheromone, pitfall) will be continued on selected farms in the research areas. Populations will be related to weather (temperature and rainfall) and crop phenology. Factors affecting cropping systems (i.e. fertility, nutrient levels, tillage, etc.) as well as economic loss assessments will be determined. The role of alternate hosts as reservoirs for pests and natural enemies will also be investigated.

e. Justification: From the research activities being conducted during years I-III, several yield limiting pests have been recognized on callaloo, scotch bonnet peppers and sweet potato. In order to effectively manage these pests and therefore reduce yield losses. It is necessary to understand the spatial and seasonal changes in the pest populations so that the most suitable times to implement control measures can be ascertained.

f. Relation to other research activities at the site: The activities conducted in year IV will be in part continuation of activities conducted during years II and III. Further determination and refinement of the spacial and seasonal dynamics of pest and natural enemy populations will assist in validating the most suitable time to introduce potential control tactics.

g. Projected outputs: (1) Improved capability to forecast and recommend IPM strategies for the researched crops, (2) a profile of crops phenologies, pests and natural enemies for callaloo, sweet potato and peppers, and (3) technology package- fact sheet series.

h. Progress to date: Pest and natural enemy populations on the selected farms were monitored. Major pests and natural enemies observed: Callaloo (leaf webber, mites and cucumber beetles, braconid wasps, coccinellids, hemipterans); Peppers (virus complex of tobacco etch and potato Y mites); Sweet potato (Cylas formicarius, sweetpotato weevil, spiders, coccinellids). The results have not yet been written up.

i. Projected impacts: Improved capability to forecast and recommend IPM strategies for the researched commodities.

j. Start: October, 1994

k. Projected completion: September, 1997

l. Projected person-months of scientist time per year: 14

m. Budget: CARDI and other Jamaican institutions, $36,630 (See Table 5a for a breakdown)
Ohio State: None
Penn State: None

I.3 IPM System for Pepper in Jamaica (JA 97-1-c)

a. Scientists: F.W. Ravlin, H.L. Warren - Virginia Tech; J. Reid - CARDI; S. McDonald - Jamaican graduate student at Virginia Tech

b. Status: Continuing activity

c. Objectives: To identify viruses contributing to reductions in pepper vigor and increased mortality; identify the vector(s) responsible for disseminating pepper virus(es) ; initiate the development of a bibliography of pepper diseases and disease vectors.

d. Description of research activity: As a result of this project we will identify viruses and virus vectors responsible for the decline and elimination of (in some locations), pepper production in Jamaica. This research will also initiate the development of an IPM program for pepper viruses.

e. Justification: As a result of two participatory workshops held in Kingston, Jamaica peppers and associated diseases and insect pests were identified as high priority problems to be addressed by the IPM CRSP.

f. Relation to other research activities at the site: Jamaican farmers often grow a combination of crops including hot peppers, vegetable amaranth (callaloo), and sweet potato. The disease/vector research methods developed for peppers will be applicable to other crops grown in Jamaica.

h. Projected outputs: Identification of pepper diseases (viruses) occurring in research sites; identification of disease vectors occurring in research sites; electronic bibliography of pepper diseases and disease vectors.

i. Progress to date: Established the national IPM network with five regional servers, purchased and established a workstation to serve www materials, conducted workshop on viruses in Jamaica, and assisted with or obtained laboratory chemicals and equipment for virus research in Jamaica.

j. Projected impacts: If successful this season this research will result in pest identification that in turn will result in our ability to develop an IPM system for peppers in Jamaica. This system should then be transportable to other Carribean countries.

k. Start: September, 1994

l. Projected completion: September, 1997

m. Projected person-months of scientist time per year: 12

n. Budget: Virginia Tech: $21,141
CARDI: None

II. Field Experimentation and Component Research (JA 97-2)

a. Scientists: D. Clarke-Harris, D. McGlasham, R. Martin, H. Reid, J. Lawrence, M. Pereira, J. Lindsay, J. Reid, D. Hutton, P. Chung - CARDI and other Jamaican institutions; C. Edwards - Ohio State; F. Eivazi, D. Marsh, D. Sasseville - Lincoln; D. Fery, F. Harrison, J. Thies, J. Bohac - USDA; J. Reid will be the leader.

b. Status: Continuing research

c. Objectives: The objectives of this activity are to (a) develop the species composition of pest and natural enemies in the major crops, (b) to determine cost effective and IPM compatible weed management tactics (c) to evaluate accessions of Scotch Bonnet peppers currently being grown in Jamaica for resistance to root-knot nematodes, (d) to determine the influence of nutrient management and varietal selection on pest incidence and yield loss.

d. Description of research activity: Different management tactics will be tested in replicated trials on select farmers' fields and on station (CARDI); greenhouse, and laboratory experiments will be conducted at Lincoln University for nutrient analysis and fertility research for Peppers and Callaloo; greenhouse tests will be conducted at USDA-ARS to evaluate the Scotch Bonnet pepper cultivar grown in Jamaica for root-knot nematode.

e. Justification: Effective management practices for weed control, cultivar and nutrient applications will reduce the incidence of pests and diseases and reduce pesticides use while increasing the yields.

f. Projected outputs: Development of effective management practices and recommendation to farmers using fact sheet series and technical bulletins.

g. Projected impacts: Improved capability to forecast and recommend IPM strategies for researched commodities and reduced pesticide usage.

h. Start: October, 1994

i Projected completion: October, 1997

j. Projected person-months of scientist time per year: Listed under sub-activities.

II.1 Integrated Pest Management of Callaloo, Peppers and Sweet Potato (JA-97-2-a)

a. Scientists: D. Clarke-Harris, J. Lawrence (CARDI), R. Martin, H. Reid, D. McGlashan - MINAG; P. Chung - RADA; D. Hutton - UWI; L. Myers, Shelby Fleischer - Penn State; R. Ferry, H. Harrison, J. Theis, J. Bohac - USDA

b. Status: Continuing activity

c. Objectives: Identify and evaluate potential control measures to manage yield limiting pests of callaloo, scotch bonnet peppers and sweet potato.

d. Hypotheses: Treatment of infested planting material with Carbaryl can protect sweet potato roots from sweet potato weevil; correct timing pesticide applications will improve the management of callaloo pests more effectively than calender spraying; utilizing Dual and Scythe to manage weeds within callaloo cropping systems will be more cost effective and less time consuming than hand weeding.

e. Description of research activity: The potential of the chemical insecticide Carbaryl will be evaluated as a potential control tactic to manage sweet potato weevil populations and protect sweet potato storage roots. At planting, slips will be treated with Carbaryl at 1.12 and 0.56 kg ha-1 for 30 minutes. Crop will be grown to reflect current farming practices. At harvest, storage root protection will be assessed as previously stated. Experimental design is randomized complete block with five replications, 450 plants per treatment (including guard rows). The correct timing of application of Methomyl, Cyhalothrin and Bacillus thuringiensis will be evaluated. Pesticide applications will be based on recommended rates and at an action threshold determined from the previous experiment. Pest incidence and damage levels are to be assessed conducted at three day intervals and crop loss assessments once per week. Experimental design is randomized complete block with seven replications, 60 plants per treatment. The evaluation of Dual and Achthe herbicides as an alternative to hand weeding for callaloo production will be determined. Dual will be applied at transplanting and Scythe will be applied between the rows when needed. The time taken for the application of the herbicides and hand weeding will be recorded and compared. Weed composition and density will be determined by visual counts and total marketable yield per treatment record at harvest. Experimental design is randomized complete block with 5 treatments, 4 replications, 50 plants per treatment.

f. Justification: Within the research areas, farmers depend largely on chemicals to manage pests. This dependency has resulted in frequent pest outbreaks, incidence of poisoning, environmental pollution and residues on marketable produce. Identifying and evaluating environmentally sound control measures which improve yield and farmer income is critical. In addition, the training of farmers in the judicious use of pesticides will be important for the successful introduction of IPM within the communities.

g. Relation to other research activities at the site: Information generated from the evaluation of potential management tactics will be pooled with the information from the monitoring and analysis, socioeconomic and policy analysis and information systems components to design and implement cost effective IPM package tailored to each research community.

h. Projected output: IPM component suitable for use on the research crops; technology package- fact sheet series.

i. Progress to date: Initiated field evaluation of pre-planting dips, pheromones and botanicals as potential control tactics for managing sweet potato pests. Initiated selection and field evaluation of pesticides (Cyhalothrin, Methomyl, Bacillus thuringiensis) for managing callaloo pests. The preliminary data indicate that there are clear differences among the treatments. The data are now being analyzed to rank the pesticides in relation to their performance and refine the action threshold which was previously used.

j. Start: October, 1995

k. Projected completion: September , 1997

l. Projected person-months of scientist time per year: 17

m. Budget: CARDI and other Jamaican instutions: $38,170 (See Table 5a for breakdown)
Penn State: None
USDA: None

II.2 Analysis of the Impact of Cropping Systems Upon Pest Incidence, Damage Levels and Management (JA 97-2-b)

a. Scientists: J. Reid, J. Lindsay, J. Lawrence, D. Clarke-Harris, R. Martin - CARDI; H. Reid; Technical Assistants: P. Myers, O. James, D. Simpson; Collaborating institutions and scientists: P. Chung, V. Edwards - RADA; D. McGlashan - MINAG Boldes; E. Guise, A.C. Allen Paulett Lyons - AEPS; B. Ravlin, Herman Warren - Virginia Tech; C. Edwards, M. Huelsman - Ohio State; S. Fleischer, G. Greaser - Penn State; F. Eivazi, D. Marsh, D. Sasseville - Lincoln Univ.

b. Status: Continuing activity

c. Objectives: (1) Establish seasonal or spacial trends in cropping system, (2) assess the effect of different social and economic needs upon selection and management, (3) investigate possible relationships between pest incidence and cropping patterns, (4) identify possible interventions that would reduce losses due to pests, enhance farm productivity and increase farmer income, and (5) select and test at least one possible set of IPM options.

d. Hypotheses: Knowledge of cropping systems, social and economic needs will assist in the implementation of IPM tactics to reduce pesticide use in Jamaica and to increase farm profitabilty.

e. Description of research activity: This study will continue to collate and analyse the information produced in the individual studies for the major crops and target areas. It will refine the agroecological maps initially developed in year 3. Other areas of the island will have been identified for which the information generated at different sites can be extrapolated within Jamaica and eventually in other CRSP sites. The determination of major trends in crop-livestock combinations that currently exist or that will be acceptable will continue to be of paramount importance. The factors which influence the choice of these nominations and the effect that these have on pest levels, degree of loss and possibilities for IPM interventions will be further evaluated. Based upon already available data, attention will also be directed at refining any numerical relationships that would describe pest/natural enemy/crop interactions that could be used as a basis for prediction of loss and the improvement in the farmer decision-making process. Hence the study will also depend upon cost of production and farm budgeting data being generated to facilitate the determination of the cost-benefit of practices to be proposed. Cost determination must also include a quantification of social costs. The analysis will thus contribute significantly to the data-base that will be a major product of this programme and, equally, will provide valuable indicators of the most feasible IPM components that could be tested. Some of these changes would depend upon the information generated by acceptability ratings for resistant varieties of the target crops and the role of specific weeds as reservoirs of pests or natural enemies. The final activity will, in consultation with farmers and other major collaborators seek to devise a set of IPM practices that could be tested in one pilot area.

f. Justification: In Jamaica, as in many other developing countries, farmers cultivate a mix of crops, sometimes including livestock. The sustainability of an IPM approach will depend upon the appropriateness and practical feasibility of practices that are to be emphasised or recommended. IPM strategies must therefore depend upon an improved understanding of the integrated farm system and the impact of different practices upon pest incidence and crop loss. The importance of a community-based approach to ensure sustainability in IPM and limitations in available funding make it imperative that information generated or collected is structured in a manner that would facilitate extrapolation to areas outside of the limits of study sites.

g. Projected output: Map of agrogeological zones; seasonal calenders providing: graphical and descriptive accounts of seasonal changes in crop combinations and relative importance, graphical and descriptive accounts of changes in production and marketing practice (inclusive of pest management practices), graphical and descriptive accounts of changes in other household practices; mathematical relationships between pest incidence-damage- crop loss; mathematical cost-benefit relationships for different control tactics.

h. Progress to date: Documented information on cropping systems of the research crops (photographs, specimen collections, reports). Based on the information collected, farm plans, profiles and crop calenders for all research farms being monitored were developed.

i. Projected impacts: (1) Improved farm productivity, and (2) improved timing for pest management practices; (3) more rational pesticide use.

j. Start: September, 1995

k. Projected completion: September, 1997

m. Projected person-months of scientist time per year: 7.5

n. Budget: CARDI and other Jamaican instutions: $9,776 (See Appendix Table 5a for workplan)
Virginia Tech: None
Ohio State: None
Penn State: None
Lincoln: None

II.3 IPM Research in Hot peppers, Callaloo and Sweet Potato with a Focus on Fresh Market Production (JA 97-2-c)

a. Scientists: S. Fleischer, G. Greaser - Penn State; J. Lawrence, R. Reid, and J. Reid CARDI

b. Status: New research

c. Objectives: (1) Evaluate resistance levels in certain insects and develop strategies to combat resistance, (2) evaluate new chemicals for control of pests on the target crops, (3) aid Jamaica site in statistical analysis and sampling methodology and analysis, and (4) continue budgetary and export cost studies of callaloo, hot pepper and sweet potatoes.

d. Hypotheses: It is essential to know the level of resistance as part of understanding the reason why certain species exhibit pest status. The hypothesis is that the *Spodoptera spp*. infesting callaloo harbor resistance, whereas the *Diabrotica* and other beetles are susceptible to relatively low dosage of the chemicals currently used by farmers. It is hypothesized that the pest status of the susceptible species are driven, in part, by repeated reintroduction associated with nearby refugia. However, the pest status of the *Spodoptera spp* is complicated by pesticide resistance. Also, it is hypothesized that the virus complex infesting hot pepper is caused, in part by aphid transmission in the early stages of growth. The rapidity of action and systemic activity of the newer nitroguanidine materials will slow the rate of virus transmission using very low rates.

e. Description of research activity: Collaborative studies will be initiated by PSU and CARDI on determining resistance levels on several of the key pests and develop strategies to prevent continued increase in levels of resistance in our target crops. Field collected insects of uniform life stage will be caged in bioassay conditions that expose the pest to log dosages (plus an untreated control) of up to two pesticides currently used by farmers. At least four dosages will be evaluated within a range that is linear in a logit-log dose scale for each material. Probit or logit analysis will be conducted after Abbott's correction for mortality in the controls. Studies will be initiated to test new chemicals such as imidacloprid as a treatment in the nursery to prevent the spread of disease and to implement vector control. This material is extremely safe and can be applied at very low rates. These tests will be initiated using a new nursery stock, applying imidacloprid at 0.001 to 0.i g ai/root ball (plus a control), with a minimum of 10 plants per treatment. Treated material will be evaluated for phytotoxicity. Statistical assistance can be provided by PSU in collaboration with CARDI biometrician. Data will be analysed as a completely randomized design using ANOVA. Field collected aphids will also be exposed to leaf material from the control and treated plant material at sequential times to evaluate longevity of activity. The final modeling of the budgets for callaloo, peppers and sweet potato will be completed.

f. Justification: The vector control studies are very important in the short run to slow down or reduce the incidence of disease especially in the hot peppers, while longer range tactics are being developed. At the same time it is important to develop strategies to reduce the incidence of resistance. The cost of production emphasis is basic to pest management.

g. Relation to other research activities at the site: These studies relate to all of the other research studies and interaction is possible.

h. Projected outputs: These studies produce tactics that can be used in implementation of sound IPM programs in the target crops and also produce information that can be used in other crops.

i. Projected impacts: Provide pest management programs for the target crops that are economical, environmentally sound and socially acceptable.

j. Start: October, 1996

k. Projected completion: September, 1997

l. Projected person-months of scientist time per year: 1.5

m. Budget: Penn State: $11, 854
CARDI: None

II.4 Effect of Soil Fertility and Varietal Selection on Vegetable Amaranth (Callaloo) Performance and Pest Incidence (JA 97-2-d)

a. Scientists: F. Eivazi, D. Marsh, D. Sasseville - Lincoln; J. Lindsay - CARDI; C. Edwards - OSU; P. Chung - RADA; D. McGlashan - JMA

b. Status: Continuing activity

c. Objectives: To (1) Conduct greenhouse and field experiments to test the effect of fertilizer rates on growth, yield, nitrate and protein content of callaloo and monitor for pest and disease incidence, (2) inventory locally grown varieties, their growth cycles, and resistance to major diseases, (3) test new cultivar of amaranth for adaptability to Jamaican growth and climatic conditions and, (4) extend information on superior varieties to the local growers through on-farm demonstration trials.

d. Hypotheses: Nutrient deficiency can be the cause of weaker plants which reduces the plant resistance to diseases and insect attack. It is hypothesized that selecting locally grown varieties which are genetically superior for disease resistance and following a sound soil fertility program will increase the growth and vigor of the plants, in turn making them more resistant to diseases.

e. Description: Field and greenhouse experiments will be conducted to evaluate the effect of rates and kinds of fertilizer on growth, disease resistance and yield of callaloo. Fertilizer source will be superphosphate, potassium chloride, and ammonium nitrate which will be applied at the rates of 200 kg/ha N; 268 kg/ha P; and 86 kg/ha K. These fertilizers will be applied either as broadcast and mixed with soil or as a slurry. In the field, plants will be placed 18" apart in a 36" rows with four replications. The design of the experiment is randomized block with a total of 28 plants per replication. During the experiment, data on visual observations for pest and disease incidence will be collected along with other information on growth and vigor. Plant leaf samples from these experiments will be tested for nitrate and protein content.

f. Justification: Edible amaranths are protein-rich annual, herbaceous dicotyledons of worldwide distribution. Their use in tropical agriculture as a vegetable or as a grain has been well documented. Amaranth has shown potential as an alternative grain crop in the Midwestern regions of United States. Amaranth produces an abundance of small seeds high in protein and well balanced in amino acids compared to other cereal crops. Also, amaranth can be utilized as a food grain, and animal feed, and has potential for industrial uses. In Jamaica, amaranth is grown widely by small farmers for local consumption or export. At this time, Jamaican farmers use large quantities of pesticides to control pests and diseases of callaloo. Integration of disease resistant and/or short-season varieties in the cropping system of Jamaica may offer a welcome alternative to the use of pesticides and help reduce the problem of pesticide residue in this export crop.

g. Relation to other research activities at the site: The proposed activity will be built on the work already done by Lincoln University scientists and other IPM-CRSP teams working in the country. Objectives 1 and 3, will entail data collected at Lincoln University and objective 2 will entail data gathered by CARDI, and objective 4 will come from on-farm trials conducted in Jamaica.

h. Projected outputs: Identification of nutrient elements that are limiting the yield of callaloo; determination of fertilizer rates required to produce optimum growth and yield; a list of recommended cultivars of callaloo for Jamaica that are capable of overcoming yield losses due to diseases; and growers acceptance of recommended varieties.

i. Progress to date: Analysis of soils and plant tissue samples were completed and summarized. The results indicated that Phosphorus is the most limiting nutritional constraint to crop production in Jamaican soils. Therefore, growth chamber studies were designed to determine the source, rates and method of phosphorus application. Scotch Bonnet (*Capsicum chinese)* plants were grown in Jamaican soils for six weeks. Treatments included: (1) superphosphate and calcium nitrate as nitrogen source; (2) superphosphate mixed with ammonium sulfate as nitrogen source; (3) control with no fertilizer applied. Plant fresh and dry weight data were collected. The fertilizer application methods included mixing of fertilizers with soil and comparing the results with a slurry method in which fertilizer was applied in slurry form. The above experiment was also conducted in the field in Jamaica and is ongoing at this time. Preliminary data indicate that there are obvious treatment differences in growth and pest incidence of Scotch Bonnet peppers due to fertilizer rates and application methods.

j. Projected impacts: Increasing yield of callaloo by application of proper kinds and rates of fertilizers without accumulation of large concentrations of nitrate which are not desirable in food products; decrease in disease incidence of the crop due to healthy and vigorous growth; promotion of disease resistant varieties to reduce farmer dependence on pesticides, thus reducing both production costs and environmental pollution; reduction of pesticide use which will also reduce the amount of residues found in this export crop.

k. Start: October, 1994

l. Projected completion: September, 1997

m. Projected person-months of scientist time per year: 6 (includes graduate student).

n. Budget: Lincoln: $32,000
CARDI: None
Ohio State: None

II.5 Integrated Pest Management Components for Vegetable Crops (Pepper and Sweetpotato) (JA 97-2-e)

a. Scientists: R.L. Fery, H.F. Harrison, Jr., J.A. Thies, J.A. Bohac -ARS-USDA; J. Reid - CARDI

b. Status: Continuing activity

c. Objectives: Initiate a breeding program to develop root-knot nematode (*Meloidogyne incognite)* resistant habonero-type pepper (*Capsicum chinense)*; initiate a study to determine the inheritance of root-knot nematode resistance in C. *Chinense*; continue evaluation of root-knot nematode resistant bell pepper (C. *annuum)* breeding lines and various C. *chinense* lines in Jamaica for adaptability, horticultural traits, and yield; initiate studies to evaluate M. *Incognita* resistant Scotch Bonnet peppers for resistance to other *Meloidogyn*e species; initiate studies in Jamaica to identify the *Meloidogyne* species and races present in CARDI/USDA pepper and sweetpotato plots; continue the development of herbicide use methodologies for weed control in pepper using the back-pack sprayers,weed wipers, and other simple equipment available in Jamaica; develop and extension publication on how to use inexpensive equipment to apply herbicides to small acreage vegetable plantings; cross select cream-fleshed sweetpotato lines in a field polycross nursery, harvest seed, and evaluate first year seedlings in greenhouse test for reaction to root-knot nematodes and *Fusarium* wilt; evaluate clones developed from first and second year seedlings and select advanced breeding lines of cream-fleshed sweetpotatoes in field tests for storage root yield, horticultural traits, and resistance to root-knot nematodes, diseases, and insects; evaluate select advanced sweetpotato lines in a greenhouse test to confirm resistance to root-knot nematodes and *Fusarium* wilt; and continue efforts to compare the yield, culinary quality, and insect and disease resistate traits of select USDA cream-fleshed sweetpotato clones to those of standard Jamaican sweetpotato cultivars.

d. Hypotheses: Cultivars with resistance to targeted pests and diseases can form the cornerstone of an effective IPM program. Simple, inexpensive equipment, e.g. back-pack sprayers and weed wipers, can be used to apply safe and effective herbicides to the small acreage vegetable plantings.

e. Description of research activity: F2 populations derived from crosses between various root-knot nematode susceptible Habanero pepper cultivars and a root-knot nematode resistant Scotch Bonnet pepper cultivarewill be evaluated in greenhouse tests for resistance to root-knot nematodes. Resistant plants will be selected and grown to maturity and seed from plants with acceptable horticultural characteristics will be harvested (R. Frey and J. Thies). All the hand-crossing and seed increases needed to develop the populations (Parental, F1, F2 and backcrosses) required to study the inheritance of root-knot nematode resistance in C. *Chinese* will be completed and efforts will be initiated to evaluate plants from each population for resistance to root-knot nematodes (R. Frey and L. Thies). USDA- developed root-knot nematode resistant bell pepper breeding lines and select C. *chinense* accessions will be evaluated in Jamaica for adaptability, horticultural traits and yield (D. Hutton, D. McGlashan, J. Reid, J. Lawrence, R. Frey and J. Thies). Scotch Bonnet peppers with confirmed resistance to M. *incognita* will be evaluated in replicated greenhouse tests for resistances to M. *hepla* and M. *Javanica* (J. Thies and R. Frey); differential hosts (seed of host cultivars provided by the USDA will be used to identify the Meloidogyne spp. and races present in Jamaican pepper and sweetpotato field plots (D. Hutton, and J. Thies). Replicated field experiments will be conducted in South Carolina and Jamaica to evaluate various selective herbicides and application methodologies for controlling weeds in peppers (H. Harrison, J. Reid, and J. Lawrence). An easy to understand "how to" publication will be prepared to assist Jamaican farmers in how to use inexpensive equipment to safely and effectively apply herbicides (P. Chung, and H. Harrison). Cream-fleshed sweetpotatoes with multiple resistance will be crossed in a field polycross nursery (J. Bohac) and the resulting seedlings will be evaluated in a greenhouse test for resistance to root-knot nematodes and *Fusarium* wilt (J. Thies and J. Bohac). Clones of select first and second year seedlings and select sweetpotato breeding lines will be evaluated in field tests at Blackvill, SC. for yield, quality, and disease and nematode resistance and at Charltseon, SC for insect resistances (J. Bohac and J. Thies). Select advanced sweetpotato lines will be evaluated in a replicated greenhouse test to confirm resistances to root-knot nematodes and *Fusarium* wilt; and select multi-pest resistant cream-fleshed USDA sweetpotato clones and select Jamaican sweetpotato cultivars will be compared in replicated field tests for yield, culinary quality and insect, nematode, and diseases resistances (D. McGlashan, R. Blake, D. Hutton, J. Reid, J, Lawrence, J. Bohac, and J. Thies).

e. Justification: Root-knot nematodes and weeds are widely recognized as yield-limiting pests of peppers. *Fusarium Oxysporum* f. *batatas,* insects, and root-knot nematodes are widely recognized as yield limiting pests of sweetpotato. Implementation of IPM methodology for these crops would reduce agricultural losses, reduce damage to the ecosystem, and reduce pollution and contamination of water and food supplies.

f. Relation to other research activities at site: The overall purpose of the research activities proposed above is to identify pest control methodologies that can be used as components of integrated pest management programs for controlling pests of two of the targeted crops at the Jamaican site. Previous research at the U.S. vegetable Laboratory suggests that the following approaches are potentially useful in the proposed IPM programs: host plant resistance in pepper to root knot nematodes; host plant resistance in sweetpotato to root-knot nematodes, insects, and *Fusarium* wilt; and the utilization of inexpensive equipment to apply safe and effective herbicides to control weeds. This proposal includes the continuation (2nd year) of on-site research in Jamaica to test the merits of various proposed IPM components.

h. Projected outputs: Identification of the germplasm and the development of the genetic information and methodology needed to develop pest resistant pepper and sweet potato cultivar; the identification or development of pest resistant peeper and sweetpotato cultivar that are potentially suitable for commercial production in Jamaica; the development of improved, effective, and inexpensive methods foe controlling weeds in Jamaican pepper and sweet potato plantings.

i. Progress to date: The research findings are as follows: 1) the existence of high levels of root-knot nematode resistance in three accessions of Scotch Bonnet type C. *chinensis* germplasm was confirmed. 2) No resistance to root-knot nematode was found in *Habanero* type C. *Chinensis* germplasm. 3) the root knot nematode tolerant C. *annuum* cayenne pepper accession PA-136 is not suitable for utilization in a rotation scheme, nor would it be a suitable substitute for a resistant cultivar. The resistance to root-knot nematodes exhibited by the C. *annuum* cultivar Carolina Cayenne was demonstrated to be exceptional. 5) results of preliminary tests indicated that some hybrid pepper cultivars (C. *annuum*) are tolerant to the herbicide bentozon. 6) several advanced dry-fleshed sweetpotato clones were confirmed to be highly resistant to both southern root-knot nematodes and *Fusarium* wilt, and to have high yield potential and excellent culinary quality.

j. Projected impacts: Development of key components of IPM programs suitable for use on pepper and sweetpotato plantings in Jamaica. The successful development of IPM programs will lessen the dependence of Jamaican agriculture on pesticides, and will reduce losses to diseases, nematodes and weeds.

k. Start: October, 1994

l. Projected completion: September 1997

m. Projected person-months of scientists time per year: USDA-ARS, 3.0; CARDI, 1.2

n. Budget: USDA: $38,724
CARDI: None

III.1 Sociological and Gender Analysis of Pest Managemrnt Practices

a. Scientists: A. Perkins - CARDI; M. Bertelsen, E. Robins, WID Program Director - VA Tech

b. Status: Continuing Activity

c. Objectives: To assess the impact of IPM practices upon household income and gender relations. Specifically, the research program calls for indentifying current pest management practices, including indigenous knowledge, and the social organization of the household economy; and, through monitoring changes in agricultural practices and household economic organization, evaluating the impact of change upon household well-being and its distribution among household members.

d. Hypotheses: (a) IPM raise the level of household well-being, (b) IPM alters the distribution of well-being within the household.

e. Description of research activity: The research will 1) characterize the communities of IPM partners; 2) collect and analyze socio-economic baseline data; 3) monitor changes in income and expenditure patterns; 4) institute a program of continuous farmer evaluation of IPM activities; 5) identify policy issues for future research; and 6) describe more completely the differences between high export and low export producers.

f. Justification: Knowledge of the household economy is essential to the successful introduction of IPM innovations, particularly insofar as any change requires tradeoffs in resources and how they are managed and used. The relations between men and women also will be affected by change processes and need to be monitored to safeguard equity in development. Reducing pest incidence and the use of pesticides may increase the profitabilty of farming, yet not all producers will benefit in the same way. The differences among producers which determine their success at employing IPM must be ascertained to spread the benefits of IPM equitably.

g. Relation to other research activities at the site: A program of biological research is underway in the same communities where the sociology research is conducted. Sociology and gender analysis will inform biological research of factors which may speed-up or slow down the adoption of innovation.

h. Projected outputs: Document on site characterizations; working paper on farmer evaluation of activities; working paper on the gender dynamics of household production.

i. Progress to date: Draft versions of site characterizations have been prepared; draft questionnaire for baseline survey has been prepared.

j. Projected impacts: The results of this research will clarify policies to be further researched; promote the spread of IPM by identifying the characteristics of adopters; improve the biological research program through feedback from farmer evaluations; promote gender equity.

k. Project start: September, 1994

l. Projected Completion: September, 1998

m. Projected person-months of scientist's time: 4 person months

n. Budget: Virginia Tech: $22,858 (See Appendix 5e for a breakdown)
CARDI: $2,000

Fourth-Year Research Activities for the Africa Sites

Introduction: Fourth-Year IPM activities in Mali will continue to emphasize the field testing of various indigenous and exogenous control practices that affect crop production and post-harvest storage. Close farmer participation in the redesign and evaluation of proto-typical pest management technologies will be retained and expanded through continuous participatory evaluation. The strong socio-cultural knowledge base that has been established will be used to integrate, evaluate, and further refine technology development to maximize adoption of IPM CRSP technologies.

I. *Pest Management and Field Experiments During Crop Production*

1.1 Assessment of Introduced and Natural Measures for Management of Insect Pests of Millet, Sorghum, and Horticultural Crops (Af-97-1)

a. Scientists: G.K.Touré,S.Haoua-IER;R.Edwards-Purdue; J. Caldwell - Virginia Tech.

b. Status: Continuing activity

c. Objectives: The objectives under this heading are (a) to continue systematic field assessments of pests and losses associated with these pests through field monitoring activities and ecological analyses, and (b) to conduct a series of field trials in which appropriate interventions are assessed against traditional practices. These experimental activities in most cases continue experimental efforts that focus on priority crops and pests that emerged from the participatory appraisal and biological and socioeconomic baseline studies. In several cases they represent modifications of past field work indicated from farmer participatory evaluation of the field trials and the collective knowledge of the Mali Site Team.

d. Objectives, Hypotheses, Programs, and descriptions for Subactivities

1.1.1. Pest Monitoring (AF-97-1-a)

a. Objective: To study the population dynamics of meloides (*Psalydolytta* spp. and *Rhinyptia infuscata*), other pest insects, and beneficial insects in millet and fallow fields. Progress: Results of light trap monitoring in 1995 indicated that a new meloide species, *Rhinyptia infuscata*, that has begun to enter Mali from Niger, had higher numbers than *Psalydolytta* spp.

b. Hypothesis: Pest insect populations indicated by the light traps will be higher in early millet fields than in late millet fields, and lowest in fallow fields.

c. Activity Description: Light traps will be installed in three types of fields (souna early millet, sanyo late millet, and fallow), and insects collected and counted daily from June to early December.

1.1.2. Neem in Millet (AF-97-1-6)

a. Objectives: (1) To evaluate the effectiveness of azadirachtin extracts prepared using two neem extraction methods for the control of blister beetles (*Psalydolytta* spp.) and grasshoppers (*Diablolocatantops axillaris* and *Oedaleus senegalaisis*) on millet; and, (2) to determine the economic threshold for application of village-produced neem extract.

b. Progress: First-year results in 1995 indicated that there were significant treatment-by-village interactions, with the control having higher blister beetle counts than the average of the three methods in the Sirakorola villages. The two neem treatments had lower counts than the sanitation treatment in Sirakorala, but results were not consistent in Mourdiah. No differences were found between Azatin and village-extracted neem.

c. Hypothesis: Neem extraction using village materials will be as effective in reducing blister beetles and increasing millet yield as the GRAT press, and the higher threshold will give adequate blister beetle control with less cost in time and amount of neem required.

d. Activity Description: Four treatments will be compared on 4 farms per village in 5 villages (Koroma, Oussibibougou, and Dontiéribougou in the Sirakorola zone; Koïra and Douabougou in the Moudiah zone):

(1) farmer control (no neem)
(2) neem extraction prepared using GRAT press, applied at biological threshold (2 meloides/head)
(3) neem extraction prepared using village materials, applied at biological threshold (2 meloides/head)
(4) neem extraction prepared using village materials, applied at twice the biological threshold (4 meloides/head)

A second treatment will be applied if third instar grasshopper nymphs appear.

Plot size will be 25 m x 25 m per treatment, with data taken from 5 sampling areas per plot. Farms will be treated as replications within villages, villages treated as a design factor in a hierarchical design, and treatment by village interaction assessed. Differences among treatments, villages, and treatment by village interactions will be assessed by orthogonal contrasts.

Counts will be made on 75 heads per treatment at 24 hr before treatment and 24 hr, 48 hr, and 7 days after treatment. Damage to heads and yields will also be assessed. Labor and materials costs will be recorded for each neem extraction method and economic benefit assessed by partial budgets (in collaboration with agricultural economists).

1.1.3. Sorghum/millet association as trap crop (AF-97-1-c)

a. Objective: To evaluate the effectiveness of sorghum as an intercrop in providing associational resistance and reduction of blister beetle damage on millet. Progress: This trial replaces maize as a trap crop tested in 1995. In addition to maize seed source problems in 1995, this change of trap crop has been done based on farmer evaluation, which indicated a reluctance to use maize as a trap crop due to its importance as a household-field food crop in the hungry period.

b. Hypothesis: There will be less blister beetle damage in the sorghum/millet intercrop than in pure millet.

c. Activity Description: Three treatments will be compared on 4 farms per village in 3 villages in the Sirakorola zone: (1) pure millet; (2) pure sorghum; (3) sorghum/millet intercrop. The same plot sizes and type of experimental design will used as described above in the experiment using neem on millet (1.1.2 above). Counts will be made on 75 heads per crop per treatment when blister beetles reach the biological threshold in a treatment; the other treatments will be counted at the same time even if they have not reached the threshold. Damage to heads and yields will also be assessed.

1.1.4. Ecology: Natural vegetation as a refuge for insects pests and natural enemies(AF-97-1-d)

a. Objective: To assess types of dipteran, other beneficials, and pest insects in vegetation where blister beetles and grasshoppers nymphs emerge.

b. Progress: This is the second year of this activity. Only above-ground insects will be monitored in 1996. Monitoring of ground insects done in 1995 has been dropped due to small catches and agent workload.

c. Hypotheses: An association exists between types of vegetation cover and prevalence of blister beetles and grasshoppers.

d. Activity Description: In each village, farmers will identify areas where blister beetles andgrasshoppers frequently emerge. Two areas will be selected in each village and 4 locations randomly selected in each area for sampling. Samples will be collected by above-ground sweep netting every other week from June to September. The two most dominant species of natural vegetation will be identified at each location.

1.1.5. Neem on women's tomato (AF-97-1-e)

a. Objectives: (1) To assess types and frequency of pesticide usage in women's garden crops; (2) To assess types and numbers of pest insects in women's dry season tomato; and, (3) To evaluate the effectiveness of azadirachtin extracts prepared using two neem extraction methods for the control of grasshoppers (*Diablolocatantops axillaris* and *Oedaleus senegalaisis*) on tomato seedlings.

b. Hypothesis: Neem extracts will reduce grasshopper nymph damage on tomato.

c. Activity Description: Three treatments will be compared in 4 women's tomato plots per village in one village each in the Sirakorola and Moudiah zones:
(1) farmer control (no neem)
(2) neem extraction prepared using GRAT press, applied when grasshopper nymphs appear in the plot
(3) neem extraction prepared using village materials, applied when grasshopper nymphs appear in the plot

Women’s vegetable gardens typically have many irregular beds within a fenced enclosure, so exact plot sizes will depend on each women’s garden’s layout. In general, plots should be on the order of 1-2 m x 10-15 m per treatment. Each women's garden will be treated as a replication with in the village, and treatments, villages, and village by treatment interactions assessed using a statistical design and methods similar to the neem trial (section 1.1.3) described above.

Counts will be made on 10 plants per treatment at 24 hr before treatment and 24 hr, 48 hr, and 7 days after treatment. Damage to plants and yields will also be assessed.

d. Justification: The participatory assessment conducted in July 1994 indicated that blister beetles and grasshoppers are the two highest priorities for farmers of millet and sorghum. Farmer evaluation of year 2 trials indicated strong interest in village extraction of neem. Biological damage thresholds have been identified for blister beetle control, but economic thresholds have not been established for neem application. Sorghum is not a preferred host intercropping sorghum with millet may provide associational resistance for millet, a preferred host. Women farmers' responses in the 1994 PA, interaction with women farmers during the 1995 season, and responses by women non-collaborators in the year 2 farmer evaluation all indicated that horticultural pests are a high priority for women farmers. Observations by horticulture researchers based at Baguineda indicate that pesticides are more frequently used on horticultural crops than on cereals, and that pesticide mis-usage is widespread.

e. Relationship to Other CRSP Activities at Site: Economic evaluation of treatments will be compared with results of the socio-economic baseline survey to assess potential acceptability. Sociologist team members will investigate diffusion networks within and across collaborating households in the village.

f. Expected Outputs: Better understanding of the timing of appearance of millet and sorghum insect pests and natural enemies. Reduction in losses of cereal yield due to blister beetles and grasshoppers. Better understanding of the timing of appearance of horticultural crop insect pests. Identification of pesticide misuse on horticultural crops.

g. Expected Impacts: Introduction of village-based neem extraction and sorghum/millet intercropping will provide villagers with the means to protect sorghum and millet from loss due to blister beetles and grasshoppers, and thereby increase food supplies for household consumption and sale. Introduction of a safe natural pesticide for horticultural crops will increase the production of these crops important for their nutritional value, and reduce health hazards to farmers and consumers.

h. Start: January 1997

i. Projected Completion: September 1997

j. Projected Person-Months of Scientist Time per Year: 6 months

k. Budget:

IER:	$18,425 (see table 6a for a breakdown)
Purdue:	$13,755 (see table 6e for a breakdown)
VirginiaTech:	$9,439 (see table 6d for a breakdown)

1.2. Integrated Striga Trials (AF-97-2)

a. Scientist: B. Dembélé-IER; J. Caldwell-Virginia Tech.

b. Status: Continuing activity

c. Objective: Continuation of integrated striga trials with yield/loss assessment of trial components.

d. Progress: This trial is a continuation of the 1995 trial. Results from 1995 are discussed in the Justification section below.

e. Hypotheses: (1) Combinations of striga control practices will reduce striga infestation and increase yield more than the sum of the effects of individual control practices; (2) Striga-resistant sorghum varieties will reduce striga infestation and increase sorghum yield.

f. Activity Description: Striga research will focus on two strategies for striga control. An integrated striga management trial for millet/cowpea will combine striga-resistant cowpea in an alternate row arrangement with millet and use of organic matter. Striga-resistant sorghum varieties will also be tested. Both trials will be tested in more villages, to provide a broader assessment of the strategies. Plot sizes, replications, and experimental design will use methods similar to the neem trial (1.1.3 above).

g. Justification: Striga is a critical pest species in Mali,ranked third by farmers in the 1994 PA. While considerable research has been done on individual components of striga control, these components had not been tested together in an integrated management approach until the year 2 trials in 1995. In 1995, combinations of components gave highest yields in all 3 villages, but which combination was highest was not consistent across villages. The farmer evaluation revealed both constraints associated with each component, and positive farmer evaluation of the performance of the components in combination.

h. Projected Output: Determination of which combinations give more consistent results,and development of recommendations for extension.

i. Projected Impact: Reduced losses due to striga and improved yields for target crops.

j. Start: July 1996

k. Projected Completion: October, 1997

l. Projected Person-Months of Scientist Time: 2 months

m. Budget: IER: (included in 1.1)
Virginia Tech: None

1.3 Disease Surveillance and Monitoring (AF-97-3)

a. Scientists: L. Tigana, D.M. Diakité-IER, H. Warren-Virginia Tech

b. Status: New activity

c. Objective: Surveillance of occurences of crop diseases,alternate host weeds, and natural enemies within and between crops in the millet/cowpea and sorghum/cowpea systems in the Mourdiah and Sirakorola research sites.

d. Hypotheses: Disease can be correlated with alternate hosts and natural enemies.

e. Activity Description: This activity consists of a systematic assessment of the occurrence and severity of crop diseases, weeds as alternate hosts, and natural enemy identification, in relation to crop phenology. Monitoring techniques such as spore traps, soil analysis, direct visual observations, and other monitoring techniques will be used as appropriate. Additional Specific Activities: (1) Seed and seedbed management will analyze soil from seedbeds, seeds and randomly isolate suspected diseased plants before and after planting; (2) Presence of seedborne diseases by incidence and severity per field seed weight; (3) Presence of foliar diseases by number of plants infected and severity of disease. (4) For cowpea data will be collected on number and severity of wilts and leaf diseases and incidence of seedborne diseases.

f. Justification: Although diseases were not specified by farmers during the 1994 PA as priority problems, later preliminary analyses have established the high incidence and damage from certain pathogens with both field and stored grain.

g. Projected Output:Identification of major pathogens of sorghum millet and cowpea; prioritization of major pathogens by field loss; development of alternative controls to reduce diseases of sorghum, millet, and cowpea. Behavioral changes by farmers including disease monitoring protocols and disease management decision criteria.

h. Projected Impact:Reduced losses due to pathogens and improved yields for target crops. Farmer recognition of major field crop pathogens.

i. Projected Start: July 1997

j. Projected Completion: November 1997

k. Projected Person-Months of Scientist Time: 1 month

l. Budget: IER: (included in 1.1)
Virginia Tech: $5682 (see table 6a)

1.4. Uganda Monitoring and Field Trial Implementation (A1-97-4)

a. Scientists: S. Kyamanywa-Makarere; V. Okoth-NARO; H. Wilson, M. Erbaugh-Ohio State

b. Status: Continuing activity

c. Objectives: (1) To refine and continue monitoring of pest complexes of selected crops implemented by farmer associations; and, (2) to implement and assess IPM technologies specified during the 1995 PA and by local researchers.

d. Activity Descriptions:

1.4.1 Continuation of Pest Monitoring by Farmers

Monitoring of pests by farmers as a continuation of year 4.

Progress: To date, three out of four farmer monitoring groups have been able to monitor and collect data on pest complexes of priority crops in each of the two districts. An evaluation of this exercise was conducted in July 1996, and comments and suggestions by farmers will be used to refine the effort.

1.4.2 Uganda Field Implementation and Validation of IPM Technologies

Groundnuts:

a. Activity 1: Field trials on groundnuts will be replicated on 5 farmers' fields per farmer association (total=20). Treatments in plots 8 X 10 meters, will compare farmer practices (farmer seed and seeding density) with recommended IPM package (higher seeding rates and the use of rosette resistant varieties);

b. Hypothesis: The recommended IPM package for groundnuts will reduce incidence of rosette disease and increase yields more than farmer practices;

c. Activity 2: Field trials on groundnuts will be conducted one Varietal Testing Center (VTC) per district. This trial will compare component technologies in four side-by-side treatments, each 8 x 10 meters:
(1) farmer control;
(2) increased seed density
(3) use of rosette resistant varieties;
(4) increased seed density and rosette resistant varieties.

d. Hypothesis: (1) The combination of higher plant population densities and rosette resistant varieties will reduce the incidence of rosette and increase yield more than the effects of individual control practices; (2) Increased plant population density and rosette resistant varieties will have lower incidence of rosette disease and higher yields than farmer control.

Integrated Striga Management for Sorghum:

e. Activity 1: Field trials on sorghum will be replicated on 4 farmers' fields per farmer association in Kumi (total=8). Treatments, in plots 8 X 10 meters, will compare farmer practices (farmer seed and no fertilizer) with recommennded IPM package (use of nitrogen and striga resistant variety). Fields will be selected for trials where striga is present.

f. Hypothesis: Recommended IPM practices will reduce the incidence of striga and increase yields as compared to farmer practices.

g. Activity 2: Three fields will be selected where striga is present. Three treatments, 8 X 10 meters, will be applied to each including: (1) repeated sorghum planting; (2) planted cotton (trap crop); (3) fallow.

h. Hypothesis: The fields planted to sorghum as on cotton; and lowest on fallowed fields.

Incidence of Stalk Borer on Maize:

i. Activities: Ten farmers in Iganga, 5 having fields in mono-cropped maize, 5 in intercropped maize will be selected for intensive stalk borer scouting. Fields will be scouted during the growing season to determine incidence and damage attributed to stalk borer in each system.

j. Hypothesis: Stalk borer incidence and damage will be higher in mono versus intercropped fields.

Post Harvest Technology Demonstration Trails for Cowpea and Beans:

k. Activity: Following cowpea harvest in Kumi and bean harvest in Iganga Districts, 5, one litre samples will be taken from one farmers' storage in each of the four cooperating farmers' associations. Each sample will receive a different treatment: (1) a control with only stored grain; (2) a sample stored and packed tightly in the pod; (3) a sample mixed with 1 part ash and 6 parts cowpea; (4) a sample mixed with 3 parts ash and 4 parts cowpea*; (5) a sample that is solar heated*; The demonstration experiment will be explained to groups of farmers at the time of sample extraction, and other storage practices suggested. Samples will be opened and examined 3-4 months after storage.

l. Hypothesis: Post harvest controls recommended by theBean/Cowpea CRSP will provide more effective control than indigenous practices; (1) Controls suggested by the Bean/Cowpea CRSP will be effective on beans as well as cowpeas.

* These methods have been tested by the Bean/Cowpea CRSP and found to be efficacious (Kitch et. Al., 1992).

m. Justification: The participatory assessment conducted in Uganda in 1995 suggested priority crops, pests, and indigenous pest management interventions. These have been compiled, and along with ideas suggested by scientists, combined into a series of field trials. Trial implementation will help screen and refine potential IPM technologies. On-farm trials will emphasize farmer participation and facilitate dessemination of technologies.

n. Relationship to other IPM CRSP Activities: Several of the ideas and methods to be used in Uganda in Year 4 come from the primary sub-Saharan research site Mali. Uganda thus provides an opportunity for confirmation and/or redesign of these methodologies. Also several ideas have come from other CRSPs including Bean/Cowpea, INSORMIL, and Peanut CRSPs.

o. Expected Outputs: (1) Further integration of local farmer associations into the research and development of IPM technologies; (2) Development of indigenous pests threshold levels; (3) Initiating the development of cost-effective control practices for major pests.

p. Expected Impacts: Reduced damage by insect and weed pests, increased yield and economic benefits for priority crops.

q. Projected Start: January 1997

r. Projected completion: December 1997

s. Budget:

Makerere and NARO:	$31429 (see table 6b for breakdown)
Ohio State:	$5641 (see table 6c for breakdown)
VirginiaTech:	$5683 (see table 6d for breakdown)

II. *Post Harvest IPM*

2.1 Development of Village-Based Neem Products (AF-97-5)

a. Scientist: G.K. Touré-IER; F. Dunkel-Montana State

b. Status: New activity

c. Objectives: To explore various processing parameters for producing an improved village-level neem product.

d. Hypotheses: (1) Certain conditions of heat and light (that could be experienced in the 4 villages) are deleterious to maintaining the activity of the village-produced neem extract; (2) The efficacy of the locally produced neem can be improved if formulated with natural, locally available surfactants.
Activities: (1) Evaluating the effects of heat and light on neem extract. This analysis will initially be conducted in the Montana State University (MSU) laboratory; (2) Improving the efficacy of locally produced neem by formulating it with natural, locally available surfactants.

e. Justification: There has been considerable interest expressed by farmers in the use of neem products. However, local conditions that may have deleterious effects on neem extract and the use of various materials to improve the immiscibility and uniformity of the extract formulation are not known.

f. Relationship to Other IPM CRSP activities: Development of inexpensive, locally available products for pest control will contribute to all major goals of the IPM CRSP and to the Mali Site.

g. Expected Outputs:(1) Identification of parameters that will affect neem extract. (2) Improvement of locally produced neem formulated with locally available surfactants.

h. Expected Impacts: Development of an improved, locally available, inexpensive neem product for field and post-harvest pest control.

i. Start: October 1996

j. Projected completion: August 1997

k. Projected Person-Months of Scientist Time: 2 months

l. Budget: IER: $6252 (see table 6a for a breakdown)
Montana State: $7182 (see table 6f)

2.2 Post Harvest Monitoring and Control (AF-97-6)

a. Scientists: G.K. Touré-IER; F. Funkel-Montanna State

b. Status: Continuing activity

c. Objectives: The objectives are to continue monitoring post harvest quality during the storage season; and, to demonstrate and evaluate efficacy of various post-harvest technologies.

d. Activity Description:

2.2.1 Monitoring post harvest quality over entire storage season for cowpeas, sorghum, and millet.

All stored grains will be analyzed using sieves with farmers. Aliquots of the same sample will be analyzed by the technicians in the laboratory at IER for moisture, internal infestation of molds, percentage by weight of damaged grain/cowpeas, and percentage by weight of foreign material.

2.2.2 Locally available neem extract will be evaluated as a residual postharvest protectant for long-term storage (6 months).

a. Hypothesis: Locally produced neem kernel extract and leaf preparations protect cowpeas during storage. (To be experimentally tested in the laboratory at MSU; this part of the workplan was begun in year 3 as part of a M.S. thesis [D. Jenkins] underway at MSU with parallel, non-US AID funding.)

b. Activities: Develop a protocol for evaluation of the sensory acceptablilty of the neem treated cowpeas. For this portion of the workplan, the Food Technology Laboratory of IER will be consulted. Develop a protocol for farmer evaluation of the locally produced neem products for cowpea protection postharvest.

To complete most of the above objectives for 2.0., a 2-stage experiment will be conducted. During the first stage, we will determine the EC_{95} (effective concentration to control 95% of the target insect population) for each of the natural, locally available materials. These materials will include: sand, leaves of neem, locally produced oil of neem, ashes, leaves of *Ocimum canum,* and possibly a physical change in the structure such as plastic sacs and /or other structure that provides a controlled atmosphere. The data analysis for this portion of the experiment will be probit analysis.

The procedures for the EC_{95} for neem extract were developed in the laboratory at MSU during year 3. The EC_{95} for village-produced Malian neem extract has been obtained in year 3 with non-Malian *C. maculatus.* This procedure will be repeated with Malian *C. maculatus* in year 4.

The second part of the experiment will consist of each of these test treatments at the EC_{95} level. The control for this experiment will be Phostoxin (aluminum or magnesium phosphide). Phostoxin will also have been tested with in the EC_{95} portion of the experiment. The statistical analysis of this portion of the experiment will ANOVA and comparison of means.

2.2.3 Storage technologies

a. Hypotheses: Test the hypothesis that storage technologies developed/modified by the Bean/Cowpea CRSP are appropriate, efficacious, and show a high probability of adoption in the Mali context. Triple bagging (Kitch and Ntooukam, Bean/Cowpea CRSP Technical Bulletin 3) and solar drying (Ntoukam and Kitch, Bean/Cowpea CRSP Technical Bulletin 2) are storage technologies developed by the Bean/Cowpea CRSP.

b. Activities: These activities will be evaluated in the laboratory beginning summer 1996 and on-farm trials beginning November 1996 with newly harvested cowpea. These alternatives will be evaluated for the opportunity/costs it provides Malian producers in the 4 villages. It will also be compared for efficacy with other alternatives and with the current traditional cowpea storage practices in theses villages. Farmers will evaluate in 'Storage Days' in each village. At these times we will open and analyze a destructive sample from each of the alternative procedures.

c. Justification: Initial evidence from the Year 2 and 3 monitoring of postharvest storage suggest that stored grain losses are substantial. Assessing various technologies to reduce postharvest losses will improve the food security of local people.

d. Projected Output:Identification of major postharvest pests of sorghum, millet and cowpea and the evaluation of various technologies to reduce postharvest losses.

e. Projected Impact: Reduced losses due postharvest pests and improved food security for village inhabitants.

f. Start: October 1994

g. Projected Completion: June, 1997

h. Projected Person-Months of Scientist Time: 2 months

i. Budget: IER: (included under 2.1)
Montana State: $7025 (see appendix table 6f)

III. *Socioeconomic/Gender Analyses related to pest management*

The objective of socioeconomic analyses are to continue to examine the linkage between social, economic, and gender factors of agricultural production and their impact on incidence of pests and adoption of alternative integrated pest management strategies.

3.1. An Economic and Gender Analysis of Integrated Pest Management in Mali (AF-97-7)

a. Scientists: O. Camara, M. Sissoko, H.Traoré-IER; D. Taylor, J. Mullen (graduate student), WID Director-Virginia Tech

b. Status: Continuing activity

c. Objective: To elicit farmers' attitudes toward risk and examine how those risk attitudes are correlated with socioeconomic variables.

d. Hypotheses: 1) Wealth is negatively correlated with risk aversion. 2) Women are more risk averse than men. 3) Individuals in the Mourdiah area are more risk averse than individuals in the Sirakorola area. 4) Risk aversion increases as the level of income at risk increases. 5) Risk aversion increases as the probability of the occurence of the least favorable scenario increases.

e. Progress: 1) A pilot experiment has been developed to evaluate the administrative feasibility (from the researchers' perspective) and conceptual accessibility (from the respondents' perspective) of the proposed experimental design. 2) Preliminary logistical arrangements for the administration of the full-scale experiments have been undertaken. 3) A series of preliminary interviews were conducted in each of the four project villages to determine characteristics of new technologies desirable to the farmers (i.e., the expected beneficiaries of the IPM-CRSP Mali activities). This information will help estimate the extent of farmer adoption of the techniques developed by the IPM-CRSP.

f. Activity Description: An experiment to elicit farmers' risk preferences that will consist of a series of trials in which subjects are asked to select among options with different expected payoffs and variances will be designed. To get a higher expected payoff one must accept a higher variance in income.

Real money will be used in "win-don't lose" games. Participants will receive a payoff when they "win" the game and will receive nothing when they lose. Each trial will consist of five games. The games will be based on different probability distributions. The procedure used will be one which extends the frontiers of risk assessment techniques.

Four trials will be conducted, each at different payoff levels. The choices each participant makes in these risky game situations will be a proxy for how they would make choices in similar risky situations. That is, their responses will give an indication of how risk averse each individual is. When analyzed against socio-economic characteristics, the results of the experiment will identify the characteristics of those most likely to adopt new technologies. This information will help the extension service make effective decisions regarding the allocation of its limited resources in the dissemination of IPM techniques. In addition, knowledge of the degree of risk aversion in rural areas, and how risk aversion varies across socio-economic groups will be valuable in the formulation of policy related to the rural population.

g. Justification: The IPM CRSP in Mali is currently developing integrated pest management techniques to control pests on sorghum, cowpea, and millet. These techniques include both pre- and post-harvest interventions. While considerable efforts are being put into their development, the question remains, "Who, if anyone, is going to adopt these new techniques?"

The adoption of new technologies is risky. In the absence of insurance markets, producers must bear these risks themselves. Producers' decisions to adopt will depend on their individual attitudes toward risk, and on the risk-related attributes of the technology being considered. (Relevant risk-related attributes of an agricultural technology may include the expected yield when the technology is used, the variance of the technology's yield, and the probability yields will fall below a "disaster level" if the technology is adopted.) By identifying those most likely to adopt new technologies, the magnitude and distribution of the short-run economic benefits of the IPM CRSP project can be estimated.

h. Relationship to other CRSP activities at the site: The IPM technologies being developed and adapted for use in Mali, can be evaluated from a risk perspective to assess whether they are likely to be adopted, and who is most likely to adopt them. Makan Fofana of IER is a member of the student's Ph.D. committee.

i. Expected Outputs: Ph.D. dissertation in Agricultural and Applied Economics from Virginia Polytechnic Institute and State University, and associated publications.

j. Expected Impacts: Those pest management techniques that are found to be viable will be recommended for dissemination. Policy implications for research, extension, infrastructure, education, subsidies, and so forth will be drawn.

k. Projected Start: August, 1994

l. Projected Completion: December, 1997

m. Projected Person-Months of Scientist Time: 6 months

n. Budget: IER: $5,721 (see table 6a for a breakdown)
Virginia Tech: $32,402 (see table 6d)

3.2 Marketing (Af-97-8)

a. Scientists: O.Camara, M.Sissoko, H. Touré-IER; H. Willson, M. Erbaugh-Ohio State; D. Taylor, J. Mullen-Virginia Tech

b. Status: New activity

c. Objective: To determine social and economic factors that affect the use of agricultural inputs and the sale of agricultural outputs.

d. Hypotheses: 1) The amount of land under agricultural production is positively correlated with the number of members in the production unit and the use of each of the following: chemical inputs, manure, animal traction. 2) The unit price received for an agricultural product is positively correlated with the number of units sold. 3) Agricultural inputs are not purchased with credit.

e. Activity Description: A series of factors are hypothesized to affect the purchase of agricultural inputs and sale of agricultural products including the price, quantity, source, geographical proximity, market linkages, gender, and socioeconomic level of the individual. Market information regarding these purchases and sales will be collected on a monthly basis by field agents over the course of a year. This information will be collected on 10 individuals, 5 men and 5 women, per research site, who are representative of the socioeconomic strata of the sites.

f. Justification: These factors are related to those that will affect the adoption of integrated pest management technologies. Thus they will aid in the assessment of the economic value of IPM interventions and information on price variability will help with risk analyses. Knowledge of factors that influence farmer innovativeness will assit technology diffusion programs and the design of future IPM trials.

g. Projected Outputs: A more comprehensive understanding of input and product markets including pesticide availability and factors affecting their use and associated publications.

h. Projected Impacts: Enhanced capacity to diffuse improved technological inputs to increase agricultural production and improve food security; evaluation of the impacts of the IPM CRSP.

i. Projected Start: September, 1996

j. Projected Completion: December, 1998

k. Projected Person-Months of Scientist Time:2 months

l. Budget: IER: (included in 3.1)
Ohio State: none
Virginia Tech: none

3.3 Gender analysis of IPM Practices in Mali (AF-97-9)

a. Scientists: K. Gamby, H. Sissoko-IER; WID Director, Virginia Tech

b. Status: Continuing activity

c. Objective: To (1) conduct analysis of labor and financial implications of proposed IPM technologies by gender, (2) analyze gender implications of risk and marketing activities on the project, working with economics graduate student.

d. Hypothesis: IPM practices influence labor and income allocations within the household.

e. Description of Research Activity: Gender differentiated effects of IPM technologies will be assessed through participatory appraisal and through analysis of previously collected survey data.

f. Justification: Impacts of new technologies by gender need to be assessed to safegaurd equity in development and to help increase chances of technology adoption.

g. Relations to Other Research Activities at the Site: This activity will focus on the specific technologies and other issues being addressed on the project.

h. Projected Outputs: Working paper summarizing participatory apprasial and conclusions from review of survey information. Development of methods for IPM gender analysis.

i. Progress to Date: A masters thesis is almost completed that is focused on household labor allocation patterns, the extent to which gender-differentiated constraints affect the degree of pest damage towomen's crops compared to men's, and the effects of gender-differentiated constraints on the attainment of allocative efficiency in agricultural production in two regions in Mali.

j. Projected Impacts: Increased adoption of IPM practices compared to adoption without considering gender implications of technologies.

k. Start: October 1994

l. Projected Completion: September 1998

m. Projected Person Months of Scientist Time: 2 months

n. Budget: IER: (included in 3.1)
Virginia Tech: $12,392

IV. *Continuous Participatory Evaluation (CPE)*

The dual objectives of participatory evaluation are to (1) facilitate enhanced interaction among farmers, researchers, and other stakeholders and (2) to raise awareness and increase diffusion of control methods that are being field tested.

4.1 Farmer Participatory Assessment of Year 3 Field Trials (AF-97-10)

a. Scientists: G.K. Touré, B. Dembélé, L. Tigana, D.M. Diakité, O. Camara-IER; R. Edwards-Purdue; J. Caldwell-Virginia Tech

b. Status: New Activity

c. Objective: To carry out a follow-up farmer participatory evaluation of field trials similar to that held in Year 3.

d. Activity Description: A collaborative on-site assessment of progress will be conducted in early January, 1997. Farmer collaborators and non-collaborators will evaluate the past year's field trials with IER researchers, field agents, and co-principal investigators from the U.S.

e. Time Frame: January, 1997

f. Projected Person-Months of Scientist Time: 2 months

g. Budget: IER: $ 4,763 (activities 4.1-4.4)
Purdue: none
Virginia Tech: none

4.2 Expanding Organizational Contacts (AF-97-11)

a. Scientists: IER

b. Status: New activity

c. Objective: To contact and involve representatives from active NGOs and other villages in each zone.

d. Activity: Active NGOs and nearby villages and representatives identified for participation in future field evaluation exercises.

e. Time Frame: April, 1997

f. Projected Person-Months of Scientist Time: 1 month

g. Budget: IER (see 4.1)

4.3 Participatory assessment of temporal pest and spatial pest incidence (Af-97-12)

a. Scientists: S.H. Touré, field agents-IER, R. Edwards-Purdue, J. Caldwell - Virginia Tech

b. Status: New activity

c. Specific Objectives: (1) To determine farmer perceptions of pest incidence and priorities for pest management at different points of time of the crop season; (2) to access farmer knowledge of spatial pest incidence; (3) to develop a methodology for farmer self-assessment, sharing of knowledge, and pest management planning.

d. Activity Descriptions: In-the-field training and demonstration will be done by researchers with the field agent to initiate identification and ranking pests of millet, sorghum, and cowpea at four times during the crop season: seedling stage, flowering, head formation, and maturity. Ranking results will be presented pictorially by field agents in an informal meeting of villagers.

The field agents will also note farmer's comments about fields where striga has been more prevalent, where grasshopper nymphs have emerged, and grasshopper or blister beetle adults are found on natural vegetation. The incidence and timing of these pests will be added to a map for use in the end-of-season evaluation and planning.

e. Time Frame: July, 1997

f. Projected Person-Months of Scientist Time: 1 month

g. Budget: IER: (see 4.1)
Purdue: $715 (See table 6e)
Virginia Tech: $5248 (see table 6d)

4.4 Stakeholder Field Assessment of Trials in Mali (Af-97-13)

a. Scientists: G. Touré, B. Dembélé, L. Tigana, D. M. Diakité, O. Camara, S.H. Traoré-IER; M. Erbaugh-Ohio State; H. Warren-Virginia Tech

b. Status: New activity

c. Objectives: On-site evaluation by other stakeholders and increased dissemination of pest management strategies developed by the IPM CRSP Mali Site.

d. Activity Description: To involve local extension agents, NGOs and other nearby village representatives in a one day field assessment exercise in each zone during the Year 4 growing season. Participants will visit collaborator trials where IER researchers will explain trials and farmers asked to evaluate trials in terms of their own perceptions of effectiveness, labor requirement, and overall cost.

e. Time Frame: September, 1997

f. Projected Person-Months of Scientist Time: 1 month

g. Budget: IER: (see activity 4.1)
Ohio State: $21324 (see table 6c)
Virginia Tech: none

4.5 Field Assessment of Trials in Uganda (Af-97-14)

a. Scientists: S. Kyamanywa-Makarere; J.P. Epieru, P. Takan, P. Esele, M. Twaha-NARO; H. Willson, M. Erbaugh-Ohio State

b. Status: New activity

c. Objectives: To evaluate and disseminate farmer monitoring activities and pest management strategies implemented during the previous growing season.

d. Activity Descriptions: (1) To involve local extension agents, participating NGOs and other nearby village representatives in a one day field exercise in each zone during the Year 4 growing season. Participants will visit collaborator trials where IER researchers will explain trials and farmers asked to evaluate trials in terms of their own perceptions of effectiveness, labor requirement, and overall cost. (2) To evaluate with participating farmers the farmer controlled monitoring activities.

e. Justification: Participatory research assessments and evaluations are by design to be continuous. CPE exercises are a proven method for promoting greater interaction between farmers, researchers, extension, and NGOs, and for increasing the opportunity that demonstrated technologies are promoted and adopted with conviction. These exercises will also help spread the ideas and experiences of the IPM CRSP to a broader audience thereby increasing project impacts.

f. Projected Output: Evaluation documents defined and refined, farmer contribution to the research and development process, identification of characteristics affecting adoption of IPM technologies, technology evaluation instrument and evaluation of the participatory research process. Increased farmer ability to access and collectively assess knowledge held by individual farmers. Development of a methodological repertoire for on-going, village-based participatory assessment and evaluation.

g. Projected Impacts: (1) enhanced involvement and interaction among farmers, researchers, extension, and NGOs. (2) expanded diffusion networks. (3) improved trial design for final year. (4) increased future adoption of IPM technologies and overall greater project impacts.

h. Projected Start and Completion: March 1987

i. Projected Person-months of Scientist time: 2 months

j. Budget: Makerere and NARO: $1500 (See Table 6b)
Ohio State: $5641 (See table 6c)

Fourth Year Workplan for the Latin American Site

Fourth year IPM research in the Guatemala and Honduras sites will continue to include five major workplan areas: (I) social, economic, policy, marketing, and production system analyses; (II) assessment of cropping systems including organic approaches, (III) biological control techniques, (IV) disease and insect control, and (V) indigenous pest management knowledge. These research areas are described below along with several sub-activities for each area. A regionalization activity is also added for Ecuador.

I. Social, Economic, Policy and Production System Analyses (LA 97-1)

a. Institutions: Purdue, Ohio State, VPI, ICTA, AGRILAB, ALTERTEC, CARE, ZAMORANO, and GEXPRONT/ARF will be involved. Scientists are listed under each sub-activity.

b. Objectives: The objectives of this activity are (a) collaborate in the assessment of pest problems, current control practices, and regulatory policies, (b) assess institutional and policy factors that influence pest management practices and IPM implementation, (c) determine economically viable export market strategies for non-traditional crops and impacts of their culture on producer sustainability, and (d) determine the impact of current NTE practices and IPM alternatives on the social welfare of small farmer households.

c. Description of research activity: These activities are a continuation of prior years research which is designed to provide an assessment of the social, economic, policy and production system factors that influence development of effective pest control practices for Guatemalan and Honduran farmers growing non-traditional crops. This research is vital to the development of pest management models that meet the overall IPM CRSP project objectives of reduced pesticide use and enhanced postharvest quality for non-traditional export crops.

d. Justification: These activities result in information that provide baselines of pests, pest control practices, institutional, social and postharvest factors influencing pest management for NTE crops. This research is essential to the development of alternative IPM strategies and enhanced economic opportunities within the region that are response-effective within the context of small NTE farmer abilities.

e. Projected outputs: (1) Development of cropping calendars, identification of relevant pest problems, understanding of current control practices, development of sustainable IPM production models, and the institionalization of response-effective IPM practices, (2) definition of regulatory issues and policies that enhance IPM adoption and encourage safe food production and improved export market practices, (3) quantification of socioeconomic and economic benefits and/or risks from current pest management practices versus IPM strategies, and (4) development of recommendations for alternative crops/cropping strategies with high potential for market success.

f. Projected Impacts: (1) Assist in developing IPM CRSP strategies that target reductions in pesticide use and help achieve project objectives for food safety/export market enhancement in non-traditional crops, (2) improved pesticide registration and labeling policies resulting in lower rejections from chemical residues for non-traditional export crops; increased producer market position and profitability, and

(3) quantification of pest management practices and socioeconomic variables necessary for successful IPM acceptance at the community level, resulting in improved economic sustainability and postharvest quality, and enhanced export opportunity at the small farm level.

g. Start: Projects began in 1994

h. Projected completion: September 1998

I.1 Continue with Assessment of Insect, Disease, and Weed Pests and Natural Enemy Occurrence Within and Between the Commercially Important Fruit and Vegetable Cropping Systems in the Guatemalan Highlands and Honduras (LA 97-1-a)

a. Scientists: S. Weller, G. Sullivan - Purdue University; D. Dardon, H. Carranza, H. Sagastume - ICTA; V. Salguero - ARF; A. Hruska - ZAMORANO; R. Solorzano - ALTERTEC; M. Wade - AGRILAB; G. Sanchez, R. Williams - Ohio State University

b. Status: Continuing research activity

c. Objective(s): Assessment, identification, and phenology of pest problems and current control practices. Continue development of IPM intervention strategies.

d. Description of research activity: Provide the collaborative support for IPM research and attainment of workplan objectives. Assist in developing research plans, data collection methods, data analysis, and final reports.

e. Justification: Discovery driven assessments by cropping strategy/cropping calendar/insect pests are critical to the development of sustainable IPM strategies. The snow pea leaf miner problem is a classic example. Host country researchers require assistance/strengthening in their respective research approaches/activities, as well as, for integrating findings into sustainable IPM strategies that meet NTE market requirements.

f. Relationship to other research activities at site: Non-traditional cropping strategies in the region currently employ high pesticide inputs. This activity will assist in transferring knowledge that reduces pesticide use and enhances sustainable cropping systems, while at the same time enhances postharvest quality. This activity builds on prior workplans that established baselines for broccoli, snow peas, and small-berry fruits in the two primary research sites (Chimaltenango and Chilasco).

g. Projected outputs: Description of key soil types, cropping calendars, insect pests, current pest control practices, and improved IPM pest management practices. Evaluation of IPM research in relationship to modifying current practices to achieve IPM CRSP objectives.

h. Progress to date: Assessments are near completion and results are being compiled for development of IPM research priorities.

i. Projected impacts: Assist in developing IPM CRSP research strategies that target reductions in pesticide use and help achieve project objectives for food safety/export market enhancement in non-traditional crops.

j. Start: Continuing

k. Projected completion: Partial fulfillment by September, 1996, with continuation through September, 1997.

l. Projected person-months of scientist time per year: 2

m. Budget:

ICTA:	$6985 (See table 7d for a breakdown)
ARF:	5179 (" " 7f " " ")
Zamorano:	P.L. 480
Altertec:	P.L. 480
Agrilab:	$8008 (See table 7g for a breakdown)
Ohio St.:	None
Purdue:	$14,430 (See table 7n)

I.2 Continue Assessment of Institutional Policies, Regulations, and Practices that Impact Implementation of IPM Strategies, Export Market Opportunities, and Pesticide Use Issues in Fruit and Vegetable Cropping Systems (LA 97-1-b)

a. Scientists: G. Sullivan, S. Weller, L. Asturias - Purdue University; A. Hruska - ZAMORANO; R. Santa Cruz - GEXPRONT (ARF); G. Sanchez - ARF/Ohio State University; D. Dardon - ICTA

b. Status: Continuing research activity

c. Objective(s): Assessment of institutional and policy factors that influence pest management, pesticide use, and IPM adoption.

d. Hypotheses: Institutional and policy factors may impede implementation of IPM strategies, negtively affect export market opportunities, and encourage excessive pesticide use in fruit and vegetable production systems.

e. Description of research activity: Research activities will continue to analyze alternative policies and practices that impact IPM implementation and export trade development opportunities, and develop policy recommendations for enhancing sustainable program development in non-traditional crops and lead to reduced pesticide use. Methods will include evaluation of current Guatemalan government laws and regulations concerning exports and pesticide use.

f. Justification: Provides baseline documentation for substantive revision in current policies and practices, with particular focus on improved pesticide regulatory policies, postharvest handling practices, export marketing practices, and health (food safety) issues that impact implementation of IPM strategies.

g. Relationship to other research activities at site: Institutional policies, or the lack thereof, now place non-traditional crop producers at risk in export markets and food safety issues (witness the 1995/96 snow pea/leaf miner crisis). This activity will assist in developing policy alternatives that reduce these risks.

h. Projected outputs: Definition of policies that enhance IPM adoption and encourage safe food production/export practices.

i. Progress to date: Results to date include gathering of information from government agencies, exporters, and producers regarding policies and practices related to the export of horticultural crops. This information is being collated and prepared for our final report.

j. Projected impacts: Improved pesticide registration and labeling policies; improved in-country control of approved pesticide use practices for domestic and export markets; lower export commodity rejections at the ports of final destination, thereby increasing producer market position, enhancing profitability, and reducing pesticide use.

k. Start: 1994

l. Projected completion: September, 1996, with response-effective continuation through September, 1997 as a result of APHIS and Ministry of Agriculture collaborations.

m. Projected Person-Months of scientist time per year: 3

n. Budget:

Purdue:	$18,395 (see Table 7a)
ICTA:	None (P.L. 480)
Zamorano:	$14,520 (see Table 7e)
ARF:	$ 3,300 (See Table 7f)
Ohio State:	None

I.3 Assess Economic and Socioeconomic Impacts of Pest Management Alternatives (LA 97-1-c)

a. Scientists: L. Asturias, G. Sullivan - Purdue University; E. Robbins, WID Director - Virginia Tech; R. Santa Cruz - GEXPRONT (ARF); D. Dardon - ICTA

b. Status: Continuing research activity

c. Objectives: Assessment of intensive non-traditional crop production impacts on producer economic sustainability; assessment of IPM intervention strategies on economic sustainability and socioeconomic benefits/risks at the producer level.

d. Hypothesis: Economic and socioeconomic factors are important determinants of how alternatives to chemical pest management are viewed, and adopted or discarded, by producers.

e. Description of research activity: Implement research plans that help quantify impact of intensive pesticide/cropping strategies versus IPM/cropping strategies on economic sustainability and socioeconomic welfare at the producer level disaggregated by gender for target non-traditional crops in the primary IPM CRSP sites.

f. Justification: Current intensive practices tend to maximize yields, but do not necessarily maximize economic returns and improved socioeconomic conditions at the individual producer level, due primarily to higher long-term disease management problems, loss of productivity from non-rotational strategies, and high product rejection rates due to chemical residues, and possibly due to intra household dynamics.

g. Relationship to other research activities at site: Non-traditional cropping strategies currently employ high pesticide inputs and non-complementary crop rotations. This activity will assist in establishing greater understanding of "producer value" from IPM CRSP recommendations.

h. Projected outputs: Quantification of benefits from IPM strategies and recommendations for improved management practices that lead to increased economic and socioeconomic benefits at the small producer level, implementation of enhanced IPM production models that integrate socio-economic and economic welfare benefit awareness at the community level.

i. Progress to date: Surveys and case studies of pest management and production practices and their impact on socioeconomic and economic stability are being compiled.

j. Projected impacts: More expedient adoption of recommended IPM cropping/disease control strategies; greater net economic returns to producers; fewer product rejections.

k. Start: October, 1995

l. Projected completion: September, 1998

m. Projected persons-months of scientist time per year: 3

n. Budget:

Purdue:	$22,490 (See Table 7a)
ARF:	None (P.L. 480)
ICTA:	None (P.L. 480)
Virginia Tech:	$ 8, 437 (See Table 7i)

I.4 Development of Postharvest Handling and Expansionary Export Market Strategies for Non-Traditional Crops Relative to Baseline Assessments Previously Completed (LA 97-1-d)

a. Scientists: G. Sullivan, L. Asturias - Purdue University; A. Hruska - ZAMORANO; R. Santa Cruz - GEXPRONT (ARF); D. Dardon - ICTA

b. Status: Continuing research activity

c. Objectives: Determination of economically viable export market windows and performance requirements for non-traditional crops compatible with host country resources and accepted trade policies; development of alternative strategies for achieving market penetration, including direct to retail buyer strategies.

d. Hypothesis: Improved postharvest handling of NTE crops will allow expansion of export markets and new opportunities for Guatemalan farmers.

e. Description of research activity: Continued assessment of export trade opportunities including: market alternatives, counter-seasonal supply windows, competing supply points, threshold prices, market performance requirements, product requirements, trade policy compliance, and postharvest performance requirements.

f. Justification: Prior research findings established baseline export trade parameters in non-traditional crops, with performance requirements for trade expansion. Performances need to be fully developed and institutionalized for those crops that were found to have high potential for export trade expansion, including: snow peas, blackberries, raspberries, specialty melons, broccoli, papaya, peppers, asparagus, and specialty vegetables.

g. Relationship to other research activities at site: Non-traditional crops/cropping strategies in Guatemala are currently "production-driven". Future success of IPM CRSP will depend upon developing a more "market-driven" approach - focusing on crops with high export opportunity and well defined postharvest performance requirements. This activity assists production focused research in developing total systems IPM strategies with greater potential for marketplace success.

h. Projected outputs: Recommendations for crops/cropping and postharvest handling strategies with high potential for market success; market delivery systems with greater economic returns to producers.

i Progress to date: Programs are being developed and will be discussed with growers/exporters for the establishment of in-country pre-export inspections of NTE crops.

j. Projected impacts: Reduction of producer risks in export market-driven cropping strategies; more direct-to-retail buyer marketing opportunities; greater economic returns to individual producers/producer associations.

k. Start: October, 1995

l. Projected completion: September, 1998

m. Projected person-months of scientist time per year: 1.5

n. Budget:

Purdue:	$22,360 (See Table 7a)
Zamorano:	10,748 (See Table 7e)
ARF:	None (P.L. 480)
ICTA:	NONE (P.L. 480)

I.5 Cooperative Research And Preinspection Protocol Development for Non-Traditional Agricultural Export (NTAE) Crops from Guatemala (LA-97 I-e)

a. Scientists: G. Sullivan and S. Weller/Purdue, L.Asturias/Purdue/ESTUDIO, L.Caniz and N. Solares and F. Hamdy/APHIS-IS , V. Salguero and G. Sánchez/ARF.

b. Status: New

c. Objective: To establish performance protocols for institutionalizing pre-inspection programs in NTAE crops.

d. Hypotheses: Institutionalization of pre-inspection will serve to capitalize on the implementation of IPM practices, reduce pesticide use, and minimize pesticide residue rejections in U.S. ports of entry.

e. Description of research activity: IPM CRSP researchers in Guatemala will collaborate with APHIS-IS technical personnel in the research, monitoring, and assessment activities necessary for establishing pre-inspection protocols, using snow peas as the prototype NTAE crop. The Government of Guatemala will participate in this collaboration through the Ministry of Agriculture; Vice Minister Casteñada.

f. Justification: Guatemala is currently experiencing over 310 FDA rejections annually in U.S. ports of entry due to pesticide residues. This has resulted in significantly lower returns to small farmers who currently bear much of the risk of export rejections.

g. Relationship to other research activities at site: This new activity integrates strategically into other IPM CRSP program activities and serves to enhance the implementation of research findings to date.

h. Projected outputs: This activity will help establish Guatemala's first formal NTAE pre-inspection program.

I. Projected impacts: Pre-inspection programs are expected to significantly increase Guatemala's export trade in snow peas and other NTAE crops.

j. Start: October, 1996

k. Projected completion: September, 1997

l. Projected person-months of scientist time per year: 15

m. Budget: ARF/APHIS: $15,000 (See Table 7f)

II. Assessment of Alternative Cropping Systems Including Organic Approaches (LA 97-2)

a. Institutions: Purdue, Ohio State, U. of Georgia, ALTERTEC, AGRILAB, GEXPRONT/ARF, and ICTA will be involved. Scientists are listed under each sub-activity.

b. Status: Continuing activity

c. Objectives: The objectives of this activity are to (a) determine the effect of various cropping sequences and cultural practices on pest levels in non-traditional crops, (b) investigate the influence of mixed and strip-cropping on levels of insect pests and diseases that affect broccoli and snowpeas, (c) determine how biodiversity, crop associations, microclimate, and different vegetation strata affect pest levels and damage in organically produced non-traditional crops, and (d) develop IPM strategies to control pests and reduce pesticide use in such systems.

d. Description of research activity: These activities will involve field research in non-traditional crops to assess various cultural practices' effects on pest levels. The work will involve traditional pest control methods, as well as, evaluate how ecologically based strategies using increased levels of biodiversity of crops and associated vegetation can influence pest levels and damage. Results will be used in the design of effective IPM strategies less dependent on chemical inputs.

e. Justification: Appropriate integrated cropping systems using biodiversity, and based on sound ecological principles instead of monoculture systems which rely on intensive use of pesticides, will result in a balanced environment that minimizes pest problems, reduces pesticide use, and offers greater flexibility of cropping options for farmers and reduced use of pesticides.

f. Projected outputs: (1) Production systems that integrate crop rotation, intercropping, soil management, and other pest control strategies that employ appropriate IPM and reduce pesticide use, (2) improved knowledge of how intercropping and strip-cropping in broccoli and snowpea affect insect and disease levels, leading to design of better control practices based on sound IPM strategies, and (3) determine the value of biodiversity management offers an alternative for the ecological management of pests in organically grown non-traditional crops.

g. Projected impacts: (1) Development of functional IPM production strategies that allow farmers more flexibility in selection of crops and improved quality of produce for export, while reducing economic inputs involved in controlling pests, (2) development of specific crop management strategies for insect and disease control in broccoli and snowpeas that reduce pest levels and pesticide use, and (3) demonstrate that plant biodiversity on farms has a positive effect on reducing pest levels and damage and results in higher populations of beneficial insects that allow efficient ecological control of crop pests in organic systems.

h. Start: Projects were begun in 1995 and will be completed by October 1997.

i. Projected completion: October, 1997

II.1 Continue Determination of the Impact of Insect and Disease Carryover Within and Among Small Fruit, Vegetable, and Herb Cropping Systems (LA 97-2-a)

a. Scientists: S. Weller - Purdue University; M. Wade - AGRILAB; L. Calderon, J. Davila, D. Dardon, H. Carranza, H. Sagastume, A. del Cid, M. Ibarra - ICTA; R. Solor

b. Status: Continuing research activity

c. Objectives: Determine the effect of monoculture, crop rotations, intercropping, and other cultural practices (scouting, trapping, and allelopathic plants) on pest levels (insect and disease) in fruits and vegetables, and continue development of sustainable IPM strategies to control pests in such systems.

d. Hypothesis: Crop rotation, intercropping, and alternative crop cultural practices will reduce pest incidence and reduce pesticide use compred to monoculture.

e. Description of research activity: Integrate appropriate IPM and cultural practices for fruit and vegetable production systems that select against the buildup of problem pests (insects and diseases) that can not be controlled without the input of high levels of synthetic pesticides.

f. Justification: Appropriate integrated cropping systems provide the basis for a balanced environment that minimizes pest problems. IPM strategies work best in cropping systems that balance good biological organisms versus undesirable organisms such as this research will promote. Treatments in vegetable production include monoculture of broccoli and corn compared to intercropping of these crops and growth with and without cover crops. These tests will consist of 4 replications and plot sizes of 4m x 6m.

g. Relationship to other research activities at site: Non-traditional cropping systems currently in widespread use in Guatemala and Honduras engage high inputs of pesticides. The development of cropping practices that emphasize IPM strategies and result in production of quality fruits and vegetables while requiring reduced pesticide inputs is a major objective in the IPM CRSP and interfaces with all other IPM CRSP site activities.

h. Projected outputs: Development of production systems that integrate strategic use of crop rotations, intercropping, soil management, and other pest control regimes employing appropriate IPM to reduce insect and disease carryover and lower pesticide use.

i. Progress to date: In broccoli production, intercropping has resulted in reduced pest numbers and reduced pesticide use compared to monoculture.

j. Projected impacts: Functional IPM production strategies will allow farmers more flexibility in selection of crops to be grown and higher quality produce for export, while allowing a reduction in the labor intensive/chemical intensive methods now required to control high pest levels that currently exist.

k. Start: October, 1995

l. Projected completion: September, 1997

m. Projected person-months of scientist time per year: 2

n. Budget:

Purdue:	None
Agrilab:	$8,008 (See Table 7g)
ICTA:	None (P.L. 480)
Altertec:	None (P.L. 480)
Georgia:	None

II.2 Effects of Intercropping on the Levels of Insect Pests and Diseases in Non-Traditional Export Crops in Guatemala (LA 97-2-b)

a. Scientists: G. Sanchez, R. Williams - Ohio State University; S. Weller, L. Asturias - Purdue University; M. Wade - AGRILAB; D. Dardon - ICTA; R. Solorzano - ALTERTEC

b. Status: Continuing research activity

c. Objectives: The purpose will be to continue to study the influence of cropping systems (mixed cropping and strip-cropping) on the levels of insect pests and diseases that affect broccoli and snowpeas in Guatemala. Specific objectives are to (a) determine the diversity and identify the insect pests and diseases affecting broccoli and snowpeas, (b) determine the incidence and severity of damage caused by insects and diseases on the target crops mentioned above, (c) identify and determine the diversity of beneficial insects in the target crops, and (d) determine the yield and quality of the export crops grown under the selected cropping systems.

d. Hypotheses: Intercropping, scouting, and alternative pest management prctices will result in reduced pest incidence and pesticide use in snow pea production.

e. Description of research activity: The experiments evaluating the effect of strip-cropping on insect and disease levels in broccoli and snow peas will be conducted in local farmer's plots at Chirijuyu (Chimaltenango) and Chilasco (Salama, Baja Verapaz). Experiments at Chirijuyu will be carried out with snowpeas as the target crop while research at Chilasco will be with broccoli as the export crop. The indigenously grown corn and beans have been selected as the non-target, companion crops to be associated with the target crop since they harbor the greatest probabilities of successfully completing their life cycle without the usage of pesticides. Other crops such as potato, chiles, tomato, etc. require frequent applications of fungicides and other pesticides in order to manage potentially devastating diseases, especially during the rainy season. It is considered very likely that if these crops were planted as non-target crops in a pesticide-free environment, the purpose of this experiment would not be achieved due to premature death of these plants in the system. In addition, corn and beans are widely grown in both sites and could be easily adopted by the growers as part of new cropping systems. There will be four replications and plot size will be 4m x 6m.

f. Justification: Information generated will be used to design sound long-lasting IPM strategies to reduce the amounts of pesticides applied to the fields and still achieve satisfactory levels of insect and disease control. These cropping systems experiments are of utmost importance for the introduction of locally innovative IPM strategies. Successful implementation of mixed cropping systems as part of future IPM programs, will not only reduce the amount of pesticides to be applied to the export crop, but will help preserve the environment and decrease the exposure of the farmers to harmful chemical agents, therefore raising the quality of life.

g. Relationship to other research activities at site: This activity will have a strong collaborative component with other institutions. Identification of insect species and data analysis will be conducted in collaboration with Dr. Roger Williams at Ohio State University. Development of crop management systems will be accomplished in collaboration with Dr. Steve Weller at Purdue University. Joint efforts with ALTERTEC and ICTA will be pursued to implement the on-site research and transference of technology, respectively. Information regarding socioeconomic components of the areas of interest will be obtained through collaborations with Dr. Linda Asturias and ICTA and will be used to design strategies for future research and extension activities. In the future, technology transfer to the community leaders will be initiated (in collaboration with CARE, ALTERTEC, and ICTA) as soon as validated IPM strategies are developed. All of the mentioned collaborating institutions currently have IPM CRSP projects being executed in both Chimaltenango and Chilasco. Discussions have been held (CARE, MICUENCA project) to have the collaboration of the current Peace Corps volunteer (PCV) stationed at Chilasco for the data gathering; the PCV has already agreed to provide technical support for the study.

h. Projected outputs: Outputs will include (a) design of locally new IPM strategies that can be transferred and implemented in Chilasco and Chirijuyu, and (b) intercropping experiments will be utilized to design and analyze the mechanisms (deterrence of emigration-immigration of pests into the target crop; increase the diversity and population of beneficials, or combinations of both) by which levels of damaging organisms are reduced in the mixed cropping systems, as compared to crops grown in monoculture.

i. Progress to date: Intercropping has reduced pest incidence and pesticide use in snow pea production.

j. Projected impacts: It is believed that one of the most attractive aspects of this study will be the transferral of the generated technology to the local broccoli and snowpea growers. Most of the small growers that presently cultivate these two export crops also have other plots on which they grow corn and beans for their own consumption. If the combined farming of broccoli (and or snowpeas) with corn and beans lowers pest pressure it is very likely that the growers can easily be convinced of adopting this technology. The adoption of these cropping systems by the farmers will be a quick and very important result of the IPM CRSP project.

k. Start: September 1995

l. Projected completion: June 1997

m. Projected person-months of scientist time per year: 6

n. Budget:

Ohio State:	$13,343 (See Table 7b)
Purdue:	None
Agrilab:	None (P.L. 480)
ICTA:	None (P.l. 480)
Altertec:	None (P.L. 480)

II.3 Biodiversity Effects on the Ecological Pest Management (LA 97-2-c)

a. Scientists: R. Solorzano, R. Guzman, L. Herrera, M. Chinchilla - ALTERTEC; G. Sanchez - Ohio State University; V. Salguero - ICTA; S. Weller - Purdue University; R. Carroll - U. of Georgia

b. Status: Continuing research activity

c. Objectives: To (a) determine how biodiversity contributes to the stability of different pest insect populations, (b) evaluate the effects of different crop associations on populations of pests and beneficial insects, (c) determine the relation between biodiversity and microclimate and the influence of these on the populations of pests and beneficial insects, (d) determine the influence of different vegetation strata on the populations of the pests and beneficial insects, and (e) evaluate the damage levels of pests in multi- and monocultures.

d. Hypotheses: Increased biodiversity of plants in and near crop production areas will reduce crop damage from detrimental insect and disease pests.

e. Description of research activity: The project aims to determine the advantages of managing agroecosystems with high levels of biodiversity. Increased biodiversity should result in reduced pest populations and lower crop damage compared to that observed in monoculture systems. Methods include the use in plot areas of native plants that either act as trap crops or deter detrimental vegetable crop pests. Use of particular plants will be based on documented traditional practices and discussions with native farmers on practices used.

f. Justification: In the Chimaltenango and Baja Verapaz regions, production of export vegetables (broccoli and snowpeas) is based on monoculture systems with intensive use of pesticides. These practices expose humans to high levels of chemicals, reduce genetic diversity of plants, and can lead to agroecosystems where crop damage by insect pests is high since natural enemies tend to be eliminated.

g. Relationship to other research activities at site: ICTA, AGRILAB, and ALTERTEC are developing IPM CRSP activities in Chimaltenango and Baja Verapaz. These studies complement other IPM CRSP studies since they consider the effects of biodiversity on pest levels.

h. Projected outputs: Outputs will be (a) whether biodiversity is a viable pest management tool for pests on farms, and (b) observe the feasibility of using biodiversity based pest management in various regions by growers of different economic levels.

i. Progress to date: Experiments have been established with native plants within production areas. Final results are not yet complete, however, significant effects on increased biodiversity have been observed in plots containing native plants.

j. Projected impacts: It is expected that the maintenance of the biodiversity on farms will have a positive effect on the microclimate, resulting in the reduction of pest populations, lower crop damage, and result in an increase in beneficial insect populations. This information can then be used in the design of pest control systems for export vegetables based on ecological principles resulting in lowered need for pesticides.

k. Start: October 1995

l. Projected completion: June 1998

m. Projected person-months of scientist time per year: 6

n. Budget:

Altertec:	$6,600 (See Table 7h)
Ohio State:	None
ICTA:	None (P.L. 480)
Purdue:	None
Georgia:	None

III. Biological Control Techniques (LA 97-3)

a. Institutions: Purdue, Georgia, Ohio State, ICTA, AGRILAB, CARE, ALTERTEC, and GEXPRONT/ARF will be involved. Scientists are listed under each sub-activity.

b. Status: Continuing activity

c. Objectives: The objectives of this activity are (a) investigate Gallina ciega control in broccoli and corn related to cultural practices, (b) determine weed influence (detrimental and beneficial) in design of IPM strategies, (c) evaluate insects and diseases as biological control agents, (d) identify the best Bt products for lepidoptera control in broccoli, and (e) test biological control practices developed under IPM CRSP in field conditions.

d. Description of research activity: These studies are either a continuation of previous research or discovery-driven new activities designed to study and evaluate the potential of implementing biological control practices for control of pests in non-traditional vegetable crops. The studies are designed to test a wide variety of weed, insect, and pathogens along with Bt in order to begin development of effective biological control programs for use in the design of IPM strategies. Field testing of promising practices will be initiated in farmer fields.

e. Justification: Appropriate biological control agents integrated into IPM programs can result in reduced pest incidence and reduced pesticide use. These studies, based on replicated field experiments, serve to enhance the design, testing, and implementation of effective IPM strategies.

f. Projected outputs: (1) Improved knowledge of Gallina ciega growth biology, its effects on broccoli and corn, and how crop culture can affect its incidence as a pest, (2) improved knowledge of weed-crop associations effects on insect and disease pest levels in non-traditional crops, (3) improved knowledge on the potential of candidate insect and disease organisms for use as biological control agents in IPM programs, (4) achieve effective use of Bt for control of broccoli pests, and (5) reduce the use of synthetic pesticides and increase local biodiversity.

g. Projected Impacts: (1) Development of specific control strategies for Gallina ciega in broccoli and corn that reduce pest levels and the need for high pesticide use, (2) modification of current cropping systems to take advantage of beneficial weeds associated with fruit and vegetable crops, (3) use of biological organisms and Bt for pest control will result in reduce pesticide use, and (4) development of IPM strategies based on use of biocontrol organisms and agents.

h. Start: October, 1995

i. Projected completion: September 1997

III.1 Gallina Ciega (Phyllophaga spp.) Control in Broccoli and Corn in Guatemala (LA 97-3-a)

a. Scientists: R. Carroll, A. Dix - U. of Georgia; G. Sanchez - Ohio State University; V. Salguero - ARF

b. Status: Continuing research activity

c. Objectives: To (a) document farmers practices and cropping conditions that favor Gallina ciega in Guatemala and traditional methods for its control, (b) identify direct and indirect factors which influence Gallina ciega incidence in farmer fields, (c) continue ongoing research on the biology and ecology of Gallina ciega in Chilasco, (d) explore Metarhizium (an entomopathogenic fungus) and other possibilities for control in collaboration with project participants.

d. Hypotheses: Gallina ciega as a pest in broccoli production is influenced by crop rotaton practices and cultural practices, such as the use of chicken manure.

e. Description of research activity: We propose to study the Gallina ciega problem in the context of the changes that are taking place within the community. Some of the largest landholders in Chilasco do not have problems with Gallina ciega. Meanwhile, the small peasant farmers seem to have more problems. Why? Current findings indicate that the problem comes with the chicken manure used to fertilize the fields, and with the association of corn with broccoli in the cropping system. Current research is trying to determine whether broccoli fields adjacent to corn are more susceptible to Gallina ciega attack. The high organic matter content of the broccoli fields may actually attract Gallina ciega.

We have set up a simple weather station in the community (being managed by one of the farmers) and a light trap in order to arrive at a better understanding of when the Gallina ciega flies. We have initiated contact with entomologists in CATIE and the Institute of Ecology at UNAM in Mexico, in order to begin on the identification of the pest complex. In search of an alternative solution, we have initiated collaborations with ICTA/Quetzaltenango's Marcelo Velazquez, who has pioneered research in Guatemala on Metarhizium, a pathogenic fungus, which can be used to control Gallina ciega. We propose to experiment on some of the plots owned by farmers working with the MICUENCA project.

f. Justification: Research on Gallina ciega is important because (a) it is emerging as a limiting factor in broccoli production, (b) it had been a secondary pest and no IPM protocols have been developed for its control in broccoli, (c) it also attacks corn, and damages both broccoli as a source of income and corn as a source of basic food, (d) it is associated with a traditional crop (corn) and there may be important indigenous knowledge about the pest, (e) women and children dip transplants by hand in Class I pesticides as a control measure, thus there is an important health issue.

g. Relationship to other research activities at site: This project will serve to enhance work that was previously done in the Chilasco watershed during November and December of 1994 and March through September of 1995. We expecting to be able to have ICTA pioneer the use of Metarhizium as a control for Gallina ciega in the community. The Metarhizium is currently being maintained in stock by Agricola El Sol, a Guatemalan owned biological control business, that has also pioneered the distribution of Ecotech, a Bt formulation for Plutella xylostella.

From a human ecology perspective, this project will serve to better understand how farmers make decisions about IPM in broccoli. The work under this project will be carried out with the collaboration of CARE, ALTERTEC, Defensores de la Naturaleza and Peace Corps volunteers. The research carried out in Chilasco will help fulfill some of the conservation objectives of Defensores work in the Sierra de las Minas Biosphere Reserve and enhance the work done through the MICUENCA project.

We are using facilities and working in collaboration with students at the Universidad del Valle. AGRILAB has been providing soil analysis service.

h. Projected outputs: Better understanding of Gallina ciega growth biology, how cultural practices influence its incidence and how control practices can be improved through IPM strategies.

i. Progress to date: Gallina ciega populations are higher in areas where corn is grown as the rotation crop prior to broccoli and where chicken manure is used.

j. Projected impacts: Reduced Gallina ciega populations and damage, and improved IPM control strategies.

k. Start: October, 1994

l. Projected completion: September, 1997

m. Projected person-months of scientist time per year: 3

n. Budget:

Georgia:	$26,586 (See Table 7c)
Ohio State:	None
ARF:	None (P.L. 480)

III.2 Continue Determination of the Influences of Weed Populations on Insects, Diseases, and Natural Enemies in the Fruit and Vegetable Cropping Systems (LA 97-3-b)

a. Scientists: S. Weller - Purdue University; G. Sanchez - Ohio State University; L.Calderon, D. Dardon, H. Carranza, J. Davila - ICTA; R. Solorzano - ALTERTEC; R. Carroll - U. of Georgia

b. Status: Continuing research activity

c. Objectives: Determine the influence (detrimental and beneficial) of weeds in the design of appropriate IPM cropping strategies.

d. Hypotheses: Weeds affect crop growth and influence the population of insects and diseases present in fruit and vegetable production.

e. Description of research activity: Weeds in non-traditional crops are being monitored for their influence on insect pests, diseases, and natural predators found in the cultural systems. This assessment includes an evaluation of which associated weeds may be useful in development of IPM programs. Specific experiments are being conducted in brambles to determine the types of weeds present and the associated insects and diseases. The overall test includes two experiments. The first experiment is documenting the type of weeds present and when they appear in three areas of bramble production in the Chimaltenango area of Guatemala. The second experiment is designed to make associatons between specific weeds present in these bramble fields and their influence in affecting populations of insects (both detrimental and beneficial) and diseases. Plots or sample sites vary from site to site. Since the initial studies involved surveys, areas of fields were sampled and no predetermined plot sizes were used.

f. Justification: True IPM strategies include the use of beneficial organisms to reduce the reliance on synthetic pesticide inputs. Weeds traditionally have been considered to be a negative factor in all cropping systems. This assumption is not always true and research investigating potential benefits of certain weed species is needed, particularly in IPM.

g. Relationship to other research activities at site: An assessment of all pests, including weeds and their influences in non-traditional cropping systems, is essential to effective IPM program development.

h. Projected outputs: These experiments will result in an improved knowledge of weed species' association with other pests in non-traditional cropping systems. Findings will allow the development of effective IPM systems that take advantage of beneficial weeds to reduce the influence of harmful pests, and in addressing the impact of non-beneficial weeds.

i. Progress to date: Grower locations have been established and surveys of weeds are being conducted. Associations between weeds and specific insects and diseases will be compiled during 1997.

j. Projected impacts: Current production systems will be modified to take full advantage of beneficial weeds associated with fruit and vegetable crops. The overall result will be a reduction in pesticide inputs.

k. Start: October, 1995

l. Projected completion: September, 1998

m. Projected persons-months of scientist time per year: 2

n. Budget:

Purdue:	None
Ohio State:	None
ICTA:	None (P.L. 480)
Altertec:	None (P.L. 480)

III.3 Support Research and Technology Transfers for Enhancing Biological Control of Diseases in Vegetables (LA 97-3-c)

a. Scientists: S. Weller - Purdue University; D. Dardon, M. Gonzales, H. Carranza, H. Sagastume, A. del Cid, M. Ibarra - ICTA; R. Williams - Ohio State University; G. Sanchez, V. Salguero - ARF

b. Status: Continuing research activity

c. Objectives: Evaluate the efficacy of vegetable extracts in pest control in broccoli compared with traditional chemicals.

d. Hypotheses: Vegetable extracts will provide acceptable control of Lepidoptera in broccoli.

e. Description of research activity: Broccoli is an important NTE crop for Guatemala, however, control of Lepidoptera pests require use of high amounts of synthetic pesticides. Research is being conducted by ICTA in testing extracts of 82 plant species for activity against Lepidoptera species and aphids. Among species being tested are hot pepper (Capsicum annum) and mirasol (Titonia diversifolia). Initial studies were conducted in the greenhouse where plant extracts were applied to broccoli plants infested with Lepidoptera and aphids and evaluated for efficacy compared to commercial pesticides. Extracts identified as showing high efficacy will be tested in replicated field studies during 1997.

f. Justification: Little information exists concerning the potential of various insects, fungi, and repellent plants for use as biocontrol agents in vegetables. Current research indicates such organisms have potential to be an integral part of future IPM strategies.

g. Relationship to other research activities at site: These studies expand the range of organisms that hold potential for use in attaining the overall goal of reducing pesticide inputs of the IPM CRSP. These experiments expand on studies being conducted with the biocontrol agent Bacillus thuringiensis.

h. Projected outputs: Research results will allow an evaluation of candidate biological control agents for insect and disease management and inclusion of such agents in IPM programs.

i. Progress to date: Extracts of hot pepper and mirasol have shown excellent potential in greenhouse studies for control of insect pests on broccoli.

j. Projected impacts: IPM programs that include biological control agents will result in reduced synthetic pesticide inputs and the design of cultural practices that enhance insect and disease control.

k. Start: October, 1995

l. Projected completion: September, 1998

m. Projected persons-months of scientist time per year: 1

n. Budget:

Purdue:	None
ICTA:	P.L. 480
Ohio State:	P.L. 480
ARF:	P.L. 480

III.4 Evaluation of Commercial Products Based on *Bacillus thuringiensis* to Lepidoptera Control in Broccoli (LA 97-3-d)

a. Scientists: D. Dardon, H. Carranza, H. Sagastume - ICTA; R. Carroll - U. of Georgia; S. Weller - Purdue University

b. Status: Continuing research activity

c. Objectives: To identify the most effective commercial Bt products to control lepidoptera, with emphasis on *Plutella xylostella* in broccoli crops.

d. Hypothesis: Commercil Bt products vary in their effectiveness against *Plutella xylostella*.

e. Description of research activity: Field experiments will be conducted in the grower fields at two selected regions in Guatemala. Treatments include evaluation of over 15 commercial Bt formulations in broccoli. Each treatment is replicated four times.

f. Justification: The growers of broccoli have problems with the management of lepidoptera. Due to the exclusive use of insecticides in the past, the number of beneficial organisms for the control of these pests in broccoli have decreased. Alternative pesticides such as a Bt are needed.

g. Relationship to other research activities at site: There will be cooperative actions with CARE, to select the most problematic sites.

h. Projected outputs: To achieve the increment of the use of the Bt's, and progressively restore the natural balance of insects by the substitution of the traditional chemical insecticides.

i. Progress to date: Although some variation in control of insect pests on broccoli occurred from the various Bt formulations, all formulations have provided acceptable control. Further experiments will evaluate biological in an IPM approach.

j. Projected impacts: To decrease the environmental contamination of the regions by decreasing the use of traditional chemical insecticides.

k Start: October 1995

l. Projected completion: January 1996

m. Projected person-months of scientist time per year: 1

n. Budget:

ICTA:	$5,390 (See Table 7d)
Georgia:	None
Purdue:	None

IV. **Disease and Insect Control** (LA 97-4)

Since there is only 1 sub-activity under this topic area, no general description is given. The sub-activity is described below:

IV.1 **Evaluation of Benzimidazole and Dicarboximide Resistance of Botrytis cinerea in Guatemalan Raspberry and Blackberry Plantations** (LA 97-4-a)

a. Scientists: G. Sanchez - ARF/Ohio State University; R. Williams - Ohio State University

b. Status: Continuing research activity

c. Objectives: Purpose is to determine if the most important disease inciting pathogen in small fruits, Botrytis cinerea, has developed resistance to dicarboximide and benzimidazole fungicides in Guatemala. To collect and establish in vitro, Botrytis cinerea isolates from the different blackberry and raspberry growing regions in Guatemala. To evaluate in vitro the degree of resistance of Botrytis cinerea to both denzimidazole (benomyl) and dicarboximide (iprodione) fungicides.

d. Hypotheses: Resistance of Botrytis cinerea to dicarboximide and benzimidazole fungicides has occurred in small fruits in Guatemala.

e. Description of research activity: Botrytis cinerea isolates will be collected during two growing seasons from the main raspberry and blackberry plantations located in the departments of Guatemala, Santa Rosa, Sacatepequez and Chimaltenango. It is estimated that more than 100 isolates can be collected from plantations in the departments p previously mentioned. In addition, Botrytis isolates will also be collected from wild blackberry in each of the regions mentioned above. Resistance will be evaluated by establishment of the isolates in vitro with media containing, separately, iprodione and benomyl. Dicarboximide resistance will be evaluated by their relative sensitivity to two concentrations of iprodione and by measuring their sensitivity to osmotic stress, which has been shown to be dependent to the level of dicarboximide resistance (Beever, at al, 1990). Benomyl resistance will be determined by (1) analyzing the germination rates of Botrytis conidia and (2) colony growth rates on Benomyl amended culture medium (Johnson, et al, 1994).

   In addition to the in vitro assays, surveys will be conducted with the growers of the sampled plantations to determine what fungicide have been employed and the frequency of application. Data analysis will include comparisons between frequency of resistance to both fungicides in blackberries and raspberries. In addition the effect of frequency of fungicide applications on fungicide resistance will be evaluated.

f. Justification: Blackberries and raspberries have become an increasingly important export commodity in the Guatemalan Highlands. The most important disease affecting berries in Guatemala is fruit rot caused by Botrytis cinerea. There are a very limited number of fungicide products with EPA (Environmental Protection Agency) registration for use in blackberries or raspberries, and growers rely heavily on benomyl (benzimidazole) and iprodione (carboximide), with many growers exclusively using benomyl. The benzimidazole-class fungicides are reported to be the ones against which it is most common to find resistant races of plant pathogens. Resistance has been reported from South America, Oregon, California, New

Zealand and Europe. The increasing reliance on benomyl and iprodione in berry plantations in Guatemala makes it necessary to evaluate if Botrytis cinerea has developed resistance to these fungicides. If this information is lacking, berry growers may face in the future the following negative consequences: (1) consumers in the U.S. and Guatemala may be exposed to higher pesticide concentrations in blackberries and raspberries, (2) growers will begin to rely on heavier doses and more frequent applications of the fungicides, (3) berry shipments may be rejected increasingly at the point of entry into the U.S. for exceeding the concentration of allowable chemical residue, (4) the reliance on overdosage will bring detrimental effects on the environment and the applicator's health and (5) non-target plant pathogens may also become resistant to the fungicides therefore becoming serious pests themselves.

g. Relation to other research activities at site: This research will be a part of the current IPM CRSP effort in evaluating insect pests and diseases affecting both blackberries and raspberries, conducted by AGRILAB. Both of these crops have been selected as important target crops for IPM CRSP research. During the initial evaluation of these pests, it has been determined that Botrytis cinerea is the fungus that causes the greatest concern among growers. The outlook for the expansion of Guatemala's berry market in the U.S. is favorable as long as high quality is maintained. The increasing importance of berries as an export product of Guatemala gives this research a high-impact potential. Maintaining the export quality of the berries, through information generated with this research, will provide valuable support to other IPM CRSP efforts such as Dr. Sullivan's (Purdue University) market window opportunities for berries production in Guatemala. In addition, this research will provide the basis for similar studies in broccoli and snowpeas. Future studies can be conducted in these crops in collaboration with ICTA.

h. Projected outputs: Information about the present state of Botrytis cinerea in Guatemala relative to overuse of both benzimidazole and carboximide fungicides will be obtained. This information will be used as basis for the planning and implementation of sound IPM strategies, including rational pesticide usage, cultural controls, and monitoring. With tangible evidence of pest resistance towards the fungicides, growers can be alerted and educated about the risks of chemical overuse, and of the need for non-traditional, integrated pest management techniques for the control of plant pests. Evidence concerning Botrytis resistance in Guatemala to the commonly used fungicides will educate the growers that there are risks for pest resistance to occur when fungicides are over-applied in berry production.

i. Progress to date: Some areas of bramble production in Guatemala appear to have Botrytis cinerea resistance to fungicides dicarboximide and benzimidazole. These studies are continuing to more clearly define the extent of resistance.

j. Projected impacts: Impacts will include (a) a more rational use of chemicals with consideration to fungicide application based on the existence of favorable or unfavorable environmental conditions for disease development, fungicide rotation, and correct dosage, (b) rational use of fungicides will ensure that Guatemalan berries shipments to the U.S. are not in danger of rejection due to chemical residue inspections at the point of entry, (c) the negative effects on the environment by pesticides usage will decrease, such as the reduction of water and ground pollution, and (d) the possibility of non-target, secondary plant pathogens in becoming serious pests will be curtailed.

k. Start: September 1995

l. Projected completion: June 1997

m. Projected person-months of scientist time per year: 6

n. Budget: ARF: $3,025 (See Table 7f)
Ohio State: None

V. Indigenous Pest Management Knowledge (LA 97-5)

a. Scientists: Ohio State, Purdue, U. of Georgia, AGRILAB, ICTA, ARF, and CARE will be involved. Scientists are listed under each sub-activity.

b. Status: Continuing activity.

c. Objectives: The objectives of this activity are (a) compile a list of practices that traditional farmers use to control pests and to evaluate these practices from an ecological perspective, (b) study traditional practices of soil fertilizer management (organic versus synthetic) for their effects on corn pest, natural pest enemies and corn plant growth, and (c) evaluate and compare knowledge of traditional and non-traditional growers, extension agents and local researchers concerning pest management in fruits and vegetables.

d. Description of research activity: Surveys will be conducted with traditional and non-traditional farmers, extension agents, and local researchers concerning soil management and pest control practices in order to compare how practices vary among the groups. The traditional and non-traditional practices information will be compared in field studies and will be made available for pest control strategy design.

e. Justification: Promoters of pest management are frequently unaware of traditional pest control methods used by native people. It is important to document these methods, test them in comparison with methods using synthetic chemicals, and to use the effective traditional methods in IPM programs for fruit and vegetables.

f. Projected outputs: (1) A list of traditional pest management practices will be documented and made available to modern pest management planners, (2) a better understanding of farmer perspectives will be available for IPM extensionists and researchers, (3) the effect of synthetic and traditional organic fertilizers effects on corn pests will be better understood, and (4) new research approaches for pest control, based on traditional knowledge from farmers, will be developed.

g. Projected Impacts: These projects will integrate the best available traditional knowledge, and lead to pest management practices that reduce pesticide use, avoid environmental contamination, improve health, and result in better economic return to the farmer. Secondly, an understanding of farmers perspectives on pest control based on traditional understanding of the agroecosystem could allow these practices to be more readily incorporated into modern IPM programs.

h. Start: October 1994

i. Projected completion: September 1997

V.1 Pest Control and Traditional Knowledge in the Guatemalan Highlands: Understanding Traditional Soil Management *LA 97-5-a)

a. Scientists: R. Williams, H. Morales, G. Sanchez - Ohio State University; S. Weller - Purdue University

b. Status: Continuing research activity

c. Objectives: The general objective of this project is to compile a list of practices that traditional farmers (maize and traditional vegetable growers) in the highlands of Guatemala use to control pests, and to evaluate them from an ecological perspective. A comparison will also be made between the knowledge of pest control of traditional farmers and non-traditional farmers (export vegetable growers), extension agronomists, and pest management specialists. More specifically, traditional practices of soil management will be studied. The effect of traditional organic fertilization on corn pests, their natural enemies, and plant growth will be compared with the effect of synthetic fertilizers.

d. Hypotheses: Traditional farmer fertilization practices result in a more balanced ecosystem in relation to crop pests and their natural enemies.

e. Description of research activity: A survey of the pest control practices used by traditional growers in the Guatemalan highlands (field observations and controlled field experiments) focusing on soil management and its effect on pests will be conducted to begin the process of making traditional knowledge available to modern pest management planners. Furthermore, traditional practices, family participation in agriculture, and natural resource management will be observed. Finally, field experiments were established in farmers' plots and in ICTA's experimental station in Chimaltenango. Corn was planted May 15, 1995, and harvested the end of January, 1996. The field experiment will be repeated in 1996/97 growing season. Pest populations (*Phyllophaga* spp., *Spodoptera* spp., Aphidae), natural enemies (predators, parasitoids, pathogens), as well as soil and plant nutritional status will be monitored in all the phenological stages of the crop. The experiment will be repeated in 1996.

f. Justification: Promoters of pest management are frequently unaware of traditional methods used by native people, thus depriving modern development schemes of a rich source of potential technology. The highlands of Guatemala, with their large populations of indigenous people, is known to be a treasure of such knowledge. This information is largely oral and has not been systematically surveyed and catalogued in a way that would make it potentially useful for agricultural planners. In Patzun, traditionally, farmers have fertilized their milpas with compost, horse, sheep or chicken manure. Those organic fertilizers have been substituted by the majority of the farmers by applications of urea, even if they recognize the increase in pest populations since the introduction of synthetic fertilizers (H. Morales, unpublished data). Understanding the effects of traditional fertilization over pest populations compared with synthetic fertilizers would allow better design and management of agroecosystems not only for traditional crops, but also for the non-traditional export crops with which they are rotated.

g. Relation to other research activities at site: A survey to determine traditional pest control practices has already been started and used to produce a preliminary list of traditional pest management practices. Farmers mostly reported preventive practices, including strict schedules for planting and harvesting, soil and landscape management, use of repellent plants, and natural enemies conservation. They see their corn fields and agricultural practices as an integrated whole. Each practice is essential and has multiple purposes (H. Morales, unpublished data). Some of the practices reported by the farmers have already been proven effective for pest control, such as the use of Tagetes erecta and lime applications. Others, such as the use of organic fertilizers and the use of the moon cycle to schedule each agronomic practice, have been reported as effective several times, but there is still a lack of scientific explanations.

When studying pest populations and effects of soil nutrients on plants, it is necessary to analyze at least two crop cycles in order to have confidence in our results, a second year of field experimentation is planned.

This project will be carried out in collaboration with ICTA, ALTERTEC, and ARF. The collaboration of these institutions is essential for the project, and would allow a fast adaptation of the results of IPM programs.

h. Projected outputs: Outputs will include (a) a list of traditional pest management practices will be available to modern pest management planners, (b) a better understanding of farmers' perspectives will be available for IPM extensionists, (c) the effect of synthetic and traditional organic fertilizers over corn pests populations will be known, (d) the effects of fertilizers over pests populations will be better understood.

i. Progress to date: A list of practices that traditional farmers in the Highlands of Guatemala use to control pests has been compiled after interviewing 50 farmers. Practices most common are preventative, including soil management with organic fertilizers. In experimental plots of corn and beans, populations of aphids were higher in plots fertilized with synthetic fertilizers compared to composted cow manure, however, no other soil borne or leaf pests varied in the two fertilizer treatments.

j. Projected impacts: The project could lead to sustainable pest management practices that would avoid environmental, economic, and public health costs. A better understanding of farmers' perspectives and the ecological mechanism of their practices would allow adoption of their technologies to other agroecological systems, or to improve them if necessary.

k. Start: September, 1994

l. Projected completion: June 1997

m. Projected person-months of scientist time per year: 2.5

n. Budget:

Ohio State:	$22,498 (See Table 7b)
Purdue:	None

V.2 Documentation of Knowledge and Traditional Practices Related to Pest Management in Vegetables and Fruits (LA 97-5-b)

a. Scientists: G. Sanchez, R. Williams, H. Morales - Ohio State University; S. Weller - Purdue University; D. Dardon, M. Tucux, M. Ibarra - ICTA; A. Dix - U. of Georgia

b. Status: Continuing research activity

c. Objectives: To (1) collect baseline information about pest control practices, (2) evaluate and compare the knowledge of traditional growers, non-traditional growers, extension agents, and local researchers, and (3) suggest potential practices to be applied in the project.

d. Hypotheses: Practices used by snow pea growers to control their pests vary depending upon their socioeconomic status.

e. Description of research activity: Three snow pea grower types will be surveyed and these surveys will be compiled into a case study of production practices used by Guatemalan snow pea farmers. The three grower types are: plantation growers, large cooperative growers, and small cooperative growers. The case study for each grower type will be conducted from the beginning of the cropping cycle through harvest and grading. All practices used will be documented and included in preparation of the final report. The case study will allow us to learn more about how and why various production practices are used and how they affect final crop quality and grade for the export market.

f. Justification: Before pesticides appeared on the market, growers obtained good yields using the traditional methods. Growers have a lot of traditional knowledge about how to manage the pests with cultural practices.

g. Relation to other research activities at site: Traditionally, growers did not use a lot of pesticides because they used cultural practices. Some of these practices could be applied to export crops, and this knowledge could be made available to a wider audience of Guatemalan farmers.

h. Projected outputs: New topics for research. The use of pest control cultural practices, that came from traditional agriculture, can be used to achieve changes in production systems and pest management in non-traditional export crops in Guatemala.

i. Progress to date: The case study for snow pea growers in the central Highlands has been completed for one cropping cycle and data are being compiled and organized. A second evaluation will be conducted on the 1996 fall crop.

j. Projected impacts: Reduced use of pesticides and assistance in offering greater opportunities for organic practices by Guatemalan farmers.

k. Start: October 1994

l. Projected completion: September 1997

m. Projected person-months of scientist time per year: 6

n. Budget:

Ohio State:	None
Purdue:	None
ICTA:	$9,075 (See Table 7d)
Georgia:	None

VI. Development of Ecuador IPM Activity

a. Scientists: C. Suarez, J. Palomino - INIAP; J. Rodrigues - PROEXANT; M. Volano - CAAM; G. Norton, J. Alwang - Virginia Tech.; R. Williams - Ohio State; X. Santacruz - Nature Foundation.

b. Status: New Activity

c. Objective: (a) To conduct participatory appraisal (PA) of horticultural IPM problems, (b) design one policy and one technical research activity consistent with the highest priorities identified in the PA, (c) initiate one technical research activity and initiate other research activities, including policy research activity, if additional resources materialize.

d. Description: A brief stakeholders meeting will be held, followed by the design and implementation of a PA at a site identified by the stakeholders. Equal attention would be devoted to (a) identifying the most pressing pest problems and potential research topics to solve them and (b) the most pressing policy issues and potential research to address them. Research plans would be developed and limited research initiated.

e. Justification: Insects, diseases, and other pests cause substantial production losses and reduced product quality of fruits and vegetables in Ecuador. White fly in several vegetables and Black Sigatoka on bananas and plantain are just two examples of current pest problems in Ecuador. In efforts to prevent such problems, producers apply pesticides, often spraying on a schedule that is not closely tied to the economic damage caused by the pests and with little regard for environmental long-run sustainability of the agricultural system as the natural enemies of pests are destroyed and pests build up resistance to pesticides.

There is a need for a multi-disciplinary, multi-institutional, participatory IPM approach to identify more specifically the nature of the IPM constraints in Ecuador and to develop means for removing those constraints. Given both the importance of pest and pesticide problems in fruits and vegetables in Ecuador and the relative emphasis in the IPM CRSP on horticultural exports, it makes sense to focus the research program on fruits and vegetables. Given the relative emphasis on policy and environmental issues in the current USAID/Ecuador program portfolio, it makes sense to orient the research program toward (a) identifying and solving policy (and institutional) constraints to IPM development and adoption, and (b) designing IPM systems that will reduce environmental damage resulting from pest management practices. The current activity will begin the process.

f. Relation to other research activities: The Ecuador activity would build directly on the lessons learned in Central America on the IPM CRSP as the emphasis in both areas is horticultural export crops.

g. Projected output: Identification of key pest problems and potential IPM solutions, both technical and institutional. Results of the completed PA will be written up in an IPM CRSP Working Paper.

h. Start: October, 1996

i. Projected completion: September 1998

j. Projected person-months of scientist time per year: 3

k. Budget:

INIAP and other Ecuador institutions:	$8,000
Virginia Tech:	6,000
Ohio State:	2,000

Cross-cutting Activities in the Fourth Year

Workshop for Information Sharing across Sites and Planning for Year 5 and Renewal Proposal

A. Description of activity: Plan and implement a workshop for U.S. scientists involved in the CRSP and at least one collaborator from each of the four principal sites prior to the technical committee meeting in spring 1997. The workshop will involve sharing information across sites and planning of year 5 activities and for the five-year renewal. Site commitee meeting will be held immediately following this workshop to assess technical progress, approve changes to workplans, and to discuss site plans and technical issues that are common across sites.

B. Relation to outputs and research priorities: It is essential that the U.S. scientists and at least one collaborator from each site meet to share information across sites and discuss plans for year 5 and the second phase of the project.

C. Projected start: Preparations for workshop will begin in January 1997

D. Projected completion: May 1997

E. Projected person-months of input: 2

F. Projected outputs: Shared information across sites and materials for fourth year workplan and renewal proposal.

Information Exchange and Networking

A. Description of activity: An IPM CRSP newsletter will be produced and available both in hard-copy and on-line, facilitating contact both within the IPM CRSP and with other CRSPs.

B. Relation to outputs and research priorities: Sharing knowledge relative to IPM and other aspects of sustainable agriculture will help scientists and other stakeholders make informed decisions about designing and testing IPM strategies. Sharing research results generated by the CRSP will help others within the CRSP solve their own research and pest problems, including those related to policy and institutional changes. One of the best sources of information for project implementation will be on-going activities at other sites. Standardized, consistently formatted reports should flow between projects and ME and then to other projects in a timely manner. The ME and technical committee will design a report format. The standardized reporting framework will serve to (a) let people know what techniques are working or not in different countries, (b) allow suggestions for solving problems to come from several sources, and (c) provide a sense of camaraderie among projects. The newsletter is primarily for communicating with people outside the CRSP.

C. Projected start: October 1994

D. Projected completion: This work will be on-going throughout the life of the CRSP.

E. Projected person-months: 3

F. Projected outputs: The IPM CRSP newsletter will be produced and distibuted with on-line accessibility. The necessary hardware and software to support this work will be in place.

G. Institutions and individuals involved: Virginia Tech will lead this activity with K. Reid being the responsible individual.

Electronic Networking For IPM in Africa

The IPM CRSP will undertake several activities to develop electronic networking capability in Africa. These activities will be undertaken jointly with CICP and will include the following:

1. CICP with the support of IPM CRSP/ICN will maintain and enhance IPMnet as an informational resource without which telematics would remain an underutilized technology.

2. IPM CRSP/ICN with the support of CICP will select target countries in which activities will be undertaken and will identify enthusiastic colleagues and institutions within these target countries. Through direct consultation it will build collaborative relationships between government, academia, NGOs, and business to facilitate network development.

3. IPM CRSP/ICN with the support of CICP will solicit agreement of colleagues to participate in the electronic networking activity.

4. IPM CRSP/ICN with the support of CICP will coordinate IPM communication activities.

5. IPM CRSP/ICN with the support of CICP will conduct a participatory appraisal (PA) workshop with African collaborators to (i) demonstrate the benefits of the electronic IPM infformation, (ii) in collaboration with AfricaLink, determine the most appropriate technology for the selected countries, (iii) define the goals and future orientation of electronic networking in order to serve a broad category of users.

6. IPM CRSP/ICN with the support of CICP will investigate cost-sharing with global partners and other organizations involved in information transfer to assure that scarce resources are used effectively. It will promote a global IPM network.

7. CICP with the support of IPM CRSP/ICN will produce a report on electronic communication capabilities (issues and problems) within African Nations with recommendations on guidelines for addressing problems.

8. CICP with the support of IPM CRSP/ICN and in cooperation with AfricaLink, will assist in electronic networking training with emphasis on IPM information.

9. CICP with the support of IPM CRSP/ICN will investigate cost-effective alternatives for transmission of voluminous databases (IPMnet), such as via CD-ROM.

10. IPM CRSP/ICN with the support of CICP will search the World Wide Web and FTP sites for electronic IPM-related information in french for inclusion in the

databases. IPM CRSP/ICN will continue the search for IPM-related works at Virginia Tech and elsewhere to expand the annotated bibliography on integrated control methods of pests of millet, sorghum, and cowpea in Sub-Saharan Africa.

11. IPM CRSP/ICN with the support of CICP will create an electronic database of active IPM practitioners in Africa.

12. CICP with the support of IPM CRSP/ICN and the collaboration of AfricaLink will survey and identify effective and economical telematic service providers in the target countries.

BIOTECHNOLOGY STATEMENT

Virginia Tech and other collaborating institutions each have their own Biotechnology Compliance Committees. They will review any proposed biotechnology component of the project to ensure compliance with all relevant regulations dealing with biotechnology and genetically-engineered biological products. We will also network with the Rockefeller Foundation Rice Biotechnology program and CGIAR initiatives to introduce pest-resistant varieties in our research sites.

INTELLECTUAL PROPERTY RIGHTS

An agreement on intellectual property rights will be worked out on a case by case basis with collaborating institutions at each site.

DEGREE TRAINING

In addition to the training in participatory appraisal methods and other short-term training, graduate students from the United States and/or the sites are assisting on the project and defining thesis and dissertation topics. M.S. or Ph.D. students will be working on the project work in Year 4 of whom at least 5 are from the host countries. These students may be graduate students at academic institutions in the host countries or at our IPM CRSP institutions in the United States.

Students that will be supported in Year 4 of the IPM CRSP are broken down as follows:

Philippines

1 agricultural economics graduate student (Filipino) located at Virginia Tech collaborating with PhilRice.

1 statistics/entomology graduate student (Filipino) at Penn State.

1 weed science graduate student (Filipino) at UPLB.

Mali

1 entomology graduate student (Purdue) who will collaborate with IER.

1 agricultural economics student (U.S.) will be located at Virginia Tech who will collaborate with IER.

6 months of a horticulture graduate student (U.S.) will be located at Virginia Tech who will collaborate with IER.

Guatemala	1 entomology graduate student (Guatemalan) supervised at Ohio State but coordinating with ICTA and ALTERTEC.
	9 months of an agroecology graduate student (U.S.) located at Georgia but working with ICTA and other institutions.
Jamaica	1 sociology or agricultural economist (but working on gender issues) (U.S.) at Virginia Tech.
	12 months of an entomology graduate student (Jamaican) at Virginia Tech.
	6 months of an M.S. student (U.S.) in soil fert./plant nutrition (Lincoln University).

RESPONSE TO AID REQUESTS FOR IPM TECHNICAL ASSISTANCE

We will respond to requests from USAID missions for IPM technical assistance in other countries as specified in the grant. These activities will be cost-shared by the requesting missions. Exact details of this cost-sharing will be determined on a case by case basis in discussion among the ME, the mission, and the USAID's Office of Agriculture.

GLOBALIZATION

Globilization of the IPM CRSP will move beyond the four primary regions during Year 4 to include Eastern Europe. A total of $10,056 has been set aside for the stakeholder meeting and a participatory appraisal in either Albania or Macedonia.

EXTERNAL EVALUATION

The External Evaluation Panel is scheduled to meet sometime in the period of January-March 1997. The date has not been set.

PREPARE FIFTH YEAR WORKPLAN

Fifth year work plan will be prepared and revised following AID review.

TECHNICAL COMMITTEE MEETING:

The Technical Committee will meet in May and September of 1997.

BOARD MEETING:

The Board will meet in the period January-March 1997. This meeting will be at the same time as the EEP meeting.