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IPM CRSP

INTEGRATED PEST MANAGEMENT

COLLABORATIVE RESEARCH SUPPORT PROGRAM

FIRST ANNUAL REPORT

1993 - 94

Virginia Tech

VIRGINIA POLYTECHNIC INSTITUTE
AND STATE UNIVERSITY

IPM CRSP

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(29 September 1993 - 28 September 1994)

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IPM CRSP US Institutions

Lincoln University
Montana State University
Ohio State University
Penn State University
Purdue University
Rodale Inst. Res. Ctr
Univ of CA/Berkeley
University of Georgia
USDA Veg Lab
Virginia Tech

Host Country Institutions

Prime Sites

Guatemala - Agri-lab, ALTERTEC, CARE, ICTA
Jamaica - CARDI, Ministry of Agriculture
Mali - IER
Philippines - NCPC/UPLB, PhilRice

Satellite Sites

Ecuador - INIAP
Honduras - EAP
Thailand - Dept of Agriculture
Uganda - Makerere University

International Centers

AVRDC - Taiwan
IRRI - Philippines
CIAT - Colombia
CIP - Peru

Private Sector

The Kroger Company
Caito Foods
PICO

NGOs/PVOs

CLADES

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EXECUTIVE SUMMARY

The overall purpose of the IPM CRSP (Integrated Pest Management Collaborative Research Support Program) is to foster IPM through collaborative research between US and LDC institutions for their mutual benefit by improving their abilities to develop and implement economically and environmentally sound crop protection methods. We plan to develop and implement a replicable approach to IPM that will help reduce: (1) agricultural losses due to pests, (2) damage to national ecosystems, and (3) pollution and contamination in food and water supplies. The end result should be a stronger global IPM research and education network and improved quality of life in both developing and developed countries.

The IPM CRSP focuses on four production research regimes: off-season horticultural export crop production in the Altiplano, winter export vegetable production in the Caribbean, transitional semi-arid agricultural production systems in the Sahel, and innovative IPM research for transitional rice-based systems in Asia. The primary horticultural export-crop regime sites are Guatemala and Jamaica, whereas the primary site for the transitional agricultural production system regime is in Mali, and the primary innovative research site is in the Philippines. In the first year, the CRSP started its work in the four primary sites with the ultimate aim of globalizing the IPM concepts and technologies generated at these sites.

In terms of operational management, Virginia Tech is the Management Entity (ME) for the IPM CRSP and is the primary grantee of USAID. Virginia Tech subgrants have been made to the following US and host country institutions/organizations involved as IPM CRSP partners:

US Institutions

1. Lincoln University
2. Montana State University
3. Ohio State University
4. Penn State University
5. Purdue University
6. University of Georgia
7. USDA Vegetable Lab
8. Virginia Tech

Host Country Institutions/Organizations

1. Agrilab, Guatemala
2. Altertec, Guatemala
3. CARE, Guatemala
4. ICTA, Guatemala
5. Zamorano, Honduras
6. CARDI, Jamaica
7. IER, Mali
8. IRRI, Philippines
9. PhilRice/NCPC, Philippines
10. AVRDC, Taiwan
11. Dept of Agriculture, Thailand
12. Makerere University, Uganda

Work in each of the four primary sites is managed and conducted by a site committee that is led by a site committee Chair and Vice Chair chosen from the U.S. university partners. Each site committee is composed of representatives from the institutions working in the site, so that the workplans are developed and carried out by the scientists themselves. For each site, an on-site coordinator has been selected from among the representatives of the host country institutions. Three of the four site committee chairs and all four of the vice chairs have been selected from institutions other than Virginia Tech in order to promote

collaboration among institutions and ensure widespread involvement in the development of workplans and budgets.

GUATEMALA

ICTA agreed to participate as the lead institution for IPM CRSP activities in Guatemala and the MOU with ICTA was signed during the year. Ing. Danilo Dardon Avila will serve as ICTA's lead administrator for IPM CRSP and Victor Salguero agreed to serve as Site Coordinator for 1993/94 through 1994/95. Dr. Salguero's expertise in IPM for non-traditional crops provides the basis for a strong leadership role in IPM CRSP.

Purdue University, Virginia Tech, Ohio State University, and the University of Georgia have all assumed major program responsibilities for effectuating IPM CRSP project activities in Guatemala and the Central American site. Two graduate research assistants, Anne Dix and Helda Morales, sponsored by Ron Carroll, University of Georgia and Roger Williams, Ohio State University, respectively, have been funded on IPM CRSP, and are currently completing their graduate research in Guatemala.

Two sites were selected for the participatory appraisals; Chilascó/Baja Verapaz and Chimaltenango. We also identified potential constraints to the participation of women as IPM collaborators. One of the requests from counterparts in Guatemala is to get positive identification of some of the pest species that we will be dealing with, particularly in the brambles (blackberry & red raspberry) for export. A beetle which is very pesky destroying the white flower petals of these brambles has just been identified and will perhaps aid in the control of this pest by conducting literature searches with the scientific name, recent publications refer to these insects as, "escarabajos" which means beetles.

The main pest problems identified by the people in Chilascó were *Plutella xylostella* (Diamondback moth), *Leptophobia aripa* (mariposa blanca, gusano anillado), *Brevicorne brassicae* (Aphids), *Phyllophaga* sp. (gallina ciega) and quite unexpectedly, houseflies. Two of the problems are linked by the villagers, with the introduction of chicken manure as fertilizer. Among the pesticides most frequently mentioned were Dipel 2x, Ambush and Lorsban. Most farmers spray immediately after they spot 5 caterpillars of any kind in a sample of fifty plants distributed through five cardinal points in the field. The main IPM concerns for this community are the development of pesticide resistance and the elimination of alternate hosts for natural enemies, and the poor management of the timing of harvests. Of special concern is the farmers' heavy reliance on agrichemical information and products ("medicines") provided by people who come from outside the community and the apparent deterioration of soil quality through intensive use and erosion. Water quality may be impacted by a Leatherleaf export operation located upstream from Chilasco. The introduction of broccoli in Chilasco has had a lot of both positive and negative impacts on the social structure and economic well being of the community. Many of these impacts directly influence farmers choices about IPM.

A strategic assessment of institutions and individuals was completed. Stakeholders were identified and commitments for IPM CRSP collaborations were obtained. Workplan collaborations were established with each stakeholder, along with implementation schedules and timelines for workplan fulfillment.

In one of the satellite sites, Ecuador, we participated in stakeholders meeting with USAID, INIAP, the Presidential Commission on the Environment (CAAM), the Nature Foundation, and others. A proposal for funding for a buy-in from the USAID/Ecuador Mission was submitted along with a draft MOU.

JAMAICA

An MOU was signed between the CARDI (Caribbean Agricultural Research and Development Institute), the Jamaica Ministry of Agriculture (MINAG) and the Management Entity at Virginia Tech representing the IPM CRSP. Stakeholders meetings were held in Jamaica with the participation of CARDI, RADA, UWI, MINAG, ALCAN, USAID, PSU, LU, USDA-ARS, VPI. Sites for field work were identified in two parishes, St. Mary and St. Catherine (north east and central Jamaica), in which research will be conducted. Farmers and their families, local cooperatives, USAID "Hillside project," UWVRONCO/USDA, APHIS, chemical companies, seed companies were among other stakeholders and collaborators identified and visited.

Based on observations and discussions related to the crops cultivated in the areas visited a list of potential vegetables for IPM CRSP research was selected. For the primary crops, a list of potential areas for investigation was developed and a resource analysis conducted (resources available, needs, limitations identified). Based on the proposed research, baseline studies were selected for Year II. Linkages between Jamaican and US institutions and organizations were discussed and their roles in the implementing the proposed workplan for year II identified.

A Site Coordinator (Janet Lawrence) was recruited in the latter part of May and officially assumed duties on 1 June 1994. Ms. Lawrence's duties include coordinating the activities of IPM CRSP in Jamaica as well as conducting entomological research on IPM CRSP research projects.

A list of possible crops for research was developed and a vote taken to determine the crop combination to be investigated in the IPM CRSP research program. The criteria for selecting crops were those of export importance, pesticide usage residues, potential for developing IPM and crop classification (vegetable/horticultural). Callaloo (*Amaranthus* spp.), peppers (hot and sweet) (*Capsicum* spp.) and sweet potato (*Ipomoea batatus*) obtained the highest ratings, and were designated primary research crops. Callaloo was the most frequently planted crop in Bushy Park, St. Catherine. Farmers cultivate callaloo continuously throughout the year and plant mixed varieties. Sweet peppers are grown mostly by farmers in St. Catherine where hot peppers (scotch and cayenne) are grown principally in Annotto Bay. Sweet potatoes are cultivated predominantly in Clarendon where farmers reported that they planted sweet potato throughout the year.

Several of the pests observed during the baseline survey are consistent with the pest complex described in the literature for callaloo, peppers (hot and sweet), and sweet potato and included insects, fungi, viruses, nematodes and weeds. A Lepidopteran complex of *Spodoptera spp., Pilemia* and an unidentified genus ("green worm") was reported as the predominant pests of callaloo. Red spider mites ("silver back") attacking callaloo were also identified by farmers as economically important. Sweet potato weevil was reported to be the most important pest of sweet potato. Leaf miners affected all crops in varying abundance.

The fungal disease "white rust" was observed on callaloo and sweet potato, but appeared to be a bigger problem for callaloo as it affects the marketable product. Leaf spots *Alternaria* and *Cercospora* sp. were observed on peppers and sweet potato. A viral complex of Potato Y and Tobacco Edge viruses were observed on scotch bonnet peppers.

The majority of farmers visited relied heavily on chemicals to manage pests. Several farmers interviewed mentioned inappropriate use and application of pesticides and incidents

of poisoning. The need therefore exists to train farmers within these target areas in appropriate pesticide technology.

Non-chemical approaches employed by farmers involved hoeing between rows of crops to remove weeds and removal of crop residues. The introduction of traps, baited with sweet potato weevil sex pheromone (by CARDI), was used by farmers within Clarendon to manage weevil populations. The three hymenopteran parasites reared from the leaf webber on sweet potato and those from the lepidopteran complex attacking callaloo may be potential biological control agents whose populations could be augmented by inundative releases to manage the respective pests.

Hot peppers, particularly the Scotch Bonnet cultivar class, are extremely popular in Jamaica. The root-knot nematode (*Meloidogyne* spp.) is a major pest of the crop, and the ideal solution to the problem in Jamaica would be the development and use of resistant cultivars. During FY-94, Scotch Bonnet (and the very similar Habanero) germplasm was collected from all available commercial and private sources. Four accessions (PA426, PA-427, PA-353, and PA-398) exhibited high levels of resistance. PA-136, a pepper line with reported exceptionally high tolerance to infection by root-knot nematodes, was developed for use as a maintenance host to produce large quantities of egg inoculum. Results indicate that PA-136 is an excellent host for *M. incognita,* but the line does not exhibit true tolerance (high *M. incognita* reproduction without a reduction in yield). Carolina Cayenne exhibited exceptional resistance (minimal *Meloidogyne incognita* reproduction, minimal galling, and no yield reduction). Early Calwonder was susceptible. Pepper cultivars varied in their response to oxyfluorfen and bontazon. Bohemian Chile and Carolina Cayenne were most tolerant, and California Wonder, PA-337 and Sweet Banana were most susceptible to oxyfluorfen. Among the Scotch Bonnet types, PA-338 was most tolerant to oxyfluorfen.

Sweet potatoes vary considerably in competiveness against weeds. This variation is due in part to differences in sweet potato root content of allelopathic compounds which inhibit yellow nutsedge and other weeds. Sweet potatoes also vary in growth habit, and clones, which have a denser canopy and an earlier canopy closure, appear to compete more effectively against small seeded annual weeds. The highly competitive clones probably require a shorter period of weed control to obtain maximum yields than less competitive clones. Hand weeding with machete and hoe is the predominant method of weed control in Jamaica, and is the most labor intensive aspect of Jamaican agriculture. Use of highly competitive sweet potato clones has potential for reducing the number of seedings required and significantly increasing the productivity of Jamaican sweet potato growers by allowing cultivation of larger plots. Production of some crops of interest for export (like callaloo) has declined because of pest problems.

MALI

A stakeholders meeting was held on February 14, 1994, with 15 representatives from various organizations including IER, the Service National de Protection de Vegetaux (SNPV), the extension organization Operation Haute Vallee du Niger (OHVN), Care International, ICRISAT. At the stakeholders meeting a ranking procedure identified sorghum/cowpea and millet/cowpea as the priority crop associations for the IPM CRSP to focus on in its first two years.

A five day workshop was conducted (July 4-8) on Participatory Appraisal methods for Integrated Pest Management at the Sotuba Research Station outside Bamako. Between 16-30 Malian participants attended all workshop sessions. Dr. Oumar Niangado, Director General, IER, opened the workshop. John Caldwell served as the overall facilitator for the workshop. Workshop participants were familiarized with the participatory approach and participatory methods, and in several sessions had an opportunity to practice selected methods. Selection of most important information needs and appropriate methods was done by workshop participants.

Following the participatory appraisal, a synthesis meeting was held at Sotuba. Participating team members developed a ranking of crop-pest priorities. The table below describes the combined findings from the two field sites. The pests are listed in order of importance from left to right.

Most Important Crop	Most Important Crop Pest(s)		
millet/cowpea	blister beetles	grasshopper	*Striga*
sorghum/cowpea	grasshopper	blister beetle	*Striga*
groundnut (for women)	termites	millipedes	root worms
cowpea	bruchids (post-harvest pest control)		

The following Objectively Verifiable Indicators were achieved during the past year of activity by the IPM CRSP Mali Site:

- A commitment from stakeholders was obtained.
- Participatory appraisal teams were trained in the US and in Mali.
- The participatory appraisal process was used and results were documented.
- Results from the participatory appraisal were submitted to the site committee, management entity, USAID/Washington and Bamako.
- Results from the participatory appraisal are being incorporated into a data base.
- A functional site committee is in place.
- Priority crop-pest complexes, attempted solutions, and quick impact IPM tactics have been identified and will be implemented during the next year.

Recommendations were made to conduct a survey of natural enemies, alternate hosts, and surrounding ecosystems for major pests in the OHVN Zone; study the effect of the removal of several grasses in July, August, and September on populations of the sorghum pests *Contarinia* spp. and *Geromyea penniseti;* examine the effectiveness of neem for sorghum and millet pest control and the economic potential for establishing a neem extraction plant in Mali.

The results and methods from the Mali PA have been incorporated in one course, "Farming Systems Research and Development," at Virginia Tech (John Caldwell).

PHILIPPINES

Stakeholders and network participants were identified and commitments obtained from both institutions and individuals. An MOU was signed between the IPM CRSP ME and the Department of Agriculture in the Philippines. PhilRice and USAID were co-signatories to the MOU. Stakeholders meetings were held in the Philippines from March 7-12 with the participation of PhilRice, UPLB/NCPC, IRRI, AVRDC, FAO, USAID, Virginia Tech, and Penn State. A site for field work was identified in San José, Nueva Ecija in the Central Luzon in which research will be conducted in six villages.

At the urging of AID, stakeholders meetings were held in Thailand with the Department of Agriculture, the Rice Research Institute, Kasetsart University, Chaing Mai University, IRRI, AVRDC, Virginia Tech, Penn State, and USAID. A rice-stringbean system is most appropriate for IPM CRSP project. Chainat and Suphanburi were selected by the group for IPM CRSP research sites.

The planned set of participatory appraisal activities took place in the Philippines July 8-23. Some of the activities underway should provide short-term outputs; for example, the work assessing the impact of straw mulch on disease incidence in rice-vegetable systems. Also the basic surveillance activities underway should yield recommendations during Year 2 that will result in reductions in pesticide use.

A preliminary survey of insect pests and their natural enemies in onions, eggplant and string beans was conducted in August-September, 1994 in two of the IPM CRSP barangay sites, Abar 1st and Palestina, in anticipation of the planned research activities for 1994/95. Adult insects from these crops were observed and collected, preserved, mounted, sorted and identified. Immature forms and their associated plant parts were collected and kept in separate petri plates and/or test tubes, and reared into their adult stages. Parasitoids which emerged from them were preserved and mounted on pins. Representative specimens of each species were preserved in 70% ethyl alcohol.

A total of 23 insect pests have been observed on onions (1), eggplant (11) and stringbeans (12), with *Spodoptera litura* occurring on both onions and stringbeans. Six species of natural enemies (4 insect predators, 2 parasitoids) of eggplant insect pests were encountered, while 5 species (3 insect predators, 2 parasitoids) were observed for stringbean insect pests. Based on the *Spodoptera* pheromones, only *Spodoptera litura* was found to occur in the sampling site, both on onions and stringbeans, with more catches on beans. Pheromones for *Spodoptera exigua* had no catches. The pheromone formulations for *Leucinodes* gave interesting results. While some formulations caught a few *Leucinodes* adults (A1, 8), other formulations (As, B3) caught *Spodoptera litura* in the eggplant field. Moths of an undetermined leaf-feeder were also attracted to some formulations. These formulations will be tested again in more eggplant fields during the vegetable growing season.

In the area of socio-economics and policy, the following were accomplished during the year: began analysis of information collected on economic, policy, and other institutional factors influencing incentives to use pesticides or adopt IPM practices; prepared a baseline socioeconomic survey that will enable us to statistically test which factors are influencing misuse of pesticides; designed a set of calculations to identify degree of pesticide subsidy or tax in the Philippines; discovered through PA activities that Landbank policy of requiring farm plans that include pesticide use may be influencing incentives to adopt IPM.

TRAINING

The IPM CRSP places high priority on graduate training with the ultimate objective to contribute to the human capital development and institution building of the host countries. During the first year of its operation, this CRSP provided full or partial financial support for six graduate students. Four of the six students currently supported by the IPM CRSP are females. Considering degree candidate distribution, 50% are Ph.D. candidates and 50% are M.S. students. In institutional distribution of students, Virginia Tech has three and Lincoln University, Ohio State University, and the University of Georgia each have one graduate student.

GLOBILIZATION AND IMPACTS ON THE UNITED STATES

The primary means through which the IPM knowledge gained in the principal sites will spread globally are (a) linkages to several "satellite" country sites, (b) linkages to the international agricultural research centers (IARCs), to multilateral NGOs, to FAO training programs, and to other CRSPs, (c) degree training at participating universities and participant training through regional workshops, (d) through publications such as manuals, journal articles, and newsletters, (e) by taking advantage of computer networking, and (f) by responding to requests for services and buyins from AID missions in other countries.

Each of the primary IPM CRSP sites is linked to another site in its corresponding region. The PIPM research at the primary site in Guatemala is linked to Ecuador. The diversity of the ecosystem in Ecuador makes it well suited for evaluating the transferability of participatory IPM technologies to other sites in Latin America. The IPM CRSP site in Mali is linked to a satellite site in Uganda, a country currently in transition from subsistence to commercial crop production following years of instability. IPM research in the Philippines site is linked to a Thailand site.

Impacts on the United States

IPM technology transfer will spread not only among developing countries, but back to the United States as well. This transfer will occur not only for particular IPM component technologies on fruits and vegetables in Latin America and the Caribbean, but also for the participatory approaches developed in all the sites. Many of the same insects, diseases, and other pests exist in the horticultural commodities of both developed and developing countries. In many cases, pest pressures are higher in the developing countries. Lessons learned abroad, and, in some cases, materials such as pest resistant germplasm, can be transferred back to the United States for low-input crop production.

Conclusions

The IPM CRSP will provide a major resource to facilitate the spread of participatory IPM approaches around the world. The opportunities for this spread are almost limitless given both (a) the needs for reductions in pesticide use and for controlling pests and (b) multiple mechanisms available to encourage the spread of IPM approaches and results. Not only will developing countries benefit, but the United states will as well.

INTRODUCTION

This document is the first annual report for the Integrated Pest Management Collaborative Research Support Program (IPM CRSP), which started its operations on September 29, 1993 through a funding from USAID under Grant No. LAG-4196-G-00-3053-00. From the initiation of the IPM CRSP to July 1994, Dr. S. K. De Datta served as the Interim Program Director and the Principal Investigator. In July, Dr. Brhane Gebrekidan was hired as Program Director while Dr. De Datta continues to serve as the PI and a member of the Management Entity.

The overall purpose of the IPM CRSP is to foster IPM through collaborative research between US and LDC institutions for their mutual benefit by improving their abilities to develop and implement economically and environmentally sound crop protection methods.

As a background document, the Global Plan Summary Statement of the IPM CRSP is presented at the beginning of this annual report. The Global Plan summarizes the purpose, the objectives, the research regimes and methods, program monitoring and evaluation, and the implementation strategies of the CRSP. In the first year, the IPM CRSP started its work in four primary sites with the ultimate aim of globalizing the IPM concepts and technologies generated at these sites. The approach to be used for globalization of the IPM CRSP is described in a paper presented later in this report. The global transfer mechanisms and the linkages to be maintained are detailed in the paper.

The annual report highlights that participatory research methods are central to the activities of the IPM CRSP. Participatory methods and their relationship to the IPM CRSP, as well as descriptions of indicators for assessing sustainability of agro-ecosystems as they relate to IPM, are described in two separate papers contained in this report.

The activities undertaken during the first year in each of the four prime sites are reported separately by site, under Guatemala, Jamaica, Mali, and Philippines. The presentations under each site start with an overall site report by the site chair and are followed with reports of investigators. For the Jamaica and the Philippines sites, the host country site coordinators have submitted separate reports, which are also included. Co-Principal Investigators (Co-PIs), who have had significant activities during the year, have submitted reports under the prime site of their involvement. These reports are presented under the appropriate Co-Principal Investigators under each prime site. Across sites, significant progress has been made in identifying stakeholders in IPM, planning and implementation of PA activities, and identification of important pests and IPM issues. In selected cases, preliminary IPM research results have been obtained and are reported here.

Finally, a status report on the training aspects of the IPM CRSP is given. The IPM CRSP is currently sponsoring six graduate students.

In terms of operational management, Virginia Tech is the Management Entity (ME) for the IPM CRSP and is the primary grantee of USAID.

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Virginia Tech subgrants have been made to the following US and host country institutions/organizations involved as IPM CRSP partners:

US Institutions

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3. CARE, Guatemala
4. ICTA, Guatemala
5. Zamorano, Honduras
6. CARDI, Jamaica
7. IER, Mali
8. IRRI, Philippines
9. PhilRice/NCPC, Philippines
10. AVRDC, Taiwan
11. Dept of Agriculture, Thailand
12. Makerere University, Uganda

The Board of Directors

In the overall management of the IPM CRSP, the Board of Directors is the top policy body. The current Board members are:

1. Tom Payne, Chair, Ohio State University
2. Mary Carter, USDA
3. Ikbal Chowdhury, Lincoln University
4. S. K. De Datta, Virginia Tech
5. Peter Gregory, CIP
6. J. Dean Jansma, Pennsylvania State University
7. Ed Kanemasu, University of Georgia
8. Santiago Obien, PhilRice
9. Paul Teng, IRRI

The Board met once during the year and made important policy decisions, including program content and how to operate field sites.

The Technical Committee

The Technical Committee (TC) is responsible for technical and operational matters of the CRSP, including development and implementation of annual workplans, budgets, and overall program coordination. The members of the TC in Year One were:

1. George Norton, Chair, Virginia Tech
2. Ron Carroll, University of Georgia
3. Florence Dunkel, Montana State University
4. Frieda Eivazi, Lincoln University
5. J. Mark Erbaugh, Ohio State University
6. Charlie Pitts, Pennsylvania State University
7. Ed Rajotte, Pennsylvania State University
8. Glenn Sullivan, Purdue University
9. K.L. Heong, IRRI

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The ex-officio members were:

1. Robert Hedlund, USAID/Washington, Project Manager
2. S.K. De Datta, Principal Investigator, Interim Program Director (until July 1994)
3. Brhane Gebrekidan, Program Director
4. R. Kent Reid, Assistant Program Director

The TC met twice during the year and made a number of important recommendations including the Year Two Workplan and Budget.

The Management Entity

The Management Entity (ME) office is located in the Office of International Research and Development (OIRD) of Virginia Tech, 1060 Litton Reaves Hall, Blacksburg, VA 24061-0334. As the prime grantee, it is responsible to USAID for all fiscal matters relating to the grant. The ME staff (CRSP financed) is composed of:

Brhane Gebrekidan, Program Director
R. Kent Reid, Assistant Program Director
Sharon Lawson, Fiscal and Administrative Assistant

Salary matched by Virginia Tech:
S.K. De Datta, Director, OIRD, Principal Investigator, Interim Program Director (Until July 1994) (15%)
Peggy Hall, Fiscal Technicial Senior, OIRD (30%)
Martha Bower, Program Support Technician Senior, OIRD (15%)

Some of the main achievements of the ME during the year were:

- Finanalized and implemented grant subgrants with eight US and 12 host country institutions/organizations.
- Facilitated the signing of Memoranda of Understanding with four host countries and the implementation of collaborative work with them.
- Organized a number of meetings including Board, Technical Committee, and a workshop on PA methods.
- In cooperation with the appropriate site committees, facilitated conducting Participatory Appraisals in four prime sites.
- Worked closely with the Chair of the TC in developing and finalizing the Year Two Workplan and Budget.
- Developed a Draft Policy and Operational Procedures for the CRSP.
- Facilitated all international travels taken under this CRSP.
- Coordinated the completion of this annual report, as well as all Board and TC reports.

GLOBAL PLAN
IPM CRSP
Summary Statement

The purpose of the IPM CRSP is to develop and implement a replicable approach to IPM that will help reduce: (1) agricultural losses due to pests, (2) damage to national ecosystems, and (3) pollution and contamination in food and water supplies. The end result should be a stronger global IPM research and education network and improved quality of life in both developing and developed countries. The project fosters participatory, interdisciplinary IPM research, training, and information exchange programs that will be adopted in (1) horticultural export crop production in Latin America and the Caribbean, (2) semi-arid transitional systems in the Sahel, and (3) innovative programs for rice-based food systems in Asia.

Through the participatory IPM approach to designing, testing, and demonstrating pest management tactics and strategies, in the first three to five years of the project, the goal is to reduce crop losses, increase farmer income and societal economic benefits, reduce pesticide use, reduce pesticide residues on export products, improve IPM research and education program capabilities, improve ability to monitor pests, and increase involvement of women in IPM decision making and program design in the host country sites. With time, these changes should accelerate, water quality will be improved, and the rate of loss of biological diversity reduced. The sphere of influence of the participatory IPM approach will extend beyond the initial project sites.

Project Objectives

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.

Research Regimes and Sites

The IPM CRSP focuses on four production research regimes: off-season horticultural export crop production in the Altiplano, winter export vegetable production in the Caribbean, transitional semi-arid agricultural production systems in the Sahel, and innovative IPM research for transitional rice-based systems in Asia. The primary horticultural export-crop regime sites are Guatemala and Jamaica. The primary site for the transitional agricultural production system regime is in Mali, and the primary innovative research site is in the Philippines. Secondary sites are in Thailand, Uganda, Albania, Ecuador, Egypt, and Mexico.

Off-Season Horticultural Crop Production in the Altiplano-Guatemala

Horticultural exports from Central America to the United States have increased significantly since 1987. However, pesticide residue problems have continued to restrain more rapid development of these markets. The IPM CRSP will target horticultural crops prominent in export production that can be marketed during the off-season, so as to complement rather than compete with U.S. production. Examples include cantaloupe and related cucurbit crops, peppers, tomatoes, small fruits, snow peas, and broccoli. Broccoli and snow peas are particularly good candidates for the IPM program due to their importance in residue violations and fundamental studies already completed on ecological changes (pest populations, overall diversity, disease prevalence, etc.) bought about by these crops.

Among the pests for which improved management tactics and systems are needed are: diamond-back moth larvae, cutworms, white flies, thrips, white grubs, and armyworms. Current pesticide practices are poorly designed to control these pests. Application rates are commonly excessive and not administered in a timely manner.

U.S. institutions on the IPM-CRSP with significant interest in the Guatemala site include Purdue, Georgia, Ohio State, Virginia Tech, University of California-Berkeley, Kroger, and Caito Foods. Guatemalan and international institutions and organizations include the University del Valle de Guatemala, CARE, Agrilab, the NGO ALTEREC, and the International Potato Center (CIP). Cooperation is being sought with several other growers' associations, international organizations and projects, Guatemalan government organizations, and NGO's.

Winter Vegetable Production in the Caribbean-Jamaica

Winter vegetables are presently delivered from Jamaica to metropolitan areas on the east coast of the United States. While the potential for winter vegetable production is significant, so too are the constraints. Tropical growing conditions lend themselves to high pest pressures, and farmers often apply large amounts of pesticides, creating health, residue, and other environmental problems.

The vegetables of major economic importance that will be the target of this research are cabbage, vegetable amaranth, hot pepper, chayote, and catabaza. The major pest affecting the vegetables and fruits of this region are cabbage looper, diamond-backed larvae, aphid, leafminer, armyworm, leafhoppers, cutworm, hornworm, scale, white fly and fruitworm. Diseases include black rots, leaf spot, early blight, late blight, golden mosaic virus, anthracnose, and cucumber mosaic virus.

U.S. institutions on the IPM CRSP with significant interest in Jamaica include Lincoln University, the USDA vegetable laboratory in Charleston, S.C., Virginia Tech, Purdue, Kroger, and Caito Foods. Jamaican, regional, and international institutions include the University of the West Indies at Mona, CARDI, CIP, and CIAT. Cooperation is being sought with the Ministry of Agriculture, growers organizations, and NGOs.

Semi-Arid Transitional Production systems in the Sahel-Mali

Mali was chosen as the primary site for IPM work in transitional production systems of millet and sorghum for the following reasons: the severity of pest problems and the need for more effective, low-cost pest control in high-risk semi-subsistence production systems; the potential benefit to poor farm families in Mali and other Sahelian countries; and

previous work carried out by Virginia Tech and Purdue in association with Malian institutions.

While appropriate IPM technologies vary from country to country and region to region, we believe that the IPM approach that will be developed in Mali for this particular regime will provide the conceptual base for developing IPM approaches for similar regimes in other countries. Thus the direct benefits from research on this site would benefit a large proportion of the poorest people in several extremely low-income countries.

Major pests of millet are: smut, mildew, striga, termites, grasshoppers, locusts, various beetles including blister beetles, including cutworms, stalk borers, and millet head-miners. Sorghum is more resistant to pests than millet, but blister beetles, *Striga* and other weeds, panicle bugs, and grasshoppers have been cited as problems for sorghum production. *3* and other weeds, various insects, viruses, and bacterial infections are problems encountered in cowpea production. Various traditional methods and limited pesticides are used to combat these pests. As in much of Africa, these three crops are also plagued by birds and other vertebrate pests.

The Insitut d'Economie Rurale (IER) in Mali's Ministry of Rural development is the primary Malian institution involved in the CRSP, but a network of other local stakeholders is being developed as well. Virginia Tech, Purdue, Ohio State, and Montana State are the primary U.S. institutions involved.

In addition to Mali as the primary transitional production site, the CRSP will coordinate with IPM programs in transitional areas in the Philippines, Thailand, Uganda, and Ecuador. An important technical resource for transitional production systems will be the SANREM CRSP, especially in Ecuador and the Philippines.

Innovative IPM Research in Transitional Rice - based systems - Philippines

The Philippines is the primary site for innovative IPM research on food crops. The major focus on irrigated rice-based systems in Central Luzon. This site and topic was chosen for the innovative and transitional research components of the IPM CRSP because intensive food crop production in Southeast Asia is critical to the well-being of so many people. The strong interest of IRRI in the IPM CRSP, the breadth and depth of experience of that institution in IPM work, and the role of IRRI in the IPM research network throughout Asia make the Philippines site an irresistible component of the IPM CRSP.

Weeds are a major pest problem at the site. The main insect pests are stem borers, leaffolders, early stage defoliators, and whorl maggots. Stem borer damage can be tolerated if the crop is vigorous, lending importance to agronomic management in an IPM program. Leaffolder problems are made worse by insecticide use and late planting, so IPM programs that attempt to reduce current levels of insecticide use and encourage earlier planting may be helpful. Many other examples of pests and potential solutions can be provided, as a multitude of weed, insect, disease, nematode, and other pests are found in rice-based systems in the region.

U.S. institutions on the IPM CRSP with significant interest in the Philippines site include Penn State, Virginia Tech, and Ohio State. National institutions include PhilRice, NCPC, and the University of the Philippines at Los Baños. In addition to IRRI, international participants include AVRDC, CIAT, and FAO. Additional network participants will include NGOs, SANREM-CRSP, and producer groups among others.

An affiliated site is located in Thailand where the Department of Agriculture, Kasetsant University, Chaingmai University, Khonkhaen University, and IRRI - Thailand will participate.

Constraints to Be Addressed

Technical Information -- Development of IPM systems in the project sites has been hindered by a lack of information on specific biological, cultural and mechanical, and chemical control methods and their interactions in controlling the major pest problems.

Interdisciplinary Collaborative Research -- All too often, individual disciplines and institutions operate in isolated fashion in examining pest management problems.

Socioeconomic Factors -- Adoption of IPM practices will be weak unless social and economic factors are fully considered in their development and implementation. Accessibility to resources, land tenure arrangements, gender roles, risk aversion, age and the basic profitability of IPM practices are just a few examples of factors to be considered.

Outreach and Extension Services -- Weak extension services are evident in most of the sites proposed for the project. Women are often ignored by the extension services as well. The PIPM approach is intensive in training outreach personnel from the earliest stages, including training in gender analysis.

Policy Issues -- Regional, national, and international policies related to pesticide regulation and subsidies, quarantine rules, transport restrictions, and other issues often hinder implementation of IPM. In some cases, policies are in place but not enforced that would encourage implementation of IPM.

Research Methods

The following is a summary of the overall Participatory IPM (PIPM) methodology that is broadly applicable across all sites. Specific elements of the overall research approach will ultimately be tailored to each research site in concert with end-users of IPM programs. PIPM is grounded in two assumptions: (a) that research design, implementation, and evaluation must be a collaborative process that merges the expertise and data needs of both natural scientists and social scientists and (b) that the multiple actors involved in the decision-making and labor processes that affect pest management must be involved from the beginning of the research process. These actors include, among others, farm workers, managers, and owners, growers' associations, marketing agents and policy makers. Through the iterative process of participatory research, these actors collaborate with scientists and extension workers at all stages.

The PIPM process begins with training of natural and social scientists in participatory research methods for natural and social scientists. Part of the training aimed at team building and includes a special component on methods for incorporating analyses of gender, class, ethnicity, and age factors in the research and extension process. The first major PIPM step (which includes Objectives 1 and 2 below) is to identify site collaborators and to conduct a participatory appraisal to generate baseline data on biophysical and socioeconomic characteristics of research sites. The second major step in the PIPM approach (which includes Objective 3 below) is to design, test, and evaluate appropriate holistic PIPM strategies within the farmer:scientist continuum. The third major step (which includes objectives 4 and 5 below) is to promote education, training, and information exchange of IPM technology with farmers, farm workers, farm owners, private export companies, NGOs, scientists, extension workers, and policy makers. Methods for each of

these PIPM steps are explained briefly below and related directly to the five project objectives.

Objective 1. Identify and describe the technical factors that influence pests and pest management practice.

For each of the research sites, baseline data are gathered on crops and livestock systems, key pests and pest losses, natural enemies, nature and extent of adoption of existing pest management systems, soil and water resources, climate, biodiversity, and natural habitats. The existing pest management systems are examined both with respect to the use of indigenous knowledge and with respect to pest management systems that have been introduced by research and extension agencies, international agricultural research centers, private fruit and vegetable companies, and other sources. Some data are available from secondary sources and remote sensing, but most are generated through participatory methods such as community meetings, transect walks, and targeted interview surveys that involve not only farmers and farm workers, but also pest management specialists, government officials, and private company representatives. This participatory data gathering generates information that can be incorporated in a geographic information system (GIS) and displayed in resource maps, activity profiles, timelines, and pest incidence profiles. The information obtained can be used to characterize pest complexes that exist in each agroecosystem. To validate the information gathered, the summaries (maps, tables, pictures) will be shared with representatives from participant groups, with care exercised to ensure that different kinds of farmers (differentiated by farming system, size of operation, gender, age, ethnicity) are included.

Objective 2. Identify and describe the social, economic, political and institutional factors affecting pest management.

The gathering of information on technical factors described under Objective 1 above is integrated with gathering information on social, economic, cultural, political, and institutional factors that can influence IPM. For example, information is gathered on the scale and tenure of farm operations, family and hired labor usage, income and wealth goals and strategies of farmer and worker households, labor supply, education levels, the nature of markets, and the costs of existing pest management practices. Information is obtained with respect to policy and political factors at all levels that impinge on IPM, the roles of institutions such as NGOs, grower associations, and cooperatives, the international agricultural research centers, donors, and other current IPM support activities. Producers and government agencies are brought into the process to identify policy and institutional barriers that impede IPM adoption and the attainment of IPM program goal identified by the private sector as necessary for export trade expansion.

Objective 3. Work with participating groups to design, test, and evaluate appropriate, holistic PIPM strategies.

Appropriate PIPM systems are designed, tested, and evaluated working in a participatory mode with collaborators in each country site. PIPM is approached as a series of activities that culminates in decisions made by farmers and policy makers that are consistent with the goals of farmers and society. First, based on the current and potential economic and environmental importance of pests and pesticides, particular pest subsystems are selected that will constitute the focus of research and extension within each horticultural export crop, transitional production system, and major food crop (innovative research) site over the first years of the CRSP. However, these selections must be reevaluated on a continual basis as farmers identify emerging pest problems. Second, a series of potential PIPM tactics and strategies are identified through discussions among all actors on the participatory

team. Some of these potential solutions to pest problems will be preemptive in that they reduce or eliminate pest problems before they arise. Examples of preemptive tactics include use of pest-resistant cultivars, developing production systems and natural habitats that encourage growth of natural enemy populations, adjusting planting times to avoid key points in pest biology, and crop rotations and systems (intercropping) that discourage pest population buildup. Other solutions are reactive in that they are implemented only in response to best densities that exceed economic or action thresholds during the growing season. Examples of reactive tactics include manual removal of insect egg masses, hand weeding and, selective use of pesticides or other controls when economically damaging levels of pests are reached. A number of IPM tactics, both indigenous and designed by scientists, have already been developed and implemented to some degree in several of the proposed sites. These tactics will be evaluated by the participating team.

Regardless of the particular pest problem and tactic, most PIPM strategies will require research and demonstration plots at both the cooperating institutions' research and extension facilities and in farmers' fields. Farmers, extension officers, NGO representatives, and others can visit the on-station plots and receive instruction in and draw conclusions from the PIPM activity being demonstrated. They can suggest potential improvements in PIPM practices. Once scientists and farmers have some confidence that the practices may be useful, then broader, on-farm testing will commence with farmers in representative villages. Farmers in surrounding areas can visit the farm test sites to observe the results and receive instruction from the testing farmers themselves and from extension personnel. As practices are adopted and move from the test farm to surrounding farms, information exchange networks, education, and feed-back programs will be maintained to encourage refined and sustained IPM programs.

Some preemptive and all reactive IPM tactics require gathering information about the environment, pest, and crop or livestock during the growing season. This activity, usually termed scouting or monitoring, evolves assessment of the growth stages and general health of the crop or animals, and determination of the pressure and intensity of pest infestations. The data derived are entered into a record-keeping system. Pest levels noted during scouting are compared with threshold values. Thresholds may be economic where the damage to the crop caused by a given pest population is compared with the cost implementing a control procedure against that pest. If pest populations exceed a threshold, then a reactive control is warranted. Specific control tactics can then be selected and employed. These tactics may include biological control or judicious use of environmentally benign pesticides. The success of the control should then be assessed to help provide guidance for future pest control. All IPM activities should be permanently recorded to help in decision making in subsequent years.

Decision support tools such as economic thresholds, manuals to instruct farmers about IPM tactics, expert systems, and bio-economic models for forecasting purposes will be developed for each site as aids to the farm decision making process. Evaluation systems will also be put in place that measure such factors as: changes in crop yields and profitability, changes in pesticide use, degree of adoption of different IPM practices stratified by farm size, gender, age, class, land tenure arrangement, and so on. IPM project activities will then be adjusted as certain changes are achieved or not.

Objective 4. Work with participating groups to promote education, training, and information exchange on PIPM.

Implementation of the PIPM approach implies that a significant amount of training and other outreach activity will occur while gathering the data, and in the design, testing, and evaluation of IPM tactics and strategies. In addition, specific training and information exchange activities will be built into the project with certain topics sequenced over the first five years of the project.
During the first year of the project, training programs will be held in each of the primary sites on the methodology for participatory IPM research; the inclusion of landscape ecology in IPM research; basic concepts, principles, and case studies of IPM; recognizing special needs and overcoming barriers to acceptance of knowledge related to age, class, gender, and ethnicity; and methods for analyzing and fostering policy change. Participants from each of the collaborating institutions pertaining to each site would attend this training. This initial training will focus on scientists participating in PIPM and will help bring the various institutions and disciplines together in a team building process. Regional training will ensure that training is relevant to the developing country, and collaboration will minimize costs.

There will be continual training associated with the participatory research process, and special workshops and field days will be held on specific IPM strategies for farmers, extension agents, NGO personnel, and other groups. Also IPM extension agents train "scouts" on how to monitor biological variables in fields. Scouts will be responsible for making pest counts and assessing damage to farmers' fields and monitoring light, pheromone, sticky, and other traps as needed. These scouts may be hired at the village level or can be individual farm family members or farm workers. While some PIPM programs may not incorporate scouting as a component, most undoubtedly will. Efforts will be directed at training farm leaders, scientists, extension workers, and NGO personnel during the implementation of the project so that they will be capable of spreading the approach, if not the results, to other sites in the country.

We will also extend the PIPM production system information to farmers and other interested parties by cooperating with national and international institutions already involved in education and training of farmers. In the Philippines, for example, PhilRice, IRRI, and FAO conduct training programs on pest management in rice. Farmers who are initially involved in the PIPM program will become farm trainers themselves. We will help them design region-based pest management programs.

Formal training will take place both in the classroom and in the field with hands-on field-training emphasized. IPM specialists from within each country as well as from outside collaborating institutions will be involved in the training. Assessments will be conducted at appropriate times to determine the impact of the training through the measurement of the degree of implementation of IPM tactics and strategies.

In addition to short term participant training, graduate students from both the United States and the sites where the CRSP is working will conduct research and write theses and dissertations related to specific aspects of the project. Graduate student support will be a significant component in the budgets for the university CRSP institution members.

Once research is implemented, research approaches and results will be spread to those working on IPM in other countries through INTERNET, training manuals, publication, regional workshops and other means. The inclusion of several of the international

agricultural research centers as consortium members in the project will assist greatly with the international transfer of project approaches and results.

Objective 5. Work with participating groups to foster policy and institutional changes.

The results of the social, economic, policy, and institutional assessments under Objective 2 above should identify basic policy and institutional factors that require more in-depth assessment. Working groups that include farmers, representatives from export firms, public sector officials, sociologists, and others will be formed to assess existing policies and institutions relative to alternatives. Project economists and sociologists will assist in analyses of the economic and social implication of alternative policies and institutions and discuss these with the working groups so that recommendations for changes can be formulated as needed to achieve the goals previously established for PIPM.

The working groups can then collaborate with government agencies, AID, and other groups to design mechanisms that will facilitate the changes that are agreed upon as being needed. This process will not be simple. Regulations, taxes, subsides, cooperative organizations to control pests in a region, laws and policies that influence land tenure, cooperative marketing schemes, and other types of policies or institutions are very difficult to change. Yet the incentives created by these "rules of the game" often spell the difference between successful and unsuccessful IPM efforts. The most difficult aspects are not the analysis of the policies and institutions but the policy dialogue that must occur to convince governments and other groups of the need for change. The representation of appropriate industry groups and public official on the working groups should help facilitate the needed changes.

Dynamic Research Tools

Gender Analysis

Gender analysis will be a central component in all stages of the project. Gender analysis in PIPM will include at least the following components: development of an activity profile, which provides basic information on the division of labor as it related to pest management, and an access and control profile, which includes information on gendered benefits and incentives for participation in IPM; and an analysis of socioeconomic and cultural factors influencing access and control, to assure that gender analysis is integrated into the entire process. When cultural norms require that women receive training separate from men, the training will be conducted mindful of gender relationships. Preliminary training of project scientists in gender analysis will occur at the start of the project, first in the United States and then at the project sites. We will make use of trainers in gender analysis in the Philippine site from the SANREM project and will train local trainers at the IPM CRSP sites in other countries.

Monitoring and evaluation of research efforts will promote feedback on the gender consequences of research and identify social constraints to success. Constraints that are related to gender division of labor, social class, ethnicity, and age will also be considered.

Decision Support Tools

A variety of decision support tools will be used in this collaborative project. Expert Systems for IPM, developed at Pennsylvania State University, and expert systems for IPM decision support (IPMDS), developed at Purdue, have created new opportunities for precision in implementing IPM programs, particularly for horticultural export crops. For example, the IPMDS systems at Purdue for vegetable crops is capable of diagnosing

disease problems and incorporating historic pest management schedules in a data base for future crop management decision making.

Geographic Information Systems (GIS) are geographically-referenced data bases and computerized mapping systems that allow decision-makers to electronically overlay "maps" of variables which may include topography, hydrography, social and economic factors, political boundaries, pest infestations, and crop distributions. State-of-the-art cartographic and spatial analysis techniques will help us manage data, analyze data and model the interactions among variables, and provide effective visualization and communication of results to decision makers.

Expected Benefits

Primary beneficiaries of the IPM CRSP will be farm owners, workers, managers, and other inhabitants in the targeted countries as well as people in the countries to which PIPM methods are transferred. Increased marketable yields, higher product quality, greater producer income, reduced human exposure to pesticides, less damage to natural ecosystems, reduced pollution and contamination of food and water supplies, increased food production, and improved nutrition are just some of the benefits. Local communities will benefit from economic and environmental improvements, but so too will the countries that import horticultural products from developing countries. Preserved biodiversity, improved quality of life, and decreased pressure for environmentally and economically motivated migration benefit the whole world community. Members of the research community, including agricultural and social scientists and their graduate students who gain from improved methodologies arising from the development of the PIPM model, will also benefit. The many benefits combine to provide social and economic enhancement in the host countries.

The United States will benefit from this project in several respects. First, the potential for U.S. private firms to import unique and out-of-season fruits and vegetables with minimal pesticide residues will provide consumers with a wide selection and large quantity of high quality horticultural produce. Second, economic development in developing countries is heavily dependent on agricultural growth. Increased export and domestic production raises incomes that, in turn, stimulate demand for exports, including agricultural products. Third, U.S. agriculture benefits through transfer of certain of the IPM methods developed on the CRSP. Many of the same insects, diseases, and other pests exist in the horticultural commodities of both the developed and developing countries. In many cases, pest pressures are higher in the developing countries. Lessons learned abroad, and in some cases materials such as pest resistant germplasm, can be transferred back to the United States for low-input crop production.

Monitoring and Evaluation

Overall program evaluation and review will be conducted internally by the Management Entity (ME), technical Committee (TC) and Board of Directors (BOD). The ME in concert with the TC and the BOD will develop procedures to adequately review program activities and impact. Internal reviews will be completed by a committee, incorporating representatives of appropriate disciplines from the TC, BOD and principal investigators from collaborating institutions. Evaluation indices will be developed to assist in the overall internal evaluation by the ME, TC, and BOD. For the IPM CRSP, examples of some indexes could be time allocated to particular activities in management, publications, state of work plans, and level of communications.

The IPM CRSP will be evaluated externally on an annual basis by an External Evaluation Panel (EEP) created for the CRSP. The responsibility of this panel will be to evaluate the status, funding, progress, plans, and prospects of the research program of the CRSP and to make recommendations thereon. The EEP will consist of five members who are senior scientists recognized by their peers and selected for their in-depth knowledge of a research discipline of the IPM CRSP. Details on the functioning of the EEP are found in the Management Plan submitted with the proposal and in the CRSP Guidelines.

Milestones and Criteria

Economic, environmental, and health benefits of the PIPM CRSP can and will be quantified in the long-run using social benefit/cost analysis, contingent valuation techniques, and clinical and economic assessments of health changes. Some of the benefits can be assessed in the fifth year of the project, but in the short run (3 to 5) years, milestones and criteria will be used to measure progress toward achieving project objectives and realizing the anticipated benefits. There are four major short-run milestones that need to be reached and several criteria that will be used as measures.

Milestone 1. Successful Implementation of the PIPM Approach -- The criteria that will be used to measure success will be: (a) have the collaborative networks been built within each country site? (b) have the participatory appraisal team scientists been trained? (c) have the participatory diagnostic surveys been completed in each site? (d) has the community verification and on-site sampling occurred? (e) have the site advisory committees been formed? and (f) have the procedures for this implementation phase been documented in a manual that can be used to extend the approach to new sites?

Milestone 2. Successful Development of Appropriate IPM Tactics -- The criteria that will be used to measure success will be: (a) have specific IPM tactics been developed and demonstrated on farms or in storage facilities in each site?, (b) has a social acceptance framework been developed including ensuring that the IPM tactics are consistent with the existing gender division of labor, (c) have the IPM tactics been described in written reports?, (d) have basic biological, economic, and social evaluations been completed, including site advisory committee valuations? and (e) have solutions to institutional and policy constraints to IPM adoption been identified?

Milestone 3. Institutionalization of the PIPM Approach -- Criteria that will be used to measure achievement of this milestone are: (a) is there an IPM unit within the collaborating research organization in each country? (b) has a formal IPM network been established in each country and surrounding region?, (c) have a sufficient number of farmers, scientists, extension workers, NGO personnel, students, and others been trained to sustain and expand the PIPM approach?, (d) have decision support tools such as economic thresholds for individual pests, manuals to instruct farmers about IPM tactics, expert systems, and bio-economic models for forecasting purposes been developed as aids to the farm decision-making process?, and (e) have working groups met with government agencies, donors, and other groups to design mechanisms to facilitate the institutional changes that are agreed upon as being needed?

Milestone 4. Evidence of Economic, Environmental, and Health Benefits from PIPM -- In the fifth year we will conduct evaluations of project benefits using the following criteria: (a) the internal rate of return and net present value of the project based on realized and projected levels of adoption of PIPM in each site, changes in yields, reductions in storage losses, changes in product quality, cost changes, etc., (b) changes in pesticide use, and (c) evidence of increased horticultural exports into the United States from the Central America and Caribbean sites.

Implementation by the Management Entity and Collaborating Institutions

The implementation and management plan for the IPM CRSP reflects the participatory philosophy of the technical plan while providing for accountability and efficient decision making. A detailed management plan is given in the proposal. Briefly, Virginia Tech will be the Management Entity (ME) and there will be three additional administrative and technical bodies. These bodies include a Board of Directors, a Technical Committee, and an External evaluation Panel. Additional technical groups include: a) Rapid Response Teams, b) Informal Working Groups, c) Resource Pools for Overcoming Constraints, and d) Site Coordinators. A description of the roles of each of these is given in the proposal with its annexes.

Site Coordination

A lead institution from among our collaborating institutions will be chosen for each site. One person from each lead institution will chair a site subcommittee of the larger technical committee. Each subcommittee will be composed of representatives of the institutions working in that site, including at least one national institution. Each subcommittee will articulate and prioritize the research agenda and develop budgets for the site. Theses budgets will be submitted to the full TC, Board, and ME for discussion and approval. Thus, those working in a site participate in its management and the strengths of several institutions are combined in a coordinated manner for each site. Each site will also have a host-country coordinator whose responsibility will be to coordinate day to day program activities in the country and to provide assistance to all participants at the site.

SUMMARY OF PARTICIPATORY APPRAISAL (PA) METHODS AND HOW THEY RELATE TO THE IPM CRSP PA ACTIVITIES

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Participatory appraisal (PA) is a means of learning from, and with, farmers, community members, and others to investigate and evaluate constraints and opportunities. The IPM CRSP will be using PA to generate baseline data and analyses of biophysical and socioeconomic characteristics of the research sites. These data and analyses will help in formulating research problems and plans and in providing a baseline for evaluation of the project. PA activities provide a complement to structured interview surveys. In most sites, structured surveys will be used as well, either before or after the PA. The less formal PA methods will be particularly suited to learning about community members' attitudes and opinions. It is important for each site committee to decide (a) which data should be gathered by a structured interview survey and when, (b) which types of data should be gathered by the less structured PA methods this summer, and (c) which types of data should be gathered by PA methods after this summer. The PA itself may identify additional information that needs to be collected subsequently by a structured survey.

PA methods use a multidisciplinary team in an intensive, systematic but only semi-structured learning experience in a community. The IPM CRSP PAs will differ from most previous PAs in that they define the target community to include, in addition to the farm community, marketing firms, policy makers, and others outside the local community. The PA requires participation of the farmers and other community members, long periods of patience and listening to farmers and community members without interruption from the external team members, and the use of tools designed to help farmers and community members express, as well as analyze, their own knowledge.

The main features of a PA, regardless of the particular set of PA tools selected, are (a) triangulation, (b) use of a multidisciplinary team, (c) use of multiple techniques, (d) flexibility and informality, (e) community participation, (f) imprecision where appropriate, (g) analysis in the field, and (h) active bias avoidance (Theis and Grady, 1991). Triangulation simply means that cross checks on the accuracy of the information occur through the composition of the team, use of multiple sources of information, and applying a mix of techniques to get at the same information.

The multidisciplinary team assures that different skills and viewpoints are present. Multiple techniques are used to elicit and analyze different types of information. PA plans and methods are flexible or only semi-structured so they can be modified if needed during the PA. Farm community participation is accomplished by involving farmers and others in the discussions, mapping, and analyses in order to facilitate interpretation of the data being collected. Appropriate imprecision simply implies that data are only collected to the degree of detail required for subsequent analysis. The team constantly reviews and analyzes data in the field to help focus the information gathering and build understanding of the issues. The team seeks to avoid bias by seeking out the disadvantaged, the women and others who might be underepresented if only the well-off, better educated, more articulate men are interviewed. The team also carefully analyzes its own biases.

A long list of PA tools are available. The references by Theis and Grady (1991) and Chambers (1993) provide lists and descriptions of these techniques. Many of the techniques were commonly used before the term participatory appraisal came into vogue

and some are just plain common sense. None of our IPM CRSP PAs will use all of these techniques. Therefore, it is important to reflect on the information needed, the time available, and the resulting appropriate mix of tools for each IPM PA. The tools can be grouped into several classes: (a) Review of secondary sources, (b) Direct observation, (c) Ranking, (d) Construction of diagrams, (e) Group discussion and analysis, and (f) Semi-structured interviewing (Theis and Grady, 1991 and Chambers, 1993). The following is a brief summary of these tools.

Review of Secondary Sources

Reports, statistics, maps, and other published or unpublished sources of information can be used for background information. Secondary sources are not relied upon for information that can be better collected in the field. Each site committee should assemble much of this secondary information before the PA and in some cases already have assembled it. Secondary data serve to narrow down the questions that need to be asked during the field work.

Direct Observation

All site committees will make use of direct observation techniques to cross-check or support findings from other PA activities and from surveys. Direct observation involves developing a checklist of indicators and then systematically observing objects, people, events, and characteristics as a means of cross-checking responses from application of the other techniques.

Ranking

Ranking can be used to obtain relative rather than absolute measurements. Previous PAs have used preference rankings, pair-wise rankings, direct matrix rankings, and wealth rankings. Preference ranking involves preparing a list of items and asking interviewees to order them by value, importance, etc. With pair-wise rankings, only two items are compared at a time. The number of items to compare should be small and all possible pair-wise combinations compared. Informants should be asked why they rank one item higher than another. Direct matrix ranking (or scoring) ranks a set of alternatives or objects by scoring them from low to high (or worst to best) for each of a set of criteria and then compares total scores. Wealth ranking reveals perceptions of wealth differences and relative positions of households in a community. Interviewees sort households into wealth categories.

Construction of Diagrams

Diagrams are used in PAs to summarize data into several patterns in space, time, and relationships. They are useful for simplifying, analyzing, communicating, discussing, and consensus building. Participatory maps are drawn by farmers or community members. A **Transect** is a type of spacial map that can be drawn in a participatory fashion as the external group takes a "Transect walk" through the area with farmers and other community members.

Differences in soils, crops, livestock, problems, solutions, and opportunities are all outlined on the map.

Time diagrams include seasonal calendars, time trends, historical profiles, daily routines diagrams, etc. A seasonal calendar summarizes such information as seasons, climate, crops, pest patterns, livestock cycles, income, prices, marketing, labor demand, holidays,

etc. Of particular concern to IPM are the life cycles of pests during and across growing seasons. **Time trends** show the longer-run quantitative changes in prices, yields, area cultivated, population, pest populations, rainfall, etc. **Historical profiles** show a time line of important events such as pest and disease epidemics, droughts and famines, changes in political administrations, etc. Daily routine diagrams record when various activities, including pest management practices, are pursued during the day.

Relationship diagrams include livelihood analysis diagrams, flow diagrams, Venn diagrams, etc. A **livelihood analysis diagram** is a chart or graph that uses data such as household size and composition, livestock and land ownership, sources of income, and expenditures to depict key household characteristics and coping strategies. A **flow diagram** shows causes, effects, and relationships among key variables such as factors affecting relationships among economic, political, cultural, and climatic factors affecting pesticide use or IPM adoption. A **Venn diagram** might show the key institutions and individuals in a community and their overlapping relationships. The elements involved are represented by circles of size proportionate to importance or scope. Orientation of the circles reveals the relationship among the elements. Information passes between touching circles and the degree of overlap in circles reveals the degree of cooperation in decision making.

Group Discussions for Analysis

Information gathered in the field is discussed with community members to validate, determine further actions, make decisions, and focus ideas. Innovation assessment can take place in which researchable pest management problems and potential solutions are discussed in light of perceived benefits, likely adoption, distribution of benefits, costs, time, technical feasibility, etc. Benefits and costs may include a wide range of economic factors, cultural effects, pesticide pollution reductions, etc.

Semi-structured interviews

With semi-structured interviews, a written checklist of questions is prepared, but follow-up questions are added as new or unexpected aspects are revealed during the interviews. These interviews may occur with individuals, families, groups of farmers, groups of community members, policy makers, marketing agents, extension workers, scientists outside the PA team, and others. In some cases, key informants are selected for interviews. These people are "experts" or the most knowledgeable people on particular topics and could come from any of the individuals or groups listed above. Sometimes groups of key informants are interviewed.

The above list of tools is described more fully in Theis and Grady and in other papers. When designing the specific tools for use in one of the sites, the site committee should probably (a) start with a general outline of the information needed, (b) develop specific questions making use of some of those on the attached list and others, and (c) decide which tools including both formal surveys and PA methods are to be used to obtain, cross-check, and present the information. Development of the information needed and specific questions to be addressed will follow from the use that will be made from the information. In some cases, the information is needed to assess the most important researchable issues. In other cases it provides baseline data for subsequent evaluations of the project or information on factors affecting IPM adoption.

Before the PA fieldwork, (a) review secondary sources, (b) prepare tools such as observation checklists, lists of questions, and blank forms for diagrams, (c) identify possible key informants, (d) prepare a schedule and assign tasks, and (e) finalize logistics

regarding transportation, food, materials, etc. While some of these preparations can occur during the organizational meeting/workshop, it is best if most of them (except refinement perhaps of certain questions and tools) are completed before the team arrives in country. Each site committee should present a tentative PA plan to the ME before they initiate the PA activities. The sooner these plans come in, the more feedback will be available from other members of the IPM CRSP as these plans will be shared by the ME with all site chairs.

Theis and Grady provide the following tips for carrying out PA fieldwork:

1. Take at least four days but no more than two to three weeks.

2. Choose a leader to guide work and facilitate questions.

3. Discuss objectives with community leaders and make arrangements for interviews.

4. Capture a variety of characteristics, knowledge, and experience when choosing informants and recognize this variety when interviewing them.

5. Start by obtaining broad background information and then progress to more complex issues and methods.

6. Be flexible and adapt to the conditions in the community. Maintain a sense of equality by asking for advice and by observing, not directing or lecturing. Show interest, respect, and sensitivity.

7. Utilize skills and tools such as direct observation, key indicators, and check lists to facilitate and improve the quality of the research.

8. Monitor work closely, correcting mistakes quickly to prevent incorrect work patterns and misuse of tools.

9. Don't collect data without a clear plan.

10. Revise and redirect the research periodically based upon analyses of collected data. Adapt tools and methods to the changing focus of the research.

11. Probe into questions, even following up later, to refine the data and obtain a deeper understanding.

12. Cross-check your results. Weigh the importance of data and be critical of its accuracy and value.

13. Confirm your results. Present them to key informants and be sure that findings are consistent with the professional knowledge and experience of the team.

They provide the following advice for analysis and results:

Analysis is a continuous process and should be conducted throughout the activity in order to make sense of the collected data. To analyze:

1. Organize data according to key issues looking for patterns, differences, variations and contradictions .

2. Formulate and attempt to answer questions based upon the data.

3. Summarize and draw conclusions based upon the data.

4. Use diagrams, matrices, ranking, and other tools to interpret the data.

5. Tabulate numbers for concrete comparisons of data.

6. Findings should be consistent. Explain any contradictions.

In an analysis group discussion, summarize the results obtained and evaluate the findings and methods used. When preparing the results, decide how to present the results and organize the data. Divide the tasks of preparing diagrams among team members. Discuss the diagrams and make changes.

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Other References

Kumar, Krishna. Conducting Group Interviews in Developing Countries." AID Program Design and Evaluation Report No.8, AID, Washington, D.C., April 1987.

Thomas-Slayter, Barbara, Andrea Lee Esser, and M. Dale Shields. "Tools for Gender Analysis: A Guide to Field Methods for Bringing Gender into Sustainable Resource Management," ECOGEN Project, Clark University, July 1993.

Questions that need to be answered by a set of PA activities

A. *Technical questions*

What are the relevant crops and varieties currently used?

Where did the varieties originate?

What are the crop and livestock systems (e.g. identify cropping and livestock patterns across seasons)?

What are the key pests (insects, diseases, weeds, nematodes) and their growth cycles and epidemiological factors? (Must distinguish field problems form storage problems and soilborne from stem, foliar, and seed problems.)

Who makes pest control decisions?

What are farmers' (male and female) perceptions of crop losses due to pests? (Should be specific to different crops. Likewise with several questions below.)

What are the current spray and other pest management practices?

Are there interrelationships between insects and diseases?

Is there a perception of secondary pests?

What are the natural enemies of the pests?

Is pesticide resistance a problem and what are farmer perceptions?

How effective were the pesticide applications?

Is any rotation of pesticides employed?

What problems in human safety have been noted? Are people getting sick? Experiencing skin problems? How severe?

What indigenous knowledge is used for pest control?

What are farmers perceptions of insects and diseases generally and the injury they are causing?

Can farmers identify their pests and beneficial species?

What are farm family members' perceptions of insect growth cycles?

How often and closely do farmers (male and female) look at their crops for pests?

Can the farm family members identify beneficial species and do they use this information?

What are the site surroundings?

Are plants grown nearby that can harbor the same pests as the farmers' crops?

Are labels readable and followed (preharvest intervals, concentration, application per season, provide/area/season)?

Are only legal pesticides used?

What is the health of the plants in the field? Are there visible nutrient deficiencies?

B. *Economic, social, policy questions*

How much did the farmer spend on pesticides last season?

Who sprayed the pesticides?

If hired labor were used to spray, how much did the farmer pay?

Does the farmer own a sprayer? What kind?

If the farmer does not own a sprayer, where does he or she get one when needed and what does it cost to use?

What are the costs (particularly labor) associated with other (non-spray) pest management practices?

Where do the farmers get pest control advise?

Have the fanners had any training in pest control? If yes, what training? Who organized the training?

What was the yield last season?

How much did they sell the crop for?

What was their average size of planting?

What proportion of their crops did they sell?

How large is the farm?
What is the farmer's tenure status?

If the farm is leased, what is the lease arrangement and how are input costs shared with the owner?

Are different fields worked by different family members?

Who controls allocation of the fields?

What are the financial arrangements for different enterprises and fields? Are inputs purchased out of a common pot of money?

What are the ages of all adult family members? Gender?

How many children are there and what are their ages?

Which family members participate in agriculture and how?

How many years of schooling do the male and female farmers have?

Is the farmer a member of a farm organization and if so, what organization?

Where does the farmer market the crops?

Who in the family markets which crops? Who receives the income from those crops? Is there a single pot into which the income goes or does income from particular crops go to certain people or activities?

Does the crop move into the export market?

Is product quality a concern and what are the price differences for different product qualities?

Are there rules requiring the use of pesticides to be eligible for credit or crop insurance?

Are there any direct government subsidies or taxes of pesticides?

What are the key policy-making agencies that determine pesticide policies and regulations?

Are there pesticide registration procedures with restrictions that govern application of pesticides to specific crops and growth stages, type of application, dose rate, site, plant-back period, and workers' reentry into the field?

How are pesticide regulations enforced?

Are certain pesticides banned for import or use?

Are there commodity price support or tax policies for the commodities in question?

Are there pesticide residue analysis facilities?

What are farm family members' goals with respect to income, risk, time allocation, and health?

This list is not intended to be all inclusive and many of the questions above will have to be asked in multiple parts and using different PA methods. Some questions are for farmers and some are for extension workers, input suppliers, policy makers, etc.

LEADERSHIP PLAN FOR FIELD SITES

Effective leadership and management of field sites is essential to successful completion of IPM CRSP activities and to meet the goals of the CRSP in a collaborative fashion. Collaboration is needed between U.S. and host country scientists/institutions, among scientist/institutions within the United States and host countries, and among disciplines. The IPM CRSP institutions in the United States include eight universities, one NGO and one federal agency. The CRSP includes an even larger number of host country institutions and NGOs as well as five international and regional agricultural research centers. The Year 1 Workplan contains several U.S. universities and other institutions for each site, with the proposed scientists selected for each site based on their particular skills and experiences. Given the relatively small budget and the IPM focus, the IPM CRSP requires a site management structure that is highly integrated across institutions and disciplines. The Management Entity (ME), at Virginia Tech, ultimately is responsible for programs and budgets and is responsible and accountable to AID for all expenditures, but a structure is needed for managing individual field sites that spreads the leadership among collaborating institutions for developing workplans, proposing budget allocations, issuing subgrants, and overseeing the site-specific scientific work. The site leadership structure is given below and, as used by the IPM CRSP, provides this integration and decentralized leadership.

Primary sites - Work in each of the four primary sites, Guatemala, Jamaica, Mali, and the Philippines, will be managed and conducted by a site committee that will be led by a subcommittee of the larger Technical Committee. This leadership will include a site committee Chair and Vice Chair chosen from the U.S. university partners. Each site committee will be composed of representatives from the institutions working in the site, so that the workplans are developed and carried out by the scientists themselves. An on-site coordinator will also be selected from among the representatives of the host country institutions. At least three of the four site committee chairs and all four of the vice chairs will be selected from institutions other than Virginia Tech in order to promote collaboration among institutions and ensure widespread involvement in the development of workplans and budgets. The list of chairs and vice chairs is provided below. These institutional and individual leadership responsibilities was confirmed, both by the TC and the Board.

Site Committee Chairs and Vice Chairs

Site		Scientists	Institutions
Guatemala:	Chair	Glenn Sullivan	Purdue University
	Vice chair	Ron Carroll	University of Georgia
Jamaica:	Chair	Frieda Eivazi	Lincoln University
	Vice chair	Charlie Pitts	Penn State University
Mali:	Chair	Mark Erbaugh	Ohio State University
	Vice chair	Florence Dunkel	Montana State University
Philippines:	Chair	George Norton	Virginia Tech
	Vice chair	Ed Rajotte	Penn State University

Each primary site also has a local country coordinator who is assigned by the national institution(s). The current country coordinators are:	
Guatemala	Victor Salguero
Jamaica	Janet Lawrence
Mali	Amadou Diarra/Alpha Maiga
Philippines	Victor Gapud

Satellite sites - The TC will assign chair responsibility for satellite sites as the sites are phased in. The site chair will work with the TC to identify a site committee.

Budgets - Budgets are allocated in accordance with contributions of scientists to the workplan. Scientists collaborating on the CRSP submit proposals to the chair of the appropriate site committee with a copy to the chair of the Technical Committee and of the ME. Each site committee reviews its proposals and develops a workplan and budgets for the site. These plans and budgets are submitted to the overall Technical Committee for discussion and recommendations. The TC prepares an overall plan and budget that provides the appropriate balance of resources across sites and between U.S. and host country institutions. The TC submits the plan and budget to the ME and Board. The Board recommends approval or modifications to the ME. Final responsibility for approval rests with the ME. Following approval of budgets, the ME transfers the approved funds to the subcontracts of the collaborating institutions.

The above site leadership plan ensures (a) all partners in a site participate in the program development of the site, (b) global coordination of the IPM CRSP, (c) inter-institutionai and inter-disciplinary collaboration, (d) the best talents are put to use in each site, and (e) the ME remains ultimately responsible and accountable as called for in the CRSP guidelines and the grant document. It ensures that the IPM CRSP does not become a set of unconnected "Mini CRSPs" in which each of the four primary sites, for example, are dominated by one university in that site or that the ME itself develops the workplans for all sites.

GUATEMALA

GUATEMALA PRIME SITE ANNUAL REPORT

Glenn H. Sullivan, Site Chair
Department of Horticulture, Purdue University

OVERALL PROJECT OBJECTIVES

(1) Identify stakeholders and participants, and obtain commitments.

(2) Diagnosis and planning for participatory appraisals.

(3) Conduct participatory appraisal activities.

(4) Establish site committees.

(5) Analysis of policy alternatives and social/gender implications.

(6) Collaborate with existing IPM programs to provide short-term outputs.

WORKPLAN ACTIVITIES

Activity #1: Identify stakeholders and participants, and obtain commitments. Stakeholders and network participants were identified. Commitments were obtained from the following institutions and individuals for IPM CRSP participation:

ICTA - agreed to participate as the lead institution for IPM CRSP activities in Guatemala. The MOU with ICTA was finalized; program commitments and responsibilities were negotiated. ICTA General Director Ing. Mario Amezquita agreed to assign key personnel to administer project activities. Ing. Danilo Dardon Avila will serve as ICTA's lead administrator for IPM CRSP, with Hector Sagastume, Luis Calderon, Asdubal Bonilla, and Max Gonzales responsible for selected program activities. Victor Salguero agreed to serve as Site Coordinator for IPM CRSP 1993/94 through 1994/95. Dr. Salguero's expertise in IPM for non-traditional crops provides the basis for a strong leadership role in IPM CRSP.

CARE - agreed to collaborate as an institutional stakeholder, with Mark Dripchak assigned as the lead collaborator. CARE's primary activities will focus on socioeconomic baseline assessments and technology transfers.

ALTERTEC - agreed to collaborate as an institutional stakeholder, with Rafael Solorzano as the lead collaborator and Rodolpho Guzman in a supporting collaboration role. ALTERTEC is a leading institution in biological IPM and commercially sustainable organic farming methods.

AGRILAB - agreed to collaborate with the assignment of Guillermo Sanchez as the lead collaborator. Program activities will be administered by General Director Cristian Rodriguez. AGRILAB serves the non-traditional crop sector with services in disease management and soils testing. In-house expertise provides the basis for leadership in baseline assessments for non-traditional cropping systems.

ASIES - agreed to collaborate as an individual. Dr. Asturias will serve as the project coordinator for socioeconomic research activities, and function in supporting coordination roles in Guatemala for marketing, economic, and policy research activities. Her collaboration is supported under sub-contract with Purdue University (G.H. Sullivan).

ICAITI - agreed to collaborate as a resource institution on socioeconomic support activities, including baseline assessments. Lic. Fernando Mazariegos will serve as lead collaborator.

FLASCO - agreed to collaborate as a resource institution for economic, socioeconomic, and policy related project activities. Executive Director Rene Porrevin will serve as lead collaborator.

GEXPRONT - agreed to collaborate as a resource institution for IPM research and development activities (Ricardo Santa Cruz will serve as the lead collaborator), and for export market development activities (Jose Orive will serve as lead collaborator). The Agricultural Research Fund (ARF) of GEXPRONT is comprised of over 300 producers and/or marketing groups in Guatemala, and currently funds nearly $1 million in IPM research for non-traditional crops. GEXPRONT represents an exceptionally strong collaborating institution for IPM CRSP in Guatemala, and provides the opportunity for leveraging IPM CRSP activities for immediate results.

ZAMORANO - Honduras has agreed to collaborate in IPM CRSP program activities, with support roles in developing IPM systems for non-traditional crops and helping to regionalize IPM CRSP project missions.

U. S. INST. - Purdue University, Virginia Tech, Ohio State University, and the University of Georgia have all assumed major program responsibilities for effectuating IPM CRSP project activities in Guatemala and the Central American site. Two graduate research assistants, Anne Dix and Helda Morales, sponsored by Ron Carroll, University of Georgia and Roger Williams, Ohio State University, respectively, have been funded on IPM CRSP, and are currently completing their graduate research in Guatemala.

The IPM CRSP project responsibilities for each of the above collaborators has been defined and mutually agreed.

Activity #2: Initial participatory appraisals were completed in August 1994, with all key collaborating institutions participating in the planning, training, and participatory research activities. This activity was directed by Ginny Seitz (Virginia Tech). The IPM CRSP provided the unique opportunity for a government institution (ICTA), a local NGO (ALTERTEC), a transnational NGO (CARE), and a business (AGRILAB) to come together to work towards a common goal. This sort of collaboration is highly unusual in Guatemala. The workshop was a success in that for the first time the Guatemalan institutions had the opportunity to share in detail the work they carried out in their country. The presence of the American scientists facilitated this process. It became evident that the unique emphasis and diversity of approaches of each institution would act in synergy to favor the project.

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With the exception of the DEFENSORES study, the existing literature on non-traditionals is not site specific and does not indicate the use of participatory methodologies or gender-inclusive analysis (Ref. "Sostenibilidad de la Production Agricola No-Traditional de Exportacion por Pequeños Productores en Guatemala", INCAP, April, 1994). Two sites were selected for the participatory appraisals; Chilascó/Baja Verapaz and Chimaltenango. We also identified potential constraints to the participation of women as IPM collaborators. Preliminary results were summarized and evaluated. Follow-up participatory appraisals were conducted in October '94, with Ginny Seitz, Mark Dripchak (CARE), and Linda Asturias (ASIES) providing the leadership for on-site research activities in the Chilascó/Baja Verapaz (Matanzas) site. The results of these participatory appraisals have been summarized and integrated into year-two IPM CRSP planning and workplan activities. Chilascó's entry in the past five to eight years into the production of non-traditionals is relatively recent as compared to Chimaltenango, and the attitude of farmers can best be described as demonstrating "broccoli fever." The economic incentives for producing broccoli have created the conditions for farmers to push as much production as possible from their fields, including decreasing spacing between plants, increasing the number of crops per year in one field, and engaging in risk-aversion methods by using more than one fertilizer and pesticide application strategy depending on the advice of a particular exporter. The IPM CRSP research activities can contribute in a significant way, particularly if we follow a strategy of comparative sociological research of three communities that are in different stages of production of non-traditionals. This has already begun by working in Matanzas, Chilascó, and communities in Chimaltenango. Collaboration with the MICuenca project of CARE, as well as with Peace Corps volunteers, DIGEBOS, and DIGESA will contribute to our capacity to conduct on-going sociological research and to foster the development of a community-base for IPM practices. We have accomplished establishing cooperative links with these organizations during year one. We will pursue collaborations with DEFENSORES in the Baja Verapaz, and actively promote more collaboration among ICTA and ALTERTEC in this region.

Activity #3: The Guatemala Site Committee was established, Victor Salguero (CATIE Entomologist and IPM Specialist) will serve as Interim Site Coordinator, with support from ICTA. Other members of the Guatemala Site Committee include:

Glenn H. Sullivan - Marketing Economist, Purdue University/Guatemala Site Chair
Ing. Danilo Dardon - Vegetable Production Specialist, ICTA
Mark Dripchak - IPM Socioeconomic Specialist, CARE
Guillermo Sanchez - Plant Pathologist and IPM Coordinator, AGRILAB
Rafael Solorzano - Vegetable Production Specialist, ALTERTEC
Linda Asturias - Economic Anthropologist, ASIES
Hector Sagastume - IPM Specialist Non-traditional Crops, ICTA

Activity #4: Strategic resource assessments were initiated to identify the technical, economic, socioeconomic, policy, and institutional factors influencing IPM implementation in non-traditional export crops in Guatemala. These activities will provide much of the baseline information needed to achieve year-two IPM CRSP workplan objectives. Preliminary findings are being summarized for presentation to the Guatemala Site Committee, stakeholders, and collaborators. These activities are being directed by Glenn Sullivan (Purdue) and Linda Asturias (ASIES), in collaboration with GEXPRONT, ICTA, CARE, and Ginny Seitz (Virginia Tech).

Activity #5: Collaborations with existing IPM programs were initiated to identify short-term output opportunities. These collaborations include:

ICTA - is in the process of seeking almost $50 million in funding from the World Bank to refocus and restructure overall institutional program missions. A key component of this process centers on expansion of IPM programs in the non-traditional crops for export. IPM CRSP project collaborations have helped strengthen ICTA's World Bank request. IPM CRSP project support for current IPM research in broccoli provide the basis for short-term benefits, and document ICTA's commitment to institutional refocusing/restructuring.

AGRILAB - is in the process of developing IPM strategies that enhance Guatemalan market position in the export of blackberries and raspberries - both of which our research shows represent expanding markets in the United States. Research collaborations with Ohio State University (Roger Williams) provides the basis for immediate knowledge/technology transfers to assist AGRILAB in achieving program success much earlier than planned. Guillermo Sanchez (AGRILAB) is currently directing this program initiative. One of the requests from counterparts in Guatemala is to get positive identification of some of the pest species that we will be dealing with, particularly in the brambles (blackberry and red raspberry) for export. A beetle which destroys the white flower petals of these brambles has just been identified, which will perhaps aid in the control of this pest by conducting literature searches with the scientific name. Recent publications refer to these insects as "escarabajos" which means beetles. This information will be published in a short note with Willie Sanchez, Agrilab, as co-author.

In collaboration with Glenn Sullivan (Purdue University) and Caito Foods (Indianapolis, IN, USA), Sanchez is planning test market and direct ship blackberries to the United States in 1994. Success in these IPM CRSP activities will provide Guatemala with a strategic market position in two strong market windows; October through December and April through June.

ICTA/GEXPRONT - are collaborating on IPM strategies to reestablish Guatemalan market position in snow peas for export to the United States. These activities are proceeding in collaboration with IPM CRSP market planning activities (Sullivan/Purdue). Project collaborations focus on establishing IPM programs and policies that help assure consistent Guatemalan compliance with U.S. import standards and thereby achieve permanent removal from automatic detention at U.S. ports of entry.

Activity #6: Graduate student training and research. Helda Morales, a graduate student working with Dr. Roger Williams (OSU), is interested in solving entomological problems in traditional and non-traditional crops in the Highlands. (Details of her activities are reported by Roger Williams in the next section of this annual report.)

Anne Dix, a graduate student at the University of Georgia, is working with Dr. Ron Carroll on IPM in crucifer crops. (Details of her activities are reported by C. Ronald Carroll and Anne Dix in the next section of this annual report.)

ANNUAL REPORTS ON ACTIVITIES BY INVESTIGATORS

1. Roger N. Williams, Entomologist
Ohio State University

This has been a very fast year. It began about eight months ago with the initial visit to Guatemala and Honduras in February 1994. During this first trip we were able to make contacts with most of the primary players and establish working relationships based on future funding. The site visits to see the problems in the field at 4 - Pinos, Alcosa, Finca Cumbre, etc. gave us all a better understanding of the way such a consortium of institutions might work cooperatively.

In March I was asked by the M.E. to attend the Central America/Caribbean Integrated Pest Management Implementation Workshop. This meeting was convened by the Integrated Pest Management Working Group (IPMWG) with headquarters in Chatham Maritime, Kent, England. This was the first meeting of its kind, i.e., a joint Central American - Caribbean encounter solely dedicated to IPM. Of the 60 invited representatives present, most were Spanish speaking. Simultaneous translation provided by IICA made the meeting a complete success. It was a great opportunity for me to attend this meeting and become more familiar with the participatory procedures in IPM and for the many contacts from CA/C and the interactions during the meeting.

One of the activities early in this project was to obtain as much pertinent literature on the subject area as possible. This has been aided greatly by the agencies visited in Guatemala, Honduras and Costa Rica, namely: CATIE, IICA, ICTA, Zamorano and others. Students working in my lab at OARDC have helped in compiling a nice reference library on NTAE of Guatemala and neighboring countries.

In April I attended the IPM CRSP Workshop (A Participatory Framework) and the following Technical Committee at Virginia Tech.

With a great deal of luck I was able to find a graduate student, Helda Morales, that was interested in solving entomological problems in Traditional and Non-Traditional crops in the Highlands. She is Guatemalan with a B.S. degree from Universidad del Valle and a Masters degree in IPM from CATIE in Turrialba, Costa Rica. We are presently funding the research portion of her research while she is in Guatemala. She a has Fulbright Scholarship (LAS2AU), funding studies while in the USA. During the entire month of August 1994, Helda did her initial survey of Highland farmers in the area near Patzún (Chimaltenango). She also had an opportunity to visit Chilascó (Baja Verapaz) and may do some work in that area. Her findings in the Survey are not yet complete. In a report of her activities in August, she says the following. "In summary, the visit to Guatemala allowed me to establish contacts for conducting research next year, gave me a better understanding of farmers vocabulary, main interests and perceptions. It will produce a list of traditional practices for pest control, a comparison between traditional and non-traditional farmers,

and a list of traditional agriculture studies in Guatemala," In addition, Helda was with the IPM CRSP group for the Workshop and the P.A. which was beneficial to all because of her knowledge of IPM and her ability to translate either way, Spanish <--> English.

In July I attended the 5th Congreso Internacional de Manejo Intagrado de Plagas) in San José, Costa Rica. This meeting is unique in that it is dedicated to MIP (IPM) of crops in Latin America. Most of the presentations were in Spanish and the few in English were translated into Spanish. It was a very important meeting for me because I was able to make many contacts and the information presented gave me a better understanding of current research in progress.

In August I traveled to Guatemala for the Workshop and P.A. In addition, I was able to travel to Patzun with Helda and others to see the general research area. We will have some research plots in Year 2 at the 1CTA Experimental Station at Chimaltenango in addition to some farmer cooperators.

Most recently, September 1994, I attended the T.C. at Virginia Tech for the IPM CRSP representing Guatemala along with Glenn Sullivan.

Several research reports were forwarded to me from coworkers in Guatemala. These reports represent work recently completed in the area of IPM and are areas that will be followed up on and expanded. Our counterparts have shared this work with us and are aware that we are using it to demonstrate activities underway. The reports have been forwarded to the ME.

One of the requests from counterparts in Guatemala is to get positive identification of some of the pest species that we will be dealing with, particularly in the brambles (blackberry & red raspberry) for export. A beetle which is very pesky destroying the white flower petals of these brambles has just been identified and will perhaps aid in the control of this pest by conducting literature searches with the scientific name, recent publications refer to these insects as, "escarabajos" which means beetles. This information will be published in a short note with Willie Sanchez, Agri-Lab, as co-author.

2. C. Ronald Carroll and Anne Dix
Institute of Ecology
University of Georgia

During the 1993-94 year the University of Georgia set out to:

(1) Investigate current activities relevant to IPM at collaborating institutions
(2) Identify pest management priorities
(3) Discuss land use practices and pest management practices used by farmers at research sites
(4) Conduct preliminary samples for key pests and beneficials in wet season highland crops and in adjacent forest and weedy habitats
(5) Develop a working relationship with project collaborators and help plan participatory appraisal workshops.

Specifically we wanted to identify the pest management problems as perceived by the farmers, what their cropping patterns were, what functional groups might be used to estimate ecosystem health, identify the level of degradation in these systems and determine what kinds of information were already available both in Guatemala and Honduras (ZAMORANO). In order to do this we first had to identify our research site. We were particularly concerned with identifying a site that had been less disturbed than Chimaltenango in order to have a basis for comparison.

After an intensive literature search in Athens, GA, Anne Dix visited ZAMORANO in Honduras in order to gather the background literature on IPM related to crucifer crops. She divided her time working with Dr. Ron Cave, an authority on the taxonomy of parasitoid wasps in Central America, and Dr. Jeff Bentley, anthropologist, and leader of the effort at ZAMORANO to work with farmers as the developers of IPM technologies. She attended several workshops given through the MIP Laderas project in order to train extensionists and farmers on IPM and insect ecology, and had the unique opportunity to attend a workshop at ZAMORANO that was exclusively for farmers to exchange information on the technologies they had developed. Dr. Cave provided Anne with the unique experience of working through his lab system in order to learn all about the techniques and methodologies used to keep a natural enemy augmentation program in operation. The net result of this was an extensive database on Crucifer crop IPM and the development of invaluable collaborative ties with professionals at the ZAMORANO.

Once in Guatemala, Anne assisted in the initiation of the IPM CRSP. Due to several problems in infrastructure (some collaborators did not have access to telephones or reliable mail services) it became apparent that information was not flowing freely between collaborators in the United States and collaborators in Guatemala. Through institutional ties at the Universidad del Valle, Anne initiated communications with the collaborators in the United States and the first meeting of the collaborators in Guatemala was held. In a series of sessions before the U.S. collaborators came down for the preliminary participatory appraisal, the local institutions identified their strengths and weaknesses and became acquainted with each other's work. The CRSP provided the unique opportunity for a government institution (ICTA), a local NGO (ALTERTEC), a transnational NGO (CARE) and a business (AGRILAB) to come together to work towards a common goal. This sort of collaboration is highly unusual in Guatemala. A series of sessions led to the preliminary identification of Chimaltenango and Baja Verapaz as the focal points for the IPM/CRSP work in Guatemala. Access to e-mail through Anne Dix led to the better communications between the U.S. and Guatemalan institutions.

The workshop was headed by Glenn Sullivan (Purdue) and organized by Anne Dix during the month of July. The workshop was a success in that for the first time the Guatemalan institutions had the opportunity to share in detail the work they carried out in their country. The presence of the American scientists facilitated this process. It became evident that the unique emphasis and diversity of approaches of each institution would act in synergy to favor the project. Invited speakers from the Peace Corps, USAID, Defensores de la Naturaleza, CATIE, and the Universidad del Valle were supportive and helped give direction to the IPM CRSP participants. Anne led a site visit to Chilascó, Baja Verapaz, where collaborators had the opportunity to speak with farmers growing broccoli for export. The group had the participation of regional representatives of CARE/MICUENCA, Defensores de la Naturaleza, ALTERTEC and ICTA, as well as individuals from Virginia Tech, the University of Georgia and several community leaders from Chilascó. ICTA and CARE already have ongoing projects with the community and Anne is doing her dissertation research within the community. ICTA has been testing several varieties of broccoli for ALCOSA on farmers fields and CARE is developing a plan for the watershed with community members.

Anne spent a considerable amount of time interviewing farmers in the community about the production process (IPM strategies) and problems encountered (pest problems). The farmers appear to be very interested in developing information exchanges with organizations other than the companies they work with. The main pest problems identified by the people in Chilascó were *Plutella xylostella* (Diamondback moth), *Leptophobia aripa* (mariposa blanca, gusano anillado), *Brevicorne brassicae* (Aphids), *Phyllophaga* sp. (gallina ciega) and quite unexpectedly, houseflies. Two of the problems are linked by the villagers, with the introduction of chicken manure as fertilizer. Among the pesticides most frequently mentioned were Dipel 2x, Ambush and Lorsban. Most farmers spray immediately after they spot 5 caterpillars of any kind in a sample of fifty plants distributed through five cardinal points in the field. The main IPM concerns for this community are the development of pesticide resistance and the elimination of alternate hosts for natural enemies, and the poor management of the timing of harvests. Of special concern is the farmers' heavy reliance on agrichemical information and products ("medicines") provided by people who come from outside the community and the apparent deterioration of soil quality through intensive use and erosion. Water quality may be impacted by a Leatherleaf export operation located upstream from Chilasco. The introduction of broccoli in Chilasco has had a lot of both positive and negative impacts on the social structure and economic well being of the community. Many of these impacts directly influence farmers choices about IPM.

Anne also gained access a set of aerial photographs from 1965, 1981 and 1991 of the community and is working on an analysis of the changes in landscape use that have taken place between these time periods. The Institute of Ecology is currently researching the potential use of cover crops and intercropping as an alternative form of pest control in broccoli.

During the first year of the project (which basically consisted of the funded period between May 1994 and September 1994) the Institute of Ecology accomplished the following activities. A background literature search at UGA and ZAMORANO on IPM related to crucifer crops and biodiversity was completed. We also identified proposed work sites and the socioeconomic context of the community of Chilascó. We also coordinated the initiation of the IPM/CRSP activities in Guatemala and participated in an institutional analysis and the identification of a site coordinator. We also did a preliminary survey of the pest problems in Chilascó and a landscape analysis of the IPM practices in Chilascó and their environmental implications. We are in the process of completing a map of the

agricultural land use in the community. Finally, we identified stakeholders and organizations working with the people in Chilascó and have a list of the pesticides currently used by the farmers.

3. Glenn H. Sullivan and Stephen C. Weller
Department of Horticulture
Purdue University

OBJECTIVES:

I. Identify stakeholders and obtain commitments.

II. Diagnosis and planning for participatory appraisals.

III. Conduct participatory appraisals.

IV. Identify social, economic, policy, and institutional factors affecting IPM and export market development.

ACTIVITIES:

I. A strategic assessment of institutions and individuals was completed. Stakeholders were identified and commitments for IPM CRSP collaborations were obtained. Workplan collaborations were established with each stakeholder, along with implementation schedules and timelines for workplan fulfillment. Stakeholders with established IPM CRSP collaborations include:

ICTA - the Institute for Science and Agricultural Technology collaborated in planning and effectuating the participatory appraisals, and in the identification of technical issues influencing IPM in Guatemala. ICTA will continue to collaborate in activities assessing social, economic, and policy issues that impact successful implementation of IPM for non-traditional crops, and in developing baseline production information for IPM CRSP.

GEXPRONT - the Guatemalan Non-Traditional Products Exporter's Association is affiliated with the Guatemalan Chamber of Industry, and the leading export assistance agency in Guatemala. The primary objective of GEXPRONT is to improve fiscal policies and incentives for the exporting sector. GEXPRONT collaborated in IPM CRSP activities with assistance in identifying non-traditional crops for export, cropping regimes, existing pest problems, regulatory and policy issues impacting trade development, and pest management problems. GEXPRONT will continue to play an important role in IPM CRSP collaborations.

ASIES - the Association for Investigation in Social Studies agreed to collaborate in providing access to baseline economic and socioeconomic information needed to achieve IPM CRSP workplan objectives. Dr. Linda Asturias is a Senior Fellow at ASIES, and a funded collaborator in IPM CRSP through Purdue University (G.H. Sullivan). Strategic resource assessments are now in process. In collaboration with Dr. Sullivan, Dr. Asturias provides host country leadership in: (1) conducting and documenting farmer baseline studies at the household and community levels, (2) conducting baseline assessments of institutional policies, regulations, and practices that impact implementation of IPM strategies and export opportunities in non-traditional crops, (3) evaluation of economic, social and gender impacts of pest

management alternatives, and (4) assessment of alternative non-traditional crop export market strategies.

AGRILAB - is a soils and disease analysis laboratory with senior scientists who have expertise in IPM and non-traditional cropping regimes. Dr. Guillermo Sanchez has agreed to collaborate in IPM CRSP, and has played an important role in all phases of our workplan activities. He has provided strategic resource information in the production, management, and marketing of small fruits and berries, and he will play a continuing role in establishing baseline production and pest management information. His associations with ICTA and GEXPRONT are extremely important to achieving our overall objectives.

II. Secondary information assessments were completed in preparation for participatory appraisal planning and training. Participatory appraisal training workshops were completed in August 1994. These activities were completed under the leadership of Ginny Seitz (Virginia Tech). Guatemalan stakeholders and topical experts presented background and baseline information on selected issues. Information was summarized and integrated into an "action plan" for completing the participatory appraisals.

III. Participatory appraisals were completed in two targeted sites: Chilascó/Baja Verapaz (intensive commercial broccoli production area) and Chimaltenango (diversified non-traditional crops area). Stakeholders and site committee members divided responsibilities for PA activities, with review and consensus building at the mid-point and conclusion. PA findings were used to establish IPM CRSP research priorities and develop year-two workplans.

In addition to the standard PA's, we conducted participatory appraisals with two grower cooperatives, two marketing/exporting firms, and two export assistance agencies (GEXPRONT and PROEXAG). These latter PA's provided extremely valuable insights into the regulatory, policy, and economic concerns and issues impacting IPM and export trade expansion in non-traditional crops. This information was summarized and integrated into the baseline data previously assembled. All PA information was incorporated into the planning process for developing year-two IPM CRSP workplans.

IV. The process of establishing baseline information on the economic, socioeconomic, and policy issues that impact IPM in non-traditional crops export was initiated. ICTA, GEXPRONT, ASIES, and PROEXAG are collaborating in these activities. Our first focus was to assess the commercially important non-traditional export crops, and determine the "export market windows" for each. The "market window" analysis includes assessment of product specifications, regulatory requirements, and policy considerations. This activity is well underway, and useful findings are now being summarized and integrated into the year-two workplan schedules.

Key non-traditional crops currently being researched include: blackberry, raspberry, strawberry, specialty melons, asparagus, broccoli, Brussels sprouts, artichoke, green onion, snow peas, okra, and specialty squash. In addition, as a result of the "institutional participatory appraisals", we are assessing the herb and spice crops. Findings suggest that this segment of the non-traditionals might offer significant opportunities for export market development and domestic production expansion. Discussions are currently in progress for developing a substantive rural economic development proposal, in collaboration with ICTA and GEXPRONT, targeting the expansion of the Guatemalan herb and spice industry through export trade. Project funding would be solicited from major international institutions and appropriate governmental agencies. While these discussions are only

preliminary, IPM CRSP strategic resource assessments to date indicate high development potential in this segment of the non-traditional crops.

4. George Norton
Department of Ag & Applied Economics
Virginia Tech

Ecuador

Planned activity: Identify stakeholders and obtain commitments

Progress: Participated in stakeholders meeting in Ecuador with USAID, INIAP, the Presidential Commission on the Environment (CAAM), the Nature Foundation, and others. A proposal for funding for a buy-in from the USAID/Ecuador Mission was submitted along with a draft MOU. The Ecuadorian groups are very interested in committing to the CRSP if funding can be obtained for the Ecuador site.

JAMAICA

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JAMAICA PRIME SITE ANNUAL REPORT

F. Eivazi, Site Chair
Plant Science and Natural Resources Department
Lincoln University

For the Jamaica prime site, six major objectives were planned to be met during Year 1 of the IPM CRSP. Progress made during the year under each objective is presented below.

Objective 1. *Identify stakeholders and parheipants and obtain commitments*

Progress: An initial meeting of the interim Technical Committee was held October 26-27, 1993: 1) to develop activities for inclusion in the first-year workplan 2) to initiate operational procedures and 3) to begin team building for each site. Representatives from the Jamaica site were not present; however, co-principal investigators from U.S. institutions who were interested in working in the Jamaica site provided input to the draft workplan. This draft was then distributed to all IPM CRSP collaborators for review and input into final workplan. In addition to the workplan, a logical framework or "logframe" was developed for the Jamaica site. A site visit was arranged and a five day meeting was held in Kingston, Jamaica and surrounding areas, February 7-12, 1994 (U.S. scientists, F. W. Ravlin. R. Fery, C. W. Pitts, and D. N Sasseville). During this meeting stakeholders and network participants were identified and commitments obtained from both institutions and individuals. An MOU was signed between the CARDI (Caribbean Agricultural Research and Development Institute), the Jamaica Ministry of Agriculture (MINAG) and the Management Entity at Virginia Tech representing the IPM CRSP. Stakeholders meetings were held in Jamaica with the participation of CARDI, RADA, UWI, MINAG, ALCAN, USAID, PSU, LU, USDA-ARS, VPI. Sites for field work were identified in two parishes, St. Mary and St. Catherine (north east and central Jamaica), in which research will be conducted. Farmers and their families, local cooperatives, USAID "Hillside project," UWVRONCO/USDA, APHIS, chemical companies, seed companies were among other stakeholders and collaborators identified and visited.

Objective 2. *Diagnosis and planning for Participatory Appraisal (PA)*

Progress: Secondary information was gathered on pest management programs. During the course of the site visit in February commodities such as mango, okra, pepper (scotch bonnet), callaloo, pumpkin and yam were observed in the field by the team. The objective was to identify and prioritize the commodities to be addressed by the IPM CRSP. The pest problems for each commodity, the existing and potential control tactics, etc. were identified. Detail information is presented in "Jamaica Site Trip Report, February 1994."

Objective 3. *Summarize results of diagnosis and recommend a PA process*

Progress: At the April 1994 workshop at Virginia Tech, a schedule was developed and the specific PA process to be conducted in Jamaica was prepared and recommendations were made to the TC and ME. The team who attended and participated in the workshop consisted of one CARDI representative and the members of U.S. institutions involved in Jamaica site.

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Objective 4. *Conduct participatory appraisal activities*

Progress: The PA activities took place in Jamaica during June 20-July 2, 1994. The PA plan consisted of: 1) workshop which was held for three days. Participating in the workshop were local, regional and international researchers, extension specialists, producers, processors and distributors (with 32 people in attendance). The first half of the workshop provided the participants with a perspective on the local export and industry, trends in IPM, current USAID agricultural projects and team building. The second half of the workshop introduced participants to the sociological considerations for implementing IPM in Jamaica, gender analysis and participatory appraisals. Methods and tools used in conducting PA were reviewed and discussed. 2) field exercise for PA was conducted in two parishes, St. Mary and St. Catherine for four days. Researchers (North American and Jamaican) were divided into two groups with each group conducting interviews in one of the selected locations. An average of two farm families were visited per day by each pair. At the end of the field exercise information gathered was presented to the farmers interviewed for verification and clarification. 3) based on observations and discussions related to the crops cultivated in the areas visited a list of potential vegetables for IPM CRSP research was selected. For the primary crops, a list of potential areas for investigation was developed and a resource analysis conducted (resources available, needs, limitations identified). Based on the proposed research, baseline studies were selected for Year II. Linkages between Jamaican and North American institutions and organizations were discussed and their roles in the implementing the proposed workplan for year II identified. A tentative workplan and budget for Year II was established. (A detailed trip report is available.)

Objective 5. *Establish community advisory committee*

Progress: The first advisory committee meeting was held at the Center for Nuclear Sciences (UWI, Mona Campus) on July 4, 1994. Present were North American researchers and local Jamaican representatives from RADA, Hillside agriculture Project (HAP), Agricultural Export Services Project (AESP), Pre-Clearance Project, Pesticide Control Authority (PCA) and industry.

Objective 6. *Analysis of policy alternatives, social/gender implications, pest ecology, and disease epidemiology*

Progress: Pest ecology and disease epidemiology work is underway. Data collected by gender specialist, during the PA, is being analyzed Preliminary assessment of Jamaican export opportunities to the United States and Europe for selected non-traditional crops were made. Analysis included identification of viable supply/demand periods (market windows), assessment of performance requirements for achieving market entry and penetration, determination of product specifications for retail and merchant wholesalers buyers, and assessment of policy issues impacting Jamaican imports into U.S.

REPORT OF PROGRESS MADE IN YEAR 1 OF THE IPM CRSP

F. Eivazi, D. Marsh, D. Sasseville
Plant Science and Natural Resources Department
Lincoln University

Objective 1. *Identify stakeholders and participants and obtain commitments*

Progress: Lincoln scientist, David Sasseville (along with scientists from Virginia Tech, Penn State, and the USDA Vegetable Laboratory) traveled to Jamaica in February of 1994 and participated in the activities related to the identification of stakeholders. A report was filed with Management Entity providing complete details of the trip.

Objective 2. *Diagnosis and planning for participatory appraisal (PA)*

Prograss: Lincoln scientist, Frieda Eivazi, attended a workshop on participatory approach to IPM in April 1994. She participated in the meeting of Jamaican-U.S. network participants arranged to discuss the needs assessments of gaps and intervention points. In this meeting, a tentative selection of priority crops and key pest problems was made. Also, the specific PA process to be used in Jamaica was discussed and recommendation was made to the TC and ME.

Objective 3. *Conduct participatory appraisal activities*

Progress: Two Lincoln scientist, F. Eivazi, and D. Sasseville traveled to Jamaica (June 19 through July 1, 1994) to participate in the activities related to on-site training of the team conducting the PA process and field work. The PA involved gathering of technical, sociaVgender, and economic information from farm-household and community. A trip report was filed.

Lincoln scientist, F. Eivazi, attended the TC meeting in September 1994 and participated in finalization of Year 2 workplan for Jamaica site.

A graduate student was identified and agreement was made with the University of Missouri-Columbia to start the student with her course work.

JAMAICA COUNTRY REPORT

Janice Reid (Country Representative) and Janet Lawrence (Coordinator)
CARDI

SUMMARY

IPM-CRSP activities in Jamaica for Year 1 involved non-technical and technical activities. Initial activities included the identification of stakeholders and participants, establishment of a site committee, recruitment of a site coordinator, planning and conducting a participatory appraisal and the development of a workplan for Year 2. Technical activities were conducted during the last two months of Year 1 and involved a baseline survey in selected research areas to determine the pests and natural enemies present.

This report gives a brief outline of the non-technical activities and a detailed description of the baseline survey. Details and appendices are not included in the initial activities as this was included in a previous report ("Participatory Approach to IPM", July 1994).

NON - TECHNICAL ACTIVITIES

IDENTIFICATION OF STAKEHOLDERS AND PARTICIPANTS:

IPM CRSP activities began in Jamaica in February 1994 with a visit from three scientists from participating US institutions. An initial meeting with the North American scientists introduced stakeholders and participants from RADA, MINAG, UWI, USAID and private sector to the goals and objectives of IPM CRSP and the participatory process. Scientists were taken on a two day field visit for orientation to Jamaican agriculture and to initiate discussions on crops/pests for research. Following field visits a stakeholders workshop was held to determine crops/pests suitable for research, current IPM activities and technology transfer activities and extension programs that could produce short term impact. A draft MOU was submitted to CARDI and the MINAG for review.

PLANNING WORKSHOP:

Dr. Janice Reid (Country Representative, CARDI) attended a planning workshop April 4 - 9, 1994 at the Virginia Polytechnic Institute and State University (Virginia Tech) for all participants involved in IPM CRSP. The meeting was arranged to develop a common understanding among participants of: the participatory approach to IPM, the contribution of each component to site specific objectives for research and technology transter, foster institutional linkages and develop site specific work plans.

RECRUITMENT OF SITE COORDINATOR:

A Site Coordinator (Janet Lawrence) was recruited in the latter part of May and officially assumed duties on 1 June 1994. Ms. Lawrence's duties include coordinating the activities of IPM CRSP in Jamaica as well as conducting entomological research on IPM CRSP research projects.

PARTICIPATORY APPRAISAL:

Dr. Virginia Seitz (sociologist, Virginia Tech) visited May 24 - June 1, 1994 to plan for IPM Participatory Appraisal. While visiting, Dr. Seitz established oontact with potential social science collaborators and other stakeholders from the Pesticide Control Authority Rural, Agricultural Marketing Cooperation, farmers and policymakers within the Ministry

of Agriculture. Potential sites within St. Catherine and St. Mary were visited to determine their suitability for the PA activities. A draft program of the workshop and PA training was developed by Drs. Reid and Seitz at the end of the visit.

WORKSHOP:

The workshop and field exercise "Participatory Approach to IPM" was held June 20 - July 1, 1994 with the objectives of:

I. Developing an understanding of the Participatory Appraisal (PA) to Integrated Pest Management (IPM).

II. Introducing participants to participatory research methodologies and gender analysis and to develop the sociological context for IPM research.

III. Building collaborative research teams that are committed to the full participation of farm families in the research process.

IV. Introducing participants to Jamaican export agricultural production and marketing from the perspective of all stakeholders, including small and low-resource farmers.

V. Practicing participatory research methods in a four day field appraisal.

VI. Using the information gathered to plan for research in the coming years.

VII. Producing a workplan at the end of the activities.

Participating in the three day workshop were local, regional and international researchers, extensionists, producers, processors and distributors. The workshop was officially opened by representatives from the Ministry of Agriculture, USAID, and Dr. Frieda Eivazi, Chair of the Site Committee for the IPM CRSP in Jamaica. These persons endorsed the development and implementation of the program and emphasized its importance to agricultural development in Jamaica.

The first half of the workshop provided participants with a perspective on the local export and agro-industry, trends in IPM, current USAID agricultural projects and team building. The second half of the workshop introduced participants to the sociological considerations for implementing IPM in Jamaica, gender analysis and participatory appraisals. Methods and tools used in conducting participatory appraisals were reviewed and discussed.

FIELD EXERCISE:

Practical participatory appraisal training was conducted in two parishes, St. Mary and St. Catherine, for four days. Researchers were divided into two groups with each group conducting interviews in one of the selected locales. Within groups researchers were paired (North Amencan and Jamaican) and an average of two households/day were visited by each pair. Interviews involved gathering technical, social/gender and economic information on the farm household and community through the construction of community and resource maps, flow charts and venn diagrams. At the end of the field exercise, information gathered was presented to the farmers interviewed for verification and clarification.

DEVELOPMENT OF WORKPLAN YEAR II (1994-1995)

Based on observations and discussions related to the crops cultivated in the areas visited, a list of possible crops for research was developed and a vote taken to determine the crop combination to be investigated in the IPM CRSP research program. The criteria for selecting crops were those of export importance, pesticide usage residues, potential for developing IPM and crop classification (vegetable/horticultural). Callaloo (*Amaranthus* spp.), peppers (hot and sweet) (*Capsicum* spp.) and sweet potato (*Ipomoea batatus*) obtained the highest ratings, and were designated primary research crops. A second vote was conducted to determine crops that did not fill the above criteria, but presented an opportunity for rapid results. Bananas, papaya and coffee rated highest and were selected as secondary research crops.

For the primary crops, a list of potential areas for investigations was developed and a resource analysis conducted (resources available, needs, limitations identified). Based on the proposed research, baseline studies were selected for Year 2 (1994 - 1995). Linkages between Jamaican and North American institutions and organizations were discussed and their roles in implementing the proposed workplan for Year 2 identified. A workplan and budget for Year 2 has being submitted for approval by the donor agency. The research program is scheduled to begin 1 October 1994.

SITE ADVISORY COMMITTEE:

The first site advisory committee meeting was held at the Center for Nuclear Sciences (UWI, Mona Campus) on 4 July 1994. Present were local and North American researchers and representatives, the Rural Agricultural Development Authority (RADA), Hillside Agricultural Project (HAP), Agricultural Export Services Project (AESP), Pre-Clearance Project, Pesticide Control Authority (PCA) and industry. The meeting was chaired by Dr. Janice Reid (CARDI, Country Representative) and Drs. Virginia Seitz and Charlie Pitts gave an overview of the workshop, field exercise and workplan for Year 2. Valuable contributions with respect to alternate sources of funding to be explored, areas of on going research and collaboration among institutions and organizations were made by members present.

TECHNICAL ACTIVITIES

BASELINE SURVEY:
(August - September, 1994)

AIM: Determine the pest and natural enemy complex on Callaloo (*Amaranthus* spp.), Sweet potato (*Ipomoea batatas)* and Peppers (hot and sweet) (*Capsicum* spp.) in selected areas within St. Mary, St. Catherine, and Clarendon.

PERSONNEL:

CARDI

Scientists:	Entomologists	Dionne Clarke-Harris
		Sharon McDonald
		Janet Lawrence
	Pathologist	Marlene Pereira
	Biometrician	Heather Reid
Technical Assistants:		Peter Myers
		Donald Simpson
		Oral James

Collaborating Institutions and Scientists:

MINAG - Don McGlashan
RADA - Phillip Chung
UWI - Dave Hutton

OBJECTIVES:

I. Record the pests[1] and natural enemies observed on callaloo, sweet potato and peppers.

II. Develop a collection of pests recorded.

III. Develop a photograph album of pests and damage symptoms.

METHOD: Background information on the cropping systems of farms within selected areas in St. Mary, St. Catherine and Clarendon was gathered through informal interviews with farmers. Farms in the surveyed areas were chosen based on the production of the selected commodities (callaloo, peppers and sweet potato). Fields were uniformly scouted and pests, natural enemies and damaged plant parts were collected, documented and photographed. Insect specimens were identified preserved and immature reared where necessary. Soil and plant parts with possible nematode, fungal and viral infection were isolated and identified. A standard, sterile technique and a modified Baerman funnel technique were used to isolate fungi and nematodes respectively.

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[1] pest refers to any organism that competes with man for food, i.e.: insects, fungi, viruses, nematodes, weeds.

RESULTS AND DISCUSSION: Twenty-eight (28) farms were visited during the baseline survey: 17 in St. Catherine, 6 in Annotto Bay and 5 in Clarendon. During the time of the baseline survey, Annotto Bay was experiencing a severe drought which destroyed the crops of many farmers. This resulted in a limited number of farm visits within the Annotto Bay.

CROPPING SYSTEMS: Most of the farms surveyed ranged between 3 and 10 acres and were mixed cropping stands of vegetables, root and tree crops (Table 1). Acreages of callaloo, peppers and sweet potato ranged between 0.15 - 2.0, 0.15 - 0.2, 0.1 - 2.0 respectively.

Calalloo: Callaloo was the most frequently planted crop in Bushy Park, St. Catherine. Farmers cultivate callaloo continuously throughout the year and plant mixed varieties. Three varieties of calalloo were recorded and farmers reported their colloquial names as "red stalk", "cow tongue" and "coolie calalloo". "Cow tongue" was reported to be preferred as several cuttings can be obtained from a single crop, "red stalk" seeds quickly and thus does not allow farmers to get many cuttings from a crop. Most of the farmers reported that callaloo is grown for the local market, but a few reported that their crop was grown for export. Harvesting and marketing are usually carried out by higglers who cut and prepare the crop in bundles on the farms and sell it in local markets. Two farmers reported that market of callaloo is better at the end of the year (September onwards).

Peppers (Hot and Sweet): Sweet peppers are grown mostly by farmers in St. Catherine where hot peppers (scotch and cayenne) are grown principally in Annotto Bay. One farmer reported that hot peppers were only grown for export at specific times of the year, whereas sweet peppers always had a ready market locally. Propagation of sweet peppers is usually by seeds obtained from the farm stores.

Sweet Potato: Sweet potatoes are cultivated predominantly in Clarendon. In Clarendon Park, farmers reported that they planted sweet potato throughout the year, whereas in Heifers Run farmers reported that they planted during September - October and harvested March to May. The latter planting cycle was conducted because during the dry months, June to August, they experience severe crop losses due to weevils. Sweet potato are grown mostly for local markets and, in a few cases, for export markets.

PEST AND NATURAL ENEMY STATUS: Several of the pests* observed during the baseline survey are consistent with the pest complex described in the literature for callaloo, peppers (hot and sweet), and sweet potato and included insects, fungi, viruses, nematodes and weeds (Tables 2.1, 2.2, 2.3). A Lepidopteran complex of *Spodoptera spp.*, *Pilemia* and an unidentified genus ("green worm") was reported as the predominant pests of callaloo. One farmer reported that Guango (*Samanea saman* (Jacq.)) and Hog plum (*Spondias mombin* L.) trees are alternate hosts for the " green worms". Red spider mites ("silver back") attacking callaloo were also identified by farmers as economically important. Sweet potato weevil was reported to be the most important pest of sweet potato. Leaf miners affected all crops in varying abundance.

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* Due to the lack of diagnostic services, many of the pests collected need to be confirmed or identified. Assistance is therefore needed from collaborators; Dr. Pitts is exploring potential diagnostic services.

TABLE 1.0 CROPS GROWN IN CROPPING STANDS

		CROP GROUPS		
PARISH	**TOTAL # FARMS VISITED**	**VEGETABLE**	**ROOT**	**TREE**
St. Catherine	17	Callaloo (15) Scotch Bonnet (3) Sweet Peppers (6) Okra (9) Pak Choi (2) Corn (5) String Bean (1) Pumpkin (2) Cucumber (3) Onion (2)	Cassava (1)	Banana (1)
St. Mary	6	Callaloo (2) Cayenne (3) Scotch Bonnet (3) Pak Choi (1)	Sweet Potato (1) Dasheen (1) Yam (1)	Passion Fruit (1) Coffee (1) Cocoa (1) Ackee (1) Banana (1) Plantain (1)
Clarendon	5	Onion (1) Tomato (1) Cucumber (1) Pumpkin (2)	Sweet Potato (4) Yam (1)	Sugar Cane (2)

Number in brackets = farmers reporting that they grew the crop listed.

TABLE 2.1 PESTS RECORDED ON CALLALOO, *Amaranthus sp.*

INSECT	FUNGI	NEMATODE	OTHER
Lepidopteran Complex Leaf Webber, *Pilemia* sp. Army worms, *Spodoptera* spp. *"Green Worm" Diamond Back Moth, *Plutella Xlyostella* Semi looper, *Trichoplusia ni* *Leaf Hoppers White Fly, *Bemisia tabaci* *Leaf Miner, Stmk Bug. *Nezara virdula*	White Rust, *Albugo candida* Leaf spot,	*Tylenchulussp.* *Helicotylenchus* sp.	Red Spider Mite

***Species unidentified**

TABLE 2.1 PESTS RECORDED ON HOT AND SWEET PEPPERS,Capcicum spp.

INSECT	FUNGI	VIRUS	NEMATODE	OTHER
*Leaf Miner	Leaf spot, *Alternaria*	Potato Virus Y Tobacco Edge	*Helicotylenchus* sp.	*Mites

***Species unidentified**

TABLE 2.3 PESTS RECORDED ON SWEET POTATO, *Ipomoea batatos*

INSECT	FUNGI	NEMATODE	OTHER
Sweet potato Weevil *Cylasformicarius* *Tortoise Beetles *Leaf Miner *Leaf Webber	White Rust, *Albugo candida* Leaf Spot, *Alternaria* sp.	*Tylenchulus* sp.	Slugs Rats

***Species Unidentified**

The fungal disease "white rust" was observed on callaloo and sweet potato, but appeared to be a bigger problem for callaloo as it affects the marketable product. Leaf spots *Alternaria* and *Cercospora* sp. were observed on peppers and sweet potato. A viral complex of Potato Y and Tobacco Edge viruses were observed on scotch bonnet peppers.

Plant parasitic nematodes were observed in low numbers in soil and roots of callaloo and sweet pepper fields. Several weeds were found surrounding fields. Many of these weeds harbored insects, which may be alternate hosts of pests, eg. an *Ipomoea* sp., an alternate host for the weevil, was observed bordering a sweet potato field.

Arthropod and insect predators, namely hymenopterans, spiders, and lady bird beetles, were collected from cropping stands (Table 3.0.). Several larvae collected from callaloo were parasitized by hymenopteran parasites and, in one case, superparasitism was observed A hymenopteran parasite was also obtained from the unidentified leaf webber observed on sweet potato.

CONTROL TACTICS: The majority of farmers visited relied heavily on chemicals to manage pests (Table 4.0.). Several farmers interviewed mentioned inappropriate use and application of pesticides and incidents of poisoning. The need therefore exists to train farmers within these target areas in appropriate pesticide technology.

Non-chemical approaches employed by farmers involved hoeing between rows of crops to remove weeds and removal of crop residues. The introduction of traps, baited with sweet potato weevil sex pheromone (by CARDI), was used by two farmers within Clarendon to manage weevil populations. The farmer reported that using the traps has reduced weevil populations and damage to harvestable roots. These traps therefore need to be distributed to sweet potato farmers to improve the quality of sweet potato produced. The three hymenopteran parasites reared from the leaf webber on sweet potato and those from the lepidopteran complex attacking callaloo may be potential biological control agents whose populations could be augmented by inundative releases to manage the respective pests.

OUTPUT:

Past Profile for Callaloo, Sweet potato and Peppers (Hot and Sweet).

Insect box (pest and natural enemies) for each crop.

Album of pests, damage symptoms and agronomic practices of cropping systems of Callaloo, Peppers and Sweet potato.

TABLE 3.0 NATURAL ENEMIES

ARTHROPOD GROUP	PREDATOR	PARASITE
Insect	Lady Bird Beetles	*2 Hymenopteran spp. (reared lepidoteran larvae feeding on Callaloo)
	Polistes spp.	* 1 Hymenopteran spp. (reared from leaf webber attacking sweet potato)
	Reduvid	
Arachnid	Spider spp.	

***Species unidentified**

TABLE 4.0 CONTROL TACTICS EMPLOYED BY FARMERS TO MANAGE CALLALOO, SWEET POTATO AND PEPPER PESTS

CROP	PEST	PESTICIDE (common name)	NON-CHEMICAL TACTICS
Callaloo *Amaranthus* sp.	Insects	Profemofos Diazinon Chlorothal - dimethyl Methomyl Malathion Chloropyriphos Monocrotophus *Bacillus thuringiensis* Karrate Carbaryl	Field Sanitation (removal of crop residues)
	Fungi	Copper	
	Weeds		Mechanical (Hoe)
	Molluses	Slug pellets	
Peppers (Hot) *Capsicum* sp.	Insects	Delta Metbrin	Slug pellets
	Weeds		Mechanical (Machette, Hoe)
Sweet Potato *Ipomoea batatas*	Insects	Monocrotophos	Traps baited w/Sweet Potato Weevil Ipomoea Sex Pheromone Field Sanitation (removal of crop residues)
	Fungi	Metaxlayl Diazinon	

ACTIVITY STATUS
YEAR 1

ACTIVITIES PROPOSED	STATUS
1. Identification of stakeholders and participants	Completed
2. Diagnosis	Completed
3. Design PA	Completed
4. PA (workshop and field exercise)	Completed
5. Establishment of Site Advisory Committee	Completed
6. Analysis of policy alternatives	Awaiting analysis from US collaborator
7. Research to provide short term impacts and other baseline surveys: Pesticide Residues	The market basket survey and soil analysis for pesticide residues were not conducted, but rescheduled for Year 2.
8. Pest Ecology	A baseline survey was conducted within selected areas in St. Mary, St. Catherine and Clarendon to determine the pest and natural enemy complexes on callaloo, sweet potato and peppers (hot and sweet). However, due to the lack of diagnostic services several of the specimens collected have not been identified.
9. Virus and Diseases	Fungal diseases were identified during the baseline survey, however due to the lack of proper diagnostic services virus infected materials were not confirmed. Dr. Charlie Pitts is exploring the possibility of assistance with diagnostic services.
10. Nematodes	Nematode status was determined during the baseline study.

11. Sweet potato IPM	During the baseline survey very low levels of production of sweet potato were observed in Bushy Park, St. Catherine. Therefore, sites reflecting similar ecology to Bushy Park have been selected within Clarendon to conduct sweet potato research. Initial scouting for sweet potato pests within these areas have been conducted. A Participatory Appraisal has been designed and planned for this area in November. Traps baited with female sweet potato weevil sex pheromone have been ordered and will be used to conduct population monitoring studies during Year 2.
12. GIS	Discussions have been held with persons from the Center for Nuclear Sciences (University of the West Indies) and Rural Physical Planning (Ministry of Agriculture) re: internet connections for CARDI and possible exchange of data. Dr. Joseph Lindsay (information systems resource person, CARDI) has joined a GIS user group and is presently writing a paper which addresses the implementation of GIS within the CARDI network.

INTEGRATED PEST MANAGEMENT COMPONENTS FOR VEGETABLE CROPS

R.L. Fery, H.F. Harrison, J.A. Thies, J. Bohac
U.S. Vegetable Laboratory, ARS, USDA

Integrated Pest Management Collaborative Research Support Program (IPM CRSP) activities at the U. S. Vegetable Laboratory during FY 94 Included both program development and research. Program development activities were conducted throughout the year, but on-site research at Charleston, South Carolina, did not commence until the Reimbursable Cooperative Agreement between Virginia Tech and USDA/ARS was finalized on April 6, 1994. Research was initiated on two crops, pepper and sweet potato. Virtually all of the FY 94 activities were directed toward addressing pest problems in Jamaica.

Program Development

Four Co-Principal Investigators at the U. S. Vegetable Laboratory were involved in program development activities during the year. Co-principal Investigators from the Laboratory also participated in meetings/workshops at Blacksburg, Virginia, and on-site visits to Jamaica

IPM-CRSP Planning Meeting. October 26-27. 1993

R. L. Fery participated in the initial IPM-CRSP planning meeting at Blacksburg, Virginia. The purpose of the meeting was to develop activities for inclusion In the first-year workplan, discuss operational procedures, and to begin team-building for each site.

Jamaica Site Visit. February 7-12, 1994

R. L. Fery participated in the initial Site visit to Jamaica. The objectives of the site visit were to identify crop/pest situations suitable for research and technology transfer activities, identify stakeholders, identify existing research and extension programs, begin the process of selecting locations for the Participatory Appraisal and eventual IPM technology development and transfer, and to develop a Memorandum of Understanding between Caribbean Agricultural Research and Development Institute and the Management Entity at Virginia Tech. (Raven et al., 1994).

IPM CRSP Workshop and Technical Committee Meeting. April 5-10, 1994

R. L. Fery participated In IPM CRSP Workshop on "Integrated Pest Management in a Participatory Framework", Blacksburg, Virginia. He also participated in the Technical Committee Meeting held after the workshop was concluded. The purpose of the workshop was to develop a common understanding of the participatory approach to IPM, to develop an understanding of the contribution of each IPM participatory approach component to developing site-specific research and technology transfer activities, to develop institutional and disciplinary linkages for participatory integrated pest management, to develop specific site plans, and to develop specific guidelines for IPM Participatory Appraisal (Balakrishnan, 1994).

Participatory Appraisal. Jamaica. June 19-July 2, 1994

H. F. Harrison, Jr. participated in the participatory appraisal for the Jamaica site. The purpose of the appraisal was to identify when and where problems occur, identify what portions of famines are responsible for different tasks, identify what pest-related problems

exist and when, determine the knowledge level of farmers about pests and pest control tactics, identify what pest problems exist, and introduce researchers and residents to each other (Reid et al., 1994).

Research Activities

Research was initiated on two of the identified target crops in Jamaica, pepper and sweet potato. The objectives were: 1) identify hot pepper genotypes that exhibit resistance to root-knot nematodes, 2) characterize the tolerance to root-knot nematodes exhibited by the cayenne pepper PA-136, 3) assess hot pepper cultivars for tolerance to environmentally and toxicologically safe, selective herbicides, 4) identify cream-fleshed lines of sweet potato that exhibit high levels of resistances to insect pests (e.g., grubs, wireworm, *Diabrotica*, *Systena*), root-knot nematodes, and Fusarium wilt, and 5) characterize the efficacy of allelopathic sweet potato clones in controlling weed pests.

Evaluation of Hot Peppers for Resistance to Root-Knot Nematodes

Hot peppers, particularly the Scotch Bonnet cultivar class, are extremely popular in Jamaica. The root-knot nematode (*Meloidogyne* spp.) is a major pest of the crop, and the ideal solution to the problem in Jamaica would be the development and use of resistant cultivars. During FY-94, Scotch Bonnet (and the very similar Habanero) germplasm was collected from all available commercial and private sources. A total of 59 accessions were collected and subsequently evaluated in a replicated greenhouse test for reaction to *H. incognita.* Race 3 (Table 1). A significant amount of genetic variability for resistance to root-knot nematodes was observed In both Scotch Bonnet and Habanero germplasm. Most of these accessions were moderately susceptible or susceptible. However, four accessions (PA426, PA-427, PA-353, and PA-398) exhibited high levels of resistance. Each of the resistant accessions is of considerable value as parental material in breeding programs to develop root-knot nematode resistant Scotch Bonnet type peppers adaptable for use in Jamaica. Additionally, each of the resistant lines is potentially useful in Jamaica without further development, but detailed testing must be conducted before such recommendations can be made. (Investigators: **R. L. Fery and J. A. Thies**)

Characterization of Tolerance In Pepper to Root-Knot Nematodes

Three pepper lines, Carolina Cayenne, PA-136 and Early Calwonder, were characterized for their reaction to *Meloidogyne incognita.* Race 3. Carolina Cayenne is resistant and Early Calwonder is susceptible. PA-136, a pepper line with reported exceptionally high tolerance to infection by root-knot nematodes, was developed for use as a maintenance host to produce large quantities of egg inoculum. PA-136 plants have been reported to grow well in *M. incognita*-infested soils. single 24-day old plants growing in 15-cm clay pots containing 2 sand: 1 soil mix was inoculated with 0, 3000, or 6000 *M. incognita* eggs per plant and maintained in the greenhouse for 12 weeks. The experimental design was a spilt-plot design with six replicates of four plants per treatment. Whole plots were inoculum levels and subplots were pepper entries. The roots of all inoculated Early Calwonder and PA-136 plants were severely galled and produced large numbers of egg masses; none of the inoculated Carolina Cayenne plants exhibited significant gaping or egg mass production (Table 2). Fruit yields of Early Calwonder plants inoculated with 3000 and 6000 eggs per plant were reduced by 40X and 49%, respectively, compared to the control (Fig. 1). Fruit yields of PA-136 plants at both inoculum levels were reduced by 49X compared to the control. Fruit yield of Carolina Cayenne was not reduced at either inoculum level. Our results indicate that PA-136 is an excellent host for *M. incognita,* but the line does not exhibit true tolerance (high *M. incognita* reproduction without a reduction in yield). Carolina Cayenne exhibited exceptional resistance (minimal *Meloidogyne incognita*

reproduction, minimal galling, and no yield reduction). Early Calwonder was susceptible. (Investigators: **J. A. Thies and R. L. Fery**)

Table 1. Gall indices of fifty-nine "Scotch Bonnet/Habanero" pepper accessions and ten check pepper lines inoculated with *Meloidogyne incognita*, Race 3 (Greenhouse test, 1994). [a]

Accession index[b]	Cultivar/line nomenclature	Gall
PA-426	Yellow Scotch Bonnet	1.0
PA-427	Scotch Bonnet x Equadoran Aji I	1.0
PA-353	Red Habanero	1.2
PA-398	Jamaica Scotch Bonnet	1.2
PA-376	Red Scotch Bonnet #2	2.2
PA-368	Barbados #2	2.3
PA-365	Harold's St. Barts #2	2.3
PA-373	Jamaica Small Red #1	2.3
PA-367	Barbados #1	2.4
PA-375	Red Scotch Bonnet #1	2.4
PA-374	Jamaica Small Red #2	2.5
PA-364	Harold's St. Barts #1	2.5
PA-380	Red Scotch Bonnet #6	2.5
PA-387	Yellow Scotch Bonnet #5	2.5
PA-394	Scotch Bonnet (Jamaica)	2.5
PA-423	Habanero	2.5
PA-371	Jamaican Orange #2	2.5
PA-395	Habanero	2.5
PA-366	Harold's St. Barts #2	2.6
PA-382	Red Scotch Bonnet #8	2.6
PA-359	Habanero	2.6
PA-347	Habanero	2.6
PA-350	Habanero	2.6
PA-356	Habanero	2.6
PA-385	Yellow Scotch Bonnet #3	2.6
PA-355	Habanero	2.7
PA-349	Habanero	2.7
PA-420	Habanero	2.7
PA-372	Jamaica Large Red	2.7
PA-399	Habanero	2.7
PA-402	Habanero	2.7
PA-274	Habanero	2.7
PA-361	Jamaican Hot Chocoloate #1	2.7
PA-386	Yellow Scotch Bonnet #4	2.7
PA-362	Jamaican Hot Chocolate #2	2.7

PA-225	Habanero Hot	2.7
PA-396	Habanero	2.8
PA-337	Habanero	2.8
PA-295	Habanero Hot	2.8
PA-360	Habanero	2.8
PA-351	Habanero	2.8
PA-352	Habanero	2.8
PA-400	Jamaica Scotch Bonnet (Yellow)	2.8
PA-378	Red Scotch Bonnet #4	2.9
PA-397	Chocolate Congo Habanero	2.9
PA-384	Yellow Scotch Bonnet #2	2.9
PA-358	Habanero	2.9
PA-390	Yellow Scotch Bonnet #8	2.9
PA-343	Habanero	2.9
PA-388	Yellow Scotch Bonnet #6	2.9
PA-338	Habanero	3.0
PA-377	Red Scotch Bonnet #3	3.0
PA-354	Habanero	3.0
PA-381	Red Scotch Bonnet #7	3.0
PA-370	Jamaican Orange #7	3.0
PA-383	Yellow Scotch Bonnet #1	3.0
PA-357	Habanero	3.0
PA-389	Yellow Scotch Bonnet #7	3.0
PA-379	Red Scotch Bonnet #5	3.2
Carolina Cayenne	Check (Resistent)	1.0
Charleston Hot	Check (Resistent)	1.0
Mississippi Nemaheart	Check (Resistent)	1.0
Yolo Wonder	Check	2.6
Sweet Banana	Check	2.8
California Wonder	Check	2.9
Tam Mild Chili	Check	3.0
Tam Mild Jalapeno	Check	3.0
Early Cal Wonder	Check	3.4
PA-136	Check	3.5
LSD (0.05)	-------	0.5

[a] Peppers transplanted to bench 5/27/94; inoculated with 3000 *M. incognita* eggs 6/23/94; evaluated 8/23/94.

[b] Gall index: 1-no galling or very minimal galling; 5-galling present over whole root system.

Table 2. Effect of three *Meloidogyne incognita*. Race 3 inoculum levels on gall index, egg mass index, and nematode reproduction on three pepper genotypes differing in resistence/tolerance to the southern root-knot nematode.

Inoculum level [a]/pepper genotype	Gall index[b]	Egg mass index[c]	# eggs/mg dry root
Control			
Carolina Cayenne	1.0	1.0	4
PA-136	1.0	1.0	5
Early Calwonder	1.0	1.0	3
Low level			
Carolina Cayenne	1.6	1.5	15
PA-136	8.9	8.9	2040
Early Calwonder	8.5	8.6	2026
High level			
Carolina Cayenne	1.7	1.4	34
PA-136	8.7	8.7	1975
Early Calwonder	8.3	8.3	1601
LSD (0.05)[d]	0.7	0.7	393

[a] Each 24-day old plant was inoculated with 0 (control), 3000 (low level), or 6000 (high level) eggs.
[b] Gall index: 1-no galls; 5-numerous galls.
[c] Egg mass index: 1-no egg masses; 5-numerous egg masses.
[d] LSDs shown are applicable between pepper genotypes within the same inoculum level.

Table 3. Injury ratings of 12 pepper genotypes following postemergence oxyfluorfen application in the greenhouse.

	Oxyfluorfen rate (kg/ha)		
Entry	0.125	0.25	0.5
	----------	(% injury [a,b])	----------
Santaka	24	36	50
California Wonder	36	56	76
Yolo Wonder	20	38	50
PA-337	54	74	78
PA-338	20	30	58
PA-343	40	48	68
PA-356	26	60	74
Bohemian Chile	12	30	34
Charleston Hot	22	34	50
Carolina Cayenne	10	20	20
Keystone Resistent Giant	12	30	40
Sweet Banana	32	74	80

[a] Injury rating scale: 0=no injury; 30=moderate injury; 70=severe injury; and 100=dead plants.
[b] LSD (0.05) for comparing treatment means = 7.

Evaluation of Pepper Cultivars for Herbicide Tolerance

Twelve pepper accessions, including four Habanero/Scotch Bonnet types and three bell types that are popular in Jamaica, were evaluated for response to oxyfluorfen, bentazon and metolachlor in greenhouse and field experiments. The objective was to evaluate low human toxicity herbicides for potential use for pepper weed control in Jamaica.

Metolachlor at up to 6 kg/ha applied to recently transplanted pepper seedlings did not severely injure or retard the growth of any pepper cultivar (data not presented). Weed control was excellent with 1.5 kg/ha Metolachlor controls many weed species and has low mammalian toxicity. These factors, in addition to the high tolerance of pepper to metolachlor, make this herbicide suitable for use in Jamaican pepper production where pesticides are applied manually and sprayers are not accurately calibrated.

Pepper cultivars varied in their response to oxyfluorfen and bontazon. Bohemian Chile and Carolina Cayenne were most tolerant, and California Wonder, PA-337 and Sweet Banana were most susceptible to oxyfluorfen (Table 3). Among the Scotch Bonnet types, PA-338 was most tolerant to oxyfluorfen. Santaka and Bohemian Chile were highly tolerant to bentazon, but all of the Scotch Bonnet types were susceptible (data not presented). The differences between cultivars in response to oxyfluorfen indicate that with the proper choice of cultivar, the risk of herbicide injury to peppers could be reduced. The 0.125 kg/ha rate effectively controls many weeds, and since tolerant cultivars are not severely injured at this rate, it may be useful in Jamaican pepper production. The risk of crop injury by oxyfluorfen and bentazon can be reduced by avoiding "over the crop' spraying. Further research is needed to evaluate manual applicatlons of these herbicides for weed control in pepper under Jamaican conditions. (Investigators: **H. F. Harrison, Jr. and R. L. Fery**)

Evaluation of Sweet Potato Clones for Pest Resistances and Yield

In January 1994, a total of 4300 seedlings from the 1993 polycross (32 elite parents) were evaluated in a greenhouse test for resistance to root-knot nematodes (*M. incognita*) and fusarium wilt. A total of 802 seedlings were selected as resistant, of which 504 were white or yellow. These 504 seedlings were transplanted to the field and those with the best yield and horticultural characteristics will be selected by November 1994. Those selected will be evaluated for dry matter content, texture, and culinary quality upon baking. These fines will then be stored for 5 months and assessed for storability and resistance to storage rots. Those selected will be transplanted to plant beds and evaluated for sprouting and quality of transplanting materials. The best of these will go into the 1995 second year seedling yield and insect resistance trial.

In the 1994 season, 17 second year seedlings, 11 advanced fines and 4 bunch fines with dry cream or yellow flesh were tested for yield, quality, and insect resistance. These fines are presently being harvested, and the data will be analyzed during the 94/95 winter season.

In the spring of 1994, a separate polycross was set up with 10 elite, dry fleshed parents with multiple resistances to insects, diseases, nematodes, and wilt. Seed are being harvested this fall for use in the 1995 first year seedling trials. (Investigator: **J. Bohac**)

Table 3. Injury ratings of 12 pepper genotypes following postemergence oxyfluorfen application in the greenhouse.

	Oxyfluorfen rate (kg/ha)		
Entry	0.125	0.25	0.5
	(% injury [a,b])		
Santaka	24	36	50
California Wonder	36	56	76
Yolo Wonder	20	38	50
PA-337	54	74	78
PA-338	20	30	58
PA-343	40	48	68
PA-356	26	60	74
Bohemian Chile	12	30	34
Charleston Hot	22	34	50
Carolina Cayenne	10	20	20
Keystone Resistent Giant	12	30	40
Sweet Banana	32	74	80

[a] Injury rating scale: 0=no injury; 30=moderate injury; 70=severe injury; and 100=dead plants.
[b] LSD (0.05) for comparing treatment means = 7.

Efficacy of Allelopathic Sweet Potato Clones In Controlling Weeds

Greenhouse and field experiments were conducted to evaluate the competitiveness of sweet potato clones against weeds. In a greenhouse experiment designed to eliminate competition and measure only allelopathic inhibition of yellow nutsedge by sweet potato, clones were significantly different in their ability to inhibit yellow nutsedge (Table 4). Centennial, Excel, and Regal were most inhibitory, and Tinlan, PI 399169, and Porto Rico were least inhibitory. Other clones were intermediate in their effect on yellow nutsedge. A field study was conducted to examine the competitiveness of several sweet potato clones against indigenous weed populations. Under field conditions, weed growth in Regal and Excel plots was considerably less than in plots of less competitive clones (data not presented). However, the plots were variable, and the clones did not differ significantly in yield. These experiments indicate that sweet potatoes vary considerably in competiveness against weeds. This variation is due in part to differences in sweet potato root content of allelopathic compounds which inhibit yellow nutsedge and other weeds. Sweet potatoes also vary in growth habit, and clones, which have a denser canopy and an earlier canopy closure, appear to compete more effectively against small seeded annual weeds. These results indicate that selecting highly cornpetitive sweet potato clones is a feasible plant breeding objective. Although uncontrolled high populations of weeds will cause yield losses in the most competitive clones, the highly competitive clones probably require a shorter period of weed control to obtain maximum yields than less competitive clones. Hand weeding with machete and hoe is the predominant method of weed control in Jamaica, and is the most labor intensive aspect of Jamaican agriculture. Use of highly competitive sweet potato clones has potential for reducing the number of seedings required and significantly increasing the productivity of Jamaican sweet potato growers by allowing cultivation of larger plots. (Investigator: **H. F. Harrison, Jr.**)

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Table 4. Effect of Sweet potato clones on yellow nutsedge growth in a greenhouse experiment.

Sweet potato clone	Nutsedge Shoot Number	Shoot Weight	Tuber Number	Tuber Weight
	% control			
Beauregard	59	50	69	78
Centennial	54	42	66	71
Excel	43	40	56	63
Jewel	63	59	72	84
PI 399163	65	60	82	91
Porto Rico	68	68	79	96
Regal	55	52	71	82
Sulfer	55	51	67	82
Sumor	56	54	66	67
Tinian	85	75	102	100
Travis	65	54	72	100
W-274	62	52	70	85
W-301	69	59	68	85
LSD (0.05)	26	23	22	35

SITE SELECTION AND FINDINGS FROM EXPLORATORY APPRAISALS

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During the first year of IPM activities in Jamaica, we selected two research sites which provide a varied research setting for addressing IPM in Jamaica. The Bushy Park/Clarendon area, identified in the first site visit by other co-PIs, has larger-scale and sometimes mechanized agricultural production of sweet potato, callaloo, and peppers. There are considerable urbanization pressures in the region resulting in inflated land prices and a scarcity of rentable land for resource-poor farmers. Farmers most often identified lack of sufficient water for crops as their major production concern. Pesticides are used and the knowledge base of farmers about pests and pesticides, incentives and benefits of pesticide use as they perceive it, and other social factors of IPM, need further investigation.

In this site, communities are relatively autonomous and individual interests appear to supersede collective identity. Further research into social networks will benefit the design of IPM practices. Particular attention will need to be taken to conduct research with women, particularly to explore their often invisible role in pesticide use, including handling chemicals, washing clothes, and addressing family health problems.

In May, I participated in the selection of the St. Mary site (Refer to trip report for further details). This area, a site of the USAID Hillside Agricultural Project, is markedly different from Bushy Park/Clarendon. Farms are small with numerous land parcels distributed over a large hilly area. Farmers, both men and women, tend to be older and most men have left the community for most of their productive years in order to earn a living in an urban setting. Younger men work seasonally as agricultural laborers in the United States and Canada under the Farm Work Program. Many productive activities are left to women, and often to older women.

Although there are political and other (religious and class) divisions in the community, farmers are much less individualistic than those of the other sites, and people depend on each other through social networks. Men have the advantage of a rotating labor association in agricultural production (the "day for day" system). In addition to their own labor, women rely on family or hired labor, and identify labor shortage as their most serious production problem.

Unlike the other sites, cultivation is no-till with the machete being the most-used tool. Farmers grow a wide range of crops on a small scale in order to minimize their risk in such a marginal environment. There is much interest in growing Scotch Bonnet peppers, particularly since the local church-based development project has been promoting their production. Production of some crops of interest for export (like callaloo) has declined because of pest problems and because farmers do not have access to pesticides. Exploratory investigation suggests that the low use of pesticides currently is due more to lack of access or lack of money rather than to a commitment to avoid their use. Exploratory research also suggests further investigation on the effects of pesticide application on the nearby banana plantations and on local coffee.

A distinctive characteristic of the hillside site is the relative cohesion of the community. This is due, in part, to the presence of the programs and personnel of the St. Mary's Development Project. Having their cooperation is crucial to the success of the IPM

research program in this site, and there is potential for collective IPM activities based in local institutions such as the marketing co-op or the school.

Participatory Appraisal Workshop Planning and Implementation

After my site selection visit in May, I returned in June to work with CARDI staff and Dr. Janice Reid in planning the IPM workshop and participatory appraisal, activities also held in June. I was the trainer for participatory research methodologies for the IPM CRSP Workshop and PA.

The accomplishments of the PA process included:

1. Identifying local collaborators.
2. Collecting data on community stratification, product practices, livelihood strategies, and household and community dynamics.
3. Identifying Jamaican professional collaborators
4. Identifying potential of joint follow-up collaboration with other projects, like the CIDA soil project in St. Ann.

Collaboration with UWI

In addition to identifying other projects for collaboration, I met with members of the UWI faculty (Gender Studies, Development Studies, Sociology) and discussed future possibilities for collaboration.

A UWI graduate student, Althea Perkins, was interviewed by Dr. Reid and myself and has worked with CARDI staff to develop the social research agenda of the program. She was hired October 1 by CARDI and will work with Philip Chung (RADA) and myself in developing and implementing the social research program in both sites. She is currently doing a literature review and annotated bibliography of sources available in Jamaica, primarily at UWI. She will begin preliminary research during the last week in October, and we are planning an intensive study for early January 1995.

MALI

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MALI PRIME SITE ANNUAL REPORT

J. Mark Erbaugh, Site Chair
International Programs in Agriculture
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Introduction

Excellent progress has been made during the past year in implementing IPM CRSP activities in Mali. Progress can be measured both quantitatively and qualitatively. We were able to achieve eight of the ten Objectively Verifiable Indicators contained in the Log Framework Matrix. With respect to qualitative indicators of progress, the Site Team and the Malian Site Committee have been formed; are working closely together; and have assembled a Second Year Workplan that will advance the goals and objectives of the IPM CRSP during the second year of activities. A memo by the Agricultural and Natural Resources Development Officer, USAID/Bamako, expressing satisfaction with IPM CRSP activities and achievements associated with them is another significant indicator of progress. The key for Year 2 will be to build on this solid foundation by advancing a strong research program that continues to emphasize a participatory orientation.

Summary of Accomplishments

1. On October 26-27, 1993 an initial meeting was held at Virginia Tech of US based co-principal investigators and national program representatives from some of the four prime sites. At this meeting were Mali Site Coordinators, Drs. Diarra and Maiga, and Dr. Kyamanywa, representing the satellite research site for sub-Saharan Africa in Uganda. This meeting served to familiarize all participants with the goals and objectives of the IPM CRSP, and also served as a team-building exercise for the Mali Site.

2. Three US based co-principal investigators, Rich Edwards from Purdue University, and John Caldwell and Dan Taylor from Virginia Tech, were in Mali from February 7-12, 1994 to identify stakeholders, hold an initial stakeholders' meeting, and plan activities of the IPM CRSP in Mali for the initial five years of the project.

   - A stakeholders meeting was held on February 14, 1994, with 15 representatives from various organizations including IER, the Service National de Protection de Vegetaux (SNPV), the extension organization Operation Haute Vallee du Niger (OHVN), Care International, ICRISAT.

   - At the stakeholders meeting a ranking procedure identified sorghum/cowpea and millet/cowpea as the priority crop associations for the IPM CRSP to focus on in its first two years.

   - Four rapid impact trials were proposed.

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3. An initial Site Committee Meeting and Participatory IPM Workshop was held at Virginia Tech on April 6-9, 1994. At this meeting, a draft of the Mali Site Year 1 Workplan was finalized and preparatory plans were made for the upcoming Participatory Workshop and Participatory Field Appraisal to be held in Mali. Revathi Balakrishnan, Program Director, Women in Development/OIRD coordinated the Participatory IPM Workshop. The objective of this workshop was to develop an understanding and common approach to the conduct of Participatory IPM.

4. In late April, 1994, Mark Erbaugh, The Ohio State University, joined the Mali Site Team. He went to Virginia Tech in mid-May for a two day orientation meeting.

5. Preparations for the workshop and participatory field appraisal, which were subsequently held in Mali, were made during May and June, 1994. Florence Dunkel and Revathi Balakrishnan assumed leadership for planning the workshop and John Caldwell, Dan Taylor and Mark Erbaugh worked on planning the field participatory appraisal. Three telephone conferences were held during this time, in addition to many individual calls between site team members. A draft of the workshop agenda and field participatory appraisal itinerary were sent to Mali in mid-June for comments.

6. Between June 27 and July 23, 1994, a six person interdisciplinary team was fielded in Mali to conduct the Participatory Workshop and Field Participatory Appraisal. Team members from outside Mali were John Caldwell, Dan Taylor and Revathi Balakrishnan, Virginia Tech; Florence Dunkel, Montana State University; Mark Erbaugh, Ohio State University; and Sam Kyamanywa, Makerere University, Uganda. These activities were undertaken in close collaboration with the Malian Site Committee composed of individuals from sub-units of the Malian Ministry of Agriculture, including Site Coordinators and researchers from the Institut d'Economie Rurale (IER), and representatives from the Service Nationale de Protection des Vegetaux (SNPV), and the Office de la Haute Vallee du Niger (OHV). Highlights of the workshop and field participatory appraisal follow:

   • A five day workshop was conducted (July 4-8) on Participatory Appraisal methods for Integrated Pest Management at the Sotuba Research Station outside Bamako. Between 16-30 Malian participants attended all workshop sessions. Dr. Oumar Niangado, Director General, IER, opened the workshop. John Caldwell served as the overall facilitator for the workshop. Workshop participants were familiarized with the participatory approach and participatory methods, and in several sessions had an opportunity to practice selected methods. Selection of most important information needs and appropriate methods was done by workshop participants. The last day and a half of the workshop were spent planning for the field participatory appraisal.

• Two research sites were selected for the field participatory appraisal and future IPM CRSP activities. The 16-person core PA team divided itself into two teams of eight persons each, one for the Mourdiah area (more north and semi-arid; millet/cowpea association dominant) and the other for the Sirakorola area (less north, semi-humid; millet/cowpea and sorghum/cowpea associations both present). Each team was selected to ensure a balance between technical and social sciences, and between Malian and non-Malian members.

• A participatory appraisal was conducted by core teams in two villages at each research site between July 11-15. Appraisal activities were conducted with villagers in mixed groupings or differentiated on the basis of gender and age.

• Following the participatory appraisal, a synthesis meeting was held at Sotuba. Participating team members developed a ranking of crop-pest priorities. The table below describes the combined findings from the two field sites. The pests are listed in order of importance from left to right.

Most Important Crop	Most Important Crop Pest(s)		
millet/cowpea	blister beetles	grasshopper	*Striga*
sorghum/cowpea	grasshopper	blister beetle	*Striga*
groundnut (for women)	termites	millipedes	root worms
cowpea	bruchids (post-harvest pest control)		

• Based on these findings, on the recognized need to collect additional baseline information, and on need to support field monitoring activities, proposals were requested with budgets from all participating scientists. Nine were received. The Year 2 Workplan was largely derived from these proposals.

7. Upon the return of team members to the United States a trip report of workshop and field appraisal activities was drafted for review by participating team members. Simultaneously, a draft workplan for Year 2, with budget, was drafted by John Caldwell, Dan Taylor and Mark Erbaugh, and submitted to the IPM CRSP Management Entity by the end of July. Key activities to be supported in the Year 2 Workplan include completing a literature review of crop-pest priorities; follow-up baseline data collection at the research sites; installment of a field coordination and monitoring system; screening of technology by village level advisory councils; evaluation of blister beetle control measures; evaluation of grasshopper control measures; assessment of synergistic effects of several striga control measures; assessment of storage damage by pests; a participatory evaluation of sorghum varieties; and initiation of IPM CRSP activities at the sub-Saharan secondary research site in Uganda.

8. Rich Edwards, Purdue University, returned to Mali on August 23 - 28, 1994 to revise a research protocol for the testing of azadirachtin (neem), both as a crude extract and commercial formulation, against grasshoppers and blister beetles.

Additionally, research plans were developed for research station studies on various varieties of Baillus thuringiensis san diego against several insect pests. It was also suggested that future studies focus on population dynamics of raghuva, evaluation of the feasibility of developing a neem extraction plant in Mali, and evaluation of neem seed extractions made in Mali against key pests.

9. On September 15, 1994, Mark Erbaugh, Ohio State University, Dan Taylor and John Caldwell, Virginia Tech, attended a one day meeting at Virginia Tech with members of the Management Entity, Robert Hedlund, IPM CRSP Project Manager/USAID, and Walter Knausenberger, Africa Bureau/USAID, to discuss allocation of an African Bureau Buy-in to IPM CRSP activities in sub-Saharan Africa. It was agreed at this meeting that buy-in funds would be allocated to help establish an IPM Consultative Network for Africa; assist IPM CRSP start-up activities in Uganda; provide travel funds for an IPM CRSP representative to attend an NGO workshop on IPM to be held in Bamako, Mali in mid-October, 1994; and provide additional travel support for activities in Mali.

10. A second Technical Committee Meeting was held at Virginia Tech on September 16-17, 1994. The Mali Site was represented by Site Chair, Mark Erbaugh, Ohio State University and Vice Chair, Florence Dunkel, Montana State University. Activities conducted in Year 1 and the Year 2 Workplan and Budget for the Mali Site was presented to the group for discussion. Overall, the workplan was well received. Points that led to discussion were the need for a thorough literature review of past work on striga, the relation of palatability trials to IPM, ways to include Malians in future training activities, and the need to emphasize coordination of research activities with the Mali Site Committee.

Conclusion

The following Objectively Verifiable Indicators were achieved during the past year of activity by the IPM CRSP Mali Site:

- A commitment from stakeholders was obtained.
- Participatory appraisal teams were trained in the US and in Mali.
- The participatory appraisal process was used and results were documented.
- Results from the participatory appraisal were submitted to the site committee, management entity, USAID/Washington and Bamako.
- Results from the participatory appraisal are being incorporated into a data base.
- A functional site committee is in place.
- Priority crop-pest complexes, attempted solutions, and quick impact IPM tactics have been identified and will be implemented during the next year.

Only three of the indicators have not been fully achieved. First, quick impact IPM tactics have not been tested . The Mali Site Committee did not implement these because it was believed that they should follow and be derived from the field participatory appraisal. Second, a literature data base has been started, but not completed. Third, a baseline data base will be completed during the next year. It was decided to be a priority by the Site Committee to conduct a thorough baseline survey after the participatory appraisal.

In conclusion, Year 1 has witnessed the creation of a strong research network for IPM CRSP activities in Mali. Year 2 will build on this foundation by initiating the process of field, station and laboratory implementation of both short and long term IPM research.

ANNUAL REPORTS ON ACTIVITIES BY INVESTIGATORS

1. J. Mark Erbaugh, Rural Sociologist
International Programs in Agriculture
Ohio State University

I joined the IPM CRSP in late April, 1994 and was subsequently appointed Site Chair for the Mali Site. In mid-May, I visited the Virginia Polytechnic Institute and State University campus for two days of orientation meetings. Since I joined the IPM CRSP in mid-year, this trip proved to be extremely useful. It enabled me to meet with individuals from the Management Entity and the Mali Site, and it provide me with a rapid update on IPM CRSP procedures and progress.

In early June, I coordinated planning for an ensuing Participatory Appraisal Workshop and Field Participatory Appraisal, which was held in Mali in late June and early July. Activities included several extended telephone conferences and numerous electronic mail exchanges with other Mali Site Committee members. By the date of departure, we prepared a draft agenda for the Workshop and subsequent participatory appraisal field work. I also communicated with Dr. Samuel Kyamanywa, Makerere University/Faculty of Agriculture and Forestry, regarding his participation in the Malian activities.

On June 25, 1994, John Caldwell and I left for Mali. We were later joined by three other US based members of the Mali Site Committee and Robert Hedlund, IPM CRSP Project Manager, USAID/Washington and Dr. Kyamanywa, Makerere University, Uganda. We worked directly with counterparts in the Malian Institut d'Economie Rurale (IER). All major objectives were successfully completed during our four week stay in Mali. I participated in the following activities:

- A five day workshop on Participatory Appraisal methods for Integrated Pest Management (in conjunction, Makan Fofana, IER, prepared a presentation on the history and evolution of participatory appraisals for the workshop).

- Design and conduct a participatory field appraisal resulting in identification of priority crop-pest complexes (the field PA activity was conducted in 4 rural villages in which pest constraints were differentiated on the basis of geographical location, dominant crop(s), age and gender.

- Identification of activities and development of the Year 2 Workplan.

Before departing Mali, John Caldwell and I debriefed with IER and USAID/Bamako. Both organizations complimented us on the success of our field efforts. The Year 2 Workplan

was completed with assistance from John Caldwell, on the technical portion, and Dan Taylor, on the budgetary portion. I submitted a draft of the workplan to Virginia Tech by the end of July.

In September, I participated in a one day African Bureau Meeting and the IPM CRSP Technical Committee Meeting, in which Site Committee Chairs and Vice Chairs presented their Workplans for Year 2 to the group.

Following the Technical Committee Meeting, Dr. Kyamanywa and I initiated planning for a stakeholders meeting to be held in Uganda in early December. Uganda is designated as the satellite research site for the IPM CRSP in sub-Saharan Africa.

2. John S. Caldwell
Department of Horticulture
Virginia Tech

Summary

Caldwell worked as a member of the Mali site committee, reflecting his experience in Mali dating back to 1987. In October, November, and December 1993 he worked with other site committee members to develop initial plans of work for the site. He was a member of a three-person team from the U.S. side which planned and carried out with IER collaborators the initial stakeholders' meeting in Mali February 7-19, 1994. The stakeholders' meeting identified the priority zone and cropping system to focus initial IPM research on, and developed a plan for the participatory assessment (PA) workshop and field work. He participated in the first formal site committee meeting and IPM CRSP workshop held at Virginia Tech April 1994 and subsequent planning sessions to refine PA plans. He was a member of the PA team in Mali June 2 & July 24, 1994, serving as overall facilitator for the training workshop preceding the field PA and synthesis sessions following it, and as a team member in the field PA. He incorporated PA material into a course on farming systems research and development taught fall 1994. Caldwell contributed 27% of his time to the IPM CRSP during program Year 1.

Initial Site Committee Planning

In October 1993, an initial meeting was held at Virginia Tech of U.S.-based co-principal investigators and national program representatives from some of the four principal sites. Following those meetings, in November and December a group of Virginia Tech faculty met several times to develop the site workplan and logical framework for Year 1 and the first five years of the IPM CRSP. Caldwell participated in both the October meeting and the subsequent planning, providing information and suggestions based on his experience in Mali.

Stakeholders' Meeting

Caldwell was one of three U.S.-based co-principal investigators (also Rich Edwards, Purdue University; Dan Taylor, Virginia Tech) who worked with IER colleagues in Mali

from February 7-19, 1994, to identify stakeholders, hold an initial stakeholders' meeting, and plan activities of the IPM CRSP in Mali for the initial five years of the project. Caldwell served as facilitator for the stakeholders' meeting held February 14, 1994. Fifteen representatives of IER, the crop protection service Service National de Protection des Vegetaux (SNPV), the extension organization Operation Haute Vallee du Niger (OHVN), Care International, and ICRISAT participated in the meeting. The stakeholders' meeting decided upon the Operation Haute Vallee (OHV) Zone as the initial region for IPM CRSP research and developed a ranking procedure which identified sorghum / cowpea and millet / cowpea associations as equal in importance. The stakeholders' meeting decided to begin with the sorghum / cowpea association in the first two years, and to add the millet-cowpea association from Year 3, expanding into the Segou region. Plans were also developed for a workshop on participatory assessment (PA) methods and a field PA in July.

The stakeholders' meeting was more heavily weighted towards IER researchers in Bamako and to cereals than had been envisioned. This probably was due to the team having only one week to prepare for the stakeholders' meeting, rather than two weeks as had originally been proposed. With an additional week, it might have been possible to visit more NGO's and well as persons in private sector (such as pesticide marketing), arrange for participation by representatives from research stations outside Bamako, and include researchers working on other crops, particularly those important for women producers, groundnut and horticultural crops.

During this visit, information was obtained on current IPM research and extension in Mali. This included IER research on resistance to meloides *(Psyladolytta fusca* and *P. vestida)* and *Heliocheilus albipunctella* (formerly *Raghuva albipunctella);* ICRISAT research on sorghum pests, indigenous methods of sorghum pest control, striga, grain borers *(Rhizopertha dominica),* stem borers *(Busseola fusca* and *Sesamia calamistis),* and head bugs *(Eurystylus* spp.), and predators and parasitoids in a cotton-sorghum-groundnut-fallow rotation. Information on extension materials and programs was obtained from OHVN, Peace Corps, SNPV, and the InterState Committee for the Fight Against Desertification in the Sahel (CILSS). Contacts were also established and information was obtained on the activities of three other CRSP's operating in Mali: Bean-Cowpea CRSP, Peanut CRSP, and Tropsoils.

Literature was reviewed and copies made of all or portions of 36 documents on IPM research and extension conducted in Mali from 1982 to the present by IER, SNPV, CILSS, ICRISAT, and the U. S. Peace Corps. An annotated bibliography of IER documents was begun using this material.

Information was obtained on three sets of data gathered by DRSPR, the farming systems research department of IER. Analysis of pest monitoring data taken between 1989 and 1992 for sorghum, cowpea, millet, maize, rice, groundnut, soybean, and sesame showed that chemical control was used only occasionally for bird control, and was not used at all over a total of 245 farmyears for post-germination, pre-harvest insects or disease on any of the above food crops. Grasshoppers and blister beetles had moderate effects on millet. Diseases had moderate-strong effects on groundnuts. Effects of insects and diseases on the other crops were light to light moderate only. Bird damage affected more plants for most crops than did insects and diseases. A computer program for the analysis of data obtained in 1993 by the same monitoring system was developed and provided to DRSPR. The data were most complete for 1989 and 1990, but time was inadequate to determine the causes of the gaps, or to work with the other two data sets.

Recommendations were made to conduct a survey of natural enemies, alternate hosts, and surrounding ecosystems for major pests in the OHVN Zone; study the effect of the removal of several grasses in July, August, and September on populations of the sorghum pests *Contarinia* spp. and *Geromyea penniseti;* examine the effectiveness of neem for sorghum and millet pest control and the economic potential for establishing a neem extraction plant in Mali; obtain additional information to determine the value of a supplemental mini-PA and supplemental funding for IPM for horticultural crops; request occasional assistance by a Peace Corps volunteer for the PA and subsequent work; develop stronger linkages between DRSPR and SNPV for onfarm research; develop an annotated bibliography of previous pest, disease, and weed control research in Mali; and strengthen participation by IER and the IPM CRSP in regional IPM conferences and electronic networking.

Initial Site Committee Meeting. Participatory IPM Workshop, and PA Planning

The Mali site committee had its first formal meeting during the workshop, "Integrated Pest Management in Participatory Framework," held at Virginia Tech, April 6-9, 1994. Caldwell was a participant in the workshop, served as a facilitator for the workshop's field activity, and participated in the site committee. The workshop was attended by 47 participants representing 21 institutions from 6 countries, including the two Malian co-principal investigators. The site committee meeting refined plans for the PA and developed a plan of work for preparation of materials to use in the PA workshop.

Following the workshop, Caldwell participated in three telephone conference calls of site committee members, a follow-meeting at Virginia Tech with the site committee chair, and meetings among Virginia Tech site committee members to prepare PA materials. Caldwell's graduate student Jean-Pierre Amirault, who is from Quebec, bilingual in French and English, and supported partially by the IPM CRSP, also participated in the April workshop and subsequent meetings. Based on the decisions made by the site committee, Amirault adapted material in English for use in French in the PA workshop.

PA Training Workshop. Field PA, and Workplan Development

An interdisciplinary team of six researchers from outside Mali (Caldwell, Dan Taylor, and Revathi Balakrishnan, Virginia Tech; Mark Erbaugh, Ohio State University; Florence Dunkel, Montana State University; Sam Kyamanywa, Makarere University, Uganda) collaborated with IER researchers to complete planning, conduct the PA workshop, and carry out the field PA in four villages, to determine through a farmer-participatory process IPM research priorities for Mali for program Year 2. Initial discussions with IER led to a change in the focus of the PA to millet / cowpea-based systems, instead of sorghum / cowpea-based systems. The change was made based on a meeting of IER researchers held after the February stakeholders' meeting to focus the resources of the IPM CRSP on the former system for which fewer research results had been obtained previously. In this final planning stage, a planning team of the above researchers and three IER colleagues (Amadou Diarra, Makan Fofana, and Mme. Sissoko Haoua Traore) first finalized topics and the schedule for the workshop. The planning team then divided up, and Caldwell, Erbaugh, and Fofana worked with extension colleagues to make the final selection of villages for the PA, while the other members completed workshop preparations.

In the one-week PA workshop, Caldwell served as overall facilitator. In the initial 3 1/2 days with a larger group of 25 participants, 12 priority information needs for IPM (6 biophysical and 6 socio-economic) were selected by participant voting from 43 types of information needs given by participants. The three most useful PA methods for each of the 12 information needs were identified by participant voting from a list of 12 key methods that were presented by Malian and U.S.-based resource persons working in pairs.

Participants were then divided into four groups for PA simulation of the three methods chosen for four information needs: types of pests, pest control measures, land management, and village organizations. In the remaining 1 1/2 days, a 16-person core PA team established a four-step process and methods for obtaining information on seven information needs, drawing from the workshop results.

The 16-person core PA team divided itself into two teams of eight persons each, one for the Mourdiah area (more north and semi-arid; millet-cowpea association dominant) and the other for the Sirakorola area (less north, semi-humid; millet / cowpea and sorghum / cowpea associations both present). Each team was balanced for technical and social sciences, as well as between Malian and non-Malian members. Caldwell participated in the Mourdiah field team.

During the weekend between the workshop and the actual PA field work, Caldwell organized Bambara lessons using PA materials for four U.S.-based team members. This provided members new to Mali with basic greetings and some key agricultural terms, as well as enabled Caldwell and Dunkel to conduct interviews with women farmers directly in Bambara.

Each PA field team visited two villages in their respective regions. The Mourdiah team spent two days in each village, Koira and Douabougou. The principal methods used by the team were historical profiles, matrix ranking, preferential ranking, resource mapping, and Venn diagrams. Caldwell was paired with Dunkel and Moussa Sissoko, SNPV, for interviews with women farmers in both villages. Caldwell and Dunkel developed and tested with Sissoko visual techniques of on-site drawings for constraints ranking with the women farmers.

Caldwell also served as facilitator for the synthesis sessions which followed the field PA. Based on the PA results from all four villages, blister beetles, grasshoppers, and striga on millet and sorghum of men and women farmers were identified as the priorities for IPM research in the IPM CRSP Year 2 workplan. Erbaugh and Caldwell wrote an initial draft of the workplan based on these priorities synthesized by the whole team.

In addition to the priority cereal pest problems that the workplan will address, several pest problems on women's groundnut were ranked relatively high, and garden crop and fruit pests were also important for women. Caldwell visited the horticulture unit at Baguineda, near Bamako, to obtain information on their IPM work. The horticulture unit subsequently sent a draft proposal for research on horticultural IPM, and Caldwell prepared an English version drawing from their proposal and the visit. This might be basis for seeking supplemental funding for IPM research not included in the workplan, to reduce widespread misuse of pesticides, assist in identification of beneficial insects (11 have already been identified by the unit) of horticultural crop pests, and develop IPM strategies for horticultural crop pest problems identified by farmers.

Incorporation of PA Results and Methods into Teaching

Caldwell incorporated both results and methods from the PA in the course, "Farming Systems Research and Development," which he is teaching fall 1994. The historical profile at Douabougou was presented an example of agricultural evolution in which pest problems have increased as a result of loss of diversity in the agro-ecosystem. This example provided a contrasting perspective with the course's text. An example of multi-generational women's labor use in groundnut fields obtained during constraints ranking with women farmers in the same village was compared with another informal survey example and an anthropological study, each representing different villages in Mali. The actual drawings developed and used by Caldwell and Dunkel with women farmers were demonstrated in the class methods laboratory, and other PA methods used in the workshop were explained. The students modified some of these visual techniques for their own surveys with farmers in counties around the university.

3. C. Richard Edwards
Department of Entomology
Purdue University

3.1. Identify stakeholders and participants and obtain commitments

J. Caldwell, C. R. Edwards, and D. Taylor traveled to Mali in February 1994 to hold a stakeholders meeting and to obtain commitments for the project. Meetings were held with the Malians and other interested groups and the plan of work and budget for the first year were developed. Plans were also made for the participatory assessment (PA) which was scheduled for July 1994 (the PA was conducted in July 1994).

A general outline for the five years of Phase 1 was developed. Additionally, fourteen recommendations were made based on discussions held prior to the trip and during deliberations in Mali. The recommendations were as follows: 1) A thorough survey of natural enemies (predators, parasites, and pathogens) should be conducted in the early phase of the program in the OHVN Zone; 2) A survey should be made for alternate hosts of the principal pests, to identify possible phenological indicators and alternate control strategies; 3) Studies on the population dynamics of pests and beneficial species should be undertaken if data are lacking for a particular organism; 4) A request should be made to the Peace Corps for technical assistance in the villages; 5) Consideration should be given to harmonizing the work of the SNPV and DRSPR, to enable these government organizations to work together on research and implementation; 6) Consideration should be given to establishing a neem pilot production plant in Mali, if the neem research tests provide positive results against key pests; 7) The results of DRSPR on-farm trials with horticultural crops, and monitoring of the incidence of diseases and insects in those trials, should be carefully reviewed; 8) A study should be conducted to evaluate the effect on populations of *Contarinia* spp. and *Geromyia penniseti* and damage to sorghum of the removal in July and August of the grasses *Bracharia hagenupii*, *Panicum subalibidum*, *Echinochloa colonum*, *Setaria pallidefusca*, and *Brachiaria stigmatisata*, and the removal in September of *Pennisetum* spp. from sorghum fields and border areas, building on results by Y. Doumbia; 9) IER should develop an annotated bibliography of all insect, plant pathogen, and weed work conducted in Mali; 10) The IPM CRSP should be presented at the IPM

conference in Dakar, Senegal in March/April 1994; 11) IPM CRSP and Bean Cowpea CRSP personnel should work together to conduct insect control trials in stored cowpeas based on technology developed by Bean Cowpea CRSP personnel in Cameroon; 12) The in-country coordinator for the IPM CRSP should be able to send and receive E-mail messages; 13) Malian participants in the IPM CRSP Workshop at Virginia Tech should attend the IPM workshop in Las Vegas, if it can be arranged; and 14) All researchers in the IPM CRSP should be linked to U.S. and international IPM networks.

3.2. Establish quick impact research trials

The framework for quick impact trials was established during the February meeting in Mali. Discussions were held concerning insect pest feeding studies in the laboratory on *Bacillus thuringiensis* san diego against blister beetles. Also, discussions were held concerning the testing of azadirachtin (neem), both as a crude extract and commercial formulation, against grasshoppers and blister beetles. Additionally, various mechanical mechanisms for managing the cowpea weevil in cowpeas were also discussed and slated for testing. There was also some discussion related to the testing of insecticidal soaps as insect control agents.

After considerable discussion relative to quick impact studies at the February meeting, it was decided to test a commercial preparation of azadirachtin (Azitin®) in the field against blister beetles and raghuva, a lepidopterous insect pest of the millet head. Additionally, it was decided to look at several varieties of Bt in the laboratory against some of the more common insect pests of sorghum and millet. These tests were to have been conducted in September 1994.

In Late August, C. R. Edwards returned to Mali to discuss the upcoming trials that were to be conducted in September 1994. Madame Toure, Entomologist, Sotuba, had drafted a research protocol for the testing of Azitin against blister beetles and raghuva. The protocol was reworked by Edwards and Madame Toure's technician (Madame Toure was away at a conference) during the August visit. The test was to have been conducted in September. Additionally, research plans were developed for research station studies on Azitin against various pests and on various varieties of Bt against several insect pests. It was also suggested that future studies should be enacted to study the population dynamics of raghuva, to evaluate the feasibility of developing a neem extraction plant in Mali, and to evaluate neem seed extractions made in Mali against key pests.

3.3. Graduate student program

A plan of study for a graduate student in pest management was developed, based on conversations with IER officials, during the September visit to Mali. It was decided that the M.S. student should come to Purdue University to take his/her coursework and then return to Mali to conduct his/her research. The individual would return to the U.S. to defend his/her thesis. This person will begin his/her graduate training in the Fall of 1995.

4. Revathi Balakrishnan, Program Director, WID
Office of International Research and Development
Virginia Tech

Gender Analysis and Social Sciences

4.1. Organizing Workshop on "Integrated Pest Management in a Participatory Framework".

Dr. Balakrishnan chaired the workshop planning committee. She coordinated the planning and implementing of the workshop held in April 1994. The workshop was focused on Integrated Pest Management using participatory research tools. It was the first step in the development of common approaches among IPM CRSP collaborators for conducting IPM research in various parts of the world. The best existing examples of IPM (which contain participatory elements) and the best participatory research approaches were both presented. The workshop explored conceptual underpinnings of IPM and of participatory research approaches, to integrate the most useful aspects of different methodologies for improved Integrated Pest Management and engaged in hands-on application of certain rapid appraisal methodologies to IPM issues in a field visit with Virginia farmers and community leader. Through the active involvement of the workshop participants, elements from existing IPM programs and participatory research approaches were integrated into site plans for each of the four primary sites of the IPM CRSP. Workshop participants were included representation of disciplines needed to implement the IPM CRSP, research site countries, and collaborating institutions.

The workshop was attended by 47 participants representing 21 institutions from 6 countries. They were participating scientists, graduate students, invited resource persons, scientists from other CRSPs with inter-CRSPing interests, and representatives from National Research Centers, Non-Government Organizations and USAID. It was a multi-disciplinary gathering that facilitated exchange of ideas related to IPM and participatory approaches.

The last two days of the workshop were devoted to a Technical Committee meeting.

4.2. Preparation of workshop report.

Dr. Balakrishnan prepared the technical report for the workshop on "Integrated Pest Management in Participatory Framework". This report was distributed to the workshop participants, IPM CRSP Board members and PIPM CRSP technical committee members.

4.3 Participation in Mali PA training workshop. field PA Research and workplan development.

Dr. Balakrishnan participated in planning the workshop with Malian counterparts from IER/Farming Systems research group scientists. and the U.S. Mali Site team. It was followed by participation in PA methodology workshop of Malian and U.S. Mali team scientists. The workshop was attended by Malian scientists representing various Government agencies, Extension program and National Research projects. The workshop focused on learning about PA methods, hands on experience on PA methods by role playing, discussion on information needs and identification of appropriate PA tools for the information needed.

Dr. Balakrishnan participated in PA in two villages with Mali scientists and U.S. scientists, including the IPM Project Manager of USAID. The PA results are being written up by the Mali Scientists. Two women's groups were interviewed using PA tools to identify their knowledge of pests and control methods.

The synthesis session and workplan development session focused on prioritizing research areas both in social science and bio-physical areas based on the information gathered from the field PA. The exercise resulted in the development of workplan for the year 1994-95.

4.4. Developing resource base on PA methods and gender analysis and gender variables in IPM research and out reach

This process is continuous. Dr. Balakrishnan identifies and collects resource materials, both published and unpublished, that focus on PA methods and IPM in Participatory mode. Efforts are also in progress to identify audio-visual materials that focus on PA approaches and IPM in PA mode. These are important resources to provide technical support to the scientists on IPM in PA Mode.

5. Dan Taylor
Department of Agricultural and Applied Economics
Virginia Tech

Created IPM CRSP listservers for the four prime sites and continue maintainence of them.

Attended both CRSP workshops at Virginia Tech in their entirety, including time spent working with Drs. Maiga and Diarra at the second workshop to plan PA activities.

Early in the year, traveled to Mali to initiate CRSP activities, hold a stakeholders meeting, and to plan for first-year field and laboratory trials, to plan for the PA, and to form tentative plans for the next four years of the CRSP.

In mid-year, again traveled to Mali to train for, and to conduct, the PA in four villages in two agroecological zones. Crops and pests were prioritized and field trials were suggested for this year's cropping season.

Discussed the details of the Africa Bureau's non-competitive grant to Virginia Tech for IPM work in Africa in a meeting with other interested parties.

Attended the National Integrated Pest Management symposium. Please see my two trip reports and the field work report[1] for additional information about my activities.

Helped to develop the first and second year workplans and budgets for the African sites.

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[1] Forthcoming; Makan Fofana at DRSPR is taking leadership in preparing this report.

PHILIPPINES

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PHILIPPINES PRIME SITE ANNUAL REPORT

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

1. *Planned activity: Identify stakeholders and participants and obtain commitments.*

   Progress: Stakeholders and network participants were identified and commitments obtained from both institutions and individuals. An MOU was signed between the IPM CRSP ME and the Department of Agriculture in the Philippines. PhilRice and USAID were co-signatories to the MOU. Stakeholders meetings were held in the Philippines from March 7-12 with the participation of PhilRice, UPLB/NCPC, IRRI, AVRDC, FAO, USAID, Virginia Tech, and Penn State. A site for field work was identified in San José, Nueva Ecija in the Central Luzon in which research will be conducted in six villages. Farmers and their families, a local cooperative, city agriculturalist, Landbank, Barangay captains and councils, policy makers in the Department of Agriculture, National Association of Onion Growers, chemical companies, seed companies, and Fertilizer and Pesticide Authority were among other stakeholders identified and visited. The SANREM CRSP site at Bukidan was also visited as IPM is important for sustainable agriculture. Ohio State is also committed to the Philippine site.

   At the urging of AID, stakeholders meetings were held in Thailand with the Department of Agriculture, the Rice Research Institute, Kasetsart University, Chaing Mai University, IRRI, AVRDC, Virginia Tech, Penn State, and USAID. Enthusiasm was strong and even Prince Bhisa Rachanee (a member of the royal family of Thailand who chairs the Royal Development Project that includes development of alternatives to narcotic crops) committed to the project. However, commitments had to be broken when AID decided not to allow the IPM CRSP to work in Thailand because of the closing of the USAID Mission there. One person from the Department of Agriculture in Thailand has committed to participate in IPM CRSP activities in the Philippines so as to bring approaches back to Thailand.

2. *Planned activity: Diagnosis and planning for participatory appraisal*

   Progress: Secondary information was gathered on pest management programs in the Philippines, and at the stakeholders meetings in March a decision was made to focus on vegetable IPM within the rice-based cropping system around San José. Preliminary crops and pests were identified. At the April workshop at Virginia Tech, a plan was developed to conduct research in six villages around San José. A baseline survey was developed and administered to 300 farmers to obtain information on pests and pest management practices. Results of that survey were reported on in preliminary fashion at the PA in July and summarized in the July trip report.

3. *Planned activity: Summarize results of diagnosis and recommend a PA process*

   Progress: A schedule for the PA was developed and materials on PA methods related to IPM prepared. The team was assembled consisting of 3 members from Virginia Tech, 2 from Penn State, 1 from AVRDC, and several from PhilRice, IRRI, and UPLB/NCPC.

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4. *Planned activity: Conduct participatory appraisal activities*

Progress: The planned set of participatory appraisal activities took place in the Philippines July 8-23. A detailed trip report is available, but briefly the PA consisted of three related activities. First, an organizational meeting/workshop was held (25 people in attendance) in which the results of the baseline survey were presented, PA methods were presented and discussed, and the logistics of the PA worked out. Secondly, PA activities were conducted over a week's time in which farmers in all six villages were interviewed using PA methods. Interviews were also conducted at local co-ops, the Landbank, a local hospital to check on levels of pesticide poisonings, the city agriculturalist, agricultural extension workers, Barangay captains and counselors, pesticide dealers, assistant secretaries in the Department of Agriculture, the National Economic Development Authority, AVC Chemical Corporation, USAID, National Onion Growers' Cooperative, Philippine Institute of Development Studies, and elsewhere. Extension information was gathered on the villages, farm sizes, soil type/land forms, cropping patterns/seasonal calendars, crop constraints, major crops and pests, pest management practices, yields, prices, and institutions and institutional constraints related to marketing, credit, land tenure, sources of information, gender roles, labor use, policies affecting pesticide prices, pesticide regulations, pesticide poisonings, etc. Each day we gathered information and also met among ourselves to summarize, develop research hypotheses, etc. The third major activity was a research planning workshop at the end of the PA. After the crops and pests were prioritized, working groups prepared specific research plans which were discussed by the whole group and budgets were prepared.

5. *Planned activity: Establish community advisory committee*

Progress: The committee was established with the following make-up: 1 Barangay captain, 4 farmers (2 male, 2 female), 1 city agriculturalist, 1 Barangay counselor, 1 Landbank person, 1 trader/dealer, 1 NGO representative, 1 DA technician, and 1 cooperative representative.

6. *Planned activity: Analysis of policy alternatives, social/gender implications, pest ecology, and disease epidemiology*

Progress: Data collected during the PA are being analyzed to assess the degree of tax or subsidy to pesticide use. A second survey has been prepared that focuses of socio/economic factors that may influence pest management practices. Additional PA activities were conducted in the Philippines by our gender specialist. Pest ecology and disease epidemiology work is underway.

7. *Planned activity: Collaborate with existing IPM programs to provide short-term outputs*

Progress: Some of the activities underway should provide short-term outputs; for example, the work assessing the impact of straw mulch on disease incidence in rice-vegetable systems. Also the basic surveillance activities underway should yield recommendations during Year 2 that will result in reductions in pesticide use.

PHILIPPINES COUNTRY REPORT

V.P. Gapud (Country Coordinator) and B.L. Canapi (Research Asst.)
PhilRice

I. PRELIMINARY SURVEY OF INSECTS OF ONIONS, EGGPLANT AND STRING BEANS IN SAN JOSE, NUEVA ECIJA

A preliminary survey of insect pests and their natural enemies in onions, eggplant and string beans was conducted in August-September, 1994 in two of the IPM CRSP barangay sites, Abar 1st and Palestina, in anticipation of the planned research activities for 1994/95 (Year 2). Onions were grown off-season for their leaves in Abar 1st up to mid-September. A few eggplant fields remained standing in Palestina up to end of August. Stringbeans were grown the longest and remained through September in Palestina. The insects and their associated natural enemies observed during these months will be compared with those which are expected to occur during the vegetable growing period, November-May, the dry season part of the year in Central Luzon.

Adult insects from these crops were observed and collected, preserved, mounted, sorted and identified. Immature forms and their associated plant parts were collected and kept in separate petri plates and/or test tubes, and reared into their adult stages. Parasitoids which emerged from them were preserved and mounted on pins. Representative specimens of each species were preserved in 70% ethyl alcohol. All tentative species identities are accompanied with an asterisk (*).

A total of 23 insect pests have been observed on onions (1), eggplant (11) and stringbeans (12), with *Spodoptera litura* occurring on both onions and stringbeans. Six species of natural enemies (4 Insect predators, 2 parasitoids) of eggplant insect pests were encountered, while 5 species (3 insect predators, 2 parasitoids) were observed for stringbean insect pests. As indicated in the inventory, some of these species show potential for biological control. Manipulation of field populations of natural enemies will be studied as opportunities arise.

A. INSECT PESTS OF ONIONS

1. *Spodoptera litura* Fabricius - (Lepidoptera:Noctuidae) common cutworm; a polyphagous pest, its larvae are voracious leaf feeders.

B. INSECT PESTS OF EGGPLANT

1. *Leucinodes orbonalis* Guenee (Lepidoptera:Pyralidae) - fruit/shoot borer; most serious pest of eggplant; as many as 5 larvae in one fruit; larvae occurring as early as 4 to 6 weeks after transplanting, reaching peak density at fruiting stage. Field was very high, more so with frequent insecticide application. Many farmers refrained from growing eggplant because of this pest.

2. *Henosepilachna vigintioctopunctata* Fabricius (=*Epilachna philippinensis* Dieke) Coleoptera:Coccinelildae - 28-spotted ladybird beetle; leaf feeding habit results in skeletonized leaves; both larvae and adults feed on leaves; field population low due to heavy larval/ pupal parasitism.

3. *Amrasca biguttula* Shiraki (Homoptera:Cicadellidae) - cotton leafhopper; field population increases as plants grow older; leaves curl up under heavy infestation.

4. *Aphis gossypii* Glover (Homoptera:Aphididae) - melon aphid; scattered in colonies underneath leaves, tended by ants; low field population perhaps due to coccinellids.

5. *Ferrisia virgata* Cockerell (Homoptera:Pseudococcidae) - grey mealybug; scattered in colonies underneath leaves; population very low, likewise tended by ants.

6. *Agrotis ipsilon* Hutnagel (Lepidoptera:Noctuidae) - cutworm; not common during sampling period.

7. *Leptocentrus manilaensis** Funkhouser (Homoptera:Membracidae) - common treehopper; phytophagous but a very minor pest, occurring on many crop plants; feeds on young twigs.

8. *Bemisia tabaci* Gennadius (Homoptera:Aleyrodidae) - whitefly; in low numbers, underneath leaves.

9. Undetermined lepidopterous leafminer - low numbers, no Philippine record of this species.

10. Undetermined ants - tending aphids and mealybugs.

11. *Nisia nervosa* Motschulsky (Meenopildae) - higorold; minor pest, feeding on twigs and shoots; occurrlng in low numbers.

C. INSECT PESTS OF STRINGBEANS

1. *Maruca testulalis* Geyer (Lepidoptera:Pyralidae) - bean podborer; most serious pest of stringbeans; larvae, when young, bore into buds, flowers and young pods, when older, concentrate on pods, making entrance holes near base or half the length of pod; entrance hole readily detected by mass of excrement around it and meshed with a leaf by silken threads spun by larva; damaged pods of no economic value (for home consumption only).

2. *Ophiomyia phaseoli* Tryon (Deptera:Agromyzedae) - beanfly; serious at seedling stage for stringbeans; maggots mine into leaves, creating darkened mines, extending to stem above root stock at high densities, resulting in stunted plants. Low population in standing crops, which are at fruiting stage.

3. *Spodoptera litura* Fabricius (Lepidoptera:Noctuidae) - common cutworm; common leaf feeder but low population.

4. *Stomopteryx subsecivella** Zeller (Lepidoptera:Gelechiidae) - bean leaf- miner; larvae create mines, leaving epidermal cells almost transparent and larvae visible; mature larvae turn reddish; minor pest, parasitized by a larval parasitoid.

5. *Lamprosema indicata** Fabricius (Lepidoptera:Pyralidae) - bean leaf folder; minor pest.

6. *Chrysodeixis chalcites* Esper (Lepidoptera:Noctuidae) - bean semi-looper; makes irregular patches on leaves; minor pest.

7. *Aphis craccivora* Koch (Homoptera:Aphididae) - black bean aphid; occurring in colonies on young leaves, shoots, blossoms and young pods, and cause leaf curling and pod distortion at high densities; preyed upon by coccinelilds and syrphids.

8. *Nezara viridula* Linnaeus (Hemiptera:Pentatomidae)- green soldier bug; a common pest, serious only at high densities; nymphs and adults feed on bean pods.

9. *Piezodorus hybneri* Gmelin (Hemiptera:Pentatomidae) - green stinkbug; occasional pest; nymphs and adults feed on pods.

10. *Empoasca* spp. (Homoptera:Cicadellidae) - bean leafhopper; minute green leafhoppers occurring in moderate numbers; minor pest comprising two species, *E. terminalis* Distant and *E. ricei* Dworakowska, but can cause curling of young leaves when occurring in high numbers.

11. *Ferrisia virgata* Cockerell (Homoptera:Pseudococcidae) - grey mealybug; occurring in colonies underneath leaves, twigs; minor pest.

12. Undetermined thrips (Thysanoptera) - on blossoms; probably of little economic importance.

D. NATURAL ENEMIES OF INSECT PESTS OF EGGPLANT

1. *Cotesia* sp.* (Hymenoptera:Braconidae) - numerous cocoons spread along upper leaf surfaces were collected for adult emergence; lepidopterous host has not been determined.

2. *Pediobius* prob. *flaveolus** Crawford (Hymenoptera:Eulophidae) - many adults emerged from collected pupae of *Henosepilachna vigintioctopunctata* Fabricius; out of 40 pupae, 34 were parasitized; very promising biological control agent.

3. *Coelophora inaequalis* Fabricius (Coleoptera:Coccinellidae) - larvae and adults preyed on *Aphis gossypii* Glover.

4. *Menochilus sexmaculatus* Fabricius (Coleoptera:Coccinellidae) - larvae and adults preyed on *Aphis gossypii* Glover; more common than *Coelophora inaequalis.*

5. *Campylomma livida* Reuter (Hemiptera:Miridae) - predacious on nymphs of *Amrasca biguttula* (Shiraki); low populatlon during sampling.

6. *Geocoris ochropterus* Fieber (Hemiptera:Lygaeidae) - prey not observed, but known to feed on aphids and mealybugs; further observations for prey will be pursued.

E. NATURAL ENEMIES OF INSECT PESTS OF STRINGBEANS

1. *Rhynchium* sp. (Hymenoptera:Eumenidae) - an adult was observed probing through an entry hole of bean podborer larva; eumenids are known to gather lepidopterous larvae for food provision of their larvae.

2. *Menochilus sexmaculatus* Fabricius (Coleoptera:Coccinellidae) - both larvae and adults observed feeding on *Aphis craccivora* Koch.

3. Undetermined eulophid - several adults observed emerging from collected larvae of *Stomopteryx subsecivella* (bean leafminer); solitary parasitoids; a potential biological control agent against this pest.

4. *Ischiodon scutellaris* Fabricius (Diptera:Syrphidae) - larvae fed on *Aphis craccivora* Koch.

5. Undetermined braconid (probably *Cotesla*) - several adults emerged from collected larvae of *Lamprosema indicata* (bean leaffolder).

II. INSECT PHEROMONES

Insect pheromones were sent by Dr. N.S. Talekar (AVRDC) for determination of occurrences of *Spodoptera* species. They were set up in stringbean and onion fields in Barangay Palestina in late August. A series of pheromone formulations sent for testing against the eggplant shoot/fruitborer, *Leucinodes orbonalis* Guenee, was placed in eggplant Quads.

Based on the *Spodoptera* pheromones, only *Spodoptera litura* was found to occur in the sampling site, both on onions and stringbeans, with more catches on beans. Pheromones for *Spodoptera exigua* had no catches. The *exigua* pheromones will be tested again during the onion growing season.

The pheromone formulations for *Leucinodes* gave interesting results. While some formulations caught a few *Leucinodes* adults (A1, 8), other formulations (As, B3) caught *Spodoptera litura* in the eggplant field. Moths of an undetermined leaf-feeder were also attracted to some formulations. These formulations will be tested again in more eggplant fields during the vegetable growing season.

III. VISIT OF DR. REVATHI BALAKRISHNAN

Dr. Revathi Balakrishnan, Director, Women in International Development, visited IRRI and UP Los Baños on 24-26 September to discuss the gender component of the IPM CRSP project. She was accompanied by Ms. Irene Tanzo, social science researcher of PhilRice who will participate in the gender research of IPM CRSP. Dr. Victor Gapud, Site Coordinator for the Philippines and Mr. Bernard Canapi, Research Assistant for IPM CRSP, joined her in UP Los Baños and met with some UPLB gender researchers. Dr. Roquia, Coordinator for the UPLB Gender Program, briefed Dr. Balakrishnan on the on-going activities of UPLB's program, together with Dr. Agnes Rola of Center for Policy and Development Studies (CPDS), UPLB.

The group proceeded to PhilRice, Maligaya, Munoz, Nueva Ecija on 27 September. The group visited the site for three consecutive days to gain insights on how to incorporate the gender component into the project. Discussions were facilitated with some social science researchers of PhilRice, Dr. Segfredo Serrano (division head) and Ms. Tanzo, as well as other interested PhilRice staff. Dr. Balakrishnan informed the group that she will send her comments and suggestions to PhilRice in November.

IV. PREPARATIONS FOR RESEARCH ACTIVITIES FOR YEAR 2

In anticipation of the research activities for Year 2 1994/95, consultations among concerned researchers and with barangay officials and farmers in the three barangay sites (Sto. Tomas, Abar 1st and Palestina) have begun. In retrospect, the activities lined up for the second year are:

1. Surveillance of arthropod disease and weed pests and natural enemy occurred within and between the crops in rice-vegetable systems in San Jose, Nueva Ecija.

Start: September 1994 Completion: October 1995 (Phase 1)

Outputs:

- checklist of arthropods in rice-vegetable cropping system
- list of natural enemies of both crops
- graphs and descriptions of seasonality of pests and natural enemies in the cropping cycle
- report on how arthropods move among habitats
- report on how cultural practices carried out in one crop affects pest and natural enemy abundance in the following crop
- description of management practices that will sustain natural enemy abundance through cropping cycles
- description of management interventions based on surveillance knowledge to impact pesticide use in the first year

Comments: A preliminary survey of insect pests and their natural enemies was conducted in August-September 1994 to provide initial information on what pest complexes and natural enemies would likely be encountered during the vegetable growing season in November-May. A report of this survey is presented in the preceding section (I). Except for onion insect pests, those on eggplant and stringbeans are now known. Monitoring of weeds will begin in October and of diseases in November.

2. Determine the potential for the use of Nuclear Polyhedrosis Virus (NPV) and *Bacillus thuringensis (Bt)* for *Spodoptera* control in onions and stringbeans.

Start: October 1994 Completion: October 1997 (sooner for preliminary results)

Outputs:

- o report on evaluation of usefulness of commercial preparations of NPV and Bt against *Spodoptera*
- o report on formulations and dosages for *Spodoptera*
- o recommendations for initial field trials In San Jose test sites

Comments: Research activities will be conducted by Dr. N.S. Talekar (AVRDC), backstopped by Dr. L. Padua (UPLB).

3. Development of mass rearing methods for *Maruca* pod borer and eggplarn shoot and fruit borer.

Start: October 1994 Completion: October 1996

Outputs:

- o artificial rearing protocols for *Maruca* pod borer an eggplant shoot and fruit borer
- o design of rearing facilities for Philippine site for insect pests of rice and vegetables

Comments: These activities, to be done in AVRDC under the supervision of Dr. Talekar, will involve a Ph.D. student from the Philippines. So far, only Mr. Pablito Gonzales has applied. Mr. Gonzales is conducting studies on mass rearing of *Trichogramma* species at UPLB (NCPC). If Mr. Gonzales is acceptable to Dr. Talekar, he will spend at least a year in Taiwan to train in the development of mass rearing techniques for *Maruca* and *Leucinodes* for a Ph.D. dissertation. He can be fielded in late November 1994.

4. Determine the extent and impact of diseases carried over within rice-vegetable rotational systems.

Start: October 1994 Completion: October 1997 (sooner for preliminary resluts)

Outputs:

- o major diseases affecting both rice and vegetables
- o carry-over potential in various rotations
- o control/management procedures for major diseases

5. Impact of straw mulch on disease incidence In rice-vegetable systems.

Start: October 1994 Completion: October 1997 (sooner for preliminary results)

Outputs:

- o report on role of straw mulch as a cultural practice in disease dynamics in rice-vegetable systems
- o suggestions for disease management in mulched systems
- o analysis of agronomic, plant pathogenic and economic costs and benefits of mulching

Comments: The PhilRice pathology group has met to discuss the workplan for this activity. The workplan is being refined for submission and implementation in November 1994.

6. Enhancing biological control of diseases in rice-vegetable systems.

Start: October 1994 Completion: October 1998

Outputs:

- o identification of candidate biological control agents for disease management
- o establishment of greenhouse and field screening facilities and protocols in Central Luzon
- o design of cultural practices to enhance disease biocontrol

Comments: The pathology group in PhilRice has met to discuss the workplan for this activity last September. The workplan is being finalized for submission and implementation in November.

7. Carry-over effect of weed management practices in rice on weed flora in vegetables and vice versa.

Start: October 1994 Completion: October 1996 (sooner for preliminary results)

Outputs:

- o determination of weed species carried over from crop to crop

- determination of potential cultural, chemical and biological control tactics
- design of management activities to control weeds on a systems level rather than within a single crop cycle

8. Determination of the influence of weed populations on iresects, diseases and natural enemies in rice-vegetable systems.

Start: October 1994 Completion: October 1996

Outputs:

- knowledge of relationships of weed species populations and other pests and beneficial organisms in rice-vegetable systems
- description of nature of relationships among organisms
- design of integration of this knowledge into IPM system

9. Document and extend the farmer baseline survey.

Start: Began in June 1994 Completion: December 1994

Outputs:

- report with baseline tables, graphs and verbal summary

Comments: Preparations for a follow-up survey are under way, which will expand on pesticide issues, weed control and socio-economic/gender and policy issues affecting adoption of IPM on vegetables by farmers. Dr. Balakrishnan joined the discussions during her visit to PhilRice on 27-29 September 1994.

10. Assess policies, socio-cultural beliefs and perceptions regulations and other factors affecting pest management practices in rice-vegetable systems.

Start: Began in June 1994 Completion: September 1995 (some parts in June 1995)

Outputs:

- report and article on statistical analysis on factors affecting adoption (Master's thesis)
- report and article on household decision making and socio-cultural beliefs and perceptions influencing IPM
- report and article on tax, subsidy and credit policies and regulations

Comments: The social science group has met with the pest management group in PhilRice to discuss the preparation of a workplan for this activity. Meetings with IRRI counterparts (K.L. Heong, T. Paris) are scheduled for November 1994).

11. Evaluate economic, social and gender impacts of pest management alternatives.

Start: October 1994 Completion: some alternatives by September 1995, rest in three years

Outputs:

- o research reports

12. Gather secondary data on health and environmental effects of pesticide use in the Philippines.

Start: January 1995 Completion: September 1995

Outputs:

- o summary paper and literature review

13. Performance testing of near-isogenic lines. pyramids and multilines tbr resistance to bacterial leaf blight of rice.

Start: August 1994 Completion: August 1999

Outputs:

- o knowledge of population structure of bacterial blight pathogen of rice, selection of most effective resistance genes for bacterial blight of rice, pyramided resistance genes in IR64 and/ or other elite lines, and deployment strategies for management of resistance, to reduce epidemics and increase the useful lifetime of resistance.

Comments: Dr. L. Sebastian (biotechnology/breeding, PhilRice) has started collecting samples of bacterial leaf blight in the San Jose sites of IPM CRSP.

ANNUAL REPORTS ON ACTIVITIES BY INVESTIGATORS

1. George Norton
Department of Ag & Applied Economics
Virginia Tech

1.1. *Planned activity: Identify stakeholders and participants and obtain commitments*

Progress: Participated in the stakeholders meetings in the Philippines in March 7 to 12. Made a presentation at the stakeholders meeting at PhilRice on March 7 that summarized the workplan and log frame and then at the meeting at IRRI on March 11 that summarized outputs from our stakeholders meeting at PhilRice. Key participating groups in these meetings included PhilRice, UPLB/NCPC, IRRI, AVRDC, USAID, Department of Agriculture - Thailand, and FAO. From the US, Penn State and Virginia Tech were represented in the entire planning process. Participated in discussion about draft of MOU.

1.2. *Planned activity: Diagnosis and planning for participatory appraisal*

Progress: Participated in the design of a baseline survey that was administered to 300 farmers in six villages at our site in San Jose, Nueva Ecija. Helped plan the schedule for participatory appraisal in July. Prepared document that summarized PA methods that could be used for IPM planning. Gathered papers on IPM relevant to the Philippines site.

1.3. *Planned activity: Conduct participatory appraisal activities*

Progress: Participated (with graduate student Jessica Tjornhom) in the PA July 8-23. Participated in the organizational meeting/workshop at PhilRice at the beginning of the PA process and made a presentation on PA methods. Interviewed farmers; cooperative representatives, Landbank officials, community leaders, an extension agent, chemical company representative, Department of Agriculture officials, and representatives from the Philippine seed industry, Fertilizer and Pesticide Authority, and Bureau of Plant Industry. Met with economists from the University of the Philippines, Philippine Institute of Development Studies, and a USAID agricultural policy project. Identified socioeconomic factors that potentially influence IPM adoption and pesticide use. Gathered secondary price data, production data, budgets, trade statistics, policy documents, and other information needed for subsequent analysis of policies influencing IPM and pesticide use in the Philippines. Participated in research planning workshop that helped us identify and budget specific research activities for the Philippines site.

1.4. *Planned activity: Analysis of policy alternatives*

Progress: Began analysis of information collected on economic, policy, and other institutional factors influencing incentives to use pesticides or adopt IPM practices. Prepared a baseline socioeconomic survey that will enable us to statistically test which factors are influencing misuse of pesticides. Designed a set of calculations to identify degree of pesticide subsidy or tax in the Philippines. Discovered through PA activities that Landbank policy of requiring farm plans that include pesticide use may be influencing incentives to adopt IPM. Supervising M.S. student who is writing her thesis on policies influencing IPM adoption and pesticide misuse in the Philippines.

Other Activities as Philippines Site Committee Chair and Technical Committee Chair for the IPM CRSP:

1. Drafted Philippine workplan based on Co-PI proposals and working group reports that came out of PA.

2. Drafted first and second year annual workplans and budgets for the CRSP based on plans submitted by site committee chairs and made suggested revisions.

3. Prepared document on Globalization Aspects of the IPM CRSP for USAID.

4. Chaired two T.C. meetings.

5. Prepared log frames for the project.

6. Prepared document that summarized IPM CRSP project.

7. Prepared leadership plan for field sites.

Presentations

October 26, 1993: Overviews of IPM CRSP", presented to meeting in Blacksburg of Co-PIs from participating institutions and USAID representatives.

March 7, 1994: "IPM CRSP Annual Workplan" presented to stakeholders meeting at PhilRice.

March 11, 1994: "Outputs of Stakeholders Meeting", presented at IRRI.

April 6, 1994: "Objectives, Format, and Expected Outputs", presented at workshop in Blacksburg on IPM CRSP in a participatory framework.

Judy 9, 1994: "Participatory Appraisal Methods", presented at organizational workshop at PhilRice for the PA in the Philippines.

August 2, 1994: "Sustainability and Participatory Integrated Pest Management", paper presented at the conference on "Indicators of Sustainability", sponsored by the SANREM CRSP, Washington, DC.

2. Revathi Balakrishnan, Program Director, WID
Office of International Research and Development
Virginia Tech

GENDER ANALYSIS AND SOCIAL SCIENCES

2.1. *Field visit to Philippines IPM sites.*

Visited cooperating institutions as a follow-up to PA conducted in July. Visited IPM CRSP sites in Munoz. Discussions were held on developing activities related to gender-social

issues research components with A PA approach The following institutions were visited: International Rice Research Institute (IRRI) and Policy Research Studies Center at the University of Philippines, Los Baños (UPLB) and the Philippines Rice Research Institute, Munoz (PhilRice).

At IRRI discussions were held with Dr. K.L. Heong of Plant pathology division, Mrs. Thelma Paris, Dr. Lisa Price and Dr. Prabhu Pinguli of the social science division.

Two separate meetings were held to address the gender activities and PA Methodologies with Philippine partners.

One was at IRRI with Ms. Thelma Paris and Dr. Heong and another with selected PhilRice staff. The following PhilRice staff participated in the meeting: Dr. Serrano, Head of Social Science, Dr. Capud IPM CRSP-PHLP coordinator, Ms. Irene Tanzo SRS,SSPRD, Ms. Virginia Recta, Head PCPO, Ms. Zyla Macasieb, Head TTP Training and RSTC-IPM Participants, and Mr. Bernard Canapi senior SRS, BIMP project.

The visit to barangay IPM site at Matingkis resulted in a very productive meeting with both men and women farmers. The visit to IPM-CRSP site Abar 1, San Jose resulted in meeting with group of women. The visit to IPM CRSP Site at Sto. Tomas, San Jose resulted in a meeting with female headed households (widowed) and these were practicing women farmers. The preliminary discussions centered on their concerns about pesticide management, IPM practices, institutional constraints to adopt IPM and local knowledge about pests and control methods.

In addition, during a visit to the UPLB, met with the following persons: Dr. Agnes Rola, Policy Studies Center; Dr. Flexiberto H. Roquia, Gender Studies Program and Dr. Capud, IPM CRSP-PHLP coordinator. Dr. Rola indicated her interest to participate in the IPM CRSP social science component activities.

Ms. Thelma Paris and Dr. Balakrishnan discussed the research framework and staffing. Dr. Balakrishnan agreed to provide a outline for the proposed participatory research among the selected households after visiting the site. It was suggested that both Ms. Tanzo and Mr. Canapi from PhilRice could be trained in PA to support the field work. IRRI has to identify the research assistant for the work. Dr. Capud was requested not to commence any work on the participatory component until December 1994, providing time for Ms. Thelma Paris, Dr. Balakrishnan and Dr. Heong to develop the research design. Phil Rice social science group indicated interest in cooperating in the gender and social science components and gaining more experience in PA methods.

Note: For additional information refer to Philippines Trip report by R. Balakrishnan

2.2. *Developing resource base on PA methods and gender analysis. and gender variables in IPM research and out reach.*

This process is continuous. Dr. Balakrishnan identifies and collects resource materials both published, and unpublished that focus on PA methods and IPM in Participatory mode. Efforts are also in progress to identify Audio-Visual materials that focus on PA approaches and IPM in PA mode. These are important resources to provide technical support to the scientists on IPM in PA Mode.

3. **S.K. De Datta, Principal Investigator**
Interim Program Director, IPM CRSP (Until July, 1994)
Virginia Tech

Thailand

First stakeholders meetings were held on March 1 & 2, 1994 and were attended by representatives of the Department of Agriculture, Rice Research Institute, Kasetsart University, Chiang Mai University, Khon Khaen University, Department of Extension, among others. Initial presentations were made by S. K. De Datta, of Virginia Tech, Somkid Distaporn, IPM CRSP Co-PI and coordinator of the program in Thailand, K. L. Heong, of IRRI, and N. S. Talekar, Entomologist, of AVRDC in Taiwan.

Ed Rajotte, Co-PI and Entomologist from Penn State, led the discussion on the Participatory Appraisal Workshop and reviewed the outcomes/outputs from the Logframe:

- IPM will be enhanced in Thailand and farm income will increase
- Introduce IPM in narcotic replacement crops
- Advance institutionalization of IPM in Thailand
- Modify government policies as needed to promote IPM
- Identify ecological factors affecting IPM in Thailand
- Determine technical, educational, labor, training, advice, effects on IPM
- Gender issues

A few years ago, a huge shipment of stringbeans was rejected at a US port due to pesticide contamination. A rice-stringbean system is most appropriate for IPM CRSP project. Chainat and Suphanburi were selected by the group for IPM CRSP research sites.

Chiangmai site: IPM CRSP group had the opportunity to visit the Royal Project on substitute crops where narcotic crops, like poppy, used to be grown.

In the crop substitute program switch from opium to red kidney beans, stringbeans from Yunan, China, a number of fruits such as grapes, pears and apples are researched on. Among the cutflowers, chrysanthemums and carnations are being bred and evaluated, primarily for Bangkok and export markets. For cutflowers, thrips and two-spotted mites were considered important. His Serene Highness Prince Bhisatej Rachanee, a member of the Royal family of Thailand who is the Chair of the Royal Development Project, expressed complete support of IPM CRSPs involvement in Chiangmai.

AID Directive: Subsequently AID/Washington Controller's office directed, through IPM CRSP Project Manager, that no more funds can be given to Thailand and it has graduated from receiving AID funds because of Thailand's prosperity.

As a result, in order to continue collaboration between IPM CRSP and Thailand Department of Agriculture, Thais have agreed to fund projects themselves, which will benefit Thailand as well as the entire Indochina region. Co-PIs from Thailand will continue to be involved in the Asian sites in the Philippines.

When Bangkok, Thailand will be considered a regional bureau of USAID Mission to serve Indochina, we shall seek Mission funding for regional IPM CRSP activities.

GLOBILIZATION ASPECTS OF THE IPM CRSP

George Norton, Chair, Technical Committee
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The project proposal, "Participatory IPM: A Model for Implementing Pest Management in a Global Context" laid out the overall plan for the IPM CRSP. That plan was summarized in an eleven page document entitled "IPM CRSP Summary Statement." Those two documents describe the IPM research, training, and information transfer plans associated with the four primary and six satellite sites included in the project. The purpose of this section is to highlight the globalization aspects of the overall plan. It describes how the IPM activities in each of the primary sites fits into the global IPM CRSP research agenda. It focuses particularly on how the IPM research in the four primary sites will spread to the secondary sites listed in the proposal and to other sites around the world. Finally, it describes the linkages that will be forged with other IPM activities currently underway in the world and the impacts on the United States.

Primary Site Activities in Relation to Global IPM-CRSP Research Agenda

The global agenda for the IPM CRSP is to design, implement, and replicate a participatory integrated pest management (PIPM) approach that will help reduce (1) food, fuel, and fiber losses, (2) damage to natural ecosystems, and (3) pollution and contamination damages in food and water supplies. We will pursue this agenda by developing participatory, farmer-focused, inter-disciplinary research, training, and information exchange programs focused on four production research regimes: (1) offseason horticultural export crops production in the Altiplano, (2) winter export vegetable production in the Caribbean, (3) transitional semi-arid agricultural production systems in the Sahel, and (4) innovative IPM research for transitional rice-based systems in Asia. The primary horticultural export crop regime sites are Guatemala and Jamaica. The primary site for transitional agricultural production is in Mali, and the primary innovative research site is in the Philippines. These research regimes and represented sites have high potential for transferability of approaches and results beyond the project sites. They represent important production systems in the world and many of the pests found in these systems are common to other sites in the regions and world. Reasons for their selection are described in the project proposal.

The primary focus of the IPM CRSP is on collaborative, participatory research. Degree training will go hand in hand with the research, and training of outreach personnel as well as other information exchange activities mark important components right from the beginning of the project, but large-scale extension programs for farmers (such as the FAO participatory training program for rice IPM) will not be undertaken. Our interdisciplinary, participatory approach described in our proposal will address both technical and socio-economic constraints, including gender issues and policy constraints to IPM adoption.

Our plan is to form a PIPM institute or center in each of our primary sites during the first five years. These centers would be linked to the national agricultural research systems in the countries as well as to NGOs, universities and other relevant institutions. These institutes or centers would ensure continuity of the PIPM approach after the IPM CRSP activity ends and facilitate expansion of IPM work in each region.

Our research regimes are broad enough geographically that they encompass (a) many of the countries in Latin America and the Caribbean that export horticultural export crops (b) several countries in the Sahelian region of Africa, and (c) most of the countries in Asia. While some IPM activities are currently underway in these areas, most of those activities

lack either the participatory, interdisciplinary and policy focus of the IPM CRSP or its research focus. In Asia for example, much of the current IPM work is focused on participatory training, but not research, and on rice alone as opposed to other crops, such as vegetables, in the rice-based system. Mechanisms for spreading the PIPM approach and the information learned on the primary sites to other sites around the world are described below.

Global Transfer Mechanisms

The primary means through which the IPM knowledge gained in the principal sites will spread globally are (a) linkages to several "satellite" country sites, (b) linkages to the international agricultural research centers (IARCs), to multilateral NGOs, to FAO training programs, and to other CRSPs, (c) degree training at participating universities and participant training through regional workshops, (d) through publications such as manuals, journal articles, and newsletters, (e) by taking advantage of computer networking, and (f) by responding to requests for services and buyins from AID missions in other countries.

Linkages to "Satellite" Sites

Each of the primary IPM CRSP sites is linked to another site in its corresponding region. The extent of the direct IPM CRSP activities in those satellite sites will depend in part on the extent to which the CRSP budget is fully funded by AID and on other resources that can be generated in each site. The PIPM research at the primary site in Guatemala is linked to Ecuador. The diversity of the ecosystem in Ecuador makes it well suited for evaluating the transferability of participatory IPM technologies to other sites in Latin America. INIAP, the National Institute for Crop and Livestock Research in Ecuador has a national IPM coordinator and is very interested in collaborating with the IPM CRSP. Linkage will also be developed with the SANREM CRSP in Ecuador.

The IPM CRSP site in Mali is linked to a satellite site in Uganda, a country currently in transition from subsistence to commercial crop production following years of instability. Recent strengthening of personnel at Makerere University under AID support and with the assistance of one of our collaborating universities, Ohio State, has upgraded the capabilities at that institution.

IPM research in the Philippines site is linked to a Thailand site. In the Chiangmai area, farmers traditionally grow narcotic plants and food crops such as corn, cassava, and upland rice. PIPM research will assist in making it protitable lo switch from narcotic crops to food crops and other relatively high value crops such as cut flowers, grapes, pears, apples, and vegetables.

Other satellite sites targeted from IPM CRSP activities include Albania, Egypt, and Mexico. Political changes and movement toward a market economy are proceeding at a rapid pace in Albania. The current period of change offers a unique opportunity to develop PIPM approaches that can be transferred elsewhere in Eastern Europe and the newly independent states. IPM support organizations in Albania include research institutes of the Ministry of Agriculture and the University of Tirana, with whom Virginia Tech already has a working relationship. Initial work will focus on olives, and important export crops there. In Egypt, the CRSP will build upon work of one of our collaborating universities, Penn State, that is underway with the Ministry of Agriculture and Land Reclamation. This work involves developing IPM decision support tools, primarily expert systems for horticultural crops. In Mexico, collaboration will be through the private sector economic development entity (PICO) and through the Technical Institute of Sonora (ITSON). Results from a collaborative program that is already underway there with one of our collaborating

universities, Purdue, will provide useful lessons with respect to decision support systems related to IPM and the marketing of export crops. More details on all the satellite site linkages is provided in the IPM CRSP proposal.

Linkages to IARCs, NGOs, FAO, ADB, and other CRSPs

Strong linkages will be maintained with several international agricultural research centers, particularly the International Rice Research Institute (IRRI) for our work on rice-based systems in the Philippines and elsewhere in Asia. The International Potato Center (or in Spanish, Centro Internacional de la Papa, CIP), and the International Center for Tropical Agriculture (or in Spanish, Centro Intemacional de Agricultura Tropical, CIAT) for our work on horticultural crops in Latin America, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) for our work on sorghum and millet in West Africa, the Asian Vegetable Research and Development Center (AVRDC) for our work on vegetables in rice-based systems in Asia and on horticultural export crops in Latin America, and the International Service for National Agricultural Research (ISNAR) for our work on evaluating the impacts of our IPM research programs in each site. Although not direct recipients of AID funds for research, these centers will be direct collaborators in the sites. In the Philippines, for example, joint IPM research plans will be developed among the national research institutions, IRRI, AVRDC, and the U.S. CRSP partners.

Because of the IPM CRSP linkage to these IARCs, our PIPM approach and any IPM practices developed to manage particular pests will spread more rapidly to other countries in the regions of our primary sites. For example, IRRI maintains an IPM network throughout Asia, AVRDC has an extension network that spread throughout Asia and beyond, ISNAR works around the world in developing countries, ICRISAT and IITA work extensively in IPM throughout West Africa and ICRISAT in South Asia.

Linkages to NGOs will be particularly important for technology transfer. One of our consortium members, the Division of Biological Control at the University of California at Berkeley, has been working closely with the Latin American consortium on Agroecology and Development (CLADES), a network of sixteen NGOs in twelve Latin American countries that focuses on producing vegetable crops, apples, and vineyards without pesticides. CLADES efforts, particularly in Chile, Peru, and Brazil, will serve to transfer results from those areas to our sites and vice versa.

CARE is one of our major partners in Guatemala. They have an extension network that will serve to transfer PIPM research results within that country and beyond. Rodale Institute is another NGO partner in our Latin American and Caribbean sites that will serve to help spread PIPM beyond our site borders.

The IPM CRSP will coordinate its efforts with the FAO rice-based training program in Asia. Our work in the Philippines in rice-based systems is focused more on research and on other enterprises besides rice in the cropping system and hence is complementary with the FAO and national IPM efforts and should be able to feed research information into those efforts. The IPM CRSP will collaborate also with the Asian Development Bank (ADB) to jointly sponsor workshops and seminars.

The results of IPM CRSP research will spread as well through interCRSPing with SANREM, the Bean-Cowpea CRSP, INTSORMIL and other CRSPs. The commodity CRSPs are already undertaking some IPM research and our PIPM research should allow an expansion of that work, particularly in West Africa, the Philippines, and Ecuador.

Our linkage with the Caribbean Agricultural Research and Development Institute (CARDI) will be important for disseminating results of IPM research in the Caribbean. CARDI is a major collaborating partner in the Jamaican site and has research linkages to islands throughout the region. We will collaborate also with the Ministry of Agriculture in Jamaica.

Training

Globalization will be enhanced both by degree training, with students' research supported by the CRSP, and by participant training in regional workshops. The IPM CRSP affords the opportunity for masters and Ph.D. students from the primary and satellite site countries as well as from other countries (including the United States) to conduct IPM research. The students' degrees will be in entomology, plant pathology, weed science, agricultural economics, sociology, or horticulture, but with a research focus on IPM. This investment in human capital is one of the surest ways to enhance the spread of participatory IPM approaches.

Regional workshops, focused on PIPM, will inciude participants not only from the host country but from neighboring countries in the region. These workshops will include instruction on PIPM methods as well as discussion of research results. In some cases, scientists from one region will be brought to another to encourage cross-fertilization of ideas. Finally, the IPM CRSP will develop a linkage with the Panamerican Agricultural School at Zamorano, Honduras to jointly develop participatory IPM training activities.

Newsletter and Publications

Newsletters are important for communicating within the CRSP, to other CRSPs, and to the broader community interested in IPM. An IPM newsletter will be produced and available both in hard copy and on-line. We will also include brief statements in other newsletters, such as IPM-Net, already in existence.

IPM knowledge will be spread through training manuals, publications including articles in internationally read journals, and newsletters. Training manuals are essential if the results of IPM CRSP are to reach the broadest audience. Certain manuals will be written for producers and other manuals for scientists. Even the manuals prepared for scientists will be written in a style of presentation that permits their use by a broad group of scientists. Articles in inter-disciplinary journals such as Agricultural Systems, the Journal of Production Agriculture, and others, including regional journals, are an essential means of communicating research approaches and results to a worldwide set of scientists. Every significant piece of research will be presented in an article. CRSP scientists and the ME will participate also in national scientific society forums to disseminate information on IPM CRSP research results.

Computer Networking

We will establish e-mail linkages through INTERNET with all sites, IRRI, CIP, CIAT, AVRDC, and U.S. collaborators. The possibility of satellite linkages to country sites for network conferences will also be explored.

A listserver has already been set up for each of our primary sites. People at AID, on other CRSP projects, or elsewhere who have an interest in our sites can be added to a site list and will receive news on IPM, correspondence relative to site planning, etc. These computer linkages should greatly facilitate the spread of information on IPM around the world relative to these sites.

Technical Assistance and Buyins

The IPM CRSP will respond to buyin requests from AID missions and from other funding sources with international IPM interests in order to leverage CRSP activities into sites not listed in the proposal. This expansion of activities will involve cost sharing unless those buying the service of the IPM CRSP pay for the full activity. At least 10 percent of the IPM CRSP budget will be designated for technical assistance and buyin type activities and projects. We expect the volume of buyin business to increase substantially once our research is well established in each of our primary sites and visible results are present.

Other IPM Transfer Mechanisms

In addition to the transfer mechanisms described above, the IPM CRSP will expand its work globally through coordination with other AID funded projects such as the RENARM project in Central America, certain of the AID-funded agribusiness projects, and others that have a partial mandate for IPM and improving the environment. Furthermore, each of our U.S. institutional partners will work to spread IPM in other countries where they are working on related projects. Purdue, Penn State, Berkeley, Virginia Tech, Ohio State, and Rodale, for example each have research and/or technology transfer projects in other countries.

Impacts on the United States

IPM technology transfer will spread not only among developing countries, but back to the United States as well. This transfer will occur not only for particular IPM component technologies on fruits and vegetables in Latin America and the Caribbean, but also for the participatory approaches developed in all the sites. Many of the same insects, diseases, and other pests exist in the horticultural commodities of both developed and developing countries. In many cases, pest pressures are higher in the developing countries. Lessons learned abroad, and, in some cases, materials such as pest resistant germplasm, can be transferred back to the United States for low-input crop production.

The United States will benefit in other ways as well. First, the potential for U.S. private firms to import unique and out-of-season fruits and vegetables with minimal pesticide residues will provide consumers with a wide selection and large quantity of high quality horticultural produce. Second, economic development in developing countries is newly dependent on agricultural growth. Increased export and domestic production raises incomes that, in turn, stimulate demand for U.S. exports, including agricultural products.

Conclusions

The IPM CRSP will provide a major resource to facilitate the spread of participatory IPM approaches around the world. The opportunities for this spread are almost limitless given both (a) the needs for reductions in pesticide use and for controlling pests and (b) multiple mechanisms available to encourage the spread of IPM approaches and results. Not only will developing countries benefit, but the United states will as well.

SUSTAINABILITY AND PARTICIPATORY INTEGRATED PEST MANAGEMENT[1]

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The objectives of integrated pest managernent (IPM) are to reduce commodity losses to pests while reducing or preempting reliance on chemical pest control. Achievement of these objectives contributes to the long-run sustainability of agricultural systems.[2] The goal of IPM is to increase farm income and economic benefits to society, while improving human health and the environment. IPM plays a central role in sustainable agricultural development because (a) insects, diseases, weeds, nematodes, and other pests cause severe losses in many farming systems and (b) misuse of pesticides threatens farm worker health, impairs the quality of drinking water supplies, harms aquatic ecosystems, and causes pests to become resistant to pesticides.

The word sustainability implies maintenance if not improvement over time. Agricultural systems are seldom static and maintenance or improvement of these systems requires investments in new technologies, management systems, and institutions as well as changes in knowledge, abilities, and attitudes. The Participatory Integrated Pest Management (PIPM) approach of the IPM CRSP is directed at changing each of these factors. It attempts to do so by involving scientists from multiple disciplines and by including farmers, community leaders, policy makers, marketing agents, and other stakeholders in a collaborative IPM research effort. One implication is that indicators of sustainability related to IPM should include changes in adoption of new IPM technologies and management systems, in institutions, and in knowledge, abilities, and attitudes about pests and pest management. These indicators are in addition to the more common ones of reduced pest losses, reduced pesticide use, and increased farm income. A second implication is that some of these indicators will be found at the farm or community levels while others will be found at the policy or national level.

The purpose of this paper is two-fold. First, it describes and justifies specific indicators used to assess changes in agroecosystem sustainability from a pest management perspective. Second, it discusses participatory methods being used by the IPM CRSP to enhance multidisciplinary, multi-institutional, and community involvement in IPM research.

Sustainability Indicators for IPM

Sustainability indicators for IPM can be outcome-based, process-based, or people-based. Key outcome-based indicators are reduced commodity losses due to pests, reduced variability over time of commodity losses due to pests, reduced pesticide use, increase farm income from adoption of IPM practices, and government policies that encourage, rather than discourage, adoption of IPM.

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[1] Paper presented at Indicators of Sustainability Conference, Sponsored by the SANREM CRSP, Washington, D.C., August 2, 1994.

[2] IPM can also be applied to non-farm settings such as lawns and gardens, commercial buildings, forests, and roadsides.

Reduced losses due to pests - An IPM practice or system that fails to reduce crop or livestock losses due to pests will hardly see sustained adoption. Hence, measurements that compare commodity losses for adopters and non-adopters are an indicator of sustainability. In the Mali site on the IPM CRSP, for example, few pesticides are currently applied to the target commodities, but crop losses due to pests are often substantial. Hence, an indicator such as reduced pesticide use is not much help in that site, but crop loss assessment is.

Reduced variability in commodity losses - All farmers, but particularly those close to the margin, are as concerned, or more concerned, about large losses in particular years, than they are about modest losses over several years. Hence, measurements taken over time that enable the calculation of the risk associated with IPM compared to conventional pest management practices provide a useful indicator of sustainability.

Reduced pesticide use - Evidence is mounting that indiscriminate use of pesticides in many countries is creating an escalating set of problems with environmental damage, human health effects, and increased pesticide resistance. The environmental problems are multi-fold, but one of the most serious ones for pest control is the harm caused to beneficial insects. Certain pesticides, particularly when applied in strong dosages or at the wrong-times, disturb the balance of nature in which certain insects or birds keep other insects in check. Beneficial insects, including many spiders and wasps, are easily destroyed by broad-spectrum pesticides. Furthermore, pests evolve and develop resistance to certain pesticides over time, often causing farmers to alter pesticide dosages which may exacerbate the problem. Most scientists now agree that while some pesticide usage may be needed in the short-run, until adequate substitutes are developed, pesticide reductions are needed in many systems to make them sustainable. Hence, IPM practices that require less pesticide use tend to be more sustainable, and measurements in an area that indicate reductions in pesticide use over time indicate increased sustainability of the farming systems in that area.

Increased farm income - Measured increases in farm income from adoption of IPM practices are arguably the best indicators of sustainability. First, few IPM practices will continue to be adopted or spread to additional farmers if they are not profitable. Reductions in environmental damage is usually not enough to ensure adoption as many of the environmental costs are borne by others besides the farm family. Second, increased income contributes to sustainability by placing downward pressure on population growth, a major cause of nonsustainable farming systems. Also, as incomes rise, people tend to place more value on environmental benefits. Poor people are more concerned about meeting basic needs today than they are about environmental effects that are felt more in the future.

Government policies that do not discourage IPM - In some countries, governments subsidize pesticides or require pesticide use as a condition for participation in government credit programs. They may have a lax set of pesticide regulations that permit use of broad spectrum, highly toxic pesticides, paying little regard to the environmental and human health costs involved. In Indonesia, the government found that removal of pesticide subsidies provided a major stimulus for adoption of IPM practices. Research and extension systems can develop and extend effective IPM programs, but unless the policy environment is conducive, adoption may not occur because pesticides are abundant and inexpensive. Therefore, government policies favorable to IPM development and adoption are an indicator of sustainability.

Key process-based indicators are whether new IPM technologies and pest management systems are being developed and adopted, whether IPM units or research and training

centers are in place, and whether the IPM network in a country is growing. These indicators provide evidence of institutionalization of the IPM infrastructure in a country.

Technologies and pest management systems - Evidence that a stream of new IPM technologies and pest management systems are being developed and adopted that rely on biological controls, resistant varieties, altered planting dates and rotations, etc. are an indicator that the groundwork has been laid for continued development and extension of IPM. In some countries, a limited set of IPM practices are available and are being extended in training programs. However, sustainability requires a stream of these technologies and systems over time as the pest environment does not remain stable. Development of this stream requires the existence of scientific capacity.

IPM units or centers - Evidence that the basic infrastructure has been developed to sustain an IPM program in a country is provided by the existence of a participatory IPM unit or center that is within or linked to the national agricultural research system and has ties to NGOs, universities, other relevant institutions and, of course, farmers. Both the continuity and expansion of IPM research and training depends on its institutionalization.

IPM network - The IPM unit mentioned above must be linked both to national and regional entities within the country, as well as to the burgeoning international IPM network. Many of the pest management problems and potential solutions in one region or country bear similarity to those in other regions or countries. The development of an IPM network within a country, which today often includes a computer linkage, is an indicator of whether new IPM ideas and technologies will spread.

Important as the outcome-based and process-based indicators are, the people-based indicators are fundamental to assessment of sustainability related to IPM. The reason they are so important is that IPM is more than a set of technologies or practices. It is a management philosophy that requires changes in knowledge, attitudes, and abilities.

Knowledge and attitudes - One measure of whether a sustainable farming system has been developed with respect to pest management is whether community members exhibit increased knowledge of and attitudes towards pests and beneficials. As Bentley (1989) points out, farmers know much more about plants than they do about insects and diseases. Although they know a lot about their environment and how to control pests without pesticides, there is a lot they do not know. Central American farmers, for example, do not know about insect predation or parasitism (Bentley, et al, 1994). Insects are often difficult to observe and look different at different stages of their life cycle. Because insects and diseases can destroy crops, there is a tendency for farmers to think that almost all of them are bad. They may know that toads, birds, and some spiders eat insects, but not that many insects prey on other insects. They often overreact and spray pesticides at times when the pests are not creating damage that will affect yields.

Farmers in many developing countries are bombarded with pesticide advertisements, and because farmers often view insects and diseases as their enemies and like to experiment, they tend to apply and experiment with toxic chemicals. However, farmers are often receptive to IPM alternatives once they gain increased knowledge about insect and disease ecology. Hence, one objective of an IPM program is to raise the level of knowledge about, and attitudes toward, pests and beneficials. This knowledge and attitudes indicator can be measured through interviews with farmers and observations of their pest management practices.

Farmer ability to conduct research and access information - Sustainability requires that farmers be able to experiment and adjust to changing pest conditions and to access the latest

IPM information. Participatory IPM research facilitates both of these activities, as does education in general. This ability indicator is best assessed in times of disequilibria with respect to pest problems.

Participatory IPM Methods

The diversity of the sustainability indicators described above underscores the need for a participatory IPM process that merges the expertise of both natural and social scientists and extends the farmer- or community-participatory concept to farm workers, growers' associations, marketing agents, policy makers and others. Through the iterative process of participatory research, these actors collaborate with scientists and extension workers throughout the research process. IPM programs are at different stages of development in our IPM CRSP sites and PIPM is versatile enough to interact with each of these programs.

The participatory IPM process can be broken down into three phases: diagnosis, design, and dissemination (Figure 1). The diagnosis phase begins with identifying stakeholders, and meeting with them (a) to review current pest management programs including possible gaps and intervention points, (b) to select commodities and sites within the country, and (c) to establish a country-site committee. Secondary information is reviewed, a tentative plan for a participatory appraisal developed, and a workshop held on participatory appraisal methods. A multidisciplinary participatory appraisal is undertaken to generate baseline data on biophysical and socio-economic characteristics of the research sites. A more formal diagnostic survey is also undertaken in addition to the use of less formal participatory appraisal methods such as development of resource maps, seasonal calendars, preference rankings, innovation assessments, key informant interviews, direct observation, and group discussions. At the conclusion of the participatory appraisal fieldwork, an information validation workshop is held in which key research questions are identified and plans are developed for research and other activities. A community advisory council made up of farmers, marketing system agents, bankers, local educators, and others is formed to assist with validation of plans and provide input into the development, testing, and evaluation of PIPM systems.

Figure 1. Summary of Participatory IPM Process

Diagnosis

Hold Stakeholders Meeting, Select Sites, and Establish Site Committee

Review Secondary Information and On-going Programs

Participatory Appraisal Training

Conduct Baseline Diagnostic Survey and Conduct Participatory Appraisal

Information Validation Workshop and Identification of Research Questions

Establish Community Advisory Council

Design

Develop, Test, and Evaluate PIPM Systems

Dissemination

PIPM Education and Training

Farmer Adoption and Adaption	Farmer Training and Exchanges
Policy Dialogue	Retrieve from and Contribute to Global Database

The design phase encompasses participatory design, testing, and evaluation of PIPM systems. PIPM is approached as a series of activities that culminates in decisions by farmers and policy makers that are consistent with the goals of farmers and society. Based on the current and potential economic and environmental importance of pests and pesticides, particular pest ecosystems are selected that constitute the focus of research and extention efforts. Potential IPM tactics and strategies are identified through discussions among members of the site committee and community advisory council. Examples of preemptive IPM solutions that reduce or eliminate pest problems before they arise are: use of pest-resistant cultivars, developing production systems and natural habitats that encourage growth of natural enemy populations, adjusting planting times to avoid key points in pest biology, and crop rotations and systems that discourage pest population buildup. Examples of reactive solutions that are implemented only in response to high pest densities in critical periods are manual removal of insect egg masses, hand weeding, selective use of pesticides and other controls when conditions are severe enough to warrant them.

Some research and demonstration plots are usually required both on-station and in farmers' fields. On-farm testing will occur on whole farms and in whole villages. However, PIPM research is more than technical research. Marketing research addresses the potential for profitably selling increased production of particular commodities either domestically or in export markets. Economic and sociological research examines factors influencing adoption of IPM practices and strategies. Particular attention is focused on government policies that encourage or discourage IPM adoption. Regulations, taxes, subsidies, cooperative organizations to control pests in a region, laws and policies that influence land tenure, cooperative marketing schemes, and other types of policies and institutions are difficult to change. Yet incentives created by these "rules of the game" often spell the difference between successful and unsuccessful IPM efforts. Sociological and gender research focuses on community and farm-household factors that influence the design of appropriate IPM systems.

The dissemination phase in PIPM programs begins during the diagnosis and design phases as participatory research spreads knowledge right from the start. However, specific educational and training activities also must be built in that recognize barriers to acceptance of knowledge related to age, class, gender, and ethnicity. Special workshops and field days are held on specific IPM strategies for farmers, extension agents, NGO personnel, and other groups. PIPM coordinates with training programs run by other organizations and projects as well. It involves farmers in training farmers. Policy dialogue is initiated with government officials, often working through other institutions and projects. PIPM research approaches and results will be spread through training manuals, publications, regional workshops, and the internet. Close coordination with international agricultural research centers and several regional IPM networks also assist with information dissemination.

The above brief summary of PIPM methods highlights the importance of (a) interdisciplinary and interinstitutional coordination and (b) community participation. Interdisciplinary and interinstitutional coordination is facilitated on the IPM CRSP by a committee structure in which scientists and other representatives from host country institutions form a local site committee that interacts with a committee of scientists from the external institutions. This overall site committee has a chair and vice-chair from different institutions and draws its expertise from whomever is most appropriate in any of the collaborating institutions. All workplans are initiated at the site committee level.

Community participation is initiated by the participatory appraisal activities and continues with farmer participation in the research and training activities and through a community advisory council that is involved in validating information and evaluating IPM research results. This active participation of farmers, marketing firms, policy makers, etc. in the information gathering and research evaluation is one of the two key factors associated with successful participatory research. The participatory appraisal, in which local participants help in mapping key variables, providing preference rankings, and participating in group analysis discussions, establishes the principle of local involvement.

The second principle of successful participatory research is that scientists and extension workers must bring something new to the farmers, policy makers, or other clients. That something new might be a new IPM tactic or strategy, a suggested policy change, or a new institutional structure. Unless the clients feel they are learning new methods or ideas, they quickly lose interest. Farmers, for example, are rational and relatively efficient. They usually know a lot about their environment, but are not all-knowing. They often test outsiders to see what they know, and many are willing to experiment with what scientists suggest, if they think it may work. This willingness to experiment is why many farmers have gotten into trouble with pesticides. Many farmers are looking to scientists and extension workers to suggest new pest control methods. They would eagerly accept pest-resistant varieties, biological-control methods, and other means suggested by scientists for controlling insects, diseases, and weeds. They respect scientists, but are understandably skeptical until the scientists gain their confidence. Scientists must respect farmers and their indigenous methods, but not romanticize them. Some farmers are smart; some are less so. Some are stubborn; some are quick to change. The same can be said for scientists.

In summary, successful participatory IPM research requires (a) involvement of clients in the research, and (b) high quality biophysical and social science research so that new IPM factors and strategies are in fact developed that are profitable and appropriate for the social and cultural setting. Good intentions are not sufficient.

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TRAINING

The IPM CRSP places high priority on graduate training with the ultimate objective to contribute to the human capital development and institution building of the host countries. During the first year of its operation, this CRSP provided full or partial financial support for six graduate students (Table 1.). These students are supervised by IPM CRSP investigators and have their research for their thesis on an IPM related topic. During this first year, only one of the six students is a national of one of our prime host countries. However, all the graduate students do research in one of our four prime sites.

In the future, as the IPM CRSP investigators establish stronger linkages and identify potential graduate students from the host countries, the number of foreign students is expected to increase. Four of the six students currently supported by the IPM CRSP are females. Considering degree candidate distribution, 50% are Ph.D. candidates and 50% are M.S. students. In institutional distribution of students, Virginia Tech has three and Lincoln University, Ohio State University, and the University of Georgia each have one graduate student.

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YEAR ONE (1993-94) IPM CRSP STUDENT TRAINING PARTICIPANTS

Student Name	*Sex*	*Nationality*	*Discipline*	*Research Site*	*M.S./Ph.D.*
C. Haenchen	F	U.S.A.	Agronomy	Jamaica	M.S.
H. Morales	F	Guatemalan	Entomology	Guatemala	Ph.D.
J. Mullen	M	U.S.A.	Economics of IPM	Mali	Ph.D.
J. Tjornhom	F	U.S.A.	Economics of IPM	Philippines	M.S.
A. Dix	F	U.S.A.	IPM in Non-traditional Export Crops	Guatemala	Ph.D.
J. Amirault	M	Canadian	Horticulture	Mali	M.S.

Start Date	*Comp. Date*	*IPM CRSP Fund*	*Advisor PI*	*Thesis Topic*	*University*
Sep. 94	Sep. 96	50%	F. Eivazi	Nutritional Req. of Horticultural Crops	Lincoln
Jul. 93	Jul. 96	75%	R. Williams	Traditional Pest Control	Ohio State
Aug. 94	Oct. 97	50%	D. Taylor	Economics of IPM	Virginia Tech
Aug. 93	Jul. 95	100%	G. Norton	IPM Policy	Virginia Tech
Sep. 93	Sep. 96	50%	R. Carroll	IPM in Non-traditional Export Crops	Georgia
Sep. 93	Dec. 95	65%	J. Caldwell G. Welbaum	IPM in Horti-cultural Crops	Virginia Tech

LIST OF ACRONYMS

ADB	Asian Development Bank
AESP	Agricultural Export Services Project
AGRILAB	Agriculture Laboratory
ALCOSA	Alimentos Congelados, S.A.
ALTERTEC	Technología Alternativa
APHIS	Animal and Plant Health Inspection Service
AVRDC	Asian Vegetable Research and Development Center
BoD	Board of Directors
CARDI	Caribbean Agricultural Research and Development Institute
CATIE	Centro Agronomico Tropical de Investigacion y Enseñanza
CIAT	Centro Internacional de Agricultura Tropical
CIP	Centro Internacional de la Papa
CLADES	Consorcio Latinoamerican sobre Agroecologia y Desarrollo
CRSP	Collaborative Research Support Program
DRSPR	Department Recherche sur les Systémes de Production Rurale
EEP	External Evaluation Panel
FAO	Food and Agricultural Organization of the UN
GEXPRONT	Gremial de Exportadores de Productos No Tradicionales
GIS	Geographic Information Services
HAP	Hillside Agriculture Project
IARC	International Agricultural Research Center
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICTA	Instituto de Ciencia y Tecnología Agricolas
IER	Institut d'Economie Rurale
IITA	International Institute of Tropical Agriculture
INIAP	Institute Nacional de Investigaciones Agropecuarias
IPM	Integrated Pest Management
IPMWG	Integrated Pest Management Working Group
IRRI	International Rice Research Institute
ISNAR	International Service for National Agricultural Research
LDC	Less Developed Countries
LU	Lincoln University
ME	Management Entity
MINAG	Ministry of Agriculture
MOU	Memorandum of Understanding
NGO	Non-governmental Organization
OARDC	Ohio Agricultural Research and Development Center
OHVN	Operation Haute Vallee du Niger
OIRD	Office of International Research and Development
OSU	Ohio State University

PA	Participatory Appraisal
PCA	Pesticide Control Authority
PhilRice	Philippine Rice Research Institute
PIPM	Participatory Integrated Pest Management
PSU	Pennsylvania State University
RADA	Rural Agricultural Development Authority
SANREM	Sustainable Agricultural Natural Resources Management
SNPV	Service National de Protection de Vegetaux
TC	Technical Committee
UGA	University of Georgia
UPLB	University of the Philippines Los Baños
USAID	United States Agency for International Development
USDA-ARS	United States Dept of Agriculture - Agriculture Research Service
UWI	University of West Indies