PD-ABU-061

IPM CRSP

INTEGRATED PEST MANAGEMENT

COLLABORATIVE RESEARCH SUPPORT PROGRAM

SECOND ANNUAL REPORT

1994-95

Virginia Tech

VIRGINIA POLYTECHNIC INSTITUTE
AND STATE UNIVERSITY

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(29 September 1994 - 28 September 1995)

The IPM CRSP is funded in part by the United States Agency for International Development under Grant No. LAG-4196-G-00-3053-00.

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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 Latin America, 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 this second year, the CRSP became fully operational in the four primary sites, and partially operational in some satellite 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. INRAN, Niger
9. IRRI, Philippines
10. PhilRice/NCPC, Philippines
11. 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.

LATIN AMERICA

Fully Operational Site Committee

Participatory research and sustainable deliverables cannot be accomplished without a functional viable Site Committee. Clearly, one of our major accomplishments has been the development of a strong and productive Site Committee. This will provide the basis for long-term productivity and more effective advancement of the IPM CRSP program agenda. The Guatemala/Central America Site Committee will be further strengthened in Year Three with the full-time program leadership of Dr. Victor Salguero, and the active participation of Dr. Allan J. Hruska (Zamorano).

The IPM CRSP Site Committee has done an excellent job of assessing research needs and establishing research priorities to maximize use of funds and deliverables in Year Three. This has resulted in a highly focused research agenda that targets solving some of the most pressing regional pest management related problems. This is reflected in both the Year Two and Year Three Workplans. A couple of examples are: (1) GEXPRONT and the development of a phytosanitary inspection training program for Guatemalan non-traditional exports, (2) University of Georgia and the research on gallina ciega in broccoli.

The Gremial de Exportadores de Productos No Tradicionales (GEXPRONT) have been cautious in developing their relationship with the IPM CRSP. However, Year Two activities have served to convince GEXPRONT that IPM CRSP is committed to long-term research objectives that are essential for future production and trade expansion in the non-traditional crops. This has led to greater program involvement/leadership by GEXPRONT, which will culminate with a full buy-in in Year Three. GEXPRONT will provide half of the financial resources to retain the services of Dr. Victor Salguero as IPM CRSP Site Coordinator in Guatemala/ Central America, thereby freeing Dr. Linda Asturias and Ing. Danilo Dardon to concentrate on their research deliverables in Year Three. In addition, GEXPRONT will increase matching funds to host country collaborators for IPM CRSP related research funded through PL 480/CRSP in Year Three.

Specific Research Accomplishments

- Determination of the best commercial *Bt* products for control of specific insect pests in non-traditional vegetables. The decision of distributors of *Bts* to remove from the Guatemalan market those products that are not effective for the control of lepidoptera larvae.
- Gathering of baseline data concerning important pests, control practices, and farmer attitudes concerning IPM strategies in non-traditional fruits and vegetables.
- Gathering control information for improved pesticide application techniques and evaluation of control needs in broccoli and snowpeas.

- Organization of tomato growers in research and control implementation for integrated white fly control programs. It is expected that there will be active participation of the growers in the decision making process concerning IPM strategies for controlling white fly on tomato plants.
- Studies investigating the use of oils and detergents for aphid control in broccoli. Oils and detergents have good potential for replacing some traditional pesticides for use in broccoli to control aphids. These products represent several advantages to the farmers and exporters of the country.
- Improvement in the control of aphids by use of EPA approved pesticides and a decrease in the use of prohibited pesticides.
- We have determined that buried stover seems to be attracting gallina ciega larvae in broccoli fields.
- Buried chicken manure attracts gallina ciega larvae and encourages dispersal of larvae throughout broccoli fields.
- Adult beetle host plants were identified with the help of community members, many of whom had not realized that the beetles were the adults of gallina ciega.
- Light traps were promoted in the community through CARE extensionists. Millions of beetles were captured in this manner and children in the local school participated in the activity.
- Primary gallina ciega pest species were identified.
- Partnership with CARE extensionists in Chilasco has yielded the opportunity for real farmer experimentation. We are learning many practical lessons, from farmers, who don't necessarily adopt technologies in ways we would expect. Dissemination of project results to other community members has been expedited based on a real understanding of the working conditions. Farmers have taught us much through their diverse application methods and keen field observations. This has helped focus our project and direct future investigations.

Pest Control and Cultural Practices in Vegetables

- Improved knowledge of species involved in the white grub complex, including species involved and host plants for adult beetles.
- Improved knowledge of current cultural practices that promote white grub infestations in broccoli, such as cornstover and use of raw chicken manure.
- Identification of *Plutella xyllastela, Leptophobia aripa, P. xyllastela* and aphids as major broccoli pests at Chirijuyu and Chilasco, respectively.
- Broccoli intercropping experiment in Guatemala showed that the main lepidopteran insects pests affecting broccoli were *Plutella xylastella, Leptophobia aripa* and *Trichoplusia ni.*
- Use of strip cropping (black bean/broccoli) resulted in up to 51% greater yields than broccoli monocultures, suggesting alternatives to monoculture are useful in reducing pest problems in broccoli.
- Broccoli grown in strip cropping with beans yielded 1.3 and 1.5 times more broccoli at Chirijuyú and Chilascó sites, respectively, compared to broccoli grown in monoculture.
- The use of chicken manure, in addition to chemical fertilizer, increased broccoli yields by 20% over chemical fertilizer alone.

Baseline Information

- Collection of pest problem data, natural enemies, pest management strategies, and pesticide use patterns and application techniques in broccoli, snow peas, corn and beans.
- Surveys of traditional farmers concerning methods for managing pests. The results will be used in research program planning and execution.
- Community involvement in research and production practices development in broccoli, corn, and beans in Chilasco, Chimaltenango, and Patzun.
- Farmer involvement in research design and establishment and development of IPM based Farm and Pest Management Plans.

Small Fruit

- Documentation of major insect and disease pests, so appropriate control practices in brambles can be implemented.
- Identified 22 diseases of brambles, with the most important being botrytis fruit rot and powdery mildew in blackberries; botrytis fruit rot and late leaf rust in raspberries; with increasing levels of root lesions caused by *Pratylenchus* spp. and crown gall caused by *Agrobacterium tumefasciens*. *Rosselinea* spp., an ascomycete fungus, is present in brambles grown on old coffee soils.
- The most damaging pathogens infecting blackberries found in Guatemala are *Botrytis cinerea*, causal agent of *Botrytis* fruit rot and *Oidium* spp. causing powdery mildew.
- The most important diseases affecting raspberries in Guatemala are *Botrytis* fruit rot (*Botrytis cinerea*) and a rust disease, possibly late leaf rust (*Pucciniastrum americanum*).
- Lesion nematodes (*Pratylenchus* spp.) and *Agrobacterium tumefasciens* (causal agent of crown galls) were found to be present on a large number of bramble plantations in Guatemala. Their dissemination has been conducted mostly by the exhange and planting of infected nursery plants.
- Rosselinea root rot has been found affecting several raspberry and blackberry plantations in Guatemala, on soils previously cultivated with coffee.
- The most important insect pests in brambles are spider mite (*Tetranychus* spp.), cane borers (lepidoptera), blackberry fruit borer (coleopterans) and to a lesser extent lepidopteran leaf rollers, leaf cutter ants, cutworms, white grubs, and stink bugs.
- Developed direct retail supply linkages in the United States.

Information Dissemination/Strengthening Linkages

- IPM CRSP Workshop provided a forum to discuss IPM status and research needs in Guatemala. Published Workshop Proceedings "Apoyo del IPM-CRSP a la Produccion Horticola de Exportacion".
- CARE is involved in helping disseminate IPM control strategies to local producers.
- Broccoli IPM research workshops to disseminate findings and educate growers.
- Improve communication with farmers and researchers in designing IPM programs that use traditional pest control practices.
- The development of strong institutional collaborations between GEXPRONT, Guatemalan growers and retail buyers in the United States to establish the framework for direct trade relationships in selected non-traditional export crops.

- The development of a phytosanitary inspection training program at Rafael Landivar University for achieving greater pre-export inspection of fresh produce prior to shipping.
- Establishment of workable research associations with Guatemalan collaborators on in-country research.
- Providing technical support to Guatemalan researchers.
- Opening channels of possible researcher/student exchanges between Guatemala and U.S. universities.
- Helped strengthen institutional research capabilities of Guatemalan collaborators.
- Giving talks to school children on the benefits of IPM and the precautions that should be observed when spraying vegetables was well received and most rewarding.
- Good insects are now recognized by the students and they are able to share this information with their parents.
- Results from our Year 2 studies will allow us to foster changes in the pest management practices in non-traditional crops in Guatemala. These changes will be based on information regarding pests and their natural enemies and ecological principles.
- The qualitative information obtained from the researcher-farmer association will allow closer working abilities and better potential of the gathered information to be used in IPM programs by farmers.

Market Assessments

- Identification of market window opportunities for selected non-traditional crops in U.S. markets.
- Identification of non-economic barriers to export trade expansion.
- Identification of needed policy revisions on chemical registration and labeling.
- Development of grower-direct market linkages to retail buyers in the United States.

Additional Research Funding

The Government of Guatemala became a significant supporter of IPM CRSP in Year Two, with the allocation of nearly $200,000 in PL 480 funds for IPM CRSP research. These funds will be administered by ICTA (IPM CRSP M.O.U. institution) and allocated by a Research Advisory Board comprised of: ICTA (General Director A. Fumagalli), GEXPRONT/ARF (Director R. Santa Cruz), and Purdue University (U.S. Site Chair G. Sullivan). IPM CRSP collaborators will submit research proposals on a timely basis to the Guatemala IPM CRSP Site Committee for review and recommendation. Research proposals that are approved and recommended by the Guatemala IPM CRSP Site Committee will be received and acted upon by the aforesaid Research Advisory Board. These funds provide significant new resources for advancing the program agenda and deliverables of IPM CRSP research in Guatemala.

CARIBBEAN

IPM CRSP research activities in Jamaica, for Year 2, included population dynamics studies, economic loss assessments and the determination of weed management systems of callaloo (*Amaranthus* sp.), peppers (*Capsicum chinensis*), and sweet potato (*Ipomoea batatas*). Lepidoptera larvae/spider mites, viruses and sweet potato weevils were found to be the main pests affecting callaloo, peppers and sweet potato, respectively, and the primary sources of crop loss. The data from these activities were analyzed to improve the understanding of integrated farming systems as well as determine the impact of different practices upon crop loss and pest incidence. Preliminary analyses of the cropping systems revealed a number of points in the production cycle where potential IPM interventions would be possible. These include improved timing of field sanitation and harvest; use of different traps and trap cropping. There are also obvious opportunities to reduce pesticide use and increase the selectivity of those used.

In addition to research activities, IPM CRSP in Jamaica gave technical assistance to farmers within the research communities on soil conservation, pest identification and IPM. Collaboration between IPM CRSP and local organizations involved in research relevant to the CRSP was also explored to strengthen the IPM activities.

Specific Research Accomplishments

- The existence of high levels of root-knot nematode resistance in three accessions of Scotch Bonnet type *C. chinensis* germplasm was confirmed.
- No resistance to root-knot nematodes was found in Habanero type *C. chinensis* germplasm.
- The root-knot nematode tolerant *C. annuum* cayenne pepper accession PA-136 is not suitable for utilization in a rotation scheme, nor would it be a suitable substitute for a resistant cultivar.
- The resistance to root-knot nematodes exhibited by the *C. annuum* cultivar Carolina Cayenne was demonstrated to be exceptional.
- Scotch Bonnet and Habanero peppers (*C. chinensis)* were demonstrated to be highly tolerant to the herbicide metolachlor.
- Results of preliminary tests indicate that some hybrid bell pepper cultivars *(C. annuum)* are tolerant to the herbicide bentazon.
- Some sweet potato clones were demonstrated to be allelopathic to yellow nutsedge, purple nutsedge, and annual weeds.
- Several advanced dry-fleshed sweet potato clones were confirmed to be highly resistant to both southern root-knot nematodes and *Fusarium* wilt, and to have high yield potential and excellent culinary quality.
- Diseased-free Scotch Bonnet seeds were produced which may aid in identifying viruses in Jamaica.
- Baseline soil fertility information, for the Jamaican IPM CRSP research site, was established.
- The National IPM Network, that will serve as a means to globally tie together IPM scientists, was established and funding obtained.
- There is a need for a much more detailed survey of pesticide usage on the crops studied by the IPM CRSP as well as the need for pesticide residue analysis training for a Jamaican researcher.
- Training of a biosystematic specialist in all the insect pest, mite, nematode, disease, virus and weed problems associated with callaloo, hot peppers and sweet potatoes; training of extension personnel in the basic identifications needed for field work and for

pre-clearance inspections; and training small farmers to recognize key arthropod pests diseases and weeds were identified as important for the Jamaica site.

AFRICA

Mali

- We completed Participatory Appraisal in a Malian village; developed inter-disciplinary research questionnaire, sample frame, and sample identification for base line research; and completed pretesting of questionnaire and training of field investigators.
- A need exists to conduct a detailed gender-age differentiated/women's activity analysis to identify labor constraints at the village level if the IPM interventions are to be effective.
- From the gender research perspective, the PA result indicates that in Malian villages where the social organization is characterized by a relatively less gender segregated division of labor in agriculture, women and men, as active farmers, have equivalent knowledge of control measures.
- An integrated approach to IPM that considers in totality the household crops production-pest system constraints and gender roles relevant to these crop culture activities would have sustainable impacts to achieve IPM goals as well as household food security.
- In 1995, Mali IPM CRSP found that the neem extract Azatin EC resulted in a 53% increase in early and main season millet yields., and a maximum of only 19% of the variation in yield could be explained by variation in a canonical variable for insect counts. The increase in millet yield obtained in these trials has significant potential to improve village food supplies, especially in drier areas more dependent on millet.
- In 1995, IPM CRSP Mali found hot water temperature requirement for eliminating covered smut from millet seeds prior to planting without harmful effect to the embryo.
- In the storage insect studies in Mali, the principal insects observed were *Ephestia cautella* (Walk) and secondary parasitic insects such as *Tribolium castaneum* (Herbst) and *Orysaepphilus surinamensis* (L.) were also observed. Millet was 100% destroyed. Cowpea was 100% attacked by *Callosobruchus maculatus*. All millet, sorghum, and maize grains were infested by *Apergillus* sp.
- Pest pressure, in general, was weak in Mali in 1995. High *Psalydolytta* sp. reproduction rates were not registered either in Sirakorola or Mourdiah. However, Mourdiah saw an explosion of *R. infuscata* numbers.
- In the villages of Douabougou and Koira, in the Mourdiah area several on-farm trials on *Striga* and blister beetles are underway. The *Striga* control trials, on millet, involve integrations of millet/cowpea intercropping cultural practices combined with the use of organic and mineral fertilizers on local Souna millet and improved *Striga* resistant IT89KD245 cowpea variety. As expected, the plots with manure and mineral fertilizers visually seemed to have less *Striga* than the unfertilized plots.

Uganda

- In Uganda, a four day workshop was conducted between July 12 and 15 on Participatory Integrated Pest Management for 30 representatives from agricultural research and extension, faculty from Makerere University and representatives of several NGOs. Participants were exposed to IPM and Participatory Research rationales and concepts. IPM and PA methods were discussed, demonstrated, and workshop participants provided with an opportunity to use these skills. A field protocol for conduct of the participatory assessment was designed by the group during interactive sessions following presentation and demonstration of concepts and methods.
- Two research areas, Iganga and Kumi Districts, were selected for the field participatory assessment and future IPM CRSP activities following discussions with Ugandan stakeholders. These two districts were viewed to be representative of the two predominant cereal/legume production systems in eastern Uganda. A decision was made to focus on cereals and legumes based on the recognition that IPM with these crops was still at a early stage of development; and, the desire to link research efforts between the primary IPM CRSP research site in Mali with the Uganda research site.
- Two PA teams conducted a participatory assessment in Iganga and Kumi Districts July 18 - 22. Principal methods used were semi-structured group and individual interviews, field observation with farmers, cropping calendars, preferential rankings, matrix rankings, farm mappings, and oral historical accounts.
- For all crops a follow-up program of surveillance and monitoring is advised to better understand seasonal infestations, pest biology, and to educate farmers in understanding the concept of threshold problem identification. Additionally, in Iganga, improved trapping devices and programs may be introduced; in Kumi, information on field history, fallowing and crop rotation may be examined to better understand *Striga* and its cultural control. Similar procedures being used in Mali will permit comparisons with the Uganda site.
- A proto-typical collaborative research and delivery system involving researchers, extensionists, and NGOs was demonstrated. Contact with NGOs and farmers was coordinated by the Uganda IPM Network and its representatives.
- A synthesis was conducted with both teams at each site following the PAs with the Director of the IPM CRSP. The following describes crops and primary pests that will be addressed in follow-up activities:

Crops	Key Pests Selected for Research Emphasis
Maize (Iganga)	Stalk Borers and Termites
Beans (Iganga)	Aphids and Post-harvests Pests
Groundnuts (Iganga & Kumi)	Aphids and Rosette Disease
Millet (Kumi)	Weeds (Striga & Wild Finger Millet), Borers and Grasshoppers
Sorghum (Kumi)	Striga and Stalk Borers
Cowpeas (Kumi)	Pod & Flower Pest Complex
Multi-Crops (Iganga)	Mole Rat

Other IPM CRSP initiatives, in Africa in Year 2, include:

- InterCRSP NRM in Niger in which the CRSP took leadership in organizing and implementing a Strategic Assessment of NRM issues in West Africa and a West Africa regional workshop on NRM.
- The IPM Consultative Network (ICN) which is under implementation for stengthening and institutionalizing IPM in Africa.
- West Africa InterCRSP NRM Initiative where the CRSP is leading a regional all-CRSPs effort to implement this program in West Africa.
- IPM Training in Eritrea where the CRSP has completed plans to conduct training in 1996 for 300 crop protection workers of Eritrea.

ASIA

In Philippines, building on the stakeholders meeting, participatory appraisals, farmer baseline survey, and other activities in year one, farmer field sites were made fully operational in year two and a coordinated set of research activities were initiated that included:

- Crop-pest-natural enemy surveillance to refine our view of the key pest problems
- Experimental work on insect, weed, and disease problems.

Results of these efforts have led to:

- A focusing on the nematode problem in the rice-onion system.
- Identification of which sex-pheromone combinations attracts eggplant fruit and shoot borer moths.
- Identification of *Spodoptera litura* as the key *Spodoptera* pest in onion and the testing of a particular castor bean trap crop. Many other experiments are underway.

Completion and analysis of the results of the two baseline surveys found that pesticide misuse on vegetables was increased by membership in agricultural organizations by:

- Use of credit
- Contacts with Department of Agriculture technicians and with chemical company representatives.
- Lack of knowledge about natural enemies.

On the other hand, pesticide misuse was reduced by:

- Education
- Access to the Farmer Field School training program
- Age

The implication is that increased IPM training for farmers is needed as well as increased IPM training for Department of Agriculture technicians. This training needs to be focused on younger farmers.

Specific Research Accomplishments

- The farmers' perception that *Thrips tabaci* is the most important insect pest of both native and export onions was confirmed during the monitoring activities. One possible way of reducing the damage caused by thrips is to plant early.

- The eggplant shoot and fruit borer, *Leucinodes orbonalis*, continued to be the single most important pest of eggplant.

- The presence of root-knot nematodes, *Meloidogyne graminicola*, significantly changed our view of the pest situation on onions in San Jose. Preliminary assessment of the onion farmers' fields revealed that most fields were infested with various degrees of rootknot nematode, the same species infesting rice under irrigated lowland and rainfed conditions. During the year, monitoring in other onion-growing areas within Nueva Ecija now shows that the nematode problem is more extensive than previously realized and a potentially serious threat to onion production throughout the country. Nematode damage, misperceived by farmers as insect damage, has caused insecticide applications for the wrong pest in many onion fields, without solving the problem. The declining irrigation water availability in Central Luzon has favored the spread of this nematode which easily transfers to other crops after rice, particularly onions.

- The onion fields were dominated by *Cyperus rotundus* in Sto. Tomas and *Cleome viscosa*, *Phyllanthus amarus*, and *Trianthema portulacastrum* in Abar 1st.

- Preliminary observations point out the high probability of the significant role of straw mulch in the spread and increase in incidence of sheath blight in the rice-vegetable systems. Microorganisms, such as *Trichoderma, Bacillus*, and *Pseudomonas* have been isolated and tested for control of sheath blight.

- The armyworm (*Spodoptera*) is a pest that feeds on a number of vegetable species. In our work it is mainly a pest of onions and beans. In an attempt to control this pest, to date several component mixtures of pheromone chemicals have been tested and promising mixtures will go into field testing the next growing season. Pheromones have potential at least as monitoring tools for both *Spodoptera* and the eggplant fruit and shoot borer. Better monitoring will mean better predictablility concerning the timing of pest infestation which will afford the farmer the opportunity to eliminate pesticides sprays when the pests are not a threat. In the past pesticides were overused because the farmer was not sure if the pest was invading or not and he sprayed just in case.

- In eggplant, according to our surveillance studies over the past season, the most significant pest is the eggplant fruit and shootborer (EFSB). In worst case situations this pest is sprayed 30-50 times in a single season. Pheromone tests, similar to those used for *Spodoptera* , are being carried out.

- Onion bulb and seedling rotting fungi were found to be significant in preliminary surveys of onion fields. Infestations, especially in seedbeds caused the loss of many seedlings before they could be transplanted to the field. Since these are soilborne fungi, the management of the seedbed has to be manipulated to prevent these diseases. This will be one of the focusses of research over the next several months.

- A detailed analysis of pricing and exchange rate policies in the Philippines found that the net effects of these policies are to subsidize pesticide use, but the subsidy is only six to eight percent and hence should not provide a major barrier to IPM adoption.

- Results of the PA efforts focused on women farmers identified their key role in decision making with respect to their budget, including pest management decisions, even though males are usually the ones to spray pesticides.

- Any IPM solutions to weed problems on onions that involves reduced hand weeding, will free up women's time for other activities but may also affect an important source of income for the poorest women.

- Men do exclusively the activities which are power-intensive (land preparation, threshing etc.).

- Women carry out control-intensive activities which require manual dexterity and judgment (transplanting, weeding onion fields, sorting onion seedlings, harvesting, grading onions).

- Most women are aware of the prevalent pests in rice and onions and are also aware of harmful effects of the misuse of pesticides, but are not knowledgeable about IPM in vegetables.

- Women support adoption of alternative methods of pest control in onion crops as a measure to decrease production cost to the end benefit of increase in economic returns.

In summary, in 1995 the IPM CRSP in the Philippines found that pesticide misuse on vegetables was increased by membership in agricultural organizations, by use of credit, by contacts with Department of Agriculture technicians and with chemical company representatives, and by lack of knowledge about natural enemies.

The net effects of tariff and exchange rate policies in the Philippines are to subsidize pesticide use, but the subsidy is only six to eight percent and hence should not provide a major barrier to IPM adoption.

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 second year of its operation, this CRSP provided full or partial financial support for ten graduate students. These students are supervised by IPM CRSP investigators and have their research for their thesis on an IPM related topic. During this second year, four of the ten students are from the four regions this CRSP is working in. All the graduate students do their research in our four regions. One of the graduate students, Jessica Tjornhom (the first IPM CRSP graduate), completed her training and submitted, to Virginia Tech, her M.S. thesis entitled "Assessment of Policies and Socio-Economic Factors Affecting Pesticide Use in the Philippines".

In the future, as the IPM CRSP investigators establish stronger linkages and identify more potential graduate students from the host countries, the number of foreign students is expected to increase. Six of the ten 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 seven and Lincoln University, Ohio State University, and the University of Georgia each has one graduate student.

INTRODUCTION

This is the second 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. The CRSP is now fully operational at all of its major geographical regions. Although the focus is on the prime sites, aggressive initiatives have also been taken at other sites to promote globalization of IPM.

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.

The activities undertaken during the second year in each of our geographic areas are reported separately by region, under Latin America, Caribbean, Africa, and Asia. The presentations under each region start with an overall site report by the site chair and are followed with reports of investigators in the U.S. and host countries. Reports of investigators are presented both by U.S. and host country institutions under each region. A number of significant research accomplishments have been achieved during the year and these are highlighted in the various reports of the investigators.

Finally, a status report on the training aspects of the IPM CRSP is given. The IPM CRSP has supported ten graduate students during Year 2.

In terms of operational management, Virginia Tech has 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. INRAN, Niger
9. IRRI, Philippines
10. PhilRice/NCPC, Philippines
11. AVRDC, Taiwan
12. Makerere University, Uganda

The Board of Directors

The Board of Directors (BoD) is the top policy body of the IPM CRSP. It held its meeting of the year on June 13 and 14, 1995 in Blacksburg, VA and received reports on Overview of the Year's Activities and Status of the CRSP, Results of the External Evaluation Panel Review, Technical Committee Activities, Budget, Future Strategies and New Initiatives, Communication and Information Exchange, and USAID Perspectives. The Board made decisions on a number of issues including the approval of the Policy and Operating Procedure Manual of the CRSP.

The current Board members are:

Dr. Tom Payne, Chair	The Ohio State University
Dr. Mary E. Carter	USDA Vegetable Laboratory
Dr. Ikbal Chowdhury	Lincoln University
Dr. S.K. De Datta	Virginia Tech
Dr. Peter Gregory	International Potato Center (CIP)
Dr. Dean Jansma	Pennsylvania State University
Dr. Ed Kanemasu	University of Georgia
Dr. Santiago Obien	Philippines Rice Research Inst. (PhilRice)
Dr. Paul S. Teng	Internationall Rice Research Inst. (IRRI)
Dr. Robert Hedlund (Ex-officio)	USAID, IPM CRSP Project Manager
Dr. Brhane Gebrekidan (Ex-officio)	Program Director, IPM CRSP
Dr. R. Kent Reid (Ex-officio)	Assistant Program Director, IPM CRSP

The Technical Committee

The Technical Committee (TC) met on May 21-22, 1995 in Blacksburg and conducted a telephone conference on September 7, 1995. The major achievement of the TC meetings was to discuss and finalize the Year 3 Workplan.

The current members of the TC are:

Dr. George Norton, Chair	Virginia Tech
Dr. Ron Carroll	University of Georgia
Dr. Florence Dunkel	Montana State University
Dr. Frieda Eivazi	Lincoln University
Dr. Mark Erbaugh	Ohio State University
Dr. Charlie Pitts	Pennsylvania State University
Dr. Ed Rajotte	Pennsylvania State University
Dr. Glenn Sullivan	Purdue University
Dr. Robert Hedlund (Ex-officio)	USAID, IPM CRSP Project Manager
Dr. S.K. De Datta (Ex-officio)	Principal Investigator, IPM CRSP
Dr. Brhane Gebrekidan (Ex-officio)	Program Director, IPM CRSP
Dr. R. Kent Reid (Ex-officio)	Assistant Program Director, IPM CRSP

External Evaluation Panel

The first External Evaluation Panel (EEP) Review of the IPM CRSP was done April 26-27, 1995 in Blacksburg. The members of the Panel were Dr. Melvin Blase (Interim member and Interim Chair), Dr. Sonny Ramaswamy, and Dr. Douglas Rouse. The review was based on written documents, discussions with representatives of the ME, TC, BoD, and Site Coordinators.

In the introduction section of its report the EEP states "Although plagued by budget reduction problems from the outset, the CRSP has made considerable progress in terms of initial organization. The Management Entity is staffed with experienced personnel. The Technical Committee is in place and functioning. The Board of Directors is organized. The four primary sites of Guatemala, Jamaica, Mali, and the Philippines have been selected and work is underway. The four site coordinators are functioning. Likewise, programs at the corollary sites have been launched. Hence, a considerable amount of initial activity has been accomplished."

The EEP report has highlighted the progress the CRSP has made and also suggested areas of improvement.

The current members of the EEP are:

Dr. Melvin Blase (Interim Chair)	University of Missouri
Dr. Derek Byerlee	World Bank
Dr. Donald Plucknett	Agricultural R and D International
Dr. Sonny Ramaswamy	Mississippi State University
Dr. Douglas Rouse	University of Wisconsin

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, (15%)
Peggy Hall, Fiscal Technicial Senior, OIRD (30%)
Martha Bower, Program Support Technician Senior, OIRD (15%)

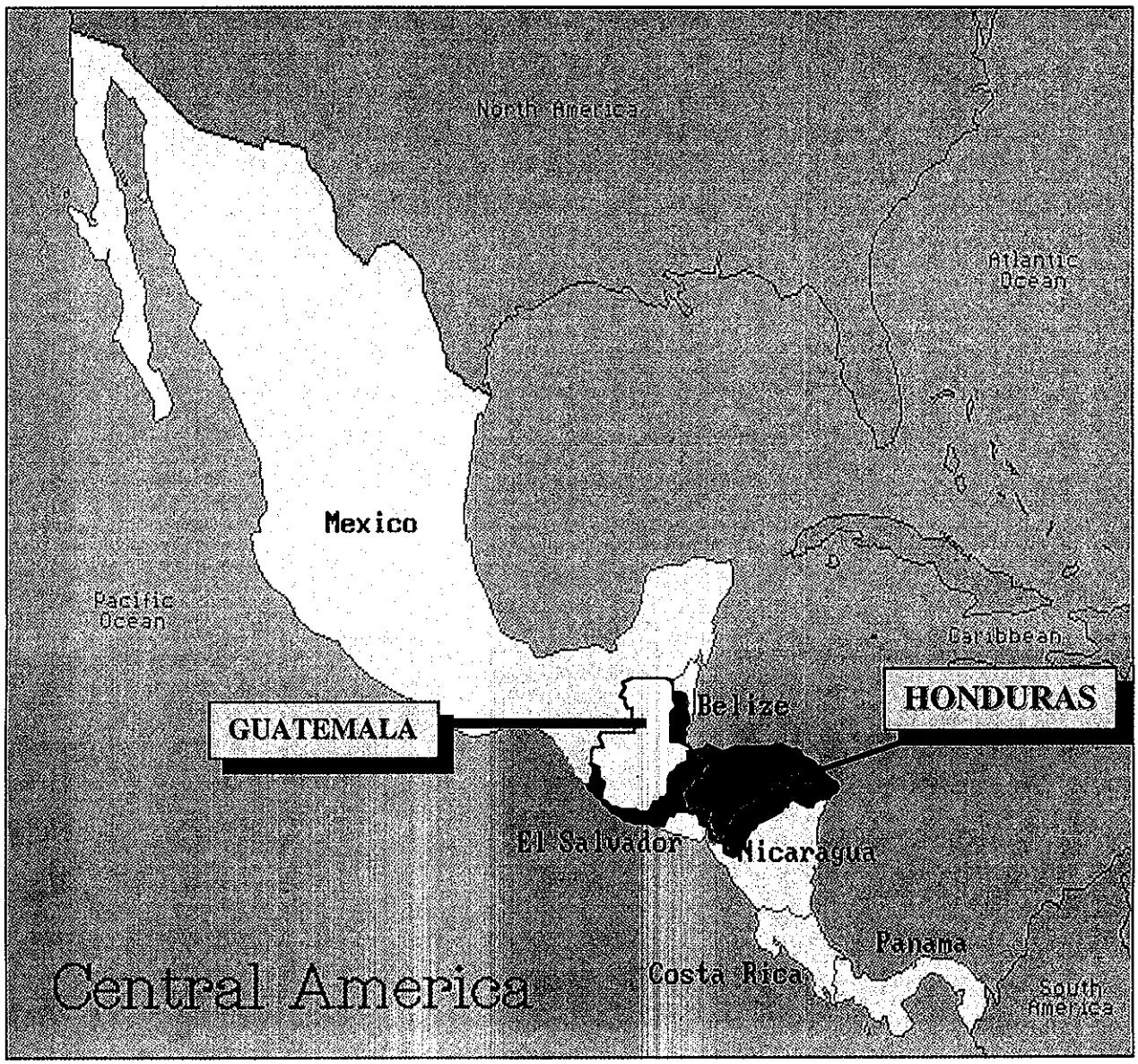
Some of the main achievements of the ME during the year were:

- Formed the EEP of the IPM CRSP, developed its scope of work, prepared the briefing documentations for the First EEP Review, implemented the review process itself, and finally participated in the review.

- Organized the TC and Board meetings of the IPM CRSP and implemented them successfully.

- Developed and finalized the IPM CRSP logo, as well as the official letterhead.
- Produced and distributed the first IPM CRSP Update and Brochure.
- Developed the IPM CRSP Policy and Operating Procedures Manual, distributed it to members of the TC, Board, EEP, and all IPM CRSP co-PIs.
- Coordinated and followed through the development of the IPM CRSP Year 3 Workplan.
- Developed the IPM Consultative Network (ICN) proposal and workplan for $100,000/two year grant Africa Bureau funding to Virginia Tech, obtained funding, and initiated implementation.
- Organized and implemented the NRM Strategic Assessment of West Africa and an all-CRSPs Regional Workshop on NRM in West Africa under a grant of about $92,000 to the IPM CRSP/Virginia Tech.
- As the "lead CRSP" for the interCRSP NRM initiative in West Africa, prepared a project proposal for USAID Africa Bureau funding ($1.6 million for three years), received approval and initiated implementation of the initiative.
- Developed a proposal for "IPM Training in Eritrea" and obtained USAID Global Field Mission Support of $300,000 and finalized plans for its implemention in 1996.
- Developed a proposal for Pest and Pesticide Management Project (PPMP) in Ukraine, received a two year USAID grant of $1.3 million, and initiated its implementation. The parties collaborating in the implementation, under the leadership of OIRD/Virginia Tech, are IPM CRSP Collaborating Institutions, U.S. Environmental Protection Agency (Region V), and The NIS Exchanges and Training Program Academy of Education Development (NET/AED).

CENTRAL-LATIN AMERICA



LATIN AMERICA REGION ANNUAL REPORT

Glenn H. Sullivan, Site Chair; Purdue University
C. Ronald Carroll, Vice Chair; University of Georgia
Linda Asturias de Barrios, Host Country Administrative Site Coordinator
Danilo E. Dardon Avila, Host Country Technical Site Coordinator

I. PROGRAM DESCRIPTION

The Guatemala/Central American IPM CRSP Site is directed by the Guatemalan Site Committee and coordinated by Dr. Linda Asturias and Ing. Danilo Dardon. The Site Committee is comprised of D. Dardon, ICTA; M. Dripchak, CARE; R. Solorzano, ALTERTEC; R. Santa Cruz, GEXPRONT; V. Salguero, CATIE; G. Sanchez, AGRILAB; L. Asturias, ASIES; A. Dix (ex officio), University of Georgia. These Site Committee collaborators meet monthly to establish future program agendas and review current research activities. Linda Asturias currently serves as the administrative coordinator, and the principal communication linkage for all collaborators. Dr. Asturias communicates regularly with the U.S. Site Coordinator (G. Sullivan) on all program matters. This organizational structure is fully operational, and served as the basis for achieving high levels of interdisciplinary collaboration among all IPM CRSP stakeholders in Year Two. This is evidenced by the highly energized collaborative efforts for achieving workplan deliverables, and the focused research agenda going into Year Three.

The Guatemala Site Committee, and its collaborators, operate under budget constraints typical of institutions in Central America. However, USAID IPM CRSP funding has served as the catalyst for bringing host country institutions and program collaborators together in an unprecedented collaborative team effort to accomplish common goals. Collaborating institutions that seldom had <u>any</u> interaction, are now meeting regularly under IPM CRSP to discuss common production problems and research needs. These shared experiences and interactions led to the hosting of a highly successful IPM Workshop in June, that was attended by 96 participants representing private and public sector organizations from throughout Guatemala. This successful workshop could not have been achieved without high levels of communication and collaboration among the Site Committee members in program planning and execution. A proceedings was edited and published by the Site Committee.

Research collaborations within the Site Committee led to the hosting of a workshop/grower training session on integrated pest management practices in broccoli. The objectives were to present research findings and educate growers/attendees on the correct use of chemicals in pest management, and to encourage reduced chemical use through IPM in broccoli production. The success of this collaborative initiative led to the development and publication of a research bulletin for growers titled "Manejo Integrado del Cultivo de Broccoli"; edited by Dr. Victor Salguero at CATIE and authored by IPM CRSP collaborators at ICTA and GEXPRONT/ARF.

IPM CRSP funding and program activities have led to the development of additional resources for advancing the Site Committee's agenda in Guatemala. GEXPRONT, through its Agricultural Research Fund (ARF), has provided matching funds for selected IPM CRSP related research that parallels GEXPRONT's grower-member needs. These matching funds are expected to increase substantially in 1995/96.

In addition, IPM CRSP Site Committee research activities will benefit from the Government of Guatemala's allocation of nearly $200,000 in PL 480 funding for 1995/96. This funding allocation to IPM CRSP related research projects is substantive evidence of the host country's support for current program activities and priorities.

II. IPM CONSTRAINTS RESEARCHED

A. Automatic Detention In Snow Peas

This is a major issue in Guatemala. Currently, 25 of the 29 registered snowpea exporters in Guatemala are still on automatic detention at U.S. Ports of Entry as a result of illegal chemical use in 1992.

IPM CRSP research collaborators have worked to establish in-country chemical use, pesticide monitoring and inspection procedures that help achieve phytosanitary compliance, and thereby reduce the use of hard chemicals and increase Guatemalan export opportunities to the United States and Europe. GEXPRONT has helped sponsor research and grower education programs, and established a Phytosanitary Inspector Training Program in collaboration with Rafael Landivar University in Guatemala City.

B. Institutional Resource Base

One of the more serious constraints relates to the resources available to accomplish our collaborators research agenda. Often this is the limiting factor for achieving fulfillment of workplan research objectives. Our collaborators are generally well trained and enthusiastic, but lack the equipment, inputs, and technology to fully accomplish their research activities. IPM CRSP has worked to develop a team approach in seeking solutions to these constraints. Institution building is a key component of the newly funded ICTA/World Bank restructuring program, as well as for the collaborative agreement between Rafael Landivar and Purdue Universities. It is envisioned that these resource building activities will be expanded in future years, with Virginia Tech, University of Georgia, and Ohio State University participating. Developing the full benefits potential of IPM CRSP will depend largely upon our success in enhancing the institutional resource base in Guatemala/Central America.

C. Research Training

Researchers in Guatemala/Central America generally are trained within the region. Often this training is enhanced through the transfer of advanced knowledge and research technique from institutions outside the region. Research design, data analysis, scientific method, and final report preparation are areas where U.S. collaborators need to provide additional assistance. Close working relationships with the host country scientists provides the basis for enhancing research capacity, and furthering the objectives of IPM CRSP. Scientific exchanges need to be encouraged, especially those that can provide the host country scientists with a U.S. training experience.

III. INSTITUTION BUILDING

IPM CRSP collaborators have worked in concert to assist ICTA (our M.O.U. institution) and GEXPRONT (association for non-traditional crop exporters) achieve highly focused program missions in integrated pest management research. ICTA has strategically developed, promoted, and received approval for a $50 million institutional restructuring program from The World Bank. This activity will take place over a six-year period, and focus heavily on reorganizing research and development programs along lines that parallel many IPM CRSP objectives - including: research and education programs that promote safer food supplies and less use of chemicals, greater reliance on integrated pest management practices, and total systems approaches to achieving greater efficiencies and export earnings in non-traditional crops.

Rafael Landivar University, through the efforts of Ricardo Santa Cruz and GEXPRONT, has negotiated an institutional agreement with Purdue University for collaborations in research, technology transfer, faculty exchange and student exchange to strengthen their participation in IPM CRSP related activities. Under this institutional agreement, Purdue University will provide both long-term and short-term training and technical assistance for faculty and students at Rafael Landivar University. In addition, Purdue University will provide the leadership for meeting selected research missions of GEXPRONT and Rafael Landivar University. It is envisioned that collaborating IPM CRSP research institutions in the United States will participate as this initiative develops and matures.

Four IPM CRSP host-country collaborators visited the United States in Year Two. Dr. Victor Salguero represented the Guatemala/Central American Site Committee at the annual Technical Committee Meeting in May 21-22, 1995, at Virginia Tech. In August, 1995 Dr. Guillermo Sanchez (AGRILAB) met with researchers at Purdue University to discuss IPM CRSP research issues, assess knowledge/ technology transfers, and establish linkages for future research collaborations. In addition, Dr. Sanchez met with retail produce buyers (Kroger, Marsh, Caito, and Schnuck) to establish performance requirements for shipping blackberries and raspberries from Guatemala. Dr. Ricardo Santa Cruz visited Purdue University in September, 1995 to formalize an institutional agreement with Rafael Landivar University, and establish research linkages in Agribusiness, Natural Resources and Environmental Sciences, Horticulture, and Forestry. Dr. Linda Asturias met with IPM CRSP collaborators at Purdue University in October, 1995 to review Year Two program activities, finalize Year Three workplans and deliverables, and develop linkages with researchers in the social sciences (Agricultural Economics and Rural Sociology).

Two Guatemalan graduate students, sponsored by U.S. collaborating institutions, are conducting their thesis research in IPM CRSP related projects. Ann M. Dix, Ph.D student in Ecology is working under the direction of Dr. Ron Carroll, University of Georgia. Her project involves understanding the impact of the gallina ciega (white grub) complex on broccoli production in Guatemala. Her project involves not only field research to identify species of white grubs involved, but to evaluate current and new IPM control practices, farmer thoughts on the nature of the problem, and socioeconomic issues relating to the problem. Her research involves a community approach and has brought the involvement of regional experts (Guatemalan University and other Central American) and U.S. scientists in the project.

Helda Morales, Ph.D. student is working with Dr. Roger Williams of The Ohio State University. Her project involves the study of how soil management practices, both traditional and non-traditional, affect pest complexes and their natural enemies in broccoli production. This research is also a community approach which involves farmer surveys, farmer research, and test plots. Her research also integrates general community involvement in defining pest problems and control approaches. Helda has been successful in broadening inputs from regional and international experts in the identification of specific pest, natural enemies, production practices involving soil management, and alternative IPM control options.

IV. NETWORKING

In June, 1995 the IPM CRSP Site Committee hosted a regional seminar/workshop to present research, and network with public and private sector agencies. This activity proved very productive. NGO's throughout the region (Guatemala, Honduras, Costa Rica, and El Salvador) have been in contact with IPM CRSP to develop participatory linkages and receive current research findings. This activity led to the development of stronger working relations with the Peace Corps in Guatemala; currently six Peace Corps Volunteers are assigned to IPM CRSP related activities with ALTERTEC.

In addition, IPM CRSP collaborators are participating in the working committee structure of GEXPRONT. These working committees are comprised of growers representing each major non-traditional export crop, across all Districts in Guatemala. IPM CRSP participation in these working committees provides direct channels of communications for problem identification, research collaboration, and distribution of collaborator research findings. This participatory activity represents an excellent opportunity to provide leadership in promoting the objectives/implementation of IPM CRSP. These same IPM CRSP collaborators (G. Sanchez, V. Salguero, and D. Dardon) also participate in AGRITRADE, the regional annual trade convention and seminar sponsored by GEXPRONT.

Collectively, these networking activities have been instrumental in elevating IPM CRSP's research to a level of high awareness and acceptance in a relatively short period of time.

V. RESEARCH ACCOMPLISHMENTS

A. *Fully Operational Site Committee*

Participatory research and sustainable deliverables cannot be accomplished without a functional viable Site Committee. Clearly, one of our major accomplishments has been the development of a strong and productive Site Committee. This will provide the basis for long-term productivity and more effective advancement of the IPM CRSP program agenda. The Guatemala/Central America Site Committee will be further strengthened in Year Three with the full-time program leadership of Dr. Victor Salguero, and the active participation of Dr. Allan J. Hruska (Zamorano).

B. Established Research Priorities

The IPM CRSP Site Committee has done an excellent job of assessing research needs and establishing research priorities to maximize use of funds and deliverables in Year Three. This has resulted in a highly focused research agenda that targets solving some of the most pressing regional pest management related problems. This is reflected in both the Year Two and Year Three Workplans, reference: (1) GEXPRONT and the development of a phytosanitary inspection training program for Guatemalan non-traditional exports, (2) University of Georgia and the research on gallina ciega in broccoli, etc.

C. Buy-In by GEXPRONT

The Gremial de Exportadores de Productos No Tradicionales (GEXPRONT) have been cautious in developing their relationship with IPM CRSP. However, Year Two activities have served to convince GEXPRONT that IPM CRSP is committed to long-term research objectives that are essential for future production and trade expansion in the non-traditional crops. This has led to greater program involvement/leadership by GEXPRONT, which will culminate with a full buy-in in Year Three. GEXPRONT will provide half of the financial resources to retain the services of Dr. Victor Salguero as IPM CRSP Site Coordinator in Guatemala/ Central America, thereby freeing Dr. Linda Asturias and Ing. Danilo Dardon to concentrate on their research deliverables in Year Three. In addition, GEXPRONT will increase matching funds to host country collaborators for IPM CRSP related research funded through PL 480/CRSP in Year Three.

D. Specific Research Accomplishments

ICTA

- Determination of the best commercial *Bt* products for control of specific insect pests in non-traditional vegetables.
- Gathering of baseline data concerning important pests, control practices, and farmer attitudes concerning IPM strategies in non-traditional fruits and vegetables.
- Gathering control information for improved pesticide application techniques and evaluation of control needs in broccoli and snowpeas.
- Organization of tomato growers in research and control implementation for integrated white fly control programs.
- Studies investigating the use of oils and detergents for aphid control in broccoli.

Pest Control and Cultural Practices in Vegetables

- Improved knowledge of species involved in the white grub complex, including species involved and host plants for adult beetles.
- Improved knowledge of current cultural practices that promote white grub infestations in broccoli, such as cornstover and use of raw chicken manure.
- Identification of *Plutella xyllastela, Leptophobia aripa, P. xyllastela* and aphids as major broccoli pests at Chirijuyu and Chilasco, respectively.
- Use of strip cropping (black bean/broccoli) resulted in up to 51% greater yields than broccoli monocultures, suggesting alternatives to monoculture are useful in reducing pest problems in broccoli.
- The use of chicken manure, in addition to chemical fertilizer, increased broccoli yields by 20% over chemical fertilizer alone.

Baseline Information

- Collection of pest problem data, natural enemies, pest management strategies, and pesticide use patterns and application techniques in broccoli, snow peas, corn and beans.
- Surveys of traditional farmers concerning methods for managing pests. The results will be used in research program planning and execution.
- Community involvement in research and production practices development in broccoli, corn, and beans in Chilasco, Chimaltenango, and Patzun.

Small Fruit

- Documentation of major insect and disease pests, so appropriate control practices in brambles can be implemented.
- Identified 22 diseases of brambles, with the most important being botrytis fruit rot and powdery mildew in blackberries; botrytis fruit rot and late leaf rust in raspberries; with increasing levels of root lesions caused by *Pratylenchus* spp. and crown gall caused by *Agrobacterium tumefasciens*. *Rosselinea* spp., an ascomycete fungus, is present in brambles grown on old coffee soils.
- The most important insect pests in brambles are spider mite (*Tetranychus* spp.), cane borers (lepidoptera), blackberry fruit borer (coleopterans) and to a lesser extent lepidopteran leaf rollers, leaf cutter ants, cutworms, white grubs, and stink bugs.
- Developed direct retail supply linkages in the United States.

Information Dissemination

- IPM CRSP Workshop provided a forum to discuss IPM status and research needs in Guatemala.
- CARE is involved in helping disseminate IPM control strategies to local producers.
- Broccoli IPM research workshops to disseminate findings and educate growers.

Market Assessments

- Identification of market window opportunities for selected non-traditional crops in U.S. markets.
- Identification of non-economic barriers to export trade expansion.
- Identification of needed policy revisions on chemical registration and labeling.
- Development of grower-direct market linkages to retail buyers in the United States.

E. *Publications and Reports*

1. Proceedings IPM CRSP Workshop: "Apoyo Del IPM CRSP a la Produccion Horticola de Exportacion". Editors: Victor Salguero (CATIE/ICTA) and Guillermo Sanchez (AGRILAB)
2. Research Report: Integrated Management Practices in Broccoli - ICTA; CATIE; ARF.
3. Research Report: Manejo Integrado Del Cultivo De Broccoli - H. Carranza; R. Morales; E. Garcia; A. Sierra; A. Rodas, D. Dardon; T. Noda, F. Gomez; V. Salguero.
4. Research Report: Corn Stalks Influence Patchy Distribution of White Grubs in Broccoli Fields - A. Dix; R. Carroll; M. Dix; G. Dal Bosco.
5. Research Report: IPM in Non-Traditional Export Agriculture in Guatemala: The Case of Chilasco, Baja Verapaz - A. Dix; R. Carroll.
6. Research Report: Integrated Pest Management on Snowpea Crops, E. Calderon.

7. Research Report: Achievement, Advances and Future of IPM CRSP with ICTA - D. Dardon; H. Carranza.
8. Research Report: Problems with Chemical Pesticides on Broccoli Crops - H. Carranza.
9. Research Report: Evaluation of Commercial Products Based on *Bacillus Thuringiensis* for Control of Lepidoptera Insects in Broccoli Crops - H. Carranza; F. Gomez; D. Dardon; V. Salguero.
10. Importancia De Los Sistemas De Produccion Organica En La Agricultura Sostenible - R. Solorzano.
11. Varietal and Cultural Control of Pests in Integrated Pest Management Programs - S. Weller; V. Salguero.
12. The Role of IPM CRSP in Achieving Global Food Safety and Production Sustainability - G. Sullivan; D. Dardon; L. Asturias.
13. Research Report: Agri-lab: Situacion actual y futuro dentro del IPM-CRSP - G. Sanchez; M. Wade.
14. Research Report: Estrategias del MIP: Control Quimico - G. Sanchez; R. Williams.
15. Research Report: Problemas Fitosanitarios en Mora y Frambuesa en Guatemala - G. Sanchez.
16. Research Report: Problemas Fitosanitarios en Cultivos no Tradicionales de Exportacion - R. Santa Cruz.
17. Research Report: Gallina Ciega *Phyllophasa spp.* y *Anomala spp.*, en el Brocoli de Chilasco, Baja Verapaz - A. Dix; C.R. Carroll; G. Dal Bosco.
18. Annotated Bibliography: IPM CRSP Central American Site in Guatemala - V. Seitz; T. Chew.

F. *Additional Research Funding*

The Government of Guatemala became a significant supporter of IPM CRSP in Year Two, with the allocation of nearly $200,000 in PL 480 funds for IPM CRSP research. These funds will be administered by ICTA (IPM CRSP M.O.U. institution) and allocated by a Research Advisory Board comprised of: ICTA (General Director A. Fumagalli), GEXPRONT/ARF (Director R. Santa Cruz), and Purdue University (U.S. Site Chair G. Sullivan). IPM CRSP collaborators will submit research proposals on a timely basis to the Guatemala IPM CRSP Site Committee for review and recommendation. Research proposals that are approved and recommended by the Guatemala IPM CRSP Site Committee will be received and acted upon by the aforesaid Research Advisory Board. These funds provide significant new resources for advancing the program agenda and deliverables of IPM CRSP research in Guatemala.

AGRILAB

Effects of Strip-Cropping on Insect Pests, Diseases, and Yield of Broccoli at Two Guatemalan Highland Locations.

Investigators: Guillermo E. Sánchez and Michael Wade, Agri-lab

II. COLLABORATING SCIENTISTS

None

III. SUMMARY OF RESEARCH RESULTS

In Year two of the IPM CRSP/Guatemala, one of agri-lab's main research activities consisted of field experiments directed to determine the influence on yield and pest pressure of strip-cropping broccoli with corn and/or black beans. Broccoli grown in monoculture was the standard treatment. The effect on broccoli's yield of incorporating chicken manure to the soil in addition to chemical fertilizer was also tested.

The broccoli strip-cropping trials were conducted at Chirijuyú and Chilascó, two distinct broccoli-growing regions located in the central and northern (Sierra de las Minas) highlands, respectively.

Results show that broccoli at both sites are affected by the same principal pests. At Chirijuyú the main lepidopteran pests was *Plutella xyllastela*. At Chilascó the main insect pest was *Leptophobia aripa* in addition to *P. xyllastela*. Aphids were common at both sites as well. Insect pressure remained low during the entire crop's cycle. At Chirijuyú the lepidopteran larval pressure in monocultured broccoli was 1.16, 1.24 and 1.09 times the larval pressure of black bean/broccoli, corn/broccoli and corn+bean/broccoli strips, respectively. Similarly, aphid counts were larger on broccoli monoculture in comparison to the three strip-cropping arrangements.

At Chilascó broccoli grown in monoculture evidenced lower larval pressure, ranging from 0.60 (corn/broccoli) to 0.72 (corn+bean/broccoli) times the number of insects found in the strip-crop patterns. Aphid counts were similar in the monoculture, bean/broccoli and corn/broccoli treatments but were approximately 1.26 times larger on the corn+bean/broccoli pattern.

Disease pressure remained low throughout the crop's cycles, being the most common ones Phoma leafspot and downy mildew, at both localities. In addition, damping-off (*Rhizoctonia solani*) was important at Chilascó during the first two week after transplant, causing approximately 20% loss of the plant population.

Broccoli production was increased in the black bean/broccoli pattern, yielding 32% and 51% more than monocultured broccoli at Chirijuyú and Chilascó, respectively. The application of chicken manure in addition to chemical fertilizer at the time of planting increased broccoli production close to 20% in contrast to chemical fertilizer alone.

These results suggest that strip-cropping broccoli with staple food crops may prove economically beneficial to the farmers. The data presented here also suggest that the evaluated cropping system may help reduce insect pressure at specific localities, although further research is necessary to determine the precise effect of strip-cropping on insect and disease pressure affecting broccoli.

IV. OBJECTIVES AND IPM CONSTRAINTS

To determine the influence of strip-cropping on yield and levels of insect pests and diseases affecting broccoli.

The specific objectives were:

- To identify the main insect pests and diseases affecting broccoli, grown in association with staple food crops and monoculture, at Chirijuyú and Chilascó.
- To determine the levels of insect populations in the evaluated crop associations and their effect on broccoli production at both sites.
- To determine the incidence and severity of biotic diseases affecting broccoli grown in 3 different strip-cropping arrangements and monoculture.
- To determine the yield and quality of broccoli produced under the evaluated cultivation conditions.
- To determine the effect of incorporating chicken manure in addition to chemical fertilizer on broccoli yields.

The IPM constraints addressed through this research deal directly with the search for a reduction in the amounts of pesticides applied in broccoli to control insect pests and diseases. The cultivation of broccoli in monoculture provides a suitable setting for a fast increase in the levels of insect pests and disease if other conditions (such as the environment) are adequate. In contrast, the association of broccoli with other crops which are not favored by the same insects and diseases may result in reduced growth rates of both harmful insects and biotic diseases. A decline in these growth rates would allow for a reduction in the amounts of pesticide being applied to the crop, resulting in less exposure by the farmer to toxic compounds, a healthier environment and larger profit margins. The final broccoli consumers (mainly the U.S. market) would also benefit greatly from enhanced food safety, derived from reduced pesticide concentrations in this export crop.

The effect of incorporating chicken manure to the soil, in addition to chemical fertilizer was included in the experiments because it is a widespread belief in Guatemala that chicken manure amendments to the soil are almost essential for satisfactory yields and quality. This belief is taken as true by the farmers, regardless of the nutritional status and organic matter contents of the soil or the incorporation of adequate fertilizer amounts to meet the crop's nutritional demands.

V. RESEARCH APPROACH AND OUTPUT

A. *Research Methods*

Field trials were conducted at both Chirijuyú and Chilascó. Chirijuyú (altitude 2,000 m above sea level) is a small community in the central highlands (municipio of Tecpán, department of Chimaltenango), located 50 miles west of Guatemala city. It is characterized by a diversified agricultural production base, in which broccoli and other non-traditional export crops (snow peas, snap beans, french beans, raddichio) have been important components for at least 12 years.

Chilascó (municipio of San Gerónimo, Department of Baja Verapaz) is an area recently introduced into the non-traditional crop production scenario. It is located 100 miles north of Guatemala city in the "Sierra de las Minas" reserve, at an altitude of 1,900 m above sea level. Broccoli was introduced into Chilascó approximately 5 years ago and has, since then, gained tremendous strength. The other non-traditional export crop grown at Chilascó is mainly french beans.

1. Experimental Design

The experimental design consisted of 4 main treatments distributed in complete randomized blocks with a split-plot arrangement, replicated 5 times. The sub-plots consisted of the incorporation of organic matter plus chemical fertilizer at the time of plantings vrs chemical fertilizer alone. The main plot treatments were: 1) broccoli in monoculture as the standard treatment (BR), 2) strips of black beans and broccoli (BE/BR), 3) strips of corn and broccoli (CO/BR) and, 4) corn associated (mixed) with black bean planted in strip-cropping with broccoli (CO+BE/BR). The sub-plots consisted of one half of the main plot treated with chicken manure plus chemical fertilizer at the time of planting; the other half received only chemical fertilizer.

The main plots consisted of 7 strips, 4 staple food strips (either BE, CO, or CO+BE) alternated with 3 broccoli strips. The BE, CO and BE+CO (staple food crops) strips were 4 rows wide planted 0.6 m apart; the broccoli strips (target crop) also consisted each of 4 rows planted 0.6 m apart. Rows of each main plot were 10 m long for a per strip area equal to 24 m^2 and 168 m^2 area per main plot. Consequently the entire experiment at each site covered an area of 3,360 m^2. At both Chirijuyú and Chilascó, the 5 replications were established on land belonging to three different farmers, due to area constraints encountered during the search for suitable land in which to establish the trials.

The Chirijuyú trial was started on May 15th date at which the non-target strips (BE, CO and BE+CO) were planted. Nearly one month later, on June 11th, broccoli speedlings supplied by ALCOSA (a private packing plant) were transplanted to the field.

Similarly, at Chilascó the bean and/or corn strips were planted one month before establishing the broccoli speedlings, which were transplanted on June the 22nd.

2. Data Collection

A total of 7 insect and disease readings were taken at both sites. Insect data was gathered by randomly inspecting a sample of 20 broccoli plants from the central strip of every main plot and counting the total number of larvae present in the sample. Aphids were counted as colonies per sample; in cases when only one aphid was located at any particular portion of the plant it was also counted as a colony. Foliar diseases, were also recorded from the 20-plant sample in terms of both incidence and severity.

At harvest time, and in order to determine the effect of chicken manure on broccoli's production, yields were estimated by taking the central portion of the sub-plots. The harvested area had a width of 4 rows and a length of 2.4 m (6 plants) for a total of 24 broccoli plants per net sub-plot. The total net subplot area was $5.76m^2$.

B. Research Results

The main pests encountered at both Chilasco and Chirijuyú were 3 lepidopteran insects namely *Plutella xylastella* (Lepidoptera:Plutellidae), *Trichoplusia ni* (Lepidoptera:Noctuidae) and *Leptophobia aripa* (Lepidoptera:Pieridae). Additionally, aphids (Homoptera:aphididae) were also typically encountered. Aphids are considered another very harmful pest since their presence is not permitted at all by the packers in the harvested product.

1. Results at Chirijuyú

i. **Insect Pests**: Insect data compilation began on June 15th. On the first two collecting dates (June 15th and June 28th) no immature lepidopteran pests were encountered. The first appearance of *Plutella* and *Trichoplusia* larvae was recorded on July 12th. *Plutella* was found in all 4 strip-crop treatments while *Trichoplusia* was detected in the BE/BR and CO/BR systems (Tables 1 and 2). From then on, immature stages of *Plutella* were detected on all treatments until the last data collection date (8/15). As can be deduced from Table 1, broccoli monoculture had 1.45, 1.31 and 1.75 times as many *Plutella* larvae as BE/BR, CO/BR and CO+BE/BR, respectively. In comparison, *Trichoplusia* larvae counts were more consistent in all 4 treatments. Furthermore, BE/BR and CO+BE/BR resulted in higher total *Trichoplusia* counts in comparison to BR (Table 2). Another important insect pest of broccoli in Guatemala is the cabbage butterfly (*Leptophobia aripa*). Throughout the duration of the Chirijuyú trials however, it was not detected until the last data collection date and at very low numbers on the CO/BR treatment (Table 3).

Aphids were detected during the second inspection date (6/28) on the BR treatment. As can be seen in Table 4, aphid total accumulated numbers were greater on the monoculture treatment than in any of the other 3 strip-cropping arrangements. Aphid colony counts remained small throughout the entire crop's cycle. In the context of the results obtained in this experiment however, aphids numbers increased considerably approximately 45 days after transplant.

If the fact that the numbers for each data collecting date shown in Tables 1-4 comprise the total number of insects found in 5 replicates (a total of 100 sampled plants, 20 per treatment in each block) it can be seen that the total number of lepidopteran pests were small throughout the entire cycle. This occurrence can possibly be explained by the fact that 1995 was one of the rainiest of the last 20

years in Guatemala, with approximately 4 times more precipitation in comparison to 1994. The excessive rainfall could account for the low insect pressure observed in this field trial. Usually, the suggested *Plutella* economic threshold for the application of pesticides in Broccoli is a density of 1 larva per 10 plants. Using this as a baseline number, pesticide application would have been justified in some of the treatments in 3 of the 7 dates (Table 1). Using this same threshold for *Trichoplusia ni*, pesticide applications would have been merited only on the last reading (8/15) in all 4 treatments. In contrast, *Leptophobia* counts alone never suggested critical population levels. As Figure 1 shows, there was nearly twice the number of *Plutella* larvae in BR, BE/BR and CO/BR in comparison to *Trichoplusia* larvae. In contrast CO+BE/BR showed similar pressure from the larval stages of both insects.

With respect to aphid populations, economic thresholds are not generally considered applicable by the farmers since there is essentially a zero-tolerance regulation on aphids present on export-quality broccoli heads. Therefore, insecticide sprays are applied when aphids are first observed. Strictly following this approach, the first spraying date for aphid control would have been justified 1 month after planting, on July 12th. Given the results in Table 4 however, the first application could have been delayed until 7/25. As seen in Figure 2, average accumulated aphid counts per treatment showed approximately 1.6 times as many aphids in broccoli monoculture in comparison to BE/BR, and nearly twice as many in the CO/BR system.

Table 1. Total *Plutella* counts (sum of 5 replicates) per date of sampling in broccoli intercropping trials at Chirijuyu, Chimaltenango, Guatemala, 1995.

Treatment	date of count							Total
	6/15	6/28	7/12	7/19	7/25	8/3	8/15	
Broccoli monoculture	0	0	4	12	16	5	21	58
Bean/Broccoli	0	0	7	3	6	4	20	40
Corn/Broccoli	0	0	3	7	13	3	12	38
Corn+bean/Broccoli	0	0	1	14	8	1	9	33

Table 2. Total *Trichoplusia* counts (sum of 5 replicates) per date of sampling in broccoli intercropping trials at Chirijuyu, Chimaltenango, Guatemala, 1995.

Treatment	date of count							Total
	6/15	6/28	7/12	7/19	7/25	8/3	8/15	
Broccoli monoculture	0	0	0	0	0	3	16	19
Bean/Broccoli	0	0	3	0	2	4	18	27
Corn/Broccoli	0	0	2	0	0	2	15	19
Corn+bean/Broccoli	0	0	0	0	3	4	30	37

Figure 2. Average[1] accumulated aphid colonies counts in strip-cropping trials at Chirijuyu, Guatemala, 1995

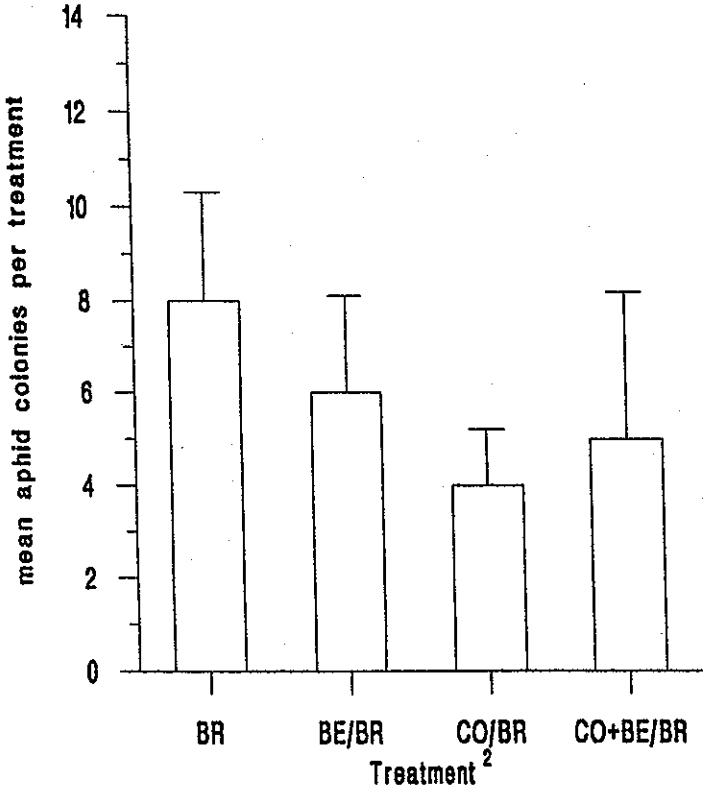
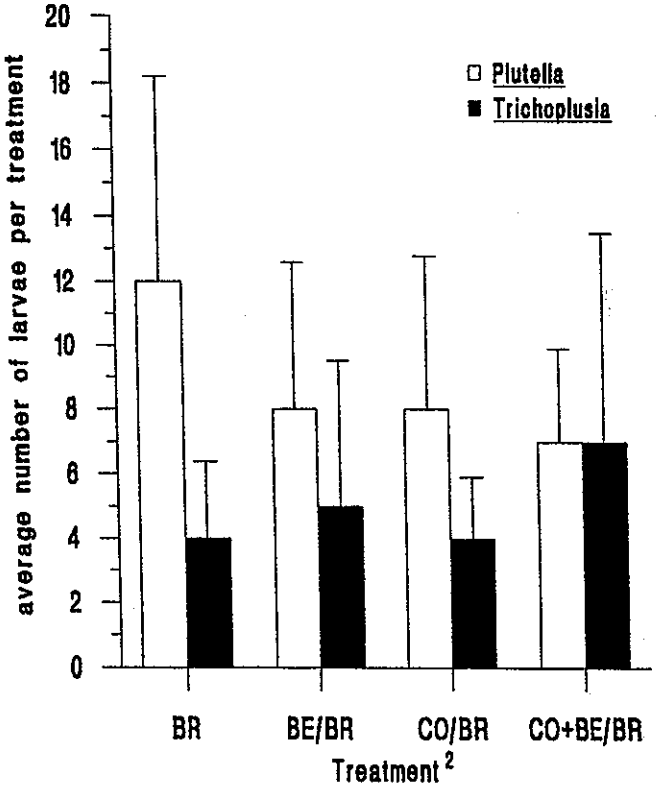


Figure 1. Average[1] accumulated Plutella and Trichoplusia larval counts in strip-cropping trials at Chirijuyu, Guatemala, 1995.



[1] Average accumulated counts represent the total sum of each insect pest detected per treatment after all 7 collection dates and divided by the number of replicates (5).

[2] BR: broccoli monoculture; BE/BR: alternating strips of blackbeans and broccoli; CO/BR: alternating strips of corn and broccoli; CO+BE/BR: strips of mixed corn and beans alternated with strips of broccoli.

Table 3. **Total *Leptophobia* counts (sum of 5 replicates) per date of sampling in broccoli intercropping trials at Chirijuyu, Chimaltenango, Guatemala, 1995.**

Treatment	date of count							Total
	6/15	6/28	7/12	7/19	7/25	8/3	8/15	
Broccoli monoculture	0	0	0	0	0	0	1	1
Bean/Broccoli	0	0	0	0	0	0	0	0
Corn/Broccoli	0	0	0	0	0	0	6	6
Corn+bean/Broccoli	0	0	0	0	0	0	1	1

Table 4. **Total aphid counts (sum of 5 replicates) per date of sampling in broccoli intercropping trials at Chirijuyu, Chimaltenango, Guatemala, 1995.**

Treatment	date of count							Total
	6/15	6/28	7/12	7/19	7/25	8/3	8/15	
Broccoli monoculture	0	1	1	0	11	7	18	38
Bean/Broccoli	0	0	3	0	10	4	13	30
Corn/Broccoli	0	0	2	0	4	8	7	21
Corn+bean/Broccoli	0	0	1	2	9	3	11	26

ii. Diseases: Very few pathogenic diseases were observed during the growing cycle. The most prevalent diseases were Phoma leafspot, caused by *Phoma lingam* (perfect stage *Leptosphaeria maculans*) and downy mildew, caused by *Peronospora parasitica*. Both diseases were observable in less than 10% of the plants throughout the growing cycle and confined to the lower leaves of the plants.

iii. Broccoli yields: The experimental plots were harvested on the week from August 16th to the 23rd. Yields were largest on the BE/BR treatment with an output of 17.41 MT/ha for the 5 replicates, representing 1.31 times more production than the standard treatment of monocultured broccoli. The other two treatments, CO/BR and CO+BE/BR yielded 0.54 and 0.69 times, respectively, the output of BR (Table 5). The lower productive response obtained from the treatments involving corn could possibly be explained by the height acquired by the corn plants (approximately 12 ft). Not only did they shade the broccoli plants significantly, but also fell on top of the broccoli strips during particularly windy conditions.

Chirijuyú farmers affirm that Broccoli yields average 12-13 MT/ha; The average yield obtained in the broccoli monoculture treatment (13 MT/ha), reflects very closely the average yields obtained at Chirijuyú by broccoli growers. Using the farmer's yield as baseline, it can be observed that strip-cropping broccoli with beans increased the farmer's average production by 35% approximately. If this value is repeated in subsequent trials it will mean that strip-cropping black beans and broccoli may prove economically beneficial to the farmers.

The application of chicken manure, tested in the sub-plots of the split-plot design, resulted in higher yields in 4 of the 5 replicates (Table 5). Yield increases in these blocks ranged from 1.13 to 1.4 times the yields obtained from the sub-plots left without the incorporation of chicken manure.

Table 5. Broccoli yields* obtained in strip cropping experiments located at Chirijuyu, Tecpan, Chimaltenango, Guatemala, 1995.

Treatment	REPLICATE (MT/HA)										MEAN		STD**	
	I		II		III		IV		V					
	Manure		Manure		Manure		Manure		Manure		Manure		Manure	
	+	-	+	-	+	-	+	-	+	-	+	-	+	-
Broccoli monoculture	18.6	13.9	13.2	10.4	13.0	13.4	19.1	14.4	10.8	5.0	14.94	11.42	3.30	3.48
Bean/Broccoli	24.3	23.1	15.8	11.6	10.8	9.0	24.8	23.1	16.7	14.9	18.47	16.35	5.36	5.82
Corn/Broccoli	10.1	10.2	9.5	6.8	2.4	5.9	10.6	7.3	6.0	3.5	7.729	6.736	3.10	2.19
Corn+bean/Broccoli	12.2	10.2	4.2	5.2	8.3	8.9	12.7	10.8	9.2	7.3	9.309	8.488	3.07	2.04
Total	65.1	57.5	42.7	34.0	34.5	37.2	67.2	55.6	42.7	30.7	50.45	42.99	13.18	11.25

* Numbers represent the yield of export-quality broccoli; ** standard deviation of the mean.

2. Results at Chilascó

i. Insect Pests: At Chilascó, the insect pests encountered were very similar to those detected at Chirijuyú. Mainly, lepidopteran pests were represented by *Plutella xyllastela*, *Trichoplusia ni* and Leptophobia aripa. Other minor pests detected included *Spodoptera* spp. (Lepidoptera:Noctuidae) and leaf miners (Diptera: Agromyzidae). At Chilascó, insect counts were started on June 29th, 1 week after broccoli transplanting (Table 6). *Plutella xyllastela* larvae were detected on 7/6 on all 4 treatments. Interestingly, *Plutella* numbers never again exceeded, on later counts, those detected on this date. As can be seen in Figure 3, average total *Plutella* numbers per treatment were smaller on the BR plots, in comparison to the three strip-crop treatments.

Immature cabbage loopers (*Trichoplusia ni*) were also present at Chilascó, being initially detected on the third sampling date (7/12). Approximately a 3-fold greater number of loopers was observed on the CO+BE treatment (Table 7). However, due to the very small total numbers detected throughout the entire inspection interval, the actual significance of these differences are doubtful. *Leptophobia aripa* represented the most common insect pest found at the Chilascó field trials. As it can be seen in Table 8, with the exception of the CO+BE/BR strips, total *Leptophobia* numbers almost doubled those of *Plutella*. It is also important to note that after two consecutive dates (7/12 and 7/19) of rather large amounts of *Leptophobia* being detected, on 7/27 not a single cabbage butterfly was found. A similar pattern was observed in Table 7, which suggests that the farmers who own the fields may have applied some kind of insecticide on the trial without reporting it to the researchers.

Total aphid counts were also similar in BR, BE/BR and CO/BR (97, 97 and 91 aphid colonies, respectively) (Table 9). The CO+BE/BR plots evidenced nearly 1.3 times as many aphid colonies as the other three treatments (Figure 4). These results in combination with those presented above suggest that the combination of corn and beans may actually provide the most suitable environment, under Chilascó conditions, for the increase in insect pest populations of the studied cropping

patterns. With the exception of *Leptophobia aripa*, insect pest populations were greater in the CO+BE/BR than in any of the other three treatments.

Table 6. Total *Plutella* counts (sum of 5 replicates) per date of sampling in broccoli intercropping trials at Chilasco, Baja Verapaz, Guatemala, 1995.

Treatment	date of sampling							Total
	6/29	7/6	7/12	7/19	7/27	8/9	8/16	
Broccoli monoculture	0	9	3	4	3	6	0	25
Bean/Broccoli	0	11	3	2	10	6	1	33
Corn/Broccoli	0	14	2	0	11	9	1	37
Corn+bean/Broccoli	0	19	5	0	5	11	0	40

Table 7. Total *Trichoplusia* counts (sum of 5 replicates) per date of sampling in broccoli intercropping trials at Chilasco, Baja Verapaz, Guatemala, 1995.

Treatment	date of sampling							Total
	6/29	7/6	7/12	7/19	7/27	8/9	8/16	
Broccoli monoculture	0	0	1	1	0	0	3	5
Bean/Broccoli	0	0	2	2	0	2	1	7
Corn/Broccoli	0	0	1	2	0	0	2	5
Corn+bean/Broccoli	0	0	8	4	0	0	2	14

Table 8. Total *Leptophobia* counts (sum of 5 replicates) per date of sampling in broccoli intercropping trials at Chilasco, Baja Verapaz, Guatemala, 1995.

Treatment	date of sampling							Total
	6/29	7/6	7/12	7/19	7/27	8/9	8/16	
Broccoli monoculture	0	0	18	7	0	6	8	39
Bean/Broccoli	0	0	28	23	0	8	10	69
Corn/Broccoli	0	0	24	41	0	5	5	75
Corn+bean/Broccoli	0	0	10	17	0	5	10	42

Table 9. Total aphid counts (sum of 5 replicates) per date of sampling in broccoli intercropping trials at Chilasco, Baja Verapaz, Guatemala, 1995.

Treatment	date of sampling							Total
	6/29	7/6	7/12	7/19	7/27	8/9	8/16	
Broccoli monoculture	0	41	9	6	3	9	29	97
Bean/Broccoli	0	32	14	3	12	15	21	97
Corn/Broccoli	0	42	5	9	4	12	19	91
Corn+bean/Broccoli	0	50	26	6	4	15	24	125

Figure 3. Average[1] accumulated Plutella and Trichoplusia larvae counts in strip-cropping trials at Chilasco, Baja Verapaz, Guatemala. 1995.

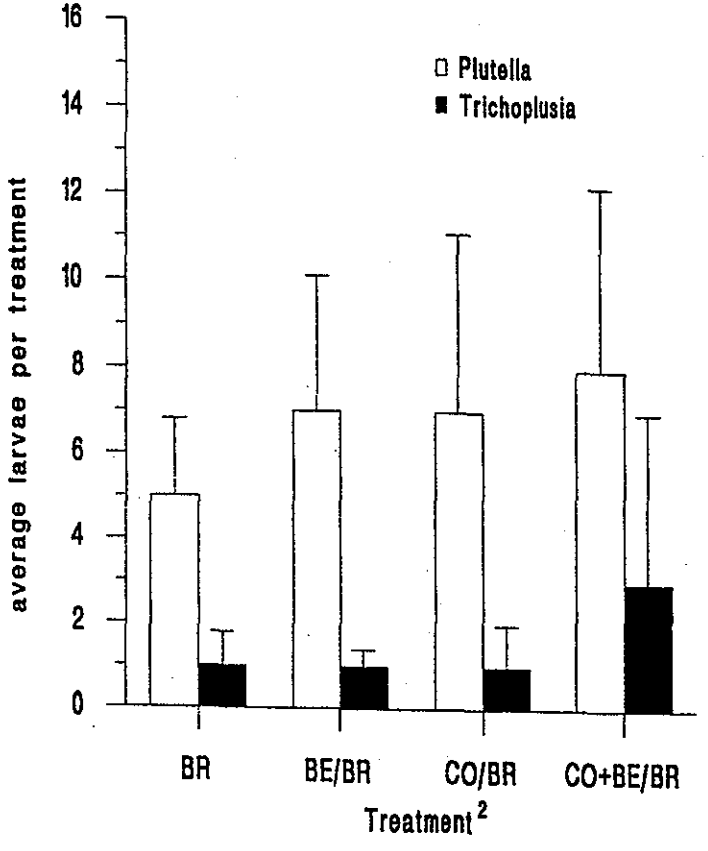
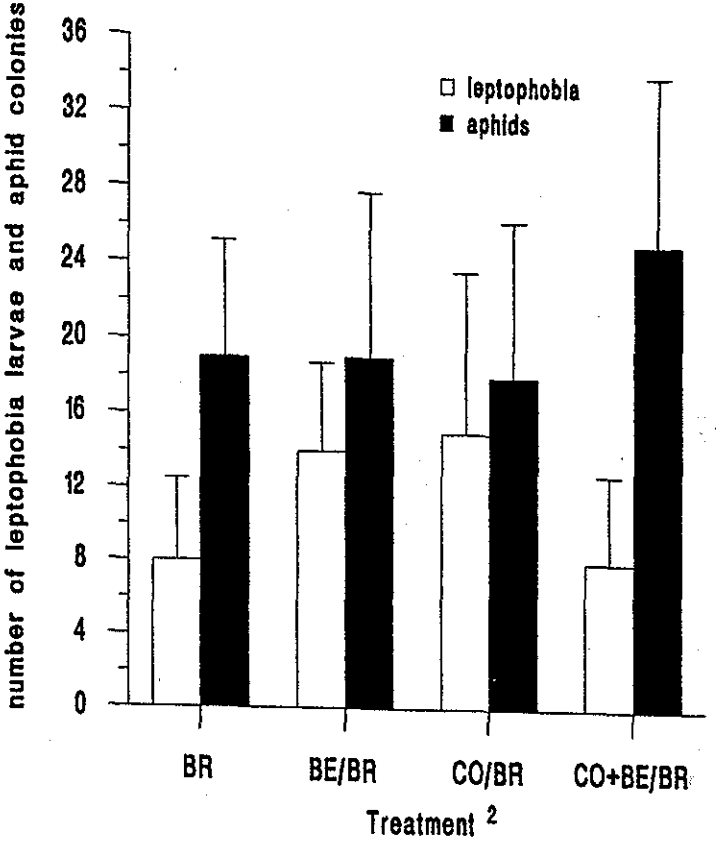


Figure 4. Average[1] accumulated Leptophobia larvae and aphid colony counts in broccoli strip-cropping trials at Chilasco, Baja Verapaz, Guatemala. 1995.



[1] Average accumulated counts represent the total sum of each insect pest detected per treatment after all 7 collection dates and divided by the number of replicates (5).
[2] BR: broccoli monoculture; BE/BR: alternating strips of blackbeans and broccoli; CO/BR: alternating strips of corn and broccoli; CO+BE/BR: strips of mixed corn and beans alternated with strips of broccoli.

ii. Diseases: At Chilascó, the prevalent diseases were damping-off, caused by *Rhizoctonia solani*, Phoma leafspot and downy mildew.

Damping-off was detected on the first two inspection dates (6/29 and 7/6). The sampling procedure for *Rhizoctonia*-infected plants was to count all affected plants in the two center rows of the central broccoli strip. Following this procedure, the sample monitored in each main treatment plot consisted of 50 plants. The percentage of broccoli plants affected by damping-off was very similar in all 4 treatments, ranging from 18% to 21%. As it can be seen in Figure 5, the number plants infected by *Rhizoctonia solani* was smaller at the first reading date when the highest percentage of affected plants ranged between 5% and 8%. In contrast, the lowest infection value at the July 6th insect count was 11% and the highest was 16%.

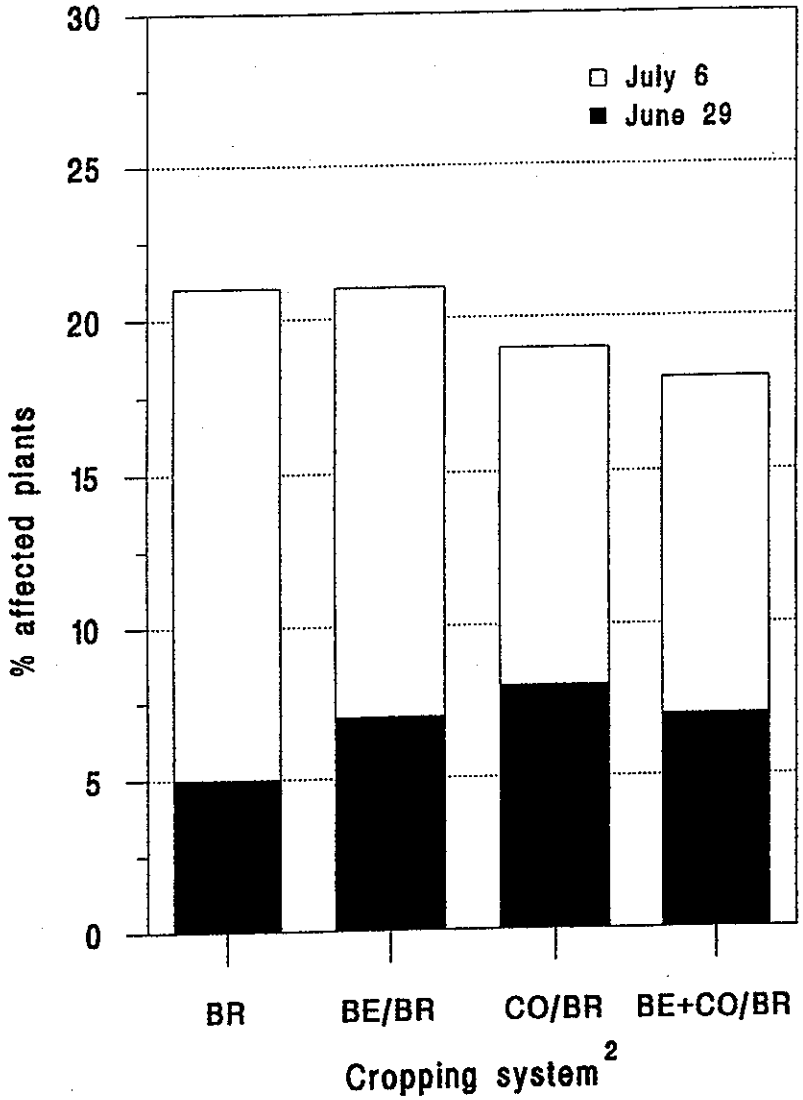
Phoma leafspot and downy mildew were the only two foliar diseases detected at Chilascó. While Downy mildew was initially detected during the second sampling date, it never became a threatening disease to the broccoli plants, since it remained located in the lower leaves throughout the crop's cycle. Incidence values of affected plants were constant throughout the trial in a range of 40%-60%, although severity values were low since only 1 or 2 mild downy mildew lesions could be detected in the older, lower leaves of the plants.
Phoma leafspot was even less noticeable since its incidence values never exceeded 10% of the plants, with only 1-3 lesions per plant.

iii. Broccoli Yields: Broccoli yields at Chilascó were obtained from only three of the replicates since one of the farmers, on whose land 2 blocks were established, proceeded to harvest before data were collected.

Data collected from the three harvested replicates show that average yields for the evaluated treatments ranged between 8.96 MT/ha and 13.5 MT/ha (Table 10). These numbers are somewhat lower than the reported average yield for the Chilascó area, which is around 13 MT/ha. However, it is important to keep in mind that damping-off damage was close to 20% in all 4 treatments, which partially accounts for the observed yield reduction. As it can be observed in Table 10, the BE/BR strip arrangement yielded 1.5 times more broccoli than the monoculture treatment. The other two strip-cropping arrangements, yielded very similar amounts to that of BR.

Chicken manure amendment to the soil resulted in an increased yield in 2 of the 3 harvested replicates (20% and 11% more production in blocks I and III, respectively). Block two showed a decrease in productivity (16% reduction) in the chicken manure sub-plot in comparison to the non-amended subplot.

Figure 5. Percentage[1] of broccoli plants affected by damping-off (Rhizoctonia solani) in strip-crop trials located at Chilasco. Guatemala, 1995.



[1] Numbers refers to the average percentage in 5 replicates of damping-off infected plants found on the two center rows (24 broccoli plantas/row) of the central broccoli strip on each treatment.

Table 10. Broccoli yields* obtained in strip cropping experiments located at Chilasco, San Geronimo, Baja Verapaz, Guatemala, 1995.

Treatment	REPLICATE (MT/HA)						MEAN		STD**	
	I		II		III					
	MANURE	MANURE	MANURE		MANURE		MANURE			
	+	-	+	-	+	-	+	-		
	+	-								
Broccoli	7.89	9.49	8.70	7.12	9.49	11.07	8.69	9.23	0.65	1.63
Bean/Broccoli	14.99	9.00	11.86	14.24	15.82	15.03	14.23	12.75	1.70	2.67
Corn/Broccoli	10.26	10.28	4.75	2.37	18.98	10.28	11.33	7.65	5.86	3.73
Corn+bean/Broccoli	10.28	7.12	3.16	10.28	12.65	15.03	8.70	10.81	4.03	3.25
Total	43.43	35.89	28.47	34.01	56.95	51.41	42.95	40.44	11.63	7.80

* Numbers represent the yield of export-quality broccoli; ** standard deviation of the mean.

C. Impacts

The impact of this research will prove to be of great value at both of the communities where the trials were conducted. Firstly, farmers in both communities have come to realize the importance of searching for alternate production systems that could result in increased production and less amount of pesticides being applied to the plants. Also, growers in both areas, especially the owners of the land on which the trials were established, observed that the exportable broccoli yields obtained through this research were satisfactory even without having applied any kind of pesticide during the entire crop's cycle. It is considered that if similar acceptable results can be achieved in 1996, strip-cropping as an alternative for monoculture production this technology could be successfully transferred to the farmer. This is probably particularly true for places like Chirijuyú, were there is a strong group of organic farmers who see these cropping systems as production alternatives in agreement with their own convictions.

We also believe that through this kind of research, farmers can be taught about the importance of applying pesticide following a rigorous scouting, pest populaton monitoring and utilization of economic thresholds, instead of employing these products based on scheduled applications.

Assessment of Insect Pests and Diseases Found in Bramble Plantations in Guatemala

Investigator: Guillermo E. Sánchez, Agri-lab

II. COLLABORATING SCIENTISTS

Roger Williams, The Ohio State University

III. SUMMARY OF RESEARCH RESULTS

The production of blackberries and raspberries (*Rubus* spp.) constitute a rapidly expanding sector in Guatemala's non-traditional agricultural sector. In just 5 years their combined production area is estimated to be greater than 500 ha. As with other imported crops not previously grown in Guatemala, the technology and plant health management practices applied locally rely on imported strategies from other producing countries. Previous to this research, no information other than the producers' own experience had been documented on the prevalent insect pests and diseases affecting brambles in Guatemala. During the 1.5 years in which bramble plantations have been visited, a total of 22 diseases caused by plant pathogens have been recorded.

The most important pathogen-induced diseases are *Botrytis* fruit rot and powdery mildew in blackberry, affecting virtually all plantations in different degrees of severity. In raspberries these are *Botrytis* fruit rot and late leaf rust. Other diseases which are rapidly expanding in Guatemala's bramble acreage are root lesions caused by *Pratylenchus* spp. and crown gall, provoked by *Agrobacterium tumefasciens*.

Rosselinea spp., an ascomycete, is a soilborne fungus that has been found infecting blackberry and raspberry root systems on grounds with a previous history of coffee production. No reports have been found in the literature documenting Rosselinea root infections in brambles.

Insect and mites constitute other important pests with the potential of causing significant yield losses in brambles. The most important of the arthropod pests is the red spider mite (*Tetranychus* spp.), which may reduce raspberry yields significantly during the dry season. Other insects that may impact negatively on bramble production are coleopterans which feed mostly on floral buds and flowers. Cane borers (Lepidoptera) are also a cause of great concern among growers especially during the rainy season. All of the above insect pests have been found in all of the bramble-growing regions of Guatemala. Of particular importance was the detection in 1995 of a blackberry fruit borer. The direct damage this insects inflicts on berry plantations is minor. However, if a shipment of brambles, is found infested with this pest at the point of entry to the U.S. market, inspection and fumigation fees can be very costly. Other minor insects pests include lepidopteran leaf rollers, leafcutter ants, cutworms, white grubs and stink bugs.

IV. OBJECTIVES AND IPM CONSTRAINTS

The purpose of this study was to determine which are the prevalent insect pests and diseases affecting blackberry and raspberry plantations in Guatemala's central highland region.

The specific objectives were:

- To establish a photographic and written inventory of the principal insect pests and diseases affecting Guatemala.
- To determine the seasonality of the insect pests and diseases encountered throughout the year.
- To rank in order of importance the different pests recorded.
- To document the main management strategies utilized by the growers for the control of the encountered pests.

Bramble (*Rubus* spp.) production for the export market has experienced a tremendous growth in the Guatemalan highlands during the last 7 years. As with other crops not previously grown commercially in the country, all the practices and technology employed for the farming of brambles have come from foreign experiences. The pest management strategies are no exception, even though Guatemala's pests and environmental conditions may be different from those reported in other countries. To implement successfully any integrated pest management program (IPM) it is indispensable to understand and have as much information as possible regarding the biology and ecology of the pests (insects, plant pathogens and others) affecting the crop. With this information in hand, the growers may take advantage of local conditions and available resources to establish an appropriate IPM approach. It is also possible that through certain practices and farming operations, unaware farmers may be favoring certain pests, which may prove very costly to contain in the future.

V. RESEARCH APPROACH AND OUTPUT

A. *Research Methods*

The main strategy for the documentation of insect pests and diseases was to conduct scheduled field trips (2-3 trips per month) to blackberry and raspberry plantations throughout the year. The regions covered by this assignment included the main growing areas in the departments of Santa Rosa, Guatemala, Sacatepequez and Chimaltenango. During the field trips, samples of diseased tissue and/or insect pests were taken and brought to the laboratory for identification. When a pathogen was suspected to be involved, the samples were analyzed using techniques such as direct examination under light microscopy, growth promotion in moist chambers and in vitro isolation of pathogens with culture growth media. In cases where nematodes were suspected the extraction procedure was the sieving, centrifugation and floatation method. Insect identification was conducted with the collaboration of the laboratory of Entomology at Universidad del Valle and Dr. Roger Williams from The Ohio State University. For most of the encountered insects and diseases, a photographic record has been established.

From April to November 1994, this activity was funded by the AID-financed project, PROEXAG II (Chemonics International). From December 1994 to this date, field trips and pest identification have been supported by IPM CRSP.

B. *Research Results*

From January to September 1995, there has been a total of 23 field trips. The visited areas included berry growing regions in the Departments of Sacatepequez, Chimaltenango, Guatemala and Jalapa (Table 1). Of these four, the latter department was not included in the IPM CRSP's main research area; trips were planned because it is a newly developed berry-growing regions with unique climatic characteristics.

Table 1. Bramble-growing regions included in the field trips, number of farms and type of plantation visited from January to September 1995.

MONTH	DEPARTMENT	No. of Visited Farm[1]	COMMODITY BLACKBERRY	RASPBERRY
January	Chimaltenango	5	5	4
	Sacatepequez	1	1	1
	Guatemala	2	2	2
February	Chimaltenango	4	4	3
March	Chimaltenango	5	5	4
April	Chimaltenango	4	4	3
	Guatemala	2	2	2
	Jalapa	2	1	2
	Santa Rosa	1	1	1
May	Chimaltenango	3	3	3
	Sacatepequez	1	1	1
June	Chimaltenango	3	3	3
	Sacatepequez	2	1	1
July	Chimaltenango	3	3	2
August	Chimaltenango	4	4	3
September	Chimaltenango	5	5	3
	Guatemala	2	2	2

[1] The numbers under the "visited farms", "blackberry" and "raspberry" headings may not necessarily coincide because while some of the farms visited grew both blackberry and raspberry plantations others had only one of the two crops.

B.1 Diseases

A total of 22 diseases incited by plant pathogens have been detected during the field trips during the years 1994 and 1995. Of these, 17 are fungal pathogens, 2 are phytopathogenic bacteria and 3 are plant parasitic nematodes (Table 2).

Table 2. Inventory of plant pathogens detected during 1994-95 affecting blackberry and/or raspberry in Guatemala.

DISEASE OR PATHOGEN	AFFECTED TISSUE	HOST BLACKBERRY	HOST RASPBERRY	DETECTED (year)
Agrobacterium tumefaciens	roots and crown	x	x	1994
Alternaria	canes	x	x	1994
Armillaria	roots	x		1994
Botrytis cinerea	berries	x	x	1994
Botrytis cinerea	canes		x	1994
Botrytis cinerea	foliage	x	x	1994
Cercospora	mature leaves	x	x	1994
Cladosporium	berries	x	x	1994
Colletotrichum	canes	x		1995
Coniothyrium	canes	x		1994
Erwinia amylovora	young shoots and twigs	x	x	1994
Fusarium	crown and roots		x	1994
Helicotylenchus	roots	x	x	1994
Meloidogyne	roots			1995
Oidium	vegetative shoots & floral buds	x		1994
Phoma	canes	x		1994
Phomopsis	canes	x		1994
Phyllosticta	foliage	x		1994
Pestalotia	canes	x		1994
Pratylenchus	roots	x	x	1994
Rhizoctonia	roots	x	x	1994
Rosselinea	roots	x	x	1994
Rust	matures leaves & berries	x		1994
Sphaceloma	canes	x		1994

B.1.a Fungal Diseases

The most prevalent fungal diseases in blackberry are powdery mildew, caused by *Oidium* spp. and *Botrytis cinerea*, causal agent of leaf, flower and cane blight and fruit rot.

i. Powdery mildew (*Oidium* spp.): Powdery mildew is a disease that can be found in practically all of the blackberry plantations, when these are in the vegetative growth or flowering stages; raspberry has not yet been found affected by this disease. It can be particularly destructive since it attacks the young growing portions of the blackberry plant including both vegetative and floral buds. The only time of the year when powdery mildew is not found in a regular basis is immediately after pruning and defoliation, activity that is carried out to promote flowering for the next harvest. This practice takes place during the months of June and July. At present, the perfect stage, *Sphaerotheca macularis*, has not been found in Guatemala.

In 1994, powdery mildew was found in > 80% of the blackberry plantations that were visited. In 1995 the percentage was > 90%, an increase in its incidence possibly due to the abnormally damp and overcast conditions that were prevalent in Guatemala from the months of June to early October.

Control strategies for powdery mildew include the application of chemical pesticides such as benomyl (benzimidazole) and inorganic sulfur. No other fungicides effective against powdery mildew have been registered for their use in blackberries. The main pruning activity also helps tremendously to reduce the amount of inoculum present in the field. It not only eliminates infected tissue but also increases ventilation and light penetration altering the environmental conditions which favors the infection process.

This disease has not been found to be a cause of major losses to the berry growers because of adequate control. However in April of the current year, a particularly severe attack was found in small landholders' blackberry plantations located in San Jose Poaquil, Chimaltenango. Incidence of powdery mildew was found to be practically 100% and severity close to 80% of flower buds infected. Severely affected flower buds become atrophied and fail to develop.

ii. *Botrytis* blight and fruit rot: *Botrytis* blight, caused by *Botrytis cinerea*, is undoubtedly the most important fungal disease affecting blackberries and raspberries, particularly during the flowering and fruiting stages. This fungus has been detected on practically all aerial portions of the plant, including fruits, flowers, leaves and canes. During 1994, the most prevalent disease was *Botrytis* fruit rot in both blackberry and raspberry. Occasionally it was found affecting blackberry and raspberry leaves, during the rainy months of September and October. In raspberry the fungus was also detected causing cane blight. In 1995, leaf and flower blights were much more prevalent during the months of August through the early part of October, again, due to extremely damp environmental conditions. In 1995, yield losses have been due to *Botrytis* fruit rot have been found to be of approximately 20-25%. However, losses of up to 50-60% have been reported by growers.

The main control activities for *Botrytis*-incited diseases have been the application of benzimidazole (benomyl) and carboximide (Iprodione) fungicides. Other chemicals applied include ferbam, captan and dicloran. Although many growers do rotate these products to minimize repeated applications of benomyl, dicloran and iprodione, some less technified producers used benomyl excessively. During the visits growers have been advised of the risks inherent with the overuse of pesticides. Many growers also employ other control tactics such as mechanically removing rotted fruits from the bushes. The great majority of berry producers do understand that having excessively dense berry stands will favor the development of disease. The removal and elimination of crop residues during pruning have also been implemented by a small percentage of growers (roughly 20%), although the majority leave the residues at the base of the pruned plants. Growers claim that high costs don't allow them to eliminate all crop residues.

iii. Raspberry rust: Rust is one of the most destructive diseases in raspberry, maybe even more so than *Botrytis* fruit rot. In Guatemala only one type of rust has been found on raspberry and based on symptoms, signs and plant tissues affected, it has been found to be very similar to late leaf rust, caused by *Pucciniastrum americanum*. This is a non-sistemic rust that affects fruits and leaves, exhibiting yellow to light orange pustules on the underside of leaves and on the drupelets. This rust has not been found on raspberry leaves during the young stages of the plant. It becomes more conspicuous as plants mature and reach the fruiting stage. The behavior of the seasonal rust outbreak was similar in 1995 compared to the previous year. After cane pruning, carried out in mid to late June, rust in not found on the new emerging canes for approximately 2 months. AT the end of August to early September, initial pustules may be found on the underside of the lower leaves of raspberry canes. In late September 1995, rust was found in all 7 of the visited plantations. Furthermore, based on interviews held with other growers, rust was a generalized problem in raspberry fields. Since the raspberry harvest season is at its very early stages, losses due to raspberry rust are hard to estimate.

The management of this disease is primarily carried out by the application of triadimefon and copper-based sprays. Both triadimefon and copper are registered for their use in raspberries. Other practices that growers have recently implemented as part of their control strategies include defoliation of the lower part of the raspberry cane, up to a height of approximately 0.30-0.40 m. This foliage removal is done both manually and by herbicide or dissolved urea. Other practices include increasing aeration and light penetration to the lower portions of the plants by an open or "V" type support. In this procedure raspberry canes are tied on to the plastic string which supports them from bending over during fruit set. By affixing the canes to both sides of the string support the rows are 'opened' at their middle portion, therefore facilitating ventilation and light penetration.

Cultivated blackberries have not been found to be affected by any type of rust. However, in a January trip to Chilascó, Baja Verapaz, wild blackberry plants were found infected by a rust disease, mostly on the leaves (both dorsal and ventral portions) and petioles. A similar rust disease was also found on wild blackberry at aldea La Cumbre, Tecpán, Chimaltenango. At "La Cumbre", native peasants and farmers harvest the wild blackberry plants that grow on recently cleared areas. There is a medium-sized group of farmers (approximately 20) who care and harvest these wild berries, making this activity their main income source. A few blackberry plants of the texan "brazos" cultivar (the most widely grown cultivar in Guatemala) were donated to these farmers. It will be interesting to observe if the rust affecting the local wild berry plants can also infect the imported variety when grown in close proximity.

iv. Other foliar and cane fungal pathogens: Ten minor fungal pathogens affecting the leaves and/or canes of blackberry and/or raspberry have been detected in Guatemala. Of these, the most common on both blackberry and raspberry is *Cercospora* leafspot, mostly confined to the lower leaves of the plant. Although the damaging effects of this disease are usually mild, In May 1995 rather serious outbreak of *Cercospora* leafspot was detected in a blackberry plantation in the Department of Sacatépequez, in which the lower half of the plants were being defoliated by the disease.

Plant pathogens affecting canes, with the exception of *Botrytis* cane blight, have been found mostly on blackberry. This is probably due to the fact that blackberry canes are kept for an average of 3 harvest cycle, approximately 1.5 years. In contrast, raspberry canes are pruned down to soil level after every production cycle (every 6 months approximately). Blackberry canes are usually removed from the bushes once their productive capacity diminishes and their general vigor and appearance begins to decline. Pathogens such as *Phoma* spp., *Phomopsis* spp., *Alternaria* spp., *Pestalotia* spp., *Coniothyrium* spp., and *Sphaceloma* spp. have been detected mostly infecting cane in evident decline caused by poor nutrition, natural senescent stage or affected by other organisms (root pathogens, or insect pests). In March 1995, a significant cane blight attack was observed in one blackberry plantation located Fraijanes, department of Guatemala. Isolated organisms from the affected canes included *Alternaria* spp., *Colletotrichum* spp. and *Pestalotia* spp.

v. Root fungal pathogens and nematodes: Fungal pathogens detected in Guatemala infecting roots of bramble crops include *Rhizoctonia solani, Rosselinea* spp.and *Fusarium* spp. Of these three Rhizoctonia and Rosselinea root infections are the most important. Rhizoctonia root infections have been detected in all of the bramble-growing regions of Guatemala, although their severity varies tremendously. In 1995, 4 berry plantations have been detected with distinct patches or isolated plants affected by this fungus. In one of these plantations, located in the department of Santa Rosa, the affliction was particularly severe, where 30% of the canes stand had been killed or nearly killed. In this case, raspberry roots were not only affected by *Rhizoctonia* but also by lesion nematodes (*Pratylenchus penetrans*).

Rosselinea spp. is an ascomycete fungus with a broad host range. In Guatemala, it is extensively found in coffee plantations. In each and every case in which Rosselinea has been detected infecting brambles, the existence of a previous coffee plantation on that same land has been established. In 1994 it was detected in 4 bramble plantations, 2 blackberry and 2 raspberry. In 1995 it has been detected in one blackberry plantation more. There is no effective control method for this soilborne fungus. Management strategies rely on eliminating infected plants and containing the spread of the disease. Plant parasitic nematodes are a widespread pest in both blackberries and raspberries. They have been detected in all the bramble growing areas of Guatemala, including the lesion nematode, *Pratylenchus* spp., the root-knot *Meloidogyne* spp. and *Helicotylenchus* spp. The most common of the three species is *Pratylenchus* spp., accounting in 1995 for 91% of the detected nematode infections. The first and only case found until now of root know nematodes attacking brambles was found in Chimaltenango in January 1995, in blackberries.

During 1995, 50% of bramble root samples taken for nematode analysis tested positive. Of 9 raspberry plantations that were sampled, 6 (67%) yielded positive results for nematodes. In blackberry, 33% (3 of 6) of plantations assayed were found to be affected by nematodes. In contrast, in 1994, 70% and 58% of raspberry and blackberry plantations, respectively, were found to be affected by plant parasitic nematodes.

The main source of nematode dissemination is considered to be the establishment of infected planting material.

B.1.b. Bacterial Pathogens

Two plant pathogenic bacteria have been found associated with brambles: *Erwinia* spp. and *Agrobacterium tumefasciens.*

The *Erwinia* bacterium infecting brambles in Guatemala is possibly *E. amylovora.* This is an organism which affects a wide range of hosts including stone fruits and brambles. It has been found in areas of the departments of Guatemala, Sacatepequez. In May 1995, a new infection focus was found in San Miguel Dueñas, Sacatepequez, making it a total of three plantations on which it has been found; up to date it has only been found infecting blackberries.

Agrobacterium tumefasciens, causal agent of crown gall, is another bacterium that has been found widely associated with bramble plantations. It has been found present in 40% and 10% of the evaluated raspberry and blackberry plantations respectively. The trade of infected nursery plants for the establishment of new plantations, is considered to be the main dissemination avenue for this pathogen. In the area of Mataquescuintla, Jalapa, where raspberries were introduced 1.5 years ago, crown gall has already been detected in the only two plantations that are presently found there.

The main strategy employed in Guatemala to control crown gall in contaminated plantations is to eliminate all infected plants. Growers have tried chemical control through bactericides such as streptomycin and copper compounds but these applications have failed to control the disease satisfactorily. The best approach that a berry grower can follow is to inspect the nursery planting material (and if possible the donating plantation) very closely at the time of purchase and in case of doubt send it to a professional laboratory for an accurate diagnosis.

B.1.c Ranking of Diseases affecting *Rubus* spp. in Guatemala

As Table 3 shows, the most important disease affecting blackberries and raspberries in Guatemala is *Botrytis* fruit rot. It has been found in virtually 100% of the plantations that have been inspected and has been observed to cause between 5% and 40% yield losses.

Second in order of importance is powdery mildew. This is another widespread disease, affecting only blackberries but present in practically every plantation.

Late leaf rust is a disease affecting only raspberries but has been found in all the raspberry plantations that have reached the harvest stage.

A. tumefasciens and root lesion nematodes are considered to be very important disease-inducing organisms in both blackberry and raspberry. They cause considerable production damage, are present in a significant number of plantations and their rate of dissemination through contaminated nursery plants will undoubtedly increase their incidence rates.

Table 3. Ranking and estimated incidence[1] in Guatemala of the most prevalent diseases incited by plant pathogens.

DISEASE/ PATHOGEN	HOST BLACKBERRY	HOST RASPBERRY	INCIDENCE (percent)
Botrytis fruit rot	X	X	100
Powdery mildew	X		90
Late leaf rust		X	100
Pratylenchus root lesion	X	X	50
Crown gall	X	X	25

[1] Incidence represents the percentage of plantations at which the disease has been found. In the cases where both blackberry and raspberry are affected by the same pathogen, incidence takes into account the total number of affected plantations of both crops.

B.2 Insect and other Arthropod Pests

During the two years on which this study has been conducted, a varied list of insect pests have been recorded feeding on different tissues of brambles. Table 4 lists the insects and mites that have been detected on both blackberry and raspberry.

Table 4. Insect pests and mites detected on blackberry and raspberry plantations in Guatemala during 1994-1995.

INSECT PEST/ MITES:	DETECTED ON RASPBERRY	BLACKBERRY	MONTH & YEAR DETECTED
1) ATTACKING FOLIAGE			
Leaf cutter ants (*Atta* spp.)	X	X	Jan. 1995
Cutworms (Noctuidae:Lepidoptera)	X		Jan. 1995
Spider mites (*Tetranychus* spp.)	X	X	April. 1994
Leaf rollers (immature Lepidoptera)	X	X	July 1994
2) ATTACKING FLOWERS			
Scarabeids[1]			
Anomala spp.	X	X	Sept. 1994
Macrodactylus spp.	X	X	Sept. 1994
Cotinis spp.		X	Sept. 1994
Tenebrionidae *Lobometopum* spp.	X	X	Sept. 1994
Thrips (Thripidae:Thysanoptera)		X	April 1994
3) ATTACKING BERRY FRUIT			
Eriophyd mites		X	April 1994
Vespids (Hymenoptera:Vespidae)	X	X	April 1994
Stink bugs (Hemiptera:Pentatomidae)	X	X	Sept. 1994
Fruit borer (immature Lepidoptera)		X	Feb. 1995
4) ATTACKING CANES			
Cane borer (immature lepidoptera)	X	X	June 1994
5) ATTACKING CROWN AND ROOTS			
Crown borer (immature lepidoptera)	X	X	June 1994
White grub (*Phyllophaga* spp.)	X		July 1995

[1] Three scarabeids have been classified to genus, there are 2 more scarabeids that have been collected on brambles' flowers but still need to be classified to the genus level.

In the case of arthropods attacking brambles, the pest which causes the greatest concern among growers is the red spider mite on raspberries. Red spider mite populations increase during the dry, warm period between the months of March and May. In cases when they are not controlled properly, they can severely defoliate raspberry plants. Although their number start to increase as soon as the rainy season ends, they are not usually a serious problem during the harvest cycle of October-December.

One of the greatest problems that berry growers have confronted is the lack of miticide registered for their use in blackberries and/or raspberries. According to some growers, adequate control has been achieved by spraying water at a pressure high enough to forcefully remove the mites off the foliage.

Another significant pest affecting both blackberry and raspberry is the cane borer. This is a lepidopteran larva which creates burrows in the canes, causing the death of the affected portion. If the burrow is located in the crown it may kill the entire plant. It has not yet been determined if the cane and crown borers are the same organism. The cane and/or crown borers have been observed, in 1994 and 1995, to initiate their damage on blackberries during the months of June and July. In raspberries, they can be detected approximately 45 days later when the canes have begun to harden at their base. Control of cane borers has been conducted by application of pesticides such as dibrom and diazinon. In small blackberry plantations, manual removal of the larvae from their burrows has provided satisfactory control. This removal is done by injecting an irritating substance (such as alcohol) into the cavity to force the worm out of the hole, allowing the worker to kill the insect without injuring the plant.

The scarabeids and other coleopteran insects that feed on flowers and floral buds can be a damaging insect because of the direct damage they cause on the yield. Fruit from injured buds and open flowers either dry out entirely or fail to develop properly. Effective control has been achieved by the application of insecticides such as malathion, diazinon and naled. Other growers, especially small landholders, remove these insects by hand. The coleopteran pests have been observed for the last two years to become a problem from the month of September. In 1994 they were a matter of concern to the growers until the month of December.

There are a number of insects that feed on the fruit. On blackberries, a fruit borer was detected attacking the fruit during the months of February to May 1995. This pest is of particular importance to the growers and shippers, since its detection in a berry shipment at the point of entry to the U.S.A. carries a steep fine. The exporter has to absorb, added to the fine, the APHIS (animal plant and health inspection service) entomologist's fees and the cost of fumigation to remove any insect pests.

Other minor pests that have been detected include leaf cutter ants (*Atta* spp.), cutworm and wireworms. White grubs (*Phyllophaga* spp.; Coleptera:Scarabeidae), were found to be damaging some raspberry plantations in the area of Chimaltenango during the rainy months of June-early October, 1995.

C. *Impacts*

There are many positive impacts that arise from a study like the one presented here. The knowledge of factors such as pest importance, behavior, biology, incidence and severity are essential for the success of any integrated pest management program. With the data documented through this report, present and potential growers will find important information that should prove valuable in their pest management efforts. New growers will know beforehand which are the main pest problems they can expect in their production system. Even though this was not an epidemiological study, the basic results of this research should provide elemental information to help the farmers to know at what stage of the plant or season the appearance of a given insect pest or disease is likely to happen. With this knowledge in hand, the application of pesticides can be directed much better, applying these chemical only at the time they are really necessary. The time and type-specific application of pesticides will decrease the amount of pesticides being applied by reducing the number of applications needed to control the most important pests. For example, with the knowledge that raspberry rust has been observed solely on mature leaves and fruit, chemical applications for the control of this disease can be delayed until the floral differentiation stage, instead of periodically scheduled sprays. Similar programs can be implemented for mite control in raspberries.

Other important information gathered through this research is the documentation that plant parasitic nematodes and crown gall are being disseminated widely through the planting of infected nursery plants. With this information in hand, growers can take the necessary steps to avoid contaminating pest-free soils.

Apparently new arthropod studies or diseases have also been documented through this project. Although availability of scientific literature regarding bramble pests is scarce, no reports have been found of Rosselinea root rot on either blackberry or raspberry. If such is the case, this would prove to be an excellent opportunity to record a new disease affecting both blackberries and raspberries.

VI. NETWORKING ACTIVITIES

A. *Workshops*

1. Apoyo del IPM-CRSP a la producción Hortícola de Exportación. Universidad del Valle, Guatemala City, Guatemala, June 1 & 2, 1995.

2. Hongos que afectan Mora y Frambuesa en Guatemala. Hotel Camino Real, Guatemala City, Guatemala. Organized by Gremial de Exportadores de Productos no Tradicionales, GEXPRONT. March 27, 1995.

B. *Research Investigator Exchanges*

1. Co-authored paper with Dr. Roger N. Williams at IPM CRSP workshop held at Universidad del Valle de Guatemala on June 1 & 2, 1995.
2. Information exchange with Dr. Roger N. Williams (Ohio State University) regarding classification and identification of insect pests on brambles.

C. *Research Information and Product Exchange*

1. Assistance has been provided to graduate student Ann Dix (University of Georgia) on her Ph.D. research. Agri-lab's experimental plots at Chilascó and Chirijuyú were made available to her for collection of white grub data to be included in her dissertation.
2. Assistance to CARE with blackberry farmers' training at Aldea La Cumbre, Tecpán, Chimaltenango.

VII. PUBLICATIONS AND PRESENTATIONS

1. Sánchez, G.E. 1995. Hongos que afectan a los cultivos de mora y frambuesa. Memorias del seminario de acaros y hongos en berries. Departamento de Capacitación y asistencia técnica. Gremial de exportadores de productos no tradicionales, GEXPRONT, Guatemala, March, 1995.

2. Sánchez, G.E. and M. Wade. 1995. Agri-lab: Situación actual y futuro dentro del IPM-CRSP. pp 114-117 *In:* Apoyo del IPM CRSP a la producción hortícola de exportación. Memorias del Seminario-taller. V. Salguero and G. Sánchez, eds. Guatemala, 1995.

3. Sánchez, G. E. and R. Williams. 1995. Estrategias del MIP: Control Químico. pp 10-29 *In*: Apoyo del IPM-CRSP a la producción hortícola de exportación. Memorias del Seminario-taller. V. Salguero and G. Sánchez, eds. Guatemala, 1995.

VIII. TRAINING OUTPUT

IX. PROJECT HIGHLIGHTS

1. Broccoli intercropping experiment in Guatemala showed that the main lepidopteran insects pests affecting broccoli were *Plutella xylastella, Leptophobia aripa* and *Trichoplusia ni.*

2. Broccoli grown in strip cropping with beans yielded 1.3 and 1.5 times more broccoli at Chirijuyú and Chilascó sites, respectively, compared to broccoli grown in monoculture.

3. The most damaging pathogens infecting blackberries found in Guatemala are *Botrytis cinerea*, causal agent of Botrytis fruit rot and Oidium spp. causing powdery mildew.

4. Between the years 1994-95, 22 plant pathogens have been recorded in Guatemala causing disease in blackberry and raspberry plantations.

5. The most important diseases affecting raspberries in Guatemala are *Botrytis* fruit rot (*Botrytis cinerea*) and a rust disease, possibly late leaf rust (*Pucciniastrum americanum*).

6. Lesion nematodes (*Pratylenchus* spp.) and *Agrobacterium tumefasciens* (causal agent of crown galls) were found to be present on a large number of bramble plantations in Guatemala. Their dissemination has been conducted mostly by the exhange and planting of infected nursery plants.

7. Rosselinea root rot has been found affecting several raspberry and blackberry plantations in Guatemala, on soils previously cultivated with coffee.

8. Red spider mites (*Tetranychus* spp.) have been found to be the most important arthropod pest affecting raspberries in Guatemala.

9. In the years 1994 and 1995, a total of 16 arthropod pests have been recorded affecting bramble plantations in Guatemala.

ALTERTEC

Determine the Influence of Weeds on Insects, Diseases, and Natural Enemies in Vegetable and Fruit Crops.

Investigator: Rodolfo Guzman, ALTERTEC

II. COLLABORATING SCIENTISTS

Mario Chinchilla, ALTERTEC
John Kanagy, PEACE CORPS
Victor Salguero, ICTA/GEXPRONT

III. SUMMARY OF RESEARCH RESULTS

Two field experiments are located on two farmers' land in Tecpan, Chimaltenango to investigate the effects weeds on carrots. Another experiment is located in San Juan Comalapa, Chimaltenango to evaluate weed effects on chard. No results are yet available from the studies since they are still to be harvested.

Farmers are involved as a part of these experiments and are receiving IPM training with support from Peace Corps volunteers and technicians. The long-term goal of this research will be to establish farm management plans complemented with integrated pest management plans for the most economically important pests. These plans will be important in designing appropriate IPM CRSP programs.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. Objectives

Determine the effect (positive or negative) of weeks on crop yields (carrot and chard) and the incidence of pests and diseases: crop pest calendars.

B. Constraints

- The beginning of the field experiment was late and growers had already established their crops. This made it more difficult to establish the research plots.
- Need better coordination and cooperation between researchers and farmers. This will be accomplished in Year Three.

V. RESEARCH APPROACH AND OUTPUT

A. Methods

The field experiments design was a split-plot. Main plot was crop, subplots were weeds or no weeds.

B. Results

Final results are not yet available, however, preliminary observations suggest no differences in crop vigor or pest levels on crops with or without weeds.

C. Impacts

- Farmer involvement in research design and establishment
- Farmer training and involvement in Farm and Pest Management Plans
- Improved research knowledge and methods through collaborations and exchanges with IPM CRSP researchers.

VI. NETWORKING ACTIVITIES

- IPM CRSP Workshop, June 1995, University del Valle. Presented lecture "Importancia De Los Sistemas De Produccion Organica En La Agricultura Sostenible.
- Tours of ALTERTEC research plots throughout the year with personnel of CARE, ICTA, GEXPRONT, and AGRILAB.
- ALTERTEC support of CARE through incorporation of five social workers on the MICUENCA project that trains people on organic agriculture in Baja Verapaz.
- Cooperation with AGRILAB in selection of farmer collaborators.

VII. PUBLICATIONS AND PRESENTATION

See Section VI.

VIII. TRAINING OUTPUT

Peace Corps volunteers - John and Nancy Kanagy

IX. PROJECT HIGHLIGHTS

Farmer involvement in research design and establishment and development of IPM based Farm and Pest Management Plans.

Document Traditional Knowledge and Practices Related to Pest Management on Vegetable and Fruit Crops.

Investigator: Rodolfo Guzman, ALTERTEC

II. COLLABORATING SCIENTISTS

ALTERTEC Technical Personnel

III. SUMMARY OF RESEARCH RESULTS

A survey is being conducted to document traditional agriculture practice knowledge of farmers before this knowledge is lost due to modern technology. It is important to supply this knowledge of traditional practices of farmers in relation to pest management to show their validity in vegetable and fruit production systems. The results of this survey, which is being conducted in five regions where ALTERTEC works, will be presented at the end of 1995.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. Objectives

To supply research and documentation about the knowledge of traditional practices that farmers have applied for pest management on vegetable and fruit crops.

B. Constraints

Only the acceptance of these practices by farmers over higher technology methods.

V. RESEARCH APPROACH AND OUTPUT

A. Methods

Interview individual farmers and conduct workshops.

B. Results

The survey is in progress and results will be obtained by November 1995.

C. Impacts

Help implement traditional pest control methods into IPM production practices.

VI. NETWORKING ACTIVITIES

As given in the earlier ALTERTEC Report.

VII. PUBLICATIONS AND PRESENTATION

A workshop will be held in Baja Verapaz with farmers older than 45 and native to the region. The purpose of this workshop is to gain knowledge on the farmers' opinions concerning traditional practices for pest control.

VIII. TRAINING OUTPUT

None.

IX. PROJECT HIGHLIGHTS

Improve communication with farmers and researchers in designing IPM programs that use traditional pest control practices.

ICTA

Estimates of the Insect Pests, Diseases and the Presence of Natural Enemies on Snowpea Crops

Investigator: Oscar Miranda, ICTA

II. COLLABORATING SCIENTISTS

Victor Salguero Co-Researcher
Danilo Dardon Co-Researcher
Luis Calderon Co-Researcher
Marcio Ibarra Co-Researcher
Alvaro del Cid Co-Researcher
ICTA: Address: 21.5 Pacifico Road, Barcenas, Villa Nueva, Guatemala
Stephen C. Weller, Purdue University
Roger Williams, The Ohio State University

III. SUMMARY OF RESEARCH RESULTS

This work is being done in Chimaltenango. The project is still ongoing and the final results will be available at the conclusion of the experiment in May-June 1996.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. Objectives

- Determine the behavior of major pests of the snow pea at different growth stages of the crop.
- Search for and identify natural enemies of the major pests of snow peas.
- Determine what practices of pest control farmers now use and how these practices affect levels of major pest populations.

B. IPM Constraints

The project has been delayed since transfers of support dollars has not always been timely from IPM CRSP. ICTA has provided loans to continue these research activities, but this situation is not in the best interest of good research and development practices. Hopefully this will be resolved in Year Three.

V. RESEARCH APPROACH AND OUTPUT

A. *Research Methods*

An experimental plot of 1000 m^2 was established on farmers land. Five plant samples were taken every week from 5 plots, and the incidence and severity of damage by disease and insects were measured. We are in the process of identifying the pests/natural enemies of the crops. The pest and/or natural enemies that are not identifiable in Guatemala will be sent to the laboratories of US. collaborators for identification. Data will be analyzed using the t-test.

B. *Research Results*

After one growing season no conclusions have been drawn. We will wait until the second growing season is complete before analyzing and comparing both seasons results. We have been able to gather considerable data concerning types of pests and diseases and other organisms that are present but do not appear to be pests.

C. *Impacts*

These studies will provide important information concerning pests in snow pea crops. These results will have significant impact on the control measures farmers use, however, we can not yet determine this impact.

VI. NETWORKING ACTIVITIES

- IPM CRSP Workshop, June 1-2, 1995, University del Valle, Guatemala City, Guatemala. Involved in the organization of the workshop.
- CARE activities have been supported by researchers of ICTA.
- ICTA has made changes on some researchers due to changes in jobs and institutions, because of the low salaries that researchers receive from the government.
- The expected impact is to change farmers methods of managing pests, by providing them with production guides and scientific information from researchers involved in this project.

VII. PUBLICATIONS AND PRESENTATIONS

- "Integrated Pest Management on Snowpea Crops", by Eduardo Calderon Villatore, pages 65-70, IPM CRSP workshop proceedings, IPM CRSP Support to Export Horticultural Production, 1995.
- A final report of the results will be presented, in which all the activities of IPM CRSP will be included, it is expected that this results could be published in some scientific journals.

VIII. TRAINING OUTPUT

No students were found to conduct their Bachelor Thesis research in this area, however, we expect to incorporate soon one student.

IX. PROJECT HIGHLIGHTS

Results from these studies will allow us to foster changes in the pest management practices in non-traditional crops in Guatemala. These changes will be based on information regarding pests and their natural enemies and ecological principles.

Pest Management Diagnostic on Broccoli and Snow Pea Crops

Investigator: P.A. Miguel Angel Higueros, ICTA

II. COLLABORATING SCIENTISTS

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Roger Williams, The Ohio State University

III. SUMMARY OF RESEARCH RESULTS

This work was conducted in Chimaltenango and will be finished in March of 1996. Every week, at least 15 broccoli and 15 snow pea farmers have been visited, and information about their control practices have been collected. An economic quantification of the cost of each activity in relation to pest management is being documented.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. Objectives

- Study pest management practices used by farmers either receiving or not receiving IPM information for use in broccoli and snow pea production in Chimaltenango.
- Use farmer feedback to design a technological system for adaptation within the objectives of IPM practices in broccoli and snow pea crops.

B. *IPM Constraints*

- The most important limitation has been the limited monetary resources from the IPM-CRSP, again, basically slow transfer of funds. ICTA does not have the funds to support these activities without first receiving the money.
- Another limitation is the number of farmers we need to visit because this activity requires a great deal of time and effort, especially to locate them. This year it has been more difficult due to heavy spring rainfall that has rendered many roads inaccessible and made visits to the cooperating villages difficult.

V. RESEARCH APPROACH AND OUTPUT

A. *Research Methods*

1) Determine farmer cooperators in Tecpan, Patzun, and Patzicia in Chimaltenango.
2) Once farmers are identified, we visited 15 farmers and began collecting quantitative and qualitative information on pest management practices in broccoli and snow pea crops.
3) Information is being arranged, the results are being analyzed as they become available, and the final report will be prepared at the end of the growing season.

B. *Research Results*

The data collection was initiated in May at the time when broccoli was seeded. The farmers are now harvesting, therefore, the study has not yet been concluded. For snow pea, the period of seeding was at the beginning of September, therefore, we do not yet have these results.

C. *Impacts*

The contact between researchers and farmers allows an exchange of ideas that will permit us to define new strategies for pest control in the future.

VI. NETWORKING ACTIVITIES

- IPM CRSP Workshop, June 1-2, 1995, University del Valle, Guatemala City, Guatemala. Involved in the organization and delivery of the workshop.
- It is expected that the qualitative information obtained will allow feedback in design of technological pest management systems with an emphasis on IPM in broccoli and snow pea crops. In addition, exchange experiences between farmers and researchers will promote implementation of IPM programs that fit their needs.

VII. PUBLICATIONS AND PRESENTATIONS

- "Achievement, Advances and Future of IPM CRSP with ICTA", by Danilo E. Dardon Avila and Humberto Carranza, pages 118-122, IPM CRSP workshop proceedings, IPM CRSP Support to Export Horticultural Production, 1995.
- A report of the results of these studies will be published by the IPM CRSP managing entity.

VIII. TRAINING OUTPUT

No student training is involved in this study.

IX. PROJECT HIGHLIGHTS

The qualitative information obtained from the researcher-farmer association will allow closer working abilities and better potential of the gathered information to be used in IPM programs by farmers.

Evaluation of Oils and Detergents to Control of Aphids in Broccoli

Investigators: Humberto Carranza, ICTA; Arnoldo Sierra, ICTA; Albaro Orellana, ICTA

II. COLLABORATING SCIENTISTS

Manuel Ricardo Naverro Sosa	Undergraduate student FAUSAC
Victor Salguero	Co-Researcher
Danilo Dardùn	Co-Researcher
Marcio Ibarra	Co-Researcher
Alvaro del Cid	Co-Researcher

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Roger Williams, The Ohio State University

III. SUMMARY OF RESEARCH RESULTS

The experiments were conducted in three broccoli areas namely Chimaltenango, Baja Verapaz (Chilasco) and Jalapa (San Carlos Alzatate). The harvest of the crop has just been finished, and data are now being analyzed and will be discussed in a future quarterly report.

IV. OBJECTIVE AND IPM CONSTRAINTS

A. *Objective*

Determine whether commercial oils and detergents are effective and economical in improving the control of aphids in broccoli crop production.

B. *IPM Constraints*

In addition to the lack of resources from IPM-CRSP, the more important limitations were the weather conditions. The weather (rain) decreased aphid populations, therefore, we are planning to repeat the experiments under irrigation so that there are high levels of aphids infestation in order to better evaluate the treatments.

V. RESEARCH APPROACH AND METHODS

A. *Research Methods*

The experimental design was a randomized complete block with 10 treatments and 3 replications. The plot size was 40 m^2. Treatments were applied every 7 days beginning 45 days after planting, and at the beginning of the flowering stage. The equipment for spraying was manual brand "Matabi", and the applications were done on the upper and lower surface of the leaves and on the inflorescence. Hybrid broccoli "shogun" was planted. The planting distance was 0.5 m between rows and 0.4 m between plants. The fertilization was according to the soil analysis. Weeds were controlled by hand 2 to 3 times.

Variables measured:

1. **Efficacy and residual effect of the treatment.** The efficacy was measured by the Henderson and Tilton equation. The residual effect was measured on 10 plants selected at random. The reference of timing of applications was to find 6 aphids/plant and/or a colony/ 10 plants.
2. **Gross yield.** The number of harvested flowers and the plant weight in each plot at different harvests were estimated, the plant weight was added to the final harvest. Units for data were kg/ha.
3. **Quality control.** Samples were taken at each harvest and the number of heads of broccoli with aphids was determined. The gross yield minus that value was the net yield (kg/ha) and the rejection percentage.
4. The cost of each treatment was determined according to doses and/or quantities applied.
5. The statistical analysis of the results have not been done yet. It will be done by location and across location.
6. An economic analysis of the experiment will be done.

B. *Research Results*

The experiments have already been harvested, however, the results have not been analyzed . No phytotoxicity was observed from any application of the oils and detergents, however, the rainfall could have washed the products off the plants and reduced their phytotoxic effect. It has been shown in the literature that rainfall after application can reduce crop phytotoxicity. As consequence of this fact and the low aphid populations during the experiments we will repeat the experiment during the dry season.

C. *Impacts*

It is not yet possible to measure the impact of the treatments, however, it expected that the use of oils and detergents will result in the following benefits:

1. A decrease of environmental contamination compared to synthetic controls due to the fact that oils and detergents do not have a long residual effect and do not injure the natural enemies of aphids.
2. Result in oils and detergents replacing some of the traditional pesticides because of their low toxicity to humans.
3. Help reduce the rejection rate of exported broccoli.
4. Reduce the costs for pesticides in broccoli production.

VI. NETWORKING ACTIVITIES

IPM/CRSP Workshop, June 1-2, 1995, University del Valle, Guatemala City, Guatemala. Involved in the organization and delivery of the workshop.

VII. PUBLICATIONS

- "Problems with Chemical Pesticides on Broccoli Crops", IPM CRSP workshop proceedings, IPM-CRSP Support to Export Horticultural Production, 1995.
- The results will be included in the final report of IPM CRSP. It is expected to publish the results in scientific or miscellaneous journals.

VIII. TRAINING OUTPUT

One undergraduate student participated in the experiment conducted in Chimaltenango.

IX. PROJECT HIGHLIGHTS

Oils and detergents have good potential for replacing some traditional pesticides for the use in broccoli to control aphids. These products represent several advantages to the farmers and exporters of the country.

Evaluation of Chemical Pesticides with "EPA" Registration for the Control of Aphids on Broccoli Crop

Investigators: Humberto Carranza, ICTA; Arnoldo Sierra, ICTA; Albaro Orellana, ICTA

II. COLLABORATING SCIENTISTS

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III. SUMMARY OF RESEARCH RESULTS

Three experiments were carried out in Chimaltenango, Baja Verapaz (Chilasco), and Jalapa (San Carlos Alzatate). The crops have been harvested, and now the data are being analyzed.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. Objectives

Select chemical pesticides that can be efficiently used for the control of aphids on export broccoli crops.

B. IPM Constraints

In addition to the lack of resources from IPM CRSP, the most important limitations were the weather conditions (rain), which has decreased the aphids populations on the broccoli, therefore, the experiments will be repeated during the dry season.

V. RESEARCH APPROACH AND OUTPUT

A. *Research Methods*

1. The experimental design was a randomized complete block with 6 treatments and 3 replicates with a plot size of 40 m^2.
2. The applications were made every 7 days, beginning 45 days after planting, and at the beginning of the flowering stage.
3. The equipment used for spraying was manual applicator, brand "Matabi", and the applications were done on the upper and lower surface of the leaves and on the inflorescence.
4. Hybrid broccoli "shogun" was planted. The planting distance was 0.5 m between rows and 0.4 m between plants. The fertilization was according to the soil analysis. Weeds were controlled by hand 2 to 3 times during the experiment.

Variables measured:

a. **Efficacy and residual effect of the treatment.** The efficacy was measured by the Henderson and Tilton equation. The residual effect was measured on 10 plants selected at random. The reference of timing of applications was to find 6 aphids/plant and/or a colony/ 10 plants.
b. **Gross yield.** The number of harvested flowers and the plant weight in each plot at different harvests were estimated, the plant weight was added to the final harvest. Units for data were kg/ha.
c. **Quality control.** Samples were taken at each harvest and the number of heads of broccoli with aphids was determined. The gross yield minus that value was the net yield (kg/ha) and the rejection percentage.
d. The cost of each treatment was determined according to doses and/or quantities applied.
e. The statistical analysis of the results have not been done yet. It will be done by location and across location.
f. An economic analysis of the experiment will be done.

B. *Research Results*

The experiments have just been harvested, and the results are not available yet.

C. *Impacts*

The impacts can not be measured at this time since the experiments are not complete yet, but it is expected that:

1. There will be a decrease in the use of certain pesticides that are not EPA approved.
2. There will be an increase in the use of pesticides with EPA registration, instead of use of prohibited pesticides.
3. Overall production costs should decrease.

VI. NETWORKING ACTIVITIES

- IPM CRSP Workshop, June 1-2, 1995, University del Valle, Guatemala City, Guatemala. Involved in the organization of the workshop.
- Activities of collaboration have not yet been carried out since the information is still basic.

VII. PUBLICATIONS AND PRESENTATIONS

None so far.

VIII. TRAINING OUTPUT

No training.

IX. PROJECT HIGHLIGHTS

Improvement in the control of aphids by use of EPA approved pesticides and a decrease in the use of prohibited pesticides.

Evaluation of Commercial Products Based on *Bacillus thuringiensis* for the Control of Lepidoptera on Broccoli

Investigators: Humberto Carranza, ICTA; Arnoldo Sierra, ICTA

II. COLLABORATING SCIENTISTS

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III. SUMMARY OF RESEARCH RESULTS

Two experiments were carried out, one in Chimaltenango, which was reported on at the workshop of IPM CRSP held in Guatemala on June 1-2, 1995. The other experiment was carried out in Chilasco, Baja Verapaz, and has just been harvested so we do not have the results yet. In the experiment of Chimaltenango, no significant differences ($P<0.05$) were found between Agree, Xentari and MBP, and also they provided the best control of lepidopthera on broccoli crops.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. *Objectives*

Evaluate the efficiency of several commercial pesticide products based on *Bacillus thuringiensis* for the control of larvae of lepidopthera in broccoli.

B. *IPM Constraints*

Lack of resources from IPM CRSP and the weather conditions, which resulted in decreased aphid populations. The experiments will be repeated under irrigation in order to obtain higher levels of aphid infestations on the broccoli plants.

V. RESEARCH APPROACH AND METHODS

A. *Research Methods*

1. The experimental design was a randomized complete block with 12 treatments and 3 replications with a plot size of 31.5 m^2 (5 x 6.3 m).
2. The *Bt* applications were scheduled once every week.
3. The equipment of spraying was manual, brand "Matabi", and applications were done on the upper and lower surface of the leaves and on the inflorescence.
4. Hybrid broccoli "shogun" was planted on a spacing of 0.5 m between rows and 0.4 m between plants. Fertilization was according to the soil analysis and weeds were controlled by hand 2 to 3 times during the experiment.

Variables measured were:

a. Total population of lepidoptera larvae.
b. Total population of *P. xylostella.*
c. Total population of *T. ni*
d. Total population of *L.aripa*
e. Total population of *Spodoptera* sp.
f. Gross and net yield (kg/ha) of the total population.
g. Cost of the control.
h. The data were taken from 10 random plants/treatment and each species evaluated at 4 and 7 days after *Bt*'s application. The quality analysis was done on 22 lb. of product.
i. The data will be analyzed by ANOVA and t-test.
j. The cost will be obtained and analyzed economically according to the analysis of partial budget.

B. *Research Results*

The experiment of Chilasco, Baja Verapaz have just been completed and the results have not been analyzed yet. From the experiment of Chimaltenango:

1. The distributor of *Bts* decided to remove from the Guatemala market those Bts that occupied the last place after our evaluation.
2. Some *Bts* were replace by the three best Bts in the experiment.

VI. NETWORKING ACTIVITIES:

IPM CRSP Workshop, June 1-2, 1995, University del Valle, Guatemala City, Guatemala. Involved in the organization of the workshop.

VII. PUBLICATIONS AND PRESENTATIONS

The results from the experiment of Chimaltenango were published in the abstracts of the Workshop IPM CRSP hold in Guatemala on June 1 - 2, 1995. "Evaluation of Commercial Products Based on *Bacillus thuringiensis* for Control of Lepidoptera Insects in Broccoli Crops", pages 123.

VIII. TRAINING OUTPUT

Ing. Carranza presented his work in the Fourth Entomology Congress held in Costa Rica in August, 1995.

IX. PROJECT HIGHLIGHTS

The decision of distributors of *Bts* to remove from the Guatemalan market those products that are not effective for the control of lepidoptera larvae.

Organization and Active Incorporation of Tomato Growers in the Agrosocioeconomic Validation Process and the Transfer of Technology Generated by the Integrate Management of White Fly

Investigators: Rufino Salazar, ICTA; Misael Vasquez, ICTA

II. COLLABORATING SCIENTISTS

Victor Salguero Co-Researcher
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Roger Williams, The Ohio State University, Wooster, OH

III. SUMMARY OF RESEARCH RESULTS

This activity was initiated in September of 1995 and will be finished by March or April of 1996. Two groups of 25 tomato growers have been organized in the department of El Progreso to discuss IPM technology for white fly control on tomatoes and to begin to transfer this information to interested growers. In the second phase of the study, research plots will be established using the technology proposed by the growers. A variety of non-traditional and traditional technologies will be compared in these experiments.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. *Objectives*

- Organize and actively involve tomato growers from El Progreso in the integrated management of white fly through consulting, workshops, meetings and various research and extension approaches in order to train them in the newly generated IPM technology.
- To apply the proposed strategy to achieve an active participation of the growers in planning, selection, execution and evaluation of the technology generated by IPM technology with the intention of increasing its use.
- Determine what factors influence growers in the selection of the IPM technology they implement. The technique "Phillips 66" will be used, and a case study will be carried out to increase the probabilities of impact of the IPM CRSP project.
- Determine the cost/benefit ratio of using different methods of control, and the cost and benefits analysis of replacing one method by another for integrated white fly management in tomato production.

B. *IPM Constraints*

- The most important limitation has been the lack of economic resources from IPM CRSP. Loans have been provided by ICTA to avoid stopping the CRSP activities. These loans come from other projects or from the Guatemalan government.
- Heavy rainfall from May to September delayed the start of the research project.

V. RESEARCH APPROACH AND OUTPUT

A. *Research Methods*

The research involves two phases:

Phase one involves the organization, motivation and active incorporation of the tomato growers in the process of teaching, training and adoption of the technology generated by the IPM study in tomatoes. The following will be implemented:

1. Defining the areas requiring studying.
2. Conducting a survey in the study areas with tomato growers through interviews and researcher observations.
3. After obtaining survey results, define the objectives of the study.
4. Establish preliminary studies with IPM techniques for white fly control.
5. Prepare workshops and audio-visual aids for working with each farmer group in developing IPM practices.
6. Hold grower workshops in which results from effective IPM practices for white fly control will be presented.

Phase two will consist of an agro-socioeconomic evaluation of and developing a method for transfer of technology generated by IPM for white fly control in tomatoes. This requires the active participation of the growers and will include:

1. Defined technologies for grower testing.
2. Selection of the experimental areas together with the growers.
3. Definition of data to record and variables of response to measure.
4. Establishment of 6 field test plots.
5. Analyze data and evaluate economics of IPM practices.
6. Hold field tours and field days with the growers to disseminate IPM information and obtain grower feedback on the technological system.
7. Analysis and discussion of the results and writing of the final report.

B. *Research Results*

The study has only been recently initiated, and there are no results yet. The initial organization of the grower groups has occurred and preliminary discussions on approaches and needed research has begun.

C. *Impacts*

The impact can not be measured yet, but it will be possible to measure the modification done by the growers in relation to the practices of white fly control.

VI. NETWORKING ACTIVITIES

- IPM/CRSP Workshop, June 1-2, 1995, University del Valle, Guatemala City, Guatemala. Involved in the organization of the workshop.
- Activities of collaboration have been done as required.
- Some researchers have changed jobs since they were hired by private companies because of the low salaries that the government pays to research scientists. This research is expected to generate changes in the grower attitudes relating to white fly management, and will provide feedback about the technological system along with promoting exchange of research information with other researchers.

VII. PUBLICATIONS AND PRESENTATIONS

The results will be included in the final report together with other activities of IPM CRSP.

VIII. TRAINING OUTPUT

This activity in El Progreso include: training and transfer of technology to two groups of tomato growers.

IX. PROJECT HIGHLIGHTS

It is expected that there will be active participation of the growers in the decision making process concerning IPM strategies for controlling white fly on tomato plants.

UNIVERSITY OF GEORGIA

Gallina Ciega (*Phyllophaga obsoleta, Phyllophaga rugipennis, Cyclocephala complanata*, and *Anomala* spp.) Control in Broccoli and Corn in Guatemala

Investigators: C. Ronald Carroll and Anne M. Dix, University of Georgia

II. COLLABORATING SCIENTISTS

1. Mark Dripchak, Acting Sector Coordinator, Agriculture and Natural Resources, CARE/Guatemala, Guatemala City, Guatemala

CARE/Micuenca has acted as a facilitator and intermediary between the IPM CRSP research and the community. CARE has designated two extensionists in Chilasco, Baja Verapaz, to work with the IPM Project. Aura Marina Esteban has been running a light trap and using it as a tool to convince other people in the community to use light traps as a form of mechanical control of gallina ciega adults. Sergio Amperez helped us identify beetle host plants during the flights in May-June. Both extensionists have participated in gathering data on the relationship between white grubs and stover and are evaluating the effect of using different organic fertilizers on white grub populations and the use of Metarhizium (an entomopathogenic fungus) as an alternative to the pesticides currently used for white grub control in the community.

2. Michael Wade, Research Coordinator, AGRILAB, Guatemala City, Guatemala

We participated with Agrilab in the planting of their experimental plots in Chilasco, Baja Verapaz. The University of Georgia team monitored the plots for white grub incidence during the months of June, July and August and we are currently analyzing the data collected on white grub population dynamics (in the absence of pesticides) under the following treatments: chicken manure as fertilizer, buried stover, interplanting with corn, beans, and broccoli.

3. Michael Dix, Director, Centro de Estudios Ambientales, Universidad del Valle de Guatemala

The Centro de Estudios Ambientales at the Universidad del Valle has provided institutional support for this project. This has facilitated the exchange of ideas with researchers at the Universidad del Valle including Orlando Arjona (Director, Dept. of Agronomy/Forestry), Enio Cano (Curator, Entomological Collections), Michael Dix, Margaret Dix (Director, Dept. of Biology), Willy Knedel (Environmental Chemistry), Chuck MacVean (Institute of Investigations), Jack Schuster (Director, Ecotourism Program) and Margarita de Matta (Investigations). Margarita de Matta, Michael Dix and Enio Cano have been intimately involved in Phyllophaga research in Guatemala, and Enio is recognized as the local authority on Phyllophaga taxonomy. In exchange we have provided opportunities for several students to work with the project: Giuseppe Dal Bosco (Forestry), Lilian Marquez (Forestry), Claudia Quan (Biology), Olga Slowing (Ecotourism), Carla Villavicencio

(Ecotourism), and Luis Carlos Castellanos (Biochemistry). In addition, we have had the participation of two high school students: Luis Gerardo Cifuentes and Luis Ricardo Mazariegos, one of which has decided to change his program of study from Economics to Agronomy as a result of his experience with the project. Without the institutional support of the Universidad del Valle (including the use of greenhouse and office facilities) and the participation of
students in the Life Sciences this project would not be possible. During this funding year a total of 7 Guatemalan students participated in this project.

III. SUMMARY OF RESEARCH RESULTS

During the last two months of 1994, we carried out a diagnostic of the gallina ciega problem and have identified the primary species causing damage. We characterized the environmental factors that seemed to favor white grub incidence in farmer broccoli fields and carried out open-ended interviews with 50 farmers about the pest control strategies they were using and their theories on why they were having so many problems. From the interviews we were able to gather crucial historical information about agriculture in Chilasco and the development of various other pest problems. Over the course of the year we have identified the principal members of the white grub guild in Chilasco and have been trying to determine the principal factors that regulate both beetle and white grub behavior. For this purpose we have put up a light trap in Chilasco (on loan from the Centro de Estudios Ambientales) and spent May-June of this year identifying beetle host plants with the help of people in Chilasco.

The farmers in Chilasco indicated that the two probable causes of high gallina ciega levels in broccoli fields were the association of broccoli with corn and the excessive use of raw chicken manure as fertilizer. We are finding that white grubs exhibit definite preferences for some substrates in the field (such as buried corn stover) and in the lab, they tend to move towards uncomposted chicken manure in preference to buried corn stover. Based on these initial results, we believe that the adults are laying their eggs in the corn stover and that the white grubs are migrating into broccoli fields towards the fresh chicken manure. Based on lab and field experiments we are trying to understand the population dynamics of the different species. There are currently two papers in review which should reach the publishers by November.

The data from the trials with Agrilab and the laboratory trials are currently being analyzed. There are two ongoing Metarhizium trials in Chilasco and we are gathering information from farmers
on different application methods for pesticides.

IV. OBJECTIVES AND IPM CONSTRAINTS

Communication between the Management Entity and collaborators, and among project collaborators could be improved in order to streamline the implementation of this project. Travel plans should be advertised to all collaborators and reports disseminated to all parties involved.

V. RESEARCH APPROACH AND OUTPUT

Working papers submitted:

1. Dix, A.M., C.R. Carroll, M.W. Dix and G. Dal Bosco "Corn Stalks Influence Patchy Distribution of White Grubs in Broccoli Fields"

2. Dix, A.M. "IPM in non-traditional export agriculture in Guatemala: The Case of Chilasco, Baja Verapaz, Guatemala" Paper was presented at the LASA XIX International Congress, Washington D.C., September 28-30, 1995.

VI. NETWORKING ACTIVITIES

A. *Workshops and Seminars*

1. Innovations and Partnerships: Working with Natural Resource Management, Gender and Local Communities in the Tropics. March 30 to April 1, 1995. University of Florida, Gainsville. Anne Dix participated in Roundtable on Working with Stakeholders with Virginia Seitz from Virginia Tech.

2. Seminario-Taller: Apoyo del IPM-CRSP a la Produccion Horticola de Exportacion (June 1, 1995). Presented paper on white grub research in Guatemala.

3. IPM/CRSP Meeting in Virginia Tech (May 19-20, 1995)

4. CARE/Micuenca Meeting, Posada del Quetzal, Baja Verapaz (July 20-21, 1995). Provided support for farmer research activities being carried out in various communities in Baja Verapaz. Aura Esteban presented research results of activities with the University of Georgia. Part of this activity was also attended by Victor Salguero.

5. Chilasco Town Meeting (June 14, 1995) to discuss IPM activities in the community and prioritization of community defined needs by different NGOs. Attended by Virginia Seitz, Mark Dripchak, Anne Dix, and Ron Carroll.

6. IPM Course Dissemination (INCAP-Guatemala, OPS, Ministerio de Agricultura, August 11, 1995). Provided contacts in order to facilitate the dissemination of an IPM course developed by INCAP, which is directed towards training field technicians on the safe handling and use of pesticides, as well as the rudiments of IPM. This meeting was attended by Mark Dripchak, Victor Salguero and Anne Dix.

7. XIX International Congress of the Latin American Studies Association. Washington D.C. September 28-30, 1995. Anne Dix was invited to present paper titled: IPM in non-traditional export agriculture in Guatemala: the case of Chilasco, Baja Verapaz, Guatemala as part of panel titled Perspectives on Integrated Pest Management in Central America.

B. *Key Contacts and Exchanges*

1. Enio Cano, Entomology Collections Universidad del Valle. Taxonomic support. We have been documenting the life cycles of Phyllophaga and Cyclocephala and have pictures of the key characters used in their identification. At some point we would like to use this to make a publication for extensionists.

2. Charles MacVean, Institute of Investigations. Universidad del Valle. Experimental Design and Statistics.

3. Marcelo Velazquez, ICTA, Quetzaltenango. Provided Metarhizium for trials. Biological control of Phyllophaga.

4. Alvaro Hernandez, Facultad de Agronomia, Universidad San Carlos de Guatemala. Phyllophaga Management in Guatemala. He has several students who have carried out projects on Phyllophaga biology in other parts of the country.

5. Ronald Estrada, Agricola El Sol. Maintains Metarhizium strains for Marcelo Velazquez. Recognized local expert on biological control.

6. Richard Fisher, BIOFAC. Has provided us with valuable historical information on a national campaign to control Phyllophaga.

7. Oscar Nunez, Defensores de la Naturaleza. Logistical support in Chilasco. We currently stay at the house of their local park ranger and they have allowed us to use their field station in Salama free of charge.

8. Roger Williams, Ohio State University. Provided traps with feeding attractants in order to trial the attractiveness of lures developed in Ohio for beetles. Confirmed identification of some beetles collected in Chilasco.

9. Phillip Shannon, CATIE, Costa Rica. Currently doing research on Phyllophaga in Costa Rica. Has provided invaluable information on Phyllophaga behavior and control.

10. Luis Mejia. Intermediary, INEXA. Chilasco, Baja Verapaz.

11. Abundio Garcia. Community Leader, Chilasco, Baja Verapaz.

12. Berkeley Cone, President of ALCOSA. Erich Sundfeldt, Field Coordinator, and Aristides Lemus, Verapaz Coordinator for ALCOSA. Provided us with broccoli seedlings in order to the Metarhizium trials. As a result of this initial contact, they are now testing Metarhizium (available through Agricola El Sol) in some other broccoli plantations.

13. Carlos Mendoza. Manager of Leatherleaf Farm in Chilasco/Santa Cruz. Provided us with information about weather in Chilasco (summary) over the past two years.

14. Esteban Hernadez, Park Ranger, Defensores de la Naturaleza. Has been keeping a daily record of maximum/minimum temperature and rainfall since the end of November of last year.

VII. PUBLICATIONS AND PRESENTATIONS

Dix, A.M. and C.R. Carroll. 1995. Exploring the paradox between development and sustainability: a case study. Editorial, New World Agriculture.

Dix, A.M., C.R. Carroll and G. Dal Bosco. 1995. Gallina Ciega (*Phyllophaga* spp. y *Anomala* spp.) en el brocoli de Chilasco, Baja Verapaz. Memoria del Seminario-Taller sobre el apoyo del IPM CRSP a la produccion horticola de exportacion. Guatemala, Universidad del Valle, 1 y 2 de junio de 1995. pp. 108-113.

VIII. TRAINING OUTPUT

Anne Dix, PhD Candidate in Ecology, is currently conducting her graduate research as part of the IPM/CRSP. The project has provided support for short term research projects by students at the Universidad del Valle. Currently two students (Carla Villavicencio and Olga Slowing) are conducting some laboratory trials on Phyllophaga preferences for different substrates. The project has given several other students invaluable field experience in Guatemala and exposure to hands- on research. We have been supporting CARE's activities in the field and helping them teach farmers rudimentary experimental design and analysis. This is probably the most important contribution of the project, since we are helping build problem solving skills within the community that will hopefully have an impact that goes beyond the lifespan of the project. It should be noted that there is equal participation of men and women in this project and participation at all levels, from the city to the community.

IX. PROJECT HIGHLIGHTS

- We have determined that buried stover seems to be attracting gallina ciega larvae in broccoli fields.
- Buried chicken manure attracts gallina ciega larvae and encourages dispersal of larvae throughout broccoli fields.
- Adult beetle host plants were identified with the help of community members, many of whom had not realized that the beetles were the adults of gallina ciega.
- Light traps were promoted in the community through CARE extensionists. Millions of beetles were captured in this manner and children in the local school participated in the activity.
- Primary gallina ciega pest species were identified.
- Partnership with CARE extensionists in Chilasco has yielded the opportunity for real farmer experimentation. We are learning many practical lessons, from farmers, who don't necessarily adopt technologies in ways we would expect. Dissemination of project results to other community members has been expedited based on a real understanding of the working conditions. Farmers have taught us much through their diverse application methods and keen field observations. This has helped focus our project and direct future investigations.

PURDUE UNIVERSITY

Baseline Assessments of Non-Traditional Crop Exports and Development of Expansionary Export Strategies.

Investigator: Glenn H. Sullivan, Purdue University

II. COLLABORATING SCIENTISTS

Linda Asturias, ASIES
Ricardo Santa Cruz, GEXPRONT
James Julian, Graduate Research Assistant, Purdue University
Lonni Davenport, Administrative Assistant, Purdue University

III. SUMMARY OF RESEARCH RESULTS

Assessments of export trade were completed for selected non-traditional crops with particular focus on broccoli, snow peas, blackberries, and raspberries. Trade volumes, seasonal market windows, value of shipments, economic and non-economic trade barriers, and regional competitive positions were assessed for Guatemalan growers/shippers. Findings have helped collaborators engaged in production research prioritize their IPM CRSP activities, and have resulted in the development of three important program initiatives: (1) the development of direct market linkages with retail buyers in the United States for blackberry and raspberry shipments on a test market "program buying basis", (2) the identification of critical phytosanitary barriers impacting snowpea shipments, and the development of in-country inspection/training programs to help remove grower organizations from automatic detention at U.S. ports of entry, (3) the identification of needed regulatory policy changes relating to chemicals registration and labeling that negatively impact Guatemala's export trade development in non-traditionals.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. Objectives

The objective of this IPM CRSP research activity centers on the identification of IPM related issues that impact production performance requirements and export trade development in non-traditional crops. Research was designed to identify those crops that offer the greatest opportunity for export expansion and/or currently represent commercially important export crops, and assess production, postharvest, and regulatory constraints that impede market development.

V. RESEARCH APPROACH AND OUTPUT

A. *Research Methods*

Fifteen major export crops having commercial significance in Guatemala were identified and their market potentials assessed in U.S. markets. Each crop was analyzed by supply period to determine "market window" opportunities, supply competition, supply volume, and performance requirements. USDA/FAS trade statistics were used in these assessments, along with U.S. Embassy reports, Produce Marketing Association trade statistics, and ProNet price/volume data. Production, postharvest handling, and regulatory issues were analyzed for targeted crops showing the highest market potentials.

B. *Research Results*

Findings indicate that Guatemala clearly has a regional advantage in supplying blackberries and raspberries (October thru April), snowpeas (November thru June), and fresh broccoli (December thru February).

Findings in Year Two clearly identified chemical use compliance and inspection policies as serious problems for Guatemalan growers/shippers. These findings have served as the basis for helping develop strategies to overcome these problems and identify priority research needs for Year Three.

C. *Impacts*

These findings have: (1) helped GEXPRONT and Rafael Landivar University collaborate in the development of a phytosanitary inspection/training program to achieve higher levels of pre-export inspection in fresh produce prior to shipping, thereby reducing grower risk and working toward grower/shipper removal from automatic detention for snowpeas at U.S. ports of entry, (2) assisted grower groups in developing direct shipping linkages with retail produce buyers in the United States, (3) provided the basis for developing uniform chemical registration and labeling policies, thereby helping reduce the intensive use/misuse of chemicals over the long-term, (4) established baseline performance requirements for expanding exports to the United States, and (5) helped establish stakeholder interest/awareness in the need for "market-driven" production planning.

VI. NETWORKING ACTIVITIES and
VII. PRESENTATIONS/PUBLICATIONS

- IPM CRSP Workshop presentation - "The Role of IPM CRSP in Achieving Global Food Safety and Production Sustainability"; G. Sullivan, D. Dardon, and L. Asturias.
- Presentation to GEXPRONT Association of Snowpea Exporters - "IPM CRSP's Role in Developing Expanded Export Markets for Non-Traditional Crops in Guatemala"; G. Sullivan.
- Presentation to retail food buyers in the United States (Kroger Company, Marsh Foods, Schnuck Foods, Caito Foods) - "The Role of IPM CRSP in Creating New Market Opportunities for Seasonal Produce Supply from Central America"; G. Sullivan.
- Briefing paper to Richard G. Lugar, Chairman, the U.S. Senate Agriculture Committee. - "The Role of IPM CRSP in Achieving Global Food Safety, U.S. Grower/Shipper Strategic Alliances, and Production Sustainability in Central America"; G. Sullivan.

VIII. TRAINING OUTPUT

James Julian, July 1, 1995 start date. Graduate Research Assistant, Purdue University topic: "Postharvest marketing issues impacting non-traditional crop export trade development from Central America". Funded through IPM CRSP matching funds; G.H. Sullivan, Major Professor.

IX. PROJECT HIGHLIGHTS

- The development of strong institutional collaborations between GEXPRONT, Guatemalan growers and retail buyers in the United States to establish the framework for direct trade relationships in selected non-traditional export crops.
- The development of a phytosanitary inspection training program at Rafael Landivar University for achieving greater pre-export inspection of fresh produce prior to shipping.

Technical Support in Research Planning of IPM CRSP Guatemalan Activities in Pest Assessments, Pesticide Impacts, and Biological Control in Non-Traditional Export Vegetable Crops.

Investigator: Stephen C. Weller, Purdue University

II. COLLABORATING SCIENTISTS

Victor Salguero, ICTA/GEXPRONT
Danilo Dardon, ICTA

III. SUMMARY OF RESEARCH RESULTS

Primary activities in Year Two centered on resource development and technical assistance to Guatemalan research collaborators Victor Salguero, Guillermo Sanchez, and Danilo Dardon concerning experimental design, research program establishment, and data collection techniques in experiments conducted in Guatemala. The specific research support activities included: (1) assessment of disease, insects, and weed pests and their natural enemies in snow peas; (2) pest management diagnostics in snow pea and broccoli, (3) evaluation of oils and detergents to control aphids in broccoli, and a project involving Neem that will begin in Year Three. All of these projects except the Neem study were initiated in Year Two and, although full results are not yet available, they show good progress toward the research objective of IPM/CRSP involving assessing pest levels, defining natural enemies, establishing baselines, and investigating IPM control strategies using alternatives to synthetic pesticides.

The Neem project is under planning and will begin in Year Three in collaboration with Victor Salguero.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. Objectives

To assist Guatemalan collaborators in design and execution of pest control experiments and to provide technical expertise when and where it is needed.

V. RESEARCH APPROACH AND OUTPUT

A. Research Methods

Establish research plots in snow peas and broccoli in order to identify most common pests and their natural enemies. In addition, plots were established to investigate use of alternative pest control agents for aphid control in broccoli. Site arrangements are being developed for culture of Neem tree and testing of Neem seed extracts for insect control in non-traditional crops.

B. Research Results

- Data are being assembled concerning major pests and their natural enemies
- Several treatments with oils appear promising in control of aphids in broccoli.

C. Impacts

Provided ICTA and Guatemalan collaborators with access to the technical/scientific expertise of Purdue University in approaching pest control in non-traditional export vegetables. Other impacts are described in ICTA reports.

VI. NETWORKING ACTIVITIES and VII. PRESENTATIONS/PUBLICATIONS

- IPM CRSP Workshop - "Varietal and Cultural Control of Pests in Integrated Pest Management Programs" - written by Stephen Weller, presented by Victor Salguero, June 1, 1995, Guatemala City, Guatemala.
- Planning assistance with IPM CRSP Workshop held on June 1-2, 1995.
- Represented Purdue University at the IPM CRSP Technical Committee meeting at Virginia Tech, May 19-20, 1995.
- Discussed with Dr. Jack Schuster, Director Ecotourism Program, and Dr. Charles MacVean, Institute of Investigations, from the University del Valle regarding the possible collaboration on future Neem research in Guatemala.
- Met with Guillermo Sanchez, August 1995, at Purdue University to discuss potential collaborations on research relating to weeds and their influence in fruit plantings on populations of harmful/beneficial insect and fungal organisms. Discussed identifying Guatemalan students to be involved in IPM CRSP research.

- Met with Ricardo Santa Cruz, September 1995, at Purdue University to discuss possible researcher/instructor/student exchanges between Rafael Landivar University and Purdue University. This university to university agreement is in the process of being approved. We also discussed GEXPRONT/ICTA collaboration and job responsibilities of Dr. Victor Salguero, the new IPM CRSP Guatemalan research coordinator.
- Met with Linda Asturias, October 1995, at Purdue University to discuss gathering information relating to Guatemalan pesticide regulations, pesticide availability, and use data for a pesticide use publication. Discussed the need to identify student/employees to assist in IPM CRSP research.
- Assisted Dr. Glenn Sullivan with writing and coordination of PL 480 grant for strengthening research activities of Guatemalan collaborators.

VIII. TRAINING OUTPUT

None in Year Two.

IX. PROJECT HIGHLIGHTS

- Establishment of workable research associations with Guatemalan collaborators on in-country research.
- Providing technical support to Guatemalan researchers.
- Opening channels of possible researcher/student exchanges between Guatemala and Purdue University.
- Helped strengthen institutional research capabilities of Guatemalan collaborators.

OHIO STATE UNIVERSITY

Pest Control and Soil Management in the Guatemalan Highlands: Understanding Traditional Mayan Agricultural Practices

Investigators: Roger Williams, The Ohio State University; Helda Morales, Ph.D. Student from Guatemala, Cooperativo San Bernardino Patzún, Dept. of Chimaltenango, Guatemala

II. COLLABORATING SCIENTISTS

None

III. SUMMARY OF RESEARCH RESULTS

The Traditional Mayan Agricultural Practices research activities began in earnest when Helda arrived in Patzún in the early spring and began almost immediately to organize her research and make plans to plant corn and beans. Even before her crop was up she began to conduct surveys for beneficial and harmful pests in the sites where her plots are located. When I visited her plots in early September the corn in her research plots at Patzún and Chipiacul and ICTA Chimaltenango was all beginning to tassel and pollen was abundant on the upper surfaces of the corn leaves.

The survey conducted in August last year shows that farmers believe that soil management is one of the main practices for pest control. Controlled experiments have been established to analyze the effects of synthetic and organic fertilizers on pests. Furthermore, data will be gathered from farmers' plots in order to analyze different soil management practices. Much of this data has been gathered on a regular basis since May. However, the data will not be analyzed until the corn and beans are harvested in December and January. Helda has pages of data gathered in her plots and these data have not been analyzed. She is entering the data on her computer at this time.

Possibly the most advanced area is the collection and identification of scarab beetles (their larvae are known as white grubs or 'gallinas ciegas'. Helda put out several traps in a neighbors yard and has gotten help in the identification of these beetles. In addition, Anne Dix, has set out traps using the same chemicals and she has also gotten help in identification of the beetles from personnel at UVG. Several beetles which are very difficult to identify have been forwarded to a scarab specialist in Mississippi.

IV. OBJECTIVES AND IPM CONSTRAINTS

The general objective of this project is to compile a list of practices that traditional farmers (maize and traditional vegetable growers) in the highlands of Guatemala use to control pests, and to evaluate those practices from an ecological perspective. A comparison will also be made between the knowledge of pest control of traditional farmers and non-traditional farmers (export vegetable growers), extension agronomists and pest management specialists. More specifically, traditional practices of soil management, including labor distribution among family members, will be studied and described in detail. Pests, their natural enemies and plant growth will be compared between corn fields fertilized with synthetic and organic fertilizers. Effects of different fertilizers over pests populations will be analyzed by studying differences in plant nutritional status and pests' natural enemies.

Understanding the effects of traditional fertilization, compared with synthetic fertilizers would allow better design and management of agroecosystems for traditional crops, as well as for the non-traditional crops that have recently been introduced in the area. Furthermore, understanding traditional practices can help empower farmers and improve communication between farmers and extensionists.

V. RESEARCH APPROACH AND OUTPUT

A. Research Methods

Patzún is a Mayan (Cakchiquel) village in the western Department of Chimaltenango, at an altitude of 2,000 m. Traditionally, farmers have grown maize in polyculture with beans, faba beans, or squash. More recently, non-traditional vegetables (broccoli, snow-peas, zucchini) have been introduced with a package of synthetic pesticides and fertilizers, but many farmers are still growing maize with low-input traditional technology. These characteristics of Patzún make it an ideal place to study traditional agriculture and its transformation.

A survey to assess traditional and actual pest and soil management practices in the milpas has been performed in Patzún and surrounding villages in 1994. Twenty five traditional growers, and twenty five non-traditional growers have been chosen at random from a list of growers obtained from the cooperative and the bank of Patzún. Growers have been asked about practices they believe to be effective against insect pests, and to describe soil fertilization practices, using an unstructured interview with open-ended questions. Growers will also be asked about yield estimates, money and time investment, pests problems, etc. Socio-economic data will also be gathered (i.e. age, education, number of children, size of agricultural fields and membership in agriculture organizations).

Surveys will allow broad population coverage and statistical analysis of the results, but they could yield misleading information. For this reason, in addition to the survey, pest management and fertilization methods of some growers, have been observed directly. A list of practices and their frequencies will be generated. Each one of these practices will be analyzed in the framework of current pest management knowledge. Comparisons will be made between the knowledge of traditional and non-traditional growers, and between farmers and extension agronomists and IPM specialists, trying to quantify agreements and differences.

The survey accomplished in 1994 shows that farmers believe that soil management is one of the main practices for pest control. Controlled experiments have been established to analyze the effects of synthetic and organic fertilizers over pests. Furthermore, data will be gathered from farmers' plots in order to analyze different soil management practices.

Controlled experiments are evaluated in farmers' fields and in the experimental station of ICTA (Institute of Agricultural Science and Technology) in Chimaltenango. The establishment of experiments in farmers' fields allow evaluation of the treatments within the context of traditional management and local environmental conditions. Establishment of experiments at the experimental station, on the other hand, assure greater control over the treatments, and more complete knowledge of the soil management history of the plots.

B. *Research Results*

As mentioned earlier, a great deal of data have been gathered by Helda Morales since she arrived in mid-April. In particular she has recorded pest and beneficial insects, such as parasites, predators, and microorganisms which attack the pest species. She has records of phenological occurrences which can be associated with pests and beneficials.

Spodoptera frugiperda, Phyllophaga spp., and aphids are interesting pests to analyze, since the first two have been reported as the more important for farmers (Morales, unpublished data), and the latter has been reported as growing in importance since the introduction of the non-traditional crops in the area (Morales et al., 1994). Furthermore, sampling these three pests will allow study of above and below ground analyzed pests, as well as of chewing and sucking insects, which can have different responses to fertilizer applications. Pests populations and pest damage are sampled every other week using different methods. Numbers of larvae and eggs of *S. frugiperda*, aphids and percentage damage are determined by examining 12 corn plants per plot.

S. frugiperda a pupae and *Phyllophaga* larvae are sampled by examining a 10x20 cm square of soil under two plants per plot. Adults of S. frugiperda are sampled using a sticky trap. Damage by *Phyllophaga* is estimated by counting the number of plants per plot presenting the
characteristic stunting symptoms.

Soil samples were taken before planting, and one month after the application of the fertilizer. Five soil sub-samples were taken randomly in each plot to obtain a mixed sample for each plot. A third sampling will be take during harvest. Plant tissue samples have also be taken. Leaves were sampled by cutting pieces of them from five corn plants randomly selected in each plot, to form a mixed sample of leaves. The samples were sent to ICTA laboratory for chemical analysis.

C. *Impacts*

This project could lead to sustainable pest management practices that would avoid environmental, economic and public health costs. A better understanding of farmers perspectives and the ecological mechanism of their practices would allow adoption of their technologies to other agroecological systems, or to improve them if necessary.

VI. NETWORKING ACTIVITIES

A. Paper Presentation

Roger Williams and Helda Morales had inputs into the planning and participation of the first IPM CRSP Workshop in Guatemala. The input into the planning phase was minimal. However, in the participation phase a paper was jointly written by Guillermo Sánchez entitled, " Estrategias del MIP: Control Quimico" which was presented at the Workshop by Victor Salguero.

B. Research Investigator Exchanges

I have been working closely with Guillermo Sánchez on planning a bramble (blackberry & raspberry) project. We have visited plantings at many locations to have a better understanding of major problems. We have plans to initiate this research on mite problems during the year testing several miticides for efficacy. In addition, we are conducting a survey of all insects and diseases which plague bramble production in Guatemala. The beetles that attack the white flowers, particularly of blackberries, have been collected and are being determined by a specialists.

C. Research Information And Product Exchange

I have been asked to provide information on a specialist with research on monitoring whiteflies for economic thresholds in virus transmission in melons and cucurbits which was accomplished. Another request that was filled was to conduct a literature search of recent papers in the area of the use of pheromones to control insects, the confusion technique. This request was also responded to with a bibliography of recent titles along with abstracts. Insect traps and lures have been provided to four researchers working in various facets of the Guatemala IPM CRSP. In addition, I have helped locate specialists to identify insects for others on this project.

Furthermore, an IPM seminar was offered to children (6 to 12 years old) in Xepatan (Patzún, Chimaltenango) by Helda. 170 children and 5 teachers were trained on chemical pesticides dangers and alternatives to them. The seminar was offered because of teachers' concern that their students have to apply pesticides on their parents' broccoli fields. The seminar was successful, specially for older children, who now talk about natural enemies and sampling. The 6 year olds were not very receptive, mainly because of language barriers. Nevertheless, because of teachers training, they will add to their agenda IPM topics, even with the youngest. Copies of the IPM CRSP Workshop Proceedings, as well as other ICTA-CRSP booklets have been photocopied and distributed among farmers who request them.

VII. PUBLICATIONS AND PRESENTATIONS

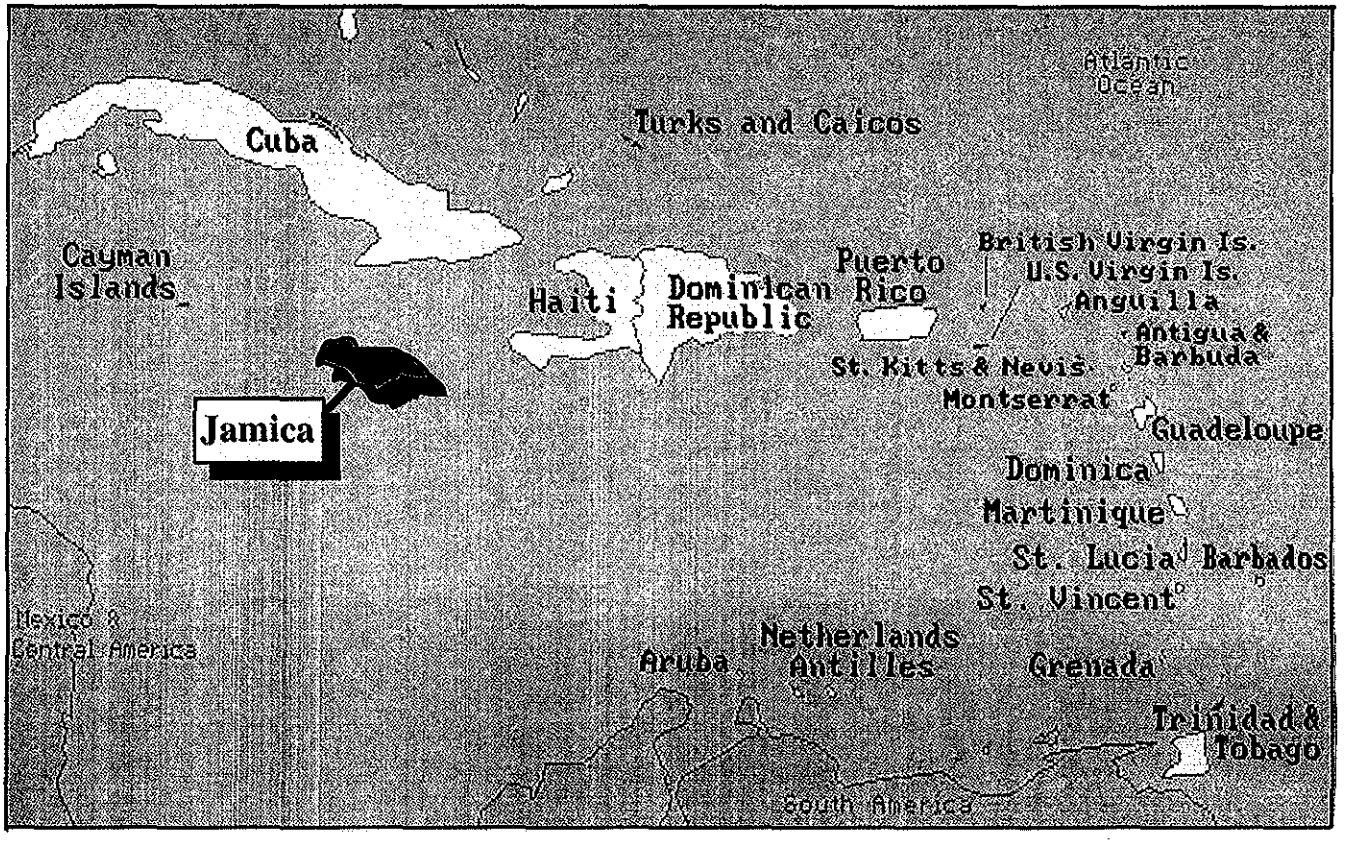
E. Guillermo Sánchez y Roger Williams. 1995. Estrategias del MIP: Control Quimico. Apoyo del IPM-CRSP a la Produccion Horticola de Exportacion. Seminario-Taller IPM CRSP Guatemala. pp. 10- 23.

VIII. TRAINING OUTPUT

IX. PROJECT HIGHLIGHTS

- Giving talks to school children on the benefits of IPM and the precautions that should be observed when spraying vegetables was well received and most rewarding.
- Helda found that the kids now talk about making insect counts (surveys).
- Good insects are now recognized by the students and they are able to share this information with their parents.

CARIBBEAN



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CARIBBEAN REGION ANNUAL REPORT

Frieda Eivazi, Site Chair; Lincoln University
Charlie Pitts, Vice Chair, Pennsylvania State University
Janet Lawrence, Host Country Site Coordinator
Janice Reid, Country Representative

I. PROGRAM DESCRIPTION

The IPM CRSP in Jamaica during Year 2 involved the research talents of entomologists, rural sociologists, soil scientists, geneticists, plant pathologist, production horticulturists, and extension educators from a broad range of institutions and agencies both from Jamaica and from the United States. This year's efforts were the collaborative effort of researchers at the Caribbean Agricultural Research and Development Institute (CARDI), and research teams with Virginia Tech, Lincoln University of Missouri, The Ohio State University, Pennsylvania State University, and the U. S. Vegetable Laboratory (South Carolina). Assistance within the host country came from Rural Agricultural Development Authority (RADA), USDA Animal & Plant Health Inspection Service-International Services (USDA-APHIS-IS), University of West Indies (UWI), the Jamaican Ministry of Agriculture and Mining (MINAM), St. Mary Development Cooperative ("Hillside Agriculture Project"). Research was conducted both within Jamaica and within the respective research units at each of the U.S. collaborative institutions.

Research conducted through the IPM CRSP was developed and planned with involvement of the host country, the site chair, technical advisory committee, and the individual research units. Priorities and coordination of the research was established in initial planning meetings with the host country during Year 1. Current research conducted in Year 2 was a continuation of research initiated or planned in Year 1 of the project. Efforts were made to include the active involvement of interdisciplinary, multi-institutional and both countries in the planning and implementation of the various research components. The total program was overseen by the IPM CRSP management entity and technical committee. The implementation of specific research objectives were left to the respective research investigators in consultation with participants in the host country. Research conducted in Jamaica was done in collaboration with U.S. researchers and was complementary to research being conducted in the U.S.

CRSP funds in support of this project were managed by the respective institution as a subcontract to Virginia Tech. Each institution provided matching support for research efforts. CARDI also provided technical and professional personnel, laboratory space and other technical support. While the local USAID Mission office provided local support in Year 1 of this project, no local funds were provided in Year 2. Efforts are currently underway to identify possible local host country funding for Year 3 of this project.

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II. IPM CONSTRAINTS RESEARCHED

IPM based on scientific technology is relatively new to Jamaica. The research-based knowledge as well as grower experience in the use of IPM is very limited. Consequently, the constraints to a successful IPM program begin with the lack of knowledge database on the pests and crops, as well as IPM crop production techniques. Access to existing IPM information and being able to deliver this information is a major constraint in the implementation of a comprehensive IPM program in Jamaica. In addition, there is inadequate Jamaican plant protection and breeding research programs to expand IPM data for these programs in the future. Also, there is a real concern regarding the safe and proper selection and use of pesticides in Jamaica, especially with small farm operations.

The concern over pesticide usage includes not only the safety of the farmer/applicator but also the potential environmental and health hazards that may result. Potential health hazards for Jamaicans include residues in food, water and air. Potential health hazards also extend to the U.S. and other importing countries of Jamaica food products. Thus, research on IPM benefits Jamaica directly and indirectly benefits the U.S. Additional benefits are gained to U.S. are a greater knowledge of IPM techniques for minor crops and those that may be potentially grown in the U.S. in the future. Greater communication, e.g. via Internet, greatly enhances the sharing of this information and also allows for mutual assistance in problem solving. Also, some of the work (e.g. with Scotch Bonnet peppers) may be transferable to more traditional vegetable crops grown in the U.S. (e.g. bell peppers).

During Year 2 of this project significant gains were made in the IPM CRSP Jamaican research. Complete details are presented in individual research reports presented elsewhere. As indicated above, base-line knowledge of Jamaican pests and crops is a major constraint. To this end, research was conducted to gain base-line information on Jamaica's situation. Cropping systems in Jamaica were analyzed for possible incorporation of IPM techniques. Results indicated that IPM intervention could be used in production systems by improved timing of field sanitation and harvest, by use of different insect traps and use of crop traps, and obvious opportunities to reduce pesticide use and increase the selectivity of those pesticides used. Base-line information on soil fertility was obtained for selected Jamaican research sites. This information will be incorporated into crop production systems. Proper nutrition enhances the vigor of plants which in turn makes them more tolerant of pests and diseases. Since a major problem in Jamaica is viral diseases in peppers, the IPM CRSP researchers have taken the first step by identifying virus free peppers seeds. These seeds will be used to evaluate disease resistance and are a source for breeding and propagation material.

With the building of IPM information, it must be shared to be used. A program of fact sheets and educational programs targeted to farms in Jamaica were implemented. The primary audience was small farm operations which have little technological input. In order to assist in the development of a system to share IPM information on a global scale, funds were obtained (by Bill Ravlin at Virginia Tech) to develop an IPM CRSP World Wide Web "home page." This will greatly enhance the ability to share IPM information world wide. This will be especially helpful in the collaboration of IPM CRSP researchers everywhere.

As indicated above, pesticides usage and pesticide residues are a major concern in Jamaica. During Year 2, IPM CRSP researchers have initiated the evaluation of the current status of the pesticide situation in Jamaica by collecting samples for pesticide residue analysis. Base-line information on the overall pesticide situation in Jamaica were collected. The most severe concerns regarding pesticides within have been identified e.g. pesticides education,

pesticide residues, pesticide usage, and pesticide availability. Potential methods to address these concerns will be developed during the coming year.

III. INSTITUTIONAL BUILDING

No equipment was obtained for the host country under this project during Year 2. Institutional building occurred primarily through the training of personnel within the host country. A laboratory chemical analyst with CARDI (Raymond Martin) went to Pennsylvania State University for a month to obtain training on pesticide residue analysis procedures. The purpose of this training was to gain an overview of methods of pesticide residue analysis to be used as part of the CRSP project. In August of Year 2, an entomologist with CARDI (Sharon McDonald) began her M.S. degree work in entomology at Virginia Tech with support from this project.

Informal training for host country technical and professional personnel was conducted individually and collectively during the various visits by U.S. researchers. This training was related to experimental design and implementation, as well as research techniques and general information on IPM and crop production. During the year Dr. Clive Edwards and Margaret Huelsman (Ohio State University), Dr. Dyremple Marsh (Lincoln University), Dr. Charlie Pitts (Penn State University), Drs. Ginny Seitz, Herman Warren, Bill Ravlin (Virginia Tech), Drs. Howard Harrison and J. R. Bohac (U.S. Vegetable Laboratory) traveled to Jamaica as part of their research efforts. Also, a seminar on virology was presented to the host country researchers to give an introductory overview of this important topic. Emphasis was placed on Scotch Bonnet peppers viral diseases which are a severe problem in Jamaica. More formal training sessions (workshops, seminars, etc.) on a broad range of IPM topics are planned for the host country personnel during Year 3.

IV. NETWORKING

The primary contractor in Jamaica is CARDI which is a regional organization. Information gained in Jamaica under the IPM CRSP is shared throughout the Caribbean through the communication network of this organization. Sharing of information within the country is gained through the efforts of RADA and MINAM which provide the equalivant of the U.S. Cooperative Extension efforts in Jamaica. As part of the these total efforts, a training seminar and a participatory field day for farmers in Annotto Bay were conducted on IPM and soil conservation. These activities were funded under the IPM CRSP as well as used knowledge gained from IPM CRSP research. Fact sheets on IPM were also prepared and distributed. Additional fact sheets on individual crops are under production, but were not complete in Year 2.

Other activities were conducted to foster cooperation and collaboration with other agencies in Jamaica. A presentation on the IPM CRSP was made to the Jamaican Exporters Association and a poster on IPM CRSP activities was presented at the Jamaican National Agriculture Show. Along with these presentations, facts sheets on IPM CRSP were handed out.

CARDI

Spatial and Seasonal Dynamics of Pests and Natural Enemies of Callaloo, *Amaranthus* sp., Hot Peppers, and Sweet Potato, within Selected Communities in St. Mary, St Catherine, and Clarendon.

Investigators: Janice Reid (Co-Principal Investigator), Janet Lawrence (IPM CRSP Site Coordinator /Entomologist - Sweet potato), Dionne Clarke-Harris (Entomologist - Callaloo) and Sharon McDonald (Entomologist - Hot Peppers), Marlene Pereira (Pathologist), Heather Reid (Biometrician), Peter Myers (Technical Assistant), Oral James (Technical Assistant) and Donald Simpson (Technical Assistant)

II. COLLABORATING SCIENTISTS

Don Mc Glashan (Agronomist/Virologist - Ministry of Agriculture and Mining), Phillip Chung (Crop Protection Specialist - Rural Agricultural Development Authority), Dave Hutton (Nematologist - University of the West Indies)

III. SUMMARY OF RESEARCH RESULTS

IPM CRSP research activities for Year 2 (September 29, 1994 - September 28, 1995), included population dynamics studies, economic loss assessments and the determination of weed management systems of callaloo (*Amaranthus* sp.), peppers (*Capsicum chinensis*), and sweet potato (*Ipomoea batatas*). Lepidoptera larvae/spider mites, viruses and sweet potato weevils were found to be the main pests affecting callaloo, peppers and sweet potato, respectively, and the primary sources of crop loss. The data from these activities were analyzed to improve the understanding of integrated farming systems as well as determine the impact of different practices upon crop loss and pest incidence. Preliminary analyses of the cropping systems revealed a number of points in the production cycle where potential IPM interventions would be possible. These include improved timing of field sanitation and harvest; use of different traps and trap cropping. There are also obvious opportunities to reduce pesticide use and increase the selectivity of those used.

In addition to research activities, technical assistance was given to farmers within the research communities on soil conservation, pest identification and IPM. Collaboration between IPM CRSP and local organizations involved in research relevant to the CRSP was also explored to strengthen the IPM activities.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. *Objectives*

- Identify and determine the seasonal and spatial dynamics of pests and natural enemies of callaloo, peppers and sweet potato.
- Quantify crop loss for each crop.
- Assess the effect of social, agronomic and economic trends upon cropping systems.
- Determine cost effective and IPM compatible weed management tactics for use in callaloo, pepper and sweet potato systems.

B. *Accomplishments*

- Introduced soil conservation techniques to farmers practicing hillside farming in research communities in Annotto Bay, St Mary.
- Introduced the concept of Integrated Pest Management (IPM) to farmers within the research sites.
- Informed farmers of selected pests and natural enemies associated with the research crops.

C. *Constraints*

- Biosystematics - identification of pests and natural enemies on the research and companion crops.
- Availability of pest management supplies.
- Proper equipment to conduct pesticide residue samples.
- Transportation to the research sites.

V. RESEARCH APPROACH AND OUTPUT

A. *Population Dynamics*

Farmer and Site Selection

From the information gathered during the baseline survey (see cropping systems report Year 1), 9 farmers were selected for the population dynamics studies; callaloo (*Amaranthus* sp.) (3), peppers (*Capsicum chinensis*) (3), and sweet potato (*Ipomoea batatas*) (3). Farmers were selected based on the crops grown, production practices, gender and well being (see sociological research report). For each farm, a farm plan, crop calendar and farmer profile were developed. The farm plan was updated whenever farmers introduced new crops and/or modified crop protection practices. Sample farm plans for each crop studied are included as Appendix 1. Before research activities were conducted, a formal agreement was drafted between CARDI and the farmers.

Agroecology of Research Sites

The research sites are located in the parishes of St Mary, St Catherine and Clarendon. St Mary is located on the northern side of the island, whereas St Catherine and Clarendon lie on the south eastern end (Figure 1). The topography of the research communities varies widely, communities within St Mary are dominated by hills and valleys, whereas those within Clarendon and St Catherine are flatter and lie on the coastal plains. Soils within the areas are predominantly clays, some of which have been formed from old and recent alluvium and limestone. Research communities within Clarendon and St Catherine generally receive less than 1000 mm precipitation annually. In contrast, St Mary receives greater than 2000 mm annually.

White fly - Color Preference

The preference of whitefly populations to two hues of yellow was determined on an old pepper plot (>6 months) and two pepper nurseries (< 6 weeks). Preference was determined by comparing the numbers of whiteflies on sticky traps after two hours of exposure. Sticky traps consisted of yellow or neon yellow cards (15.2 X 10.1 cm) attached to the top of a wooden stake (38.1 cm). Cards were placed on either side of stakes and covered with adhesive (tangle foot). The traps were placed at the farthest points of each field so that cards faced the pepper plants as well as the surrounding areas.

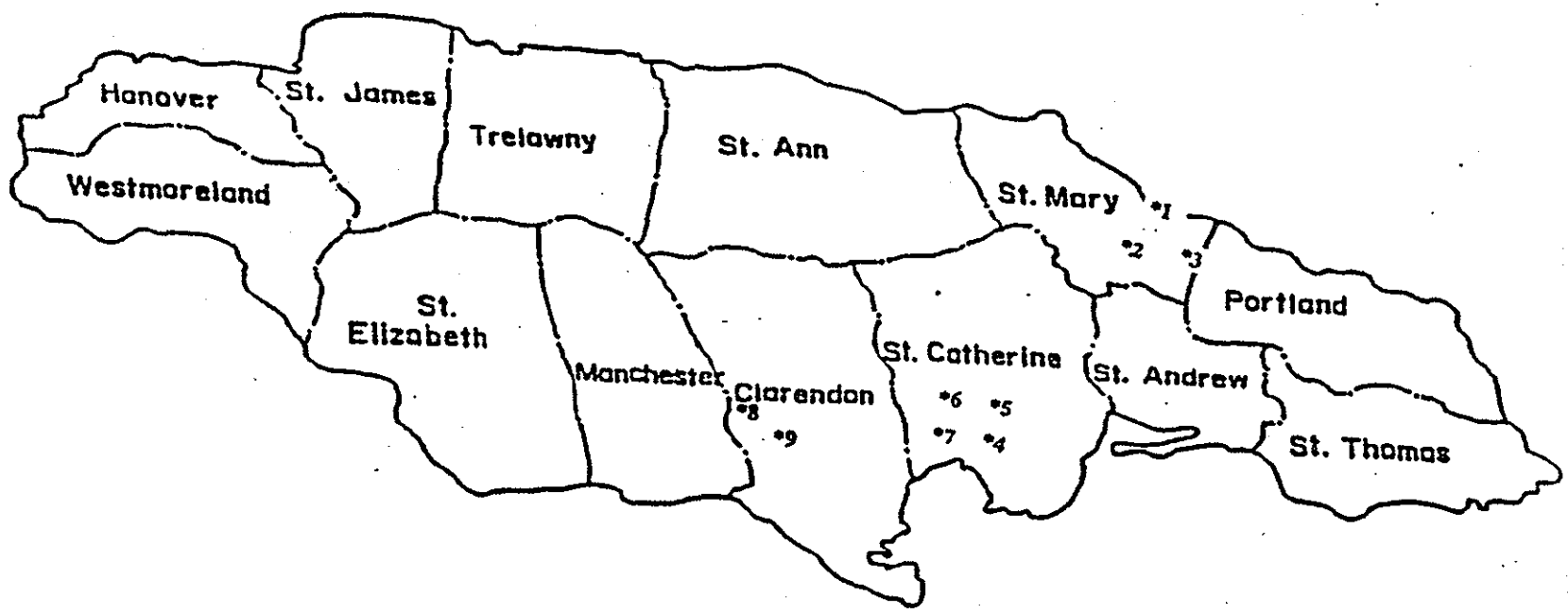
For all the test sites, a greater number of whiteflies was observed on the neon cards than on the plain yellow cards. There was also the tendency for the inner cards to have more whiteflies than the outer cards and suggests that most of the whiteflies came from among the pepper plants. Thereafter, only neon cards were used in the traps.

Population Monitoring

Pepper: Pest and natural enemies were monitored on three farms (HP1, HP2, HP3), one in Bushy Park (HP1) and two in St Mary (HP2 and HP3). Populations were monitored monthly for the Bushy Park farm and every other month for farms within St Mary. In Bushy Park, there was little activity with respect to pepper, in that farms had crops at the nursery stage or farmers were just sowing seeds to meet the winter market. The area under pepper cultivation on research farms was less than 0.04 ha and plants were less than 6 weeks old at the time of monitoring. All pepper plants were scouted for pests and natural enemies. Sticky traps were used to assess whitefly populations (Table 1).

For all farms, no arthropod pests were observed on the pepper plants. White fly populations appeared to be low, in that the number of whiteflies per trap did not exceed 5 at any time. No aphids were collected, however leafhoppers, thrips, dipterans were usually attracted to the traps. Due to very dry conditions being experienced in June in Bushy Park, the research farm was abandoned by the farmer.

Figure 1. IPM CRSP Research Communities in Jamaica



St. Mary
1. Annotto Bay
2. Timsberry
3. Forty-one

St. Catherine
4. Bushy Park
5. Grove Farms
6. Nitengale Grove
7. Tethford

Clarendon
8. Clarendon Park
9. Heifer Run

Callaloo

Similar to the pepper studies, population monitoring on callaloo farms was conducted monthly for Bushy Park farms and every other month for farms within St Mary. Experimental plots ranged from 0.01 to 0.04 ha. For each site, five plants were selected along opposing diagonals, tagged and the numbers of pests/damage observed and recorded. Sticky traps were used to monitor whitefly populations.

Three farms were monitored in Bushy Park (C1, C2, C3). Farms C2 and C3 had significantly higher proportions of leaves damaged by mites ($P < 0.001$) than farm C1 (Figure 2). The level of damage was the same for farms C3 and C1 for new leaves, but for old leaves farm C3 had greater damage than farm C1. Farm and crop age significantly influenced mite populations ($P \leq 0.1$)

Leaf hopper damage was significantly higher on farm C1 than on farms C2 and C3 (Figure 3). The effect of crop age and farm significantly affected leaf hopper damage to callaloo plants ($P < 0.001$). Although leafhopper damage was observed on all the farms, farmers do not consider it a problem as they are able to market the damaged crop locally.

Farm, crop age and time significantly affected the number of whiteflies per farm ($P \leq 0.025$). The number of whiteflies observed on Farm C2 was significantly more than for C2 and C3 and may have been due to residues from an old abandoned pepper field which was in close vicinity to the experimental plot (Figure 4).

Table 1. Pest and natural enemy population assessment methods

Crop	Pest and Natural Enemies	Population Assessment Methods
Callaloo (*Amaranthus* sp.)	Lepidoptera larvae Cucumber beetles White rust Leaf spot	Visual observation of tagged plants.
	Mites Leaf hoppers	Visual observation - 6 leaves were removed from tagged plants (3 from top and 3 from bottom). The numbers of mite colonies and leaf hopper damage were recorded.
	Whiteflies	Sticky traps Card size - 5.08 X 7.62 cm Card color - Neon yellow Exposure time - 1 hour Height of stake - 60.4 cm
	Parasitic Wasps Ladybird beetles Lace wings Spiders	Visual observation of tagged plants.

Table 1. (Continued)

Crop	Pest and Natural Enemies	Population Assessment Methods
Pepper *(Capsicum chinensis)*	Whiteflies Aphids	Sticky traps Card size - 10.16 X 15.24 cm Card color - Neon yellow Exposure time - 2 hours Height of stake - 38.1 cm
Sweet Potato *(Ipomoea batatas)*	Lepidoptera Leaf miner White rust Weeds	Visual observation within quadrat (0.58 sqm)
	White flies Aphids	Sticky traps Cards size - 10.16 X 15.24cm Card color - Neon yellow Exposure time 24 hours Height of stake - 38.1 cm
	[1]Sweet potato weevil	Traps baited with Sweet potato weevil female sex pheromone Conc - 100ug Exposure time - 24 hours
	Parasitic Wasps Ladybird beetles Lace wings Spiders	Visual observation within quadrat (0.58 sqm)

[1] Sweet potato weevil populations were assessed for the entire area cultivated with sweet potato.

Sweet Potato

Three sweet potato farms (SP1, SP2, SP3) ranging in ages of 3 to 6 months were monitored. On each research farm, a 0.08 ha experimental plot was selected from the total area of sweet potato cultivated. On each sample date, three ridges were randomly selected from the experimental plot, and the ends and middle of each ridge sampled for pests and natural enemies. Sampling was conducted by placing a 0.58 sq metre quadrat on the position to be sampled and recording the numbers of pests and natural enemies within the quadrat. For each experimental plot, nine positions were sampled. Pheromone and sticky traps were used to monitor sweet potato weevil and whitefly populations, respectively.

[1]. Sweetpotato weevil populations were assessed for the entire area cultivated with sweet potato.

Figure 2. Mite Damage on Selected Farms in Bushy Park, St Catherine, April - September 1995.

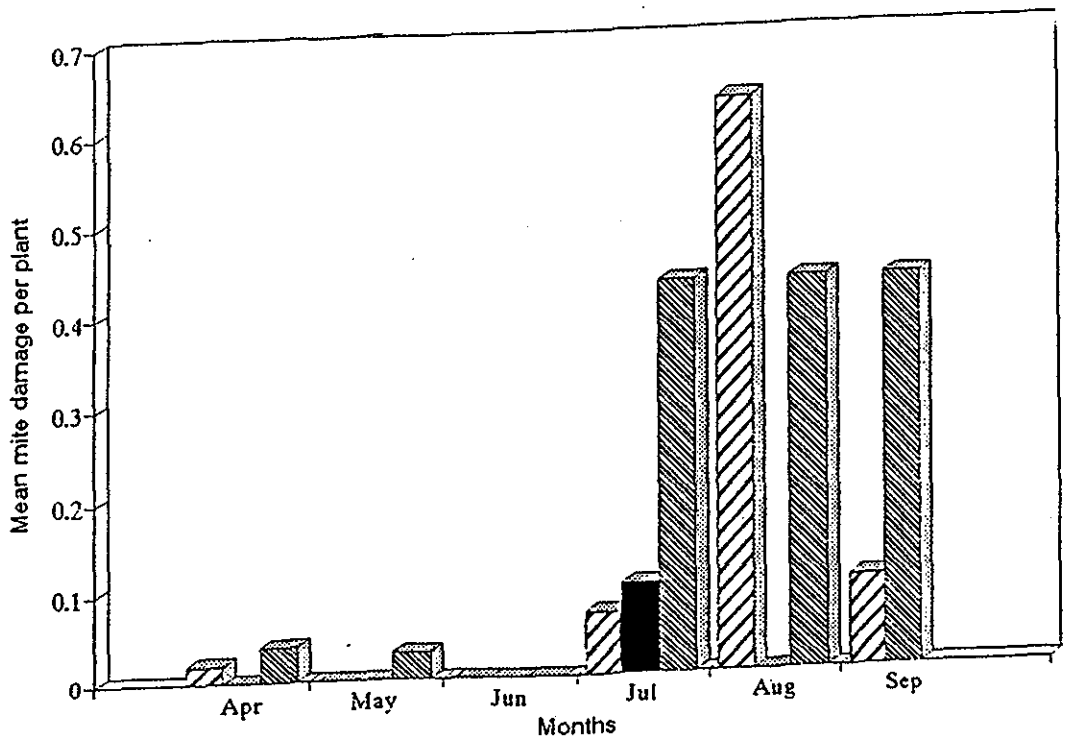


Figure 3. Leafhopper Damage on Selected Farms in Bushy Park, St Catherine, April - September 1995.

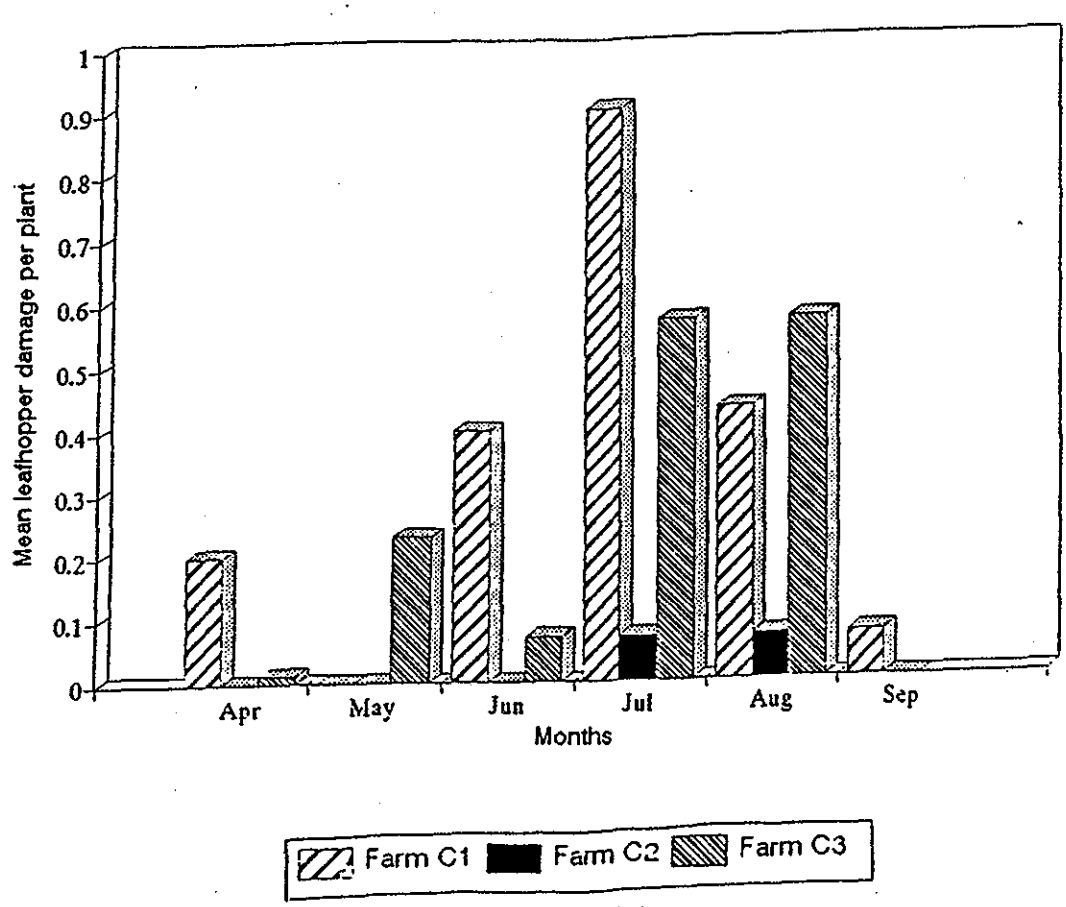
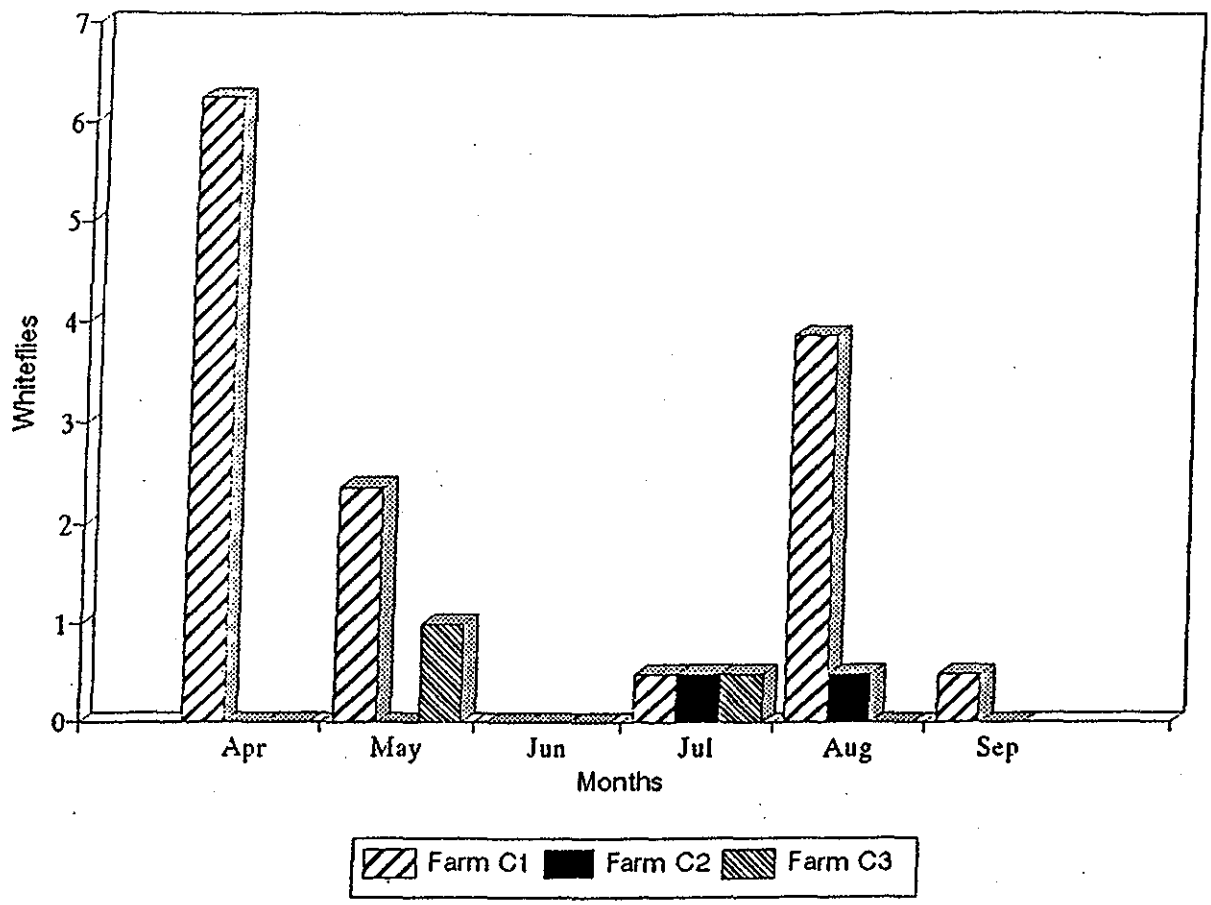


Figure 4. Population Dynamics of the Whitefly, *Bemisia* sp. on Selected Farms in Bushy Park, St Catherine, April - September 1995.



A baseline survey for nematodes was conducted on the three research farms. On each farm, the total area cultivated with sweet potato was systematically sampled for soil and roots. Nematodes were extracted from soil and root samples by a modified Baerman funnel technique (Whitehead and Hemming 1965). The extracted nematodes were identified and counted.

Data Analyses

The data were square root transformed and analyzed using ordinary least squares regression analysis in order to compare farmers, the effect of time and farmer-time interaction. The effect of age of the crop was also examined.

The inferences from the transformed data analysis were similar to those on analyzing the raw data so the results of the analysis of the raw data are shown.

Leaf miners and lepidoptera larvae were the most prevalent insects observed at the points sampled. White rust, *Albugo* sp. was also observed in high numbers. Farmers reported that they hardly ever had to control these pests as they did not affect yields and were therefore not a problem. Grasses, broom weed, and milk weed occurred in high proportions on the research farms. This was more pronounced in old fields (> 5 months). Farmers revealed that after the first 6 to 8 weeks of the crop weeding was not carried out on a regular basis. The effect of time, crop age and farmer time interaction was not ascertained from the statistical analyses which was conducted on the data collected with the quadrat. This was because the frequency of observations was low and resulted in poor predictions from the regression model. Additional data are being collected so that conclusive results regarding these factors can be made.

Generally, there was an increase in the number of weevils caught in traps during the monitoring period. This however was not significant ($P = 0.37$) and may have been due in part to the small number of observations and the large variability within the data. The number of weevils per farm ranged from 1043 to 3872 ($\pm$ 2250) per visit (Figure 5). Differences in the numbers of weevils per farm may have been due in part to the agronomic practices conducted by the farmers. Farms SP2 and SP3 with the lowest weevil damage had been using traps baited with female sweet potato weevil sex pheromones to manage weevil populations for the past two years, whereas
farm SP1 with the highest populations did not utilize pheromones to manage weevil populations.

The number of whiteflies trapped declined with the age of the sweet potato crop (Figure 6). This was more pronounced for farm SP1 where pumpkins, tomato and peas were planted and harvested during the monitoring period. These crops are alternate hosts for the whitefly and may have acted as a source of infestation for the sweet potato. Relative to Farm SP1, on farms SP2 and SP3 alternate host crops were not as prevalent.

Four genera of plant parasitic nematodes were found to be associated with sweet potato on the research farms. These included *Helicotylenchus, Rotylenchulus, Pratylenchus* and *Meloidogyne*. Nematode composition and density varied among the farms. Whereas farm SP3 had the largest composition and highest numbers of nematodes (>500), on farm SP2 no nematodes were detected. The plant parasitic nematodes observed are consistent with nematodes described in the literature for sweet potato. In order to ascertain the importance of these nematodes to the cropping systems, further studies need to be conducted to determine nematode distribution within the field, alternate hosts as well as economic importance.

Figure 5. Population Dynamics of the Sweetpotato Weevil, *Cylas formicarius* on Selected Farms in South Clarendon, April - September 1995.

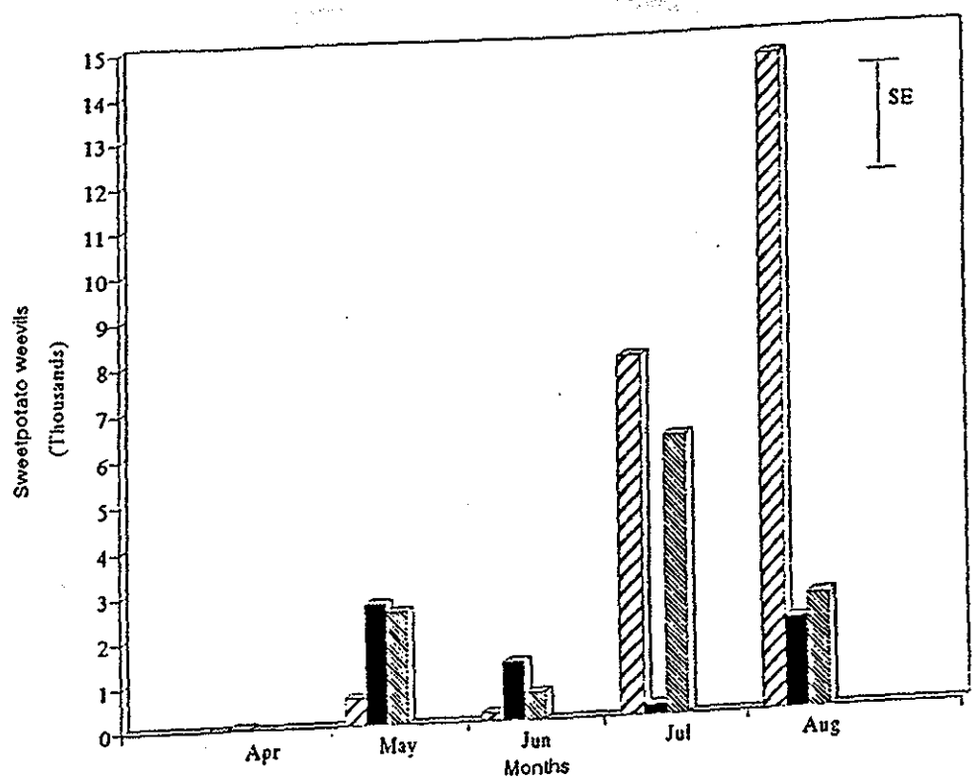
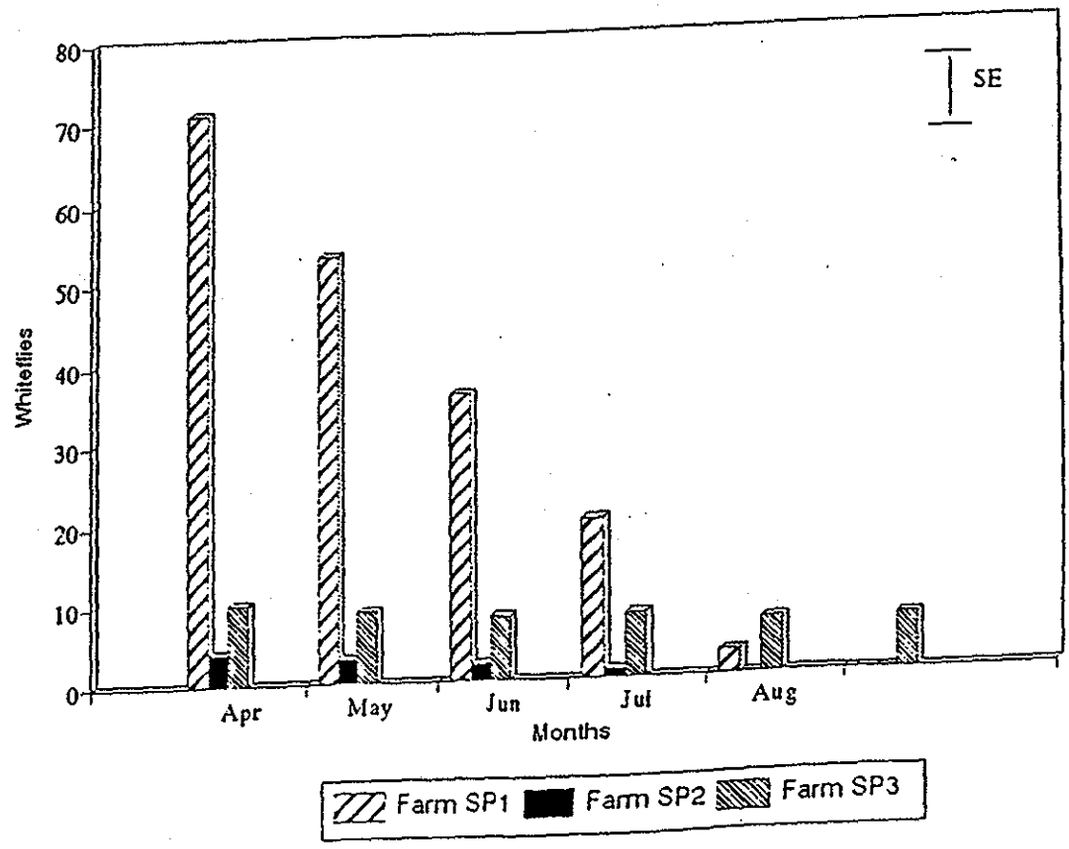


Figure 6. Population Dynamics of the Whitefly, *Bemisia* sp. on Selected Farms in South Clarendon, April - September 1995.



Spiders and predatory beetles were the most prevalent natural enemies observed on the farms. Similar to the weed, lepidoptera and leaf miner data the frequency of observations of natural enemies was too low for conclusive statements to be made.

Output

- Updated cropping systems report
- Developed farm plans, farmer profiles and crop calendars
- Reported population dynamics of pest and natural enemies of the research crops
- Updated specimen collections of the pests and natural enemies

B. Weed Management

For research farms within Bushy Park, the weed composition, coverage and management practices were recorded. Weed composition and coverage were determined by traversing the research farms, recording the weeds present and estimating the surface area coverage in relation to the farm boundaries. Coverage of weeds species was noted based on a scale of 0 (not observed) to 15 (entire field covered).

Weed Composition and Distribution

Weeds present one of the most onerous pest management problems facing farmers in the research site. This is so even though most site farmers did not list weeds as a major problem in their operations. It can, however, be seen in references to labor problems and the tedious physical effort applied in the predominant manual weed management practices. Weed control accounts for approximately 15% of total production costs. Owing to the difficulty in accessing competent, dependable labor, largely related to weed control, some farmers are forced to restrict their scale of operations. Weeds also compete with crops for applied and natural plant nutrients and water. In addition, they also hamper the flow of furrow irrigation water, in one case extending the process by an estimated 30%.

A large number of broad-leaf and grass weeds populate the site (Table 2). Those exhibiting widest coverage included *Cleome viscosa, Commelina diffusa*, and an unidentified grass (Table 3). Observations so far suggest somewhat stratified species distribution, but further observations are required to verify this. Within the research area, weed growth proliferates year-round owing to the availability of furrow and sprinkler irrigation facilities. One farmer reported that drip irrigation resulted in lower weed infestation during the dry season. Husbandry practices also promote this problem, e.g.. on some farms the abandonment of harvested fields until needed for a subsequent crop allows profuse weed seed-set and increased soil load.

Management Practices

Weed management practices are carried out by the farm family, largely males, or hired labor. The latter is avoided if at all possible, owing to a reported gross inefficiency and high cost. Depending on rainfall and crop growth/canopy cover, weeding is first conducted three to five weeks after planting and subsequently at 3 to 5 week intervals. The following techniques are often combined:

Mechanical (all crops)

Ploughing/harrowing/furrowing by tractor during land preparation activity incorporates weeds up to 1.5 metres into the soil. A frequency as low as once in three years to six to nine month intervals usually after each crop (excepting cucumber which is completely harvested within eight to nine weeks) is observed. Ploughing and possibly harrowing, may be omitted in some cases.

Table 2. Weeds species growing on research farms in Bushy Park, St. Catherine

Plant Family	Botanical Name	Common Name
Tiliaceae	*Corchorus olitorius*	Jew's Mallow
Poaceae	*Setaria barbata* *Cenchrus echinatus* *Panicum maximum*	Corn Grass Bur Grass Guinea grass
Mimosaceae	*Mimosa sp.* *Desmanthus virgatus*	Shame Weed, Sensitive Plant
Capparaceae	*Cleome viscosa* *Cleome ciliata*	Wild Caia Consumption Weed
Boraginacea	*Helitropium angiosperm* *Helitropium indicum*	Dog's Tail Scorpion Weed
Portulacaceae	*Portulaca oleraceae* *Portulaca quadrifida*	Pussley Chicken Weed
Laminaceae	*Leonotis nepetifolia*	Bald Bush, Lion's Tail
Asteraceae	*Lagascea mollis*	Velvet Bush
Malvaceae	*Sida acuta*	Broom Weed
Euphorbiaceae	*Euphorbia heterophylla* *Euphorbia hypericifolia* *Euphorbia hirta* *Phyllanthus amarus*	Red Milk Weed, Milk Grass Seed-under-leaf, Egg Woman
Commelinaceae	*Commelina diffusa*	French Weed, Water Grass
Verbanaceae	*Priva lappucea* *Lantana camara*	Clammy Bur, Velvet Bur Black Sage, White Sage
Amaranthaceae	*Achyranthes indica* *Alternanthera* sp.	Devil's Horse Whip Rabbit Meat Callaloo
Leguminaceae	*Centrosema* sp.	Bluebell, Wild Pea
Convulvaceae	*Ipomea* sp.	Morning Glory, Wild Potato
Compositae	*Vernonia cinerea* *Parthenium hysterophorus* *Wedelia trilobata*	Iron Weed, Inflammation Weed Whitehead, Worm Wood Carpet Daisy, Marigold
Nyctaginaceae	*Boerhavia erecta*	Hog Weed, Hog Feed, Sow Meat

Table 2. (Continued)

Plant Family	Botanical Name	Common Name
Paniceae	*Brachiaria* sp. *Echinocloa colonum* *Panicum maximum* *Digitaria horizantalis* *Panicum fasciculatum*	Wild or White Para Grass Jungle Rice Guinea Grass Finger Grass Birdseed Grass
Acanthanthaceae	*Ruellia tuberosa*	Duppy Gun, Heart Bush
Fabaceae	*Macroptilium lathyroides*	Wild Dolly, Wild Pea
Andropogoneae	*Sorghum halepense*	Johnson Grass
Onagraceae	*Ludwigia sp.*	Wild Clove, Jamaica Loosetrife
Chlorideae	*Cynodon dactylon* *Chloris barbata* *Eleusine indica*	Bahama Grass, Bermuda Grass Purple Top Dutch Grass, Fowl Foot Grass
Agrostideae	*Sporobulus* sp.	Drop Seed, Hay Grass
Rubiaceae	*Borreria* sp.	White Broom, Button Weed
Labiatae	*Salvia* sp.	Wild Mint, Chicken Weed
	Eragrostis sp.	Love Grass, Stink Grass
Cyperaceae	*Cyperus rotundus* *Cyperus odoratus* *Cyperus tenuis*	Nut Grass Jack-in-the-bush

Table 3. Surface area coverage of the most common weed species occurring on research farms within Bushy Park, St Catherine.

Research Community	Farm	Most Common Weeds	Coverage
Grove farms	C3	*Brachiaria* sp. *Sorghum halepense*	8
		Cyperus rotundus	6
		Priva lappulacea *Corchorus* sp.	5
		Cleome viscosa *Commelina diffusa* *Heliotropium angiospermum*	4
Nightengale grove	C1	*Commelina diffusa* *Cynodon dactylon*	9
		Boerhavia erecta *Panicum maximum* *Digitaria horizantalis*	8
		E. hirta *Parthenium hysterophorus* *E. hypericifolia*	7
		Portulaca oleracea	6
	C2	*Cleome viscosa* *Eragrostis* sp. *Parthenium hysterophorus*	8
		Digitaria horizontalis	7
		Cynodon dactylon	6
		Eleusine indica *Heliotropium indicum*	5

Manual (Callaloo, pepper, okra, early stages of cucurbits)

This method is used to different degrees by all farmers in the area, with varying levels of efficiency. This is determined largely by physical condition of the farmer, availability of financial resources and gender of hired labor, women being more effective, but slow. Manual approaches include hoeing, cutlassing and handpulling.

Hoeing between and within rows removes weed roots. Significant amounts of soil are also removed during hoeing, but this is used to "mould" (mound) plant bases. Depending on rainfall, the frequency of this activity may need to be repeated every four to six weeks. Hoeing is usually preferred to cutlassing as it involves less bending and is more thorough. It is estimated that approximately one manhour should be sufficient to completely weed 80-100 square metres of moderately infested callaloo/pepper.

Cutlassing is similar to hoeing. However there is little soil disturbance as only the above-ground portions of weeds are removed. As with hoeing, the frequency of cutlassing ranges from three to four weeks. Approximately, one manhour should be sufficient to weed 130-160 square metres. However, regrowth is more rapid than with hoeing.

Hand pulling is practiced in limited situations e.g. low infestations of manageable species. Weeds are removed close to plant bases after cutlassing/hoeing or herbicide use; along with cutlassing/hoeing. Women generally carry out the handpulling operation with the aid of knives.

Biological (all crops)

This approach is used only for land clearing. Livestock (e.g. cattle, goats, sheep) are left to graze to reduce volume of weeds present. Droppings from the animals provide added plant nutrients to soil but undoubtedly return many weed seeds as well. Land is usually ploughed after animals are removed from the field.

Chemical

Paraquat is chiefly used by farmers within the research area, followed by fluazifop-butyl and rarely with glyphosate. Knapsack sprayers are largely used, at times with a spray shield (sometimes makeshift). Precautions are normally taken against wind drift by spraying during low wind velocity periods e.g. early mornings. One novel approach involves covering young cucurbit plants with large paper cups before spraying. This could be applied for peppers as well.

Depending on rainfall, three to five applications of paraquat are made over a cropping period of four to six months. This gives effective control of most annual weeds. Others such as White Top (*Parthenium hysterophorus*), Nutgrass (*Cyperus rotundus*), Johnson grass (*Sorghum halepense*) and Bahama grass (*Cynodon dactylon*), regrow within days to weeks after application. Pepper accommodates the local use pattern of paraquat much better than callaloo. The phytotoxicity from this herbicide is frequently seen on lower foliage of callaloo plants.

Paraquat use has significantly eased hired labor demands of many site farmers, facilitating more efficient use of financial and manpower resources. In comparison with manhours previously stated for hoeing and machete weeding, paraquat spraying will complete 1,000 square metres in one manhour. Its use is therefore being increasingly adopted. Paraquat is also used to assist in removing overgrown plants in preparing a new field. The related diquat is being used by a farmer to control paraquat-resistant White Top.

The use of fluazifop-butyl (Fusillade), is largely limited to cases of difficult perennial grasses such as Johnson grass and Bahama grass. The broad weed spectrum of the project site, limits the utility of this selective herbicide. It is however becoming increasingly popular among farmers where these difficult grasses or others predominate. Adherence to the recommended pre-harvest interval is however doubtful due to the recent introduction of the product, labels are not generally read and some farmers have expressed surprise on being informed of the interval.

Nutgrass is another difficult weed at the site, requiring sustained periods of manual weeding to remove significant fractions of the tuber masses. Glyphosate is used by a minority of farmers, at times mixed with ammonium sulphate for improved efficacy. It has also been used in clearing weeds from a field before land preparation. Difficulties reported in controlling nutgrass appears related to application inadequacies and is to be investigated.

Farmers who make special efforts to ensure proper mixing and application of herbicides often achieve superior results as compared to others. Information on economics of weed management practices is being gathered for later analysis.

Outputs

- Pressed/dried specimens of 29 weed species from the site.
- Made color slides of 36 weed species and related subjects from the site. Color prints being made from these for inclusion in photographic album.

C. *Harvesting, Post Harvest Handling, Marketing Systems and Economic Loss Assessments*

Callaloo

Crop loss, post harvest handling and marketing systems were determined for the farms within the research areas. For crop loss assessments, marketable and non marketable portions of the crop were weighed. Non-marketable roots were further sorted with respect to damage categories and the weight of each category recorded.

Loss assessments were conducted on three farms for eleven harvest days. From a total of 4145.9 kg of harvested callaloo, 928.27 Kg was rejected. Damage categories and the proportions rejected are included in Table 4.

The influence of farm on the percentage of marketable yields was significant ($P<0.001$). This is partially due to different market requirements for each farm. Farm C1, which was geared toward local market, had the most lenient grading system, whereas farms C2 and C3 which supplied the fresh export, local and processing market were more stringent in their grading system (Figure 7a). Percentage per damage category on each farm is given in Table 5.

The differences among farmers in the percent of damage/loss due to arthropod, seed, packing house, herbicide, fungus and rough, were all significant ($P<0.001$) fertilizer was less significant ($P> 0.05$) while red stalk was not significant ($P<0.1$). Most of the categories were unique to individual farms, the more common loss factors being arthropod, seed and rough stalk.

Both local and export (fresh and processing) markets are supplied by callaloo from the research farms. The crop is either harvested on the demand of higglers who select the produce or by the farmer/harvester. Higglers and sometimes exporters arrange transportation of the produce to the respective destinations. Forms of transportation include taxis, pick-up trucks or donkey carts.

Fresh produce for export is taken to packing houses where stalks are trimmed to remove rough portions of stalk and to ensure acceptable stalk length. Trimmed stalks are washed before packing to remove debris and other organisms present.

Table 4. Crop loss assessments for callaloo on selected farms in Bushy Park, St Catherine, 1995.

Percentage	Category	Description of Category
77.61	marketable	suitable for designated market
7.57	seeding	mature and producing seeds
5.11	rough	barky texture
4.71	arthropod damage	severe mite damage and/or feeding damage by defoliators
3.29	packing house	trimmings from stalks being packed for export
1.11	fungus	leaves damaged by fungal infection
0.49	herbicide	damaged by herbicide drift
0.04	red stalk	variety unsuitable for canning causes gas producing reaction in can
0.04	fertilizer	supposedly fertilizer burns

Table 5. Comparative crop loss estimation on callaloo grown on different farms in Bushy Park, St Catherine, 1995.

Proportion	Farm C1	Farm C2	Farm C3	SED
Marketable	93.0	52.4	88.3	0.83
Arthropod	4.2	14.7	2.5	0.69
Seed	2.5	15.8	4.9	0.48
Packing house	0.0	8.2	0.0	5.6×10^{-4}
Fungus	0.0	0.0	2.3	5.6×10^{-4}
Red stalk	0.0	0.0	0.1	2.7×10^{-4}
Fertilizer	0.1	0.0	0.0	2.7×10^{-4}
Rough stalk	0.0	7.9	1.8	0.29
Herbicide	0.0	0.9	0.0	5.6×10^{-4}

NB Proportions are back-transformed from the Logit scale, while SED's (standard error of the difference) are on the Logit scale.

Pepper

Farmers were interviewed to determine the pepper varieties grown, expected yields, methods and frequency of harvest, selection and grading of harvested fruits and the relationship between market and the quality of fruits. Crude crop loss estimates were conducted as previously described.

Four assessments were carried out on three farms (HP4, HP5, HP6). Total yield losses ranged from 11% to 30%. The predominant pest damage on farm HP4 was due to viruses and nematodes. Most of the rejected fruits had virus damage even when other symptoms of damage were obvious. There was also a high incidence of virus on farm HP5, however no fruits were rejected except where they were extremely undersized. There was a relatively high rejection of fruit due to fungal (15.5%) and slug/snail (7.5%) damage. Water stress was cause for the greatest source of rejection on farm HP6 (Figure 7b).

The method of selection of fruits on farms HP4 and HP5 was markedly different. This may have been due, in part, to the knowledge base of the farmer/reaper. On farm HP4 the farmer had previously exported peppers and had a high standard of quality and a very good knowledge of pest symptoms. The reapers on farm HP5 did not use such strict criteria in their selection as fruit with obvious viral damage (deformed and small) were not rejected.

Figure 7a. Economic Loss Estimates for Selected Callaloo, *Amaranthus* sp. Farms in Bushy Park, St Catherine

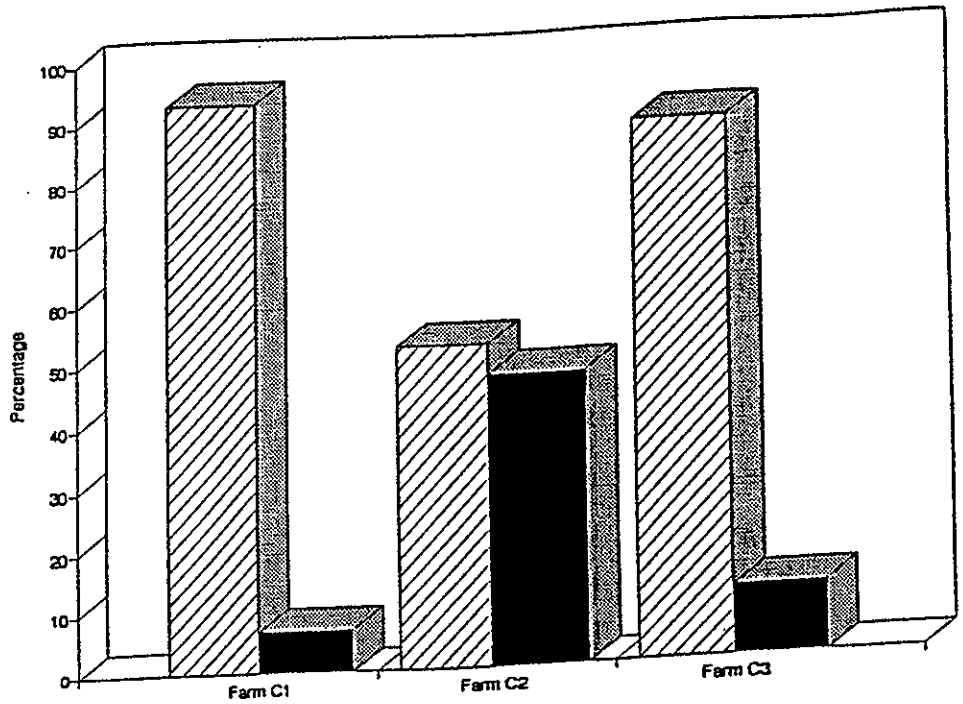
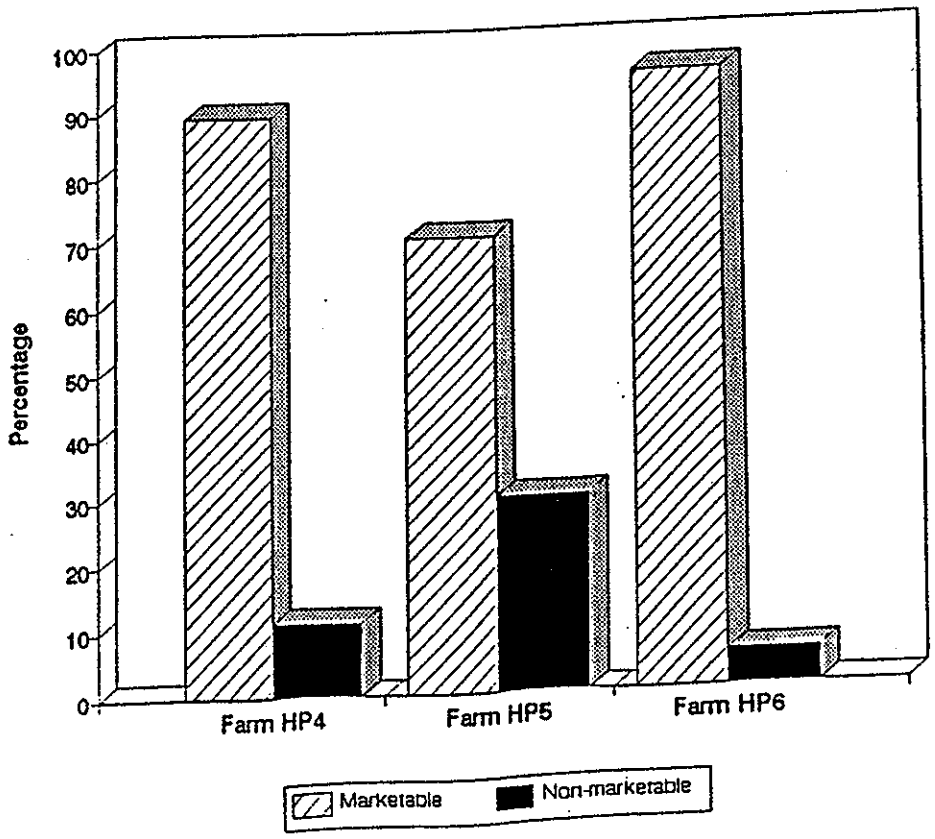


Figure 7b. Economic Loss Estimates for Selected Hot Pepper, *Capsicum* sp. Farms in Bushy Park, St Catherine



Sweet Potato

Farmers and, if present, higglers/export entrepreneurs were interviewed to determine the varieties planted, total area harvested, the types of harvest, criteria for sorting (farmer vs exporter vs higgler), damage due to pests, the destination for the crop, the market value. Economic loss assessment was conducted as previously described for callaloo. Six farmers were interviewed and seven crop loss assessments were conducted on three of the farms (SP1, SP2, SP3). Data were analyzed using logistic regression in order to compare percentage marketable and non-marketable amongst the farmers, assuming a binomial distribution.

Sweet potato harvest begins 5 - 6 months after planting and can last for up to 4 - 5 months. Three to six harvests can occur during the cropping cycle. The crop is usually harvested by hired laborers, which may be male or female. Sweet potatoes are reaped with sticks, placed along rows and vines replanted if immature potatoes are present. The roots are collected and sorted by the farmer into marketable and non-marketable lots. Depending on the amount of soil present, the marketable portion is brushed or washed in water and the potatoes placed in nylon bags and weighed. The non-marketable portions of the crop were given to other farmers to be used as fodder or left in the field.

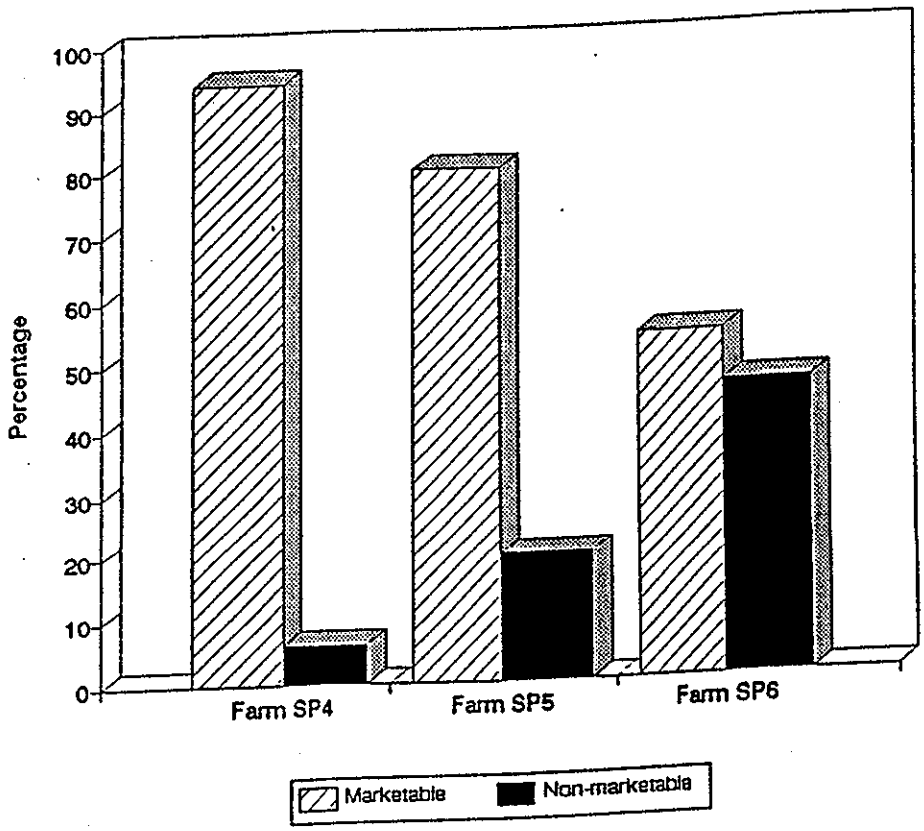
All the farms visited produced sweet potato mainly for export to Canada, United Kingdom or Cayman and planted "sidges" or "cow money" sweet potato varieties as these are preferred by exporters. Several of the farmers interviewed sought a marketing agent for their crop at the export center. Others marketed their crop through export entrepreneurs or higglers who visited their farms and purchased the crop. In order to transport the produce to the export center, farmers would have to hire a taxi or pick-up van. Farmers were reluctant to disclose the price they received for their crop.

The average marketable yield on research farms visited was 82.73% (93.5 - 53.8 ($\pm$ 1.2%) (Figure 7c) . Non-marketable portions of the crop were rejected due to damage by sweet potato weevil (7.75%), mechanical (5.44%), slugs (2.03%) and rats (0.84%). Significant differences were observed among the farms in the proportions of damaged roots due to sweet potato weevil ($P<0.001$), damage ranged from 6.4% - 42.6% ($\pm$1.2%). This may have been due to the length of the harvest period. The lowest damage was observed on the farm which was harvesting for the first time from the field, whereas the farms with the higher levels of damage proportions had been harvesting the crop for over 2 months. Slugs, rats and mechanical damage was observed mainly on one farm and resulted in a loss of 12.9%.

Outputs

- Reports on crop loss for the research areas
- Photographic documentation of harvesting, postharvest and processing activities

Figure 7c. Economic Loss Estimates for Selected Sweet Potato, *Ipomoea batatas* Farms in South Clarendon



D. *Analysis Of Cropping Systems*

This analysis is based upon information generated in the component studies (see report, October 1994 - March 1995). Specific focus will be directed at the following:

- Areas of commonality in crop selection and combinations
- Seasonal calendars for each crop
- Inventory and assessment of potential of indigenous practices
- Inventory and ranking of identified constraints to IPM adoption
- Identification of areas for component studies.

The inferences drawn will clearly be preliminary. These will be refined and relationships described in more detail as more data become available.

Comparative Features

Area differences are evident in the approach to farming. In Bushy Park(BP), farmers live upon the farm, whereas in May River(MR) and Ebony Park(EP), farmers live some distance from the farm. This difference arises chiefly from the type of national land development scheme employed. It is noteworthy that, in both BP and EP, the level of infrastructure provided is considerably more than that in May River. Hence there is a better organized development of cash crop cultivation. The May River community is emerging from basic subsistence, with scattered instances of a more commercial approach. Heavier rainfall experienced in this area also predisposes it to tree crop cultivation. No other relationships between agroecological zone (AEZ) and cropping pattern are yet evident.

Some differences in pest incidence may reflect climatic variation or specific microclimatic features. Diseases were more prevalent on peppers in St Mary which receives higher rainfall; on callaloo, lepidoptera larvae predominate on one farm, mites on another. The greater incidence of viruses and nematodes in vegetables at St Catherine may have been influenced by the longer history of vegetable cultivation and heavy pesticide use.

Perusal of the types of crops cultivated and farmer ranking highlights common criteria which determine the relative importance of the crop. Selection is primarily market-driven. Preference is also given to:

- Earliness of maturity in terms of days to harvest and
- Crops that can generate revenue for at least six months.

Hence callaloo and pumpkin are preferred to hot pepper. Other criteria include susceptibility to pests e.g. sweet-pepper is preferred over hot pepper and tomatoes. Scarcity, unreliability and high cost of labor restrict the scale of production. Similarly, water availability will have an effect upon the number of cropping sequences entertained. While in EP and BP there is available irrigation, current increases in cost of water adversely affects the scale of production. Data are now being collected to determine the relationships between climate, especially rainfall, temperature and relative humidity, crop phenology and pest incidence. These will be incorporated into the analysis for the next report. Crop scheduling is also driven by a sensitivity to markets and painful past experience with gluts. Hence farmers in Ebony Park will plant sweet-potato in July since those in Manchester plant in October.

The frequency of cultivation of specific crops must be considered in relation to any IPM system-oriented design. For the research sites, in addition to the target crops, okra, sweet-pepper and pumpkin appear most often (Figure 8). These and crops like corn share common pests with the target crops. It will therefore be necessary to monitor these to remain aware of whether production and pest management practices applied to them may impact upon the crops targeted for research.

Relative positions of the target crops are illustrated for each farm in Appendix 1. This demonstrates several features of the system. Of interest is the evidence that space can be severely limiting, hence preference appears to be given to rotation within small areas. It therefore does not provide the real benefit to pest management. In addition, the maps may not demonstrate the very dynamic nature of the system and, at this stage, the specific crops that are abandoned when the perceived risk becomes too great. Another factor in these analyses is the issue of livestock, especially where these consistently play an important role for the farmer in removal of excess vegetation, crop residue and weeds, or where farmers depend upon discarded produce for livestock feed.

At this stage, pest management practices observed suggest that, for most farmers, there does not appear to be any perceived relationship between type of pest and impact, thus there is reliance on broad-spectrum "cocktail" mixtures of multiple-purpose pesticides. There is also a pressing need for more cost-effective and environmentally sound weed management techniques. The increasingly widespread use of paraquat presents a classic conflict between socioeconomic constraints and environmental interests.

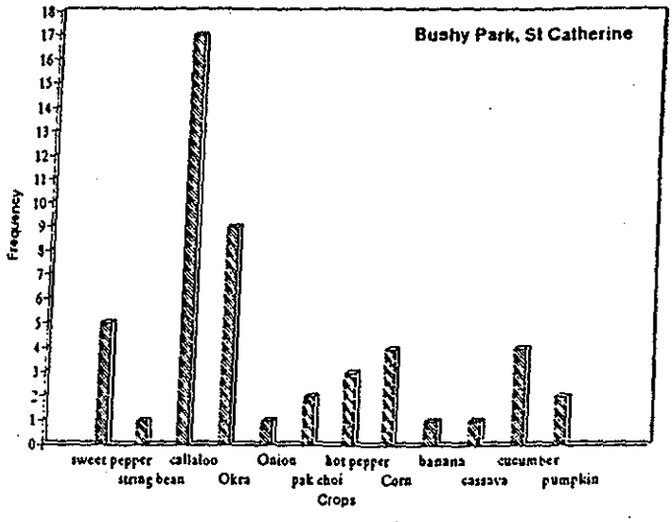
Figures 9a and 9b outline the commodity flow for callaloo and sweet potato based upon an understanding of what currently obtains. Data for peppers are limited since the number of plantings were so few. These will be incorporated as they become available. These outlines will be invaluable tools to facilitate identification of critical points of crop loss and, used in conjunction with the seasonal calendars, steps in the sequence where loss reduction interventions can best be made.

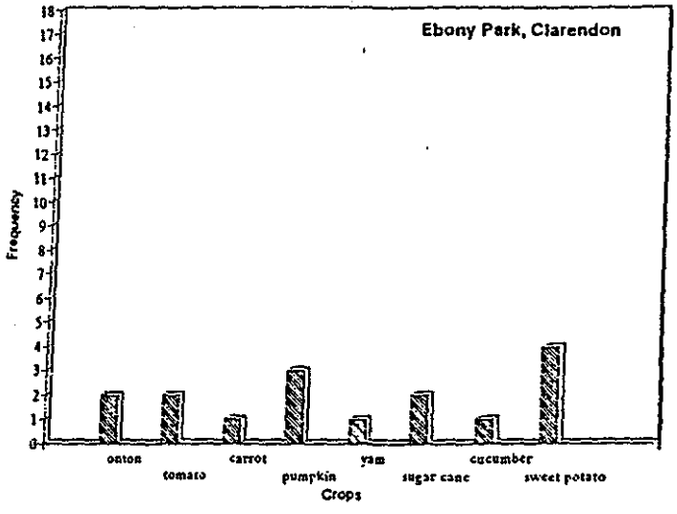
A number of interesting practices and perceptions have been noted. Alternative pest management practices include:

- Livestock for weed control and removal of crop residue
- Breadfruit extract and ash used for pest control in vegetable
- Wood ash for slug/snail control
- Diluted detergent for whiteflies

Other perceptions are of relevance in guiding the selection of strategies for evaluation. Use of almanacs is limited; it is seen primarily in the context of its relationship with full moon and occurrence of rain. To farmers with access to irrigation, this is therefore considered irrelevant. Some are already associating types of pest damage with growth stage of a crop. Hence sweet potato farmers are pointing to the increase in damage after the second reaping. Planting of callaloo in June - August is avoided because of marked increase in the extent of damage. The appreciation of many farmers for the role of birds and dogs to remove or repel pests can be used as a basis for explaining the importance of less easily discernible natural enemies. An important factor is the readiness of the farmer to use creativity in protecting the crop from visible damage. The use of plastic cups for reducing plant injury due to herbicide and the elevation of seed trays to avoid ant damage can be shared with others. The observation that drip irrigation reduces the extent of weed growth raises the issue of comparative evaluation of different approaches to irrigation for selected areas.

Figure 8. Cropping Frequency Observed on Research Farms, October 1994 - September 1995.





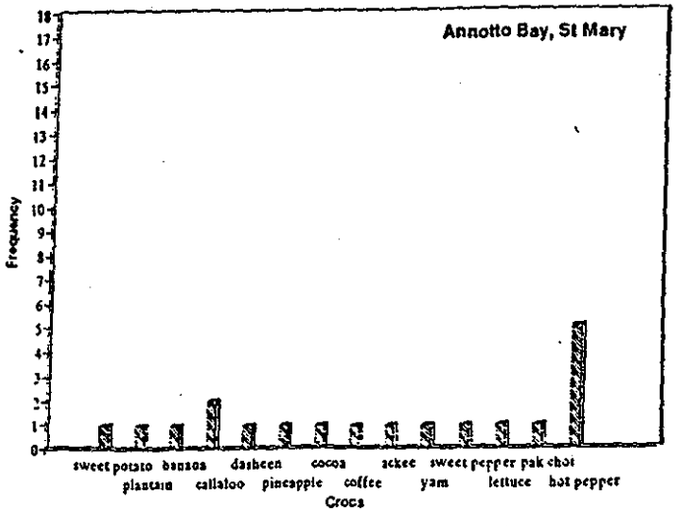


Figure 9a. Commodity flow for sweet potato, *Ipomoea batatas*

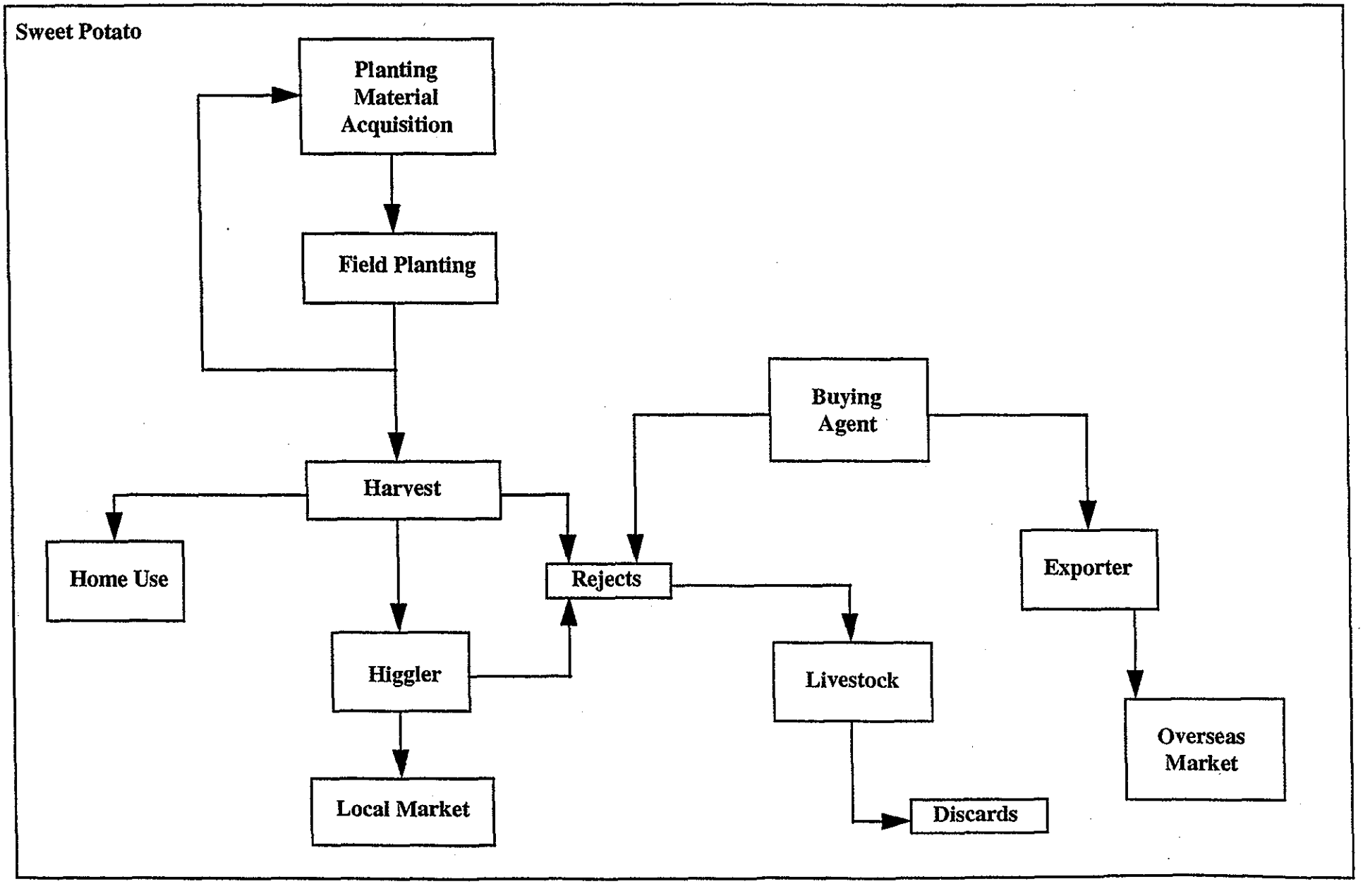
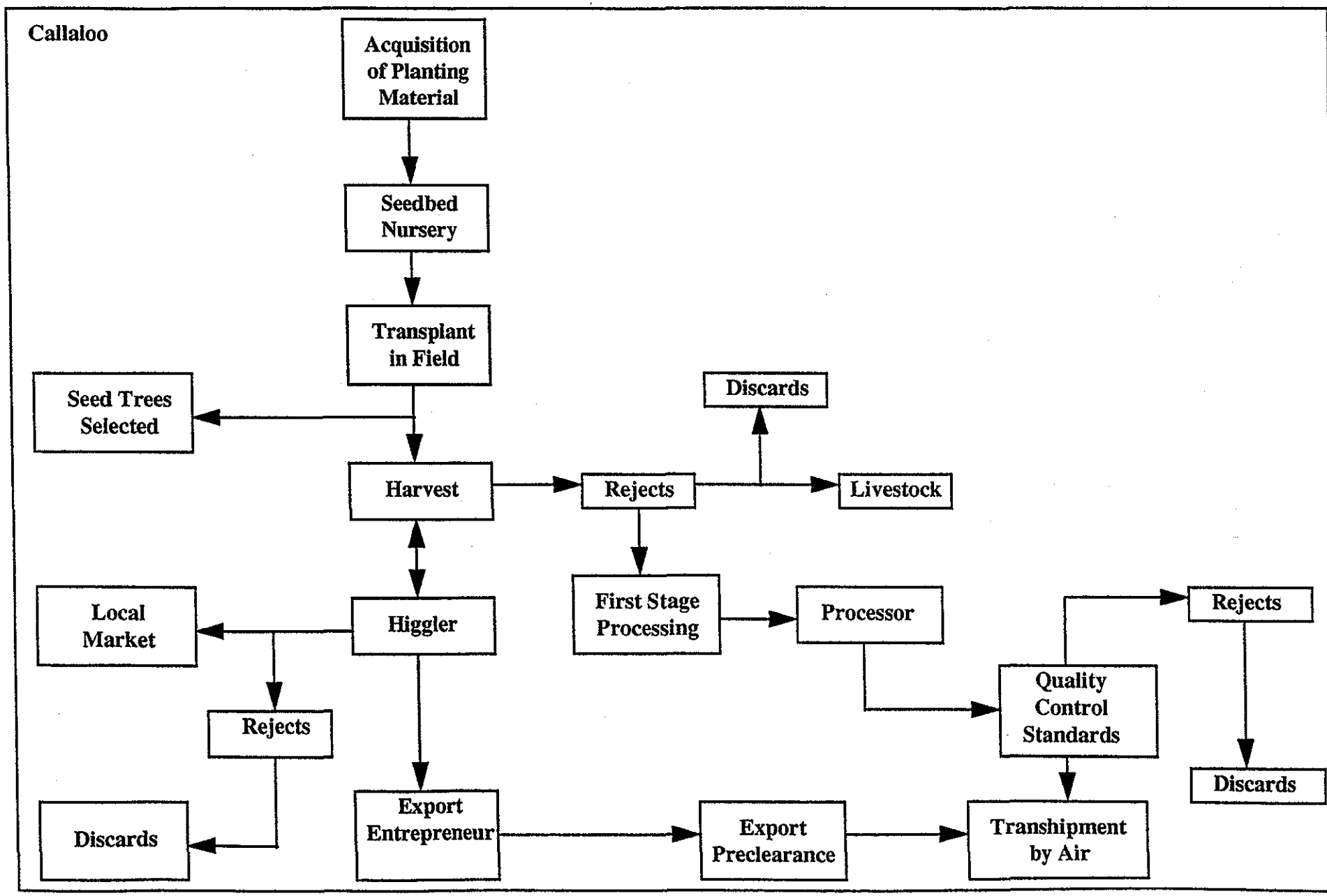


Figure 9b. Commodity flow for Callaloo, *Amaranthus* sp.



Seasonal calendars for callaloo and sweet potato have been developed (Figures 10 a & b). These highlight a number of production practices which can easily be improved with positive benefit to crop quality. Chief of these are the reduction in overlapping cropping seasons and a reduction in the frequency of application of chemical inputs e.g fertilizer and pesticides to callaloo. Additional information on the relationship with pest incidence and an analysis of conflicting demands upon farmer resources will begin shortly. These analyses will also consider the growing list of real or imagined constraints identified by the farmers. These can be grouped as follows:

A Farmer Dependent

- Poor cultivation practice:
- Retention of abandoned crop
- Incomplete removal of crop residue
- Limited area for rotation
- Inadequate skill level
- Selection of pesticides
- Safe, effective application

B Farmer Independent

- Poor condition of roads
- Absence of basic utilities
- Lack of resources: credit, market
- Limited availability of land preparation equipment
- Periodic flooding of river

Several indicators are now available to guide in the focus of studies in Year 3. Component studies must address the following:

- Possible isolation of pest effect upon yield
- Closer scrutiny of the weed complex to elucidate sources of arthropod pests and natural enemies
- Confirmation of alternate hosts of key pests
- Evaluation of the effectiveness of indigenous practices for pest control
- Quantification of the changes in species diversity with incorporation of more selective pesticide use and different approaches to fertilizer use
- Evaluation of different approaches to improving availability and use of equipment
- Potential for use of trap cropping and other traps for pest management where area for rotation is limited
- Selection of appropriate, effective techniques for upgrading farmer capability for IPM, including simple scouting techniques
- Imaginative and innovative approaches for research will have to be employed that would ensure the most rapid but sustainable improvement in IPM adoption

Outputs

First draft of the:

- Seasonal calendars
- Commodity flow charts
- Farm plans

Figure 10a. Seasonal Calendar- Callaloo, *Amaranthus sp.*

Callaloo												
Activities	Cropping Season (months)											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Site Selection	■							■				
Land Preparation												
plough	■							■				
harrow	■							■				
furrow	■							■				
herbicide	■							■				
Planting												
nursery bed preparation												■
culling of planting material												■
sowing seeds		■		■		■		■		■		■
transplanting into prep. field	■						■					
irrigation (flood/overhead/ drip)	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■ ■
Fertilizer Application												
organic	■						■					
inorganic	■	■	■	■	■	■	■	■	■	■	■	
Pest Management												
cultural practice												
manual weed control	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	
rotation within field								■				
pest avoidance						▬	▬	▬				
biological												
livestock for weeds &												
crop residue								▬				
mechanical												
hoe	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	
chemical												
insect,mite,pathogen		■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	▬	▬	▬	■ ■ ■	■ ■ ■	■ ■ ■	
weed		■			■			■				
Harvest												
sorting		▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	
Post Harvest Processing												
sorting		▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	
packaging		▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	
first-stage processing		▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	

Figure 10b. Seasonal Calendar - Sweet Potato, *Ipomoea batatas*

Sweet Potato												
Activities	Cropping Season (months)											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Site Selection						■						
Land Preparation												
plough							■	▬	■			
harrow							■	▬	■			
furrow							■	▬	■			
Planting												
collection of planting material							■	▬	■			
planting into prepared field							■	▬	■			
irrigation (flood/overhead/ drip)	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬
Fertilizer Application												
organic												
inorganic												
Pest Management												
cultural practice												
field sanitation	▬	▬	▬	▬	▬					▬	▬	
manual weed control							■	▬	▬			
rotation within field						▬	▬	▬				
avoidance of high pest period				▬	▬	▬						
livestock for weeds &												
crop residue						▬						
pheromone traps	▬	▬	▬	▬	▬		▬	▬	▬	▬	▬	▬
mechanical												
hoe							▬	▬	▬			
chemical												
insect,mite,pathogen							▬	▬	▬			
weed												
Harvest												
	▬▬▬▬	▬▬▬▬	▬▬▬▬	▬▬▬▬	▬▬▬▬	▬▬▬▬					▬▬▬▬	▬▬▬▬
Post Harvest Processing												
sorting	▬▬▬▬	▬▬▬▬	▬▬▬▬	▬▬▬▬	▬▬▬▬	▬▬▬▬					▬▬▬▬	▬▬▬▬
packaging	▬▬▬▬	▬▬▬▬	▬▬▬▬	▬▬▬▬	▬▬▬▬	▬▬▬▬					▬▬▬▬	▬▬▬▬

VI. NETWORKING ACTIVITIES

Seminar

A virology seminar was conducted in collaboration with MINAG to sensitize all IPM researchers to virus symptomology, identification and control. Twenty persons from CARDI, MINAG, St Mary Development Coop and students attended the seminar.

Field Demonstration

In order to address the potential problem of soil erosion due to hillside farming practiced in the research communities within St Mary, a seminar and a field demonstration on soil conservation practices were conducted in collaboration with the St Mary Development Project. One hundred farmers from the surrounding communities of Annotto Bay, St Mary attended the seminar and 40 persons participated in the field day. The field day was held on one of the IPM CRSP research farms and farmers assisted with the construction of the soil conservation techniques being demonstrated. An evaluation (verbal) of the day's activities indicated that participants found the exercise beneficial.

Technical Assistance

CARDI's residue analyst visited Pennsylvania State University, Residue laboratory (May 12th - June 10th). He was able to observe operations of the laboratory as well as establish useful contacts.

Visitors

Nine US collaborators from Virginia Polytechnic Institute and State University, Ohio State, Pennsylvania State and Lincoln University visited the site during year II. During their visit activities included: visiting the research sites, collecting samples from the research sites for analyses, meeting with local collaborators, planning work program for year III.

VII. PUBLICATIONS AND PRESENTATIONS

Exhibition

CARDI participated in the Denbigh Agricultural show (August 5 - 7, 1995). Posters depicting the research activities of the IPM CRSP in Jamaica were displayed. In addition, a fact sheet on the CRSP activities was developed and distributed to visitors at the show.

Presentation

An overview of the IPM CRSP research activities (global and local) was presented at a Jamaica Exporters Association workshop (June 11, 1995). Present were producers, processors, exporters, researchers and extensionists.

APPENDIX 1

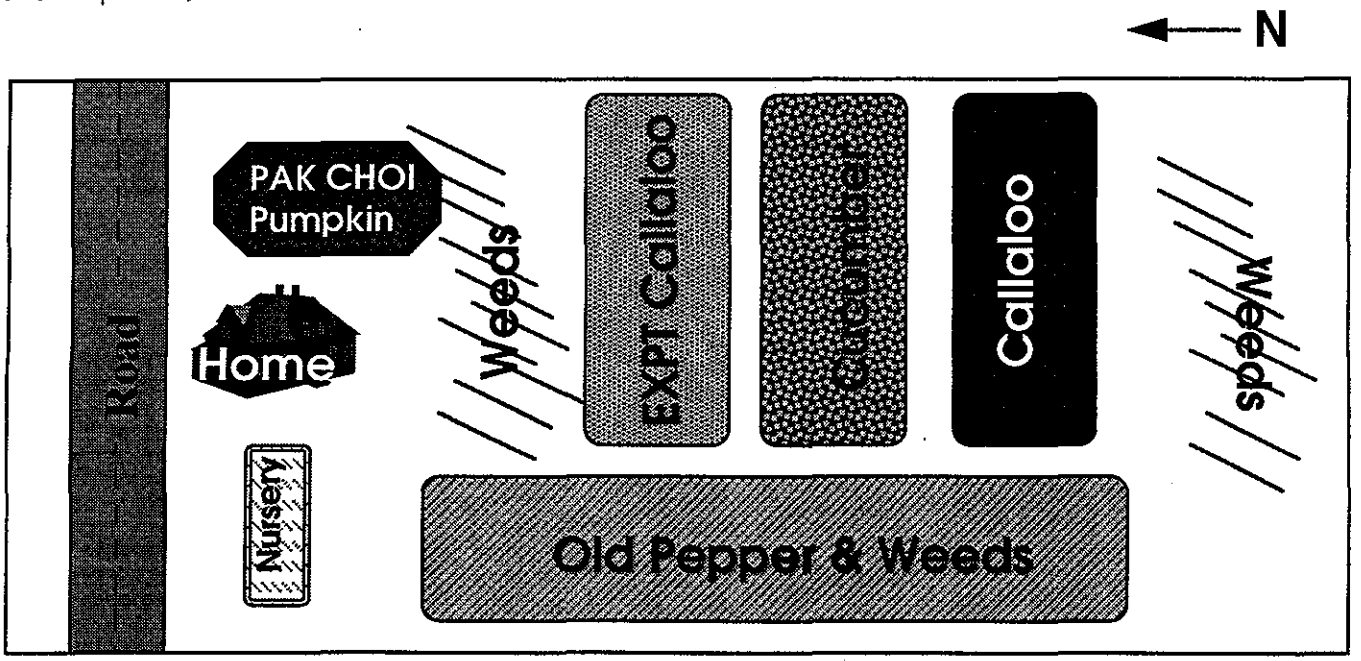
Sample plans of three of the IPM CRSP Research Farms.

FARM PLAN

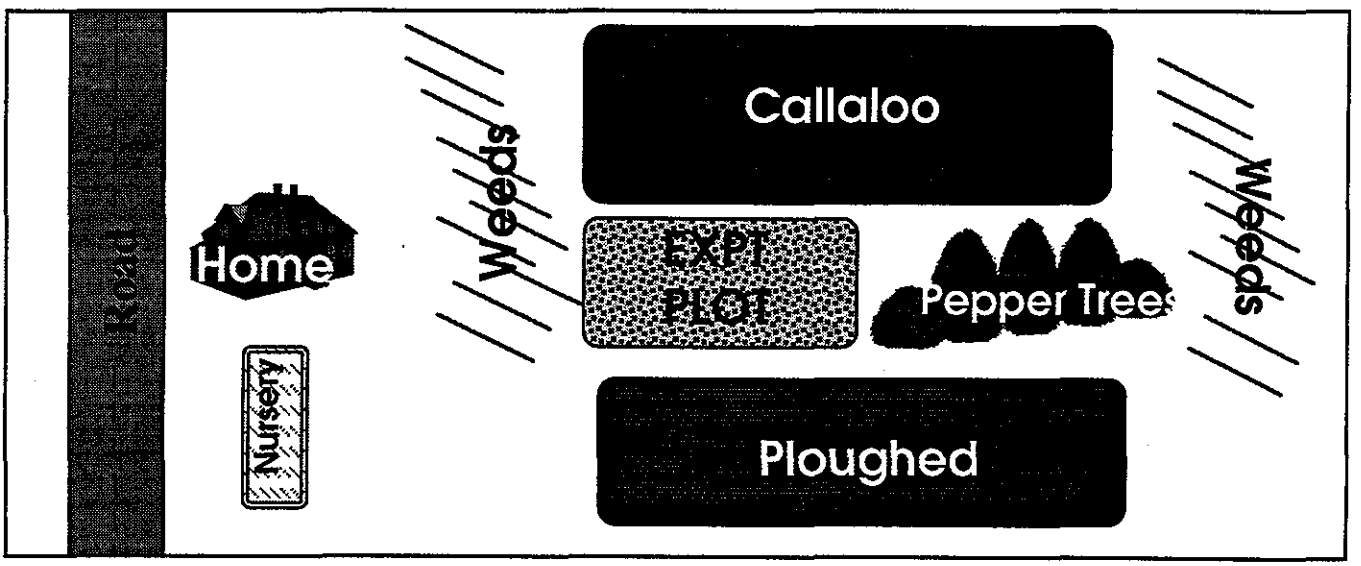
FARM: C1
Parish: St. Catherine
Area: Bushy Park

Farm Size: 6.25 ha
Area of crop being monitored: < 0.04 ha

Research Activity: Population Dynamics - Callaloo
Date: April 28, 1995



Date: Sept 18, 1995



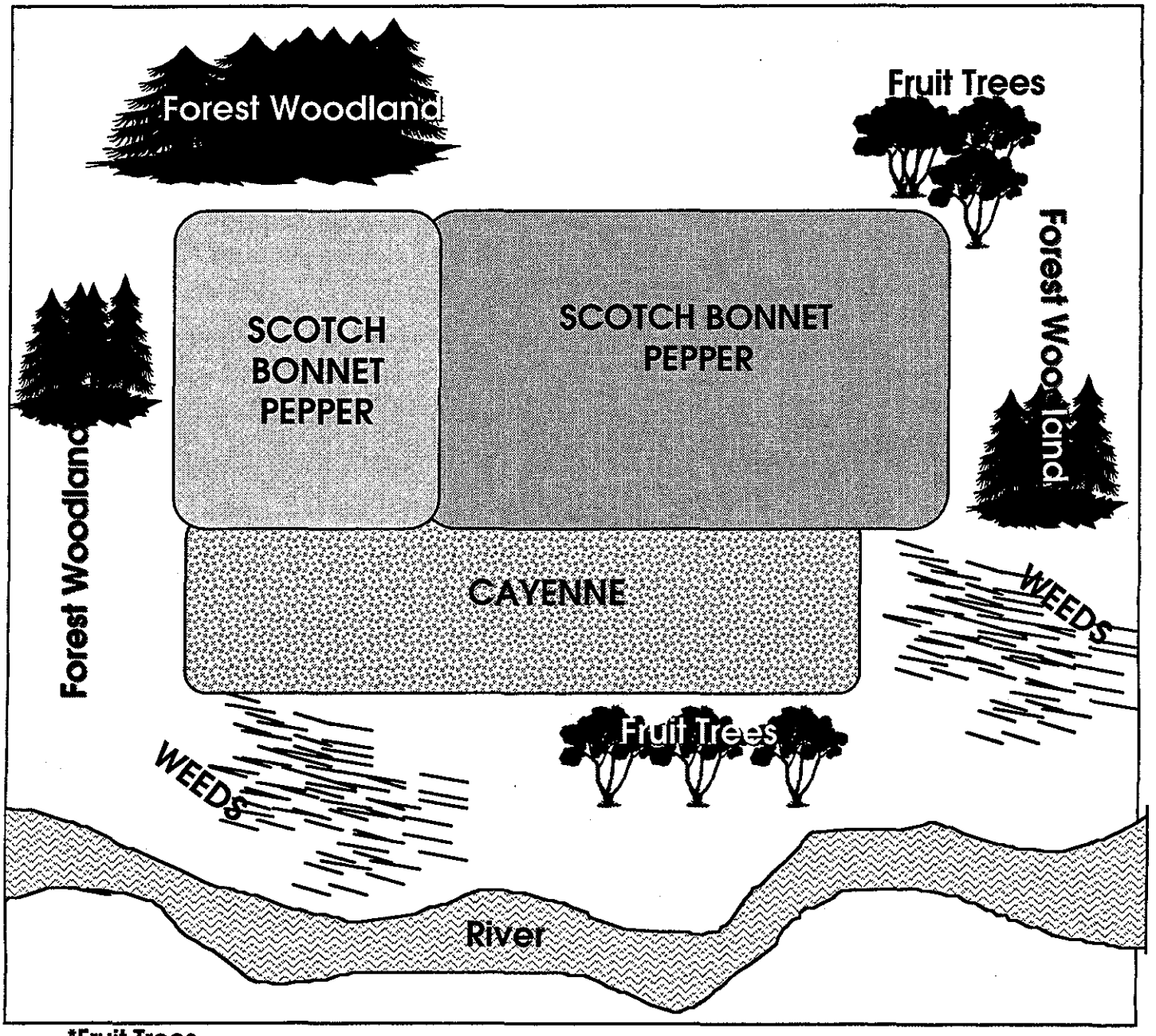
FARM PLAN

FARM: **HP2**
Parish: St. Mary
Area: Endfield

Farm Size: 10.0 ha
Area of crop being monitored: 5.0 ha

Research Activity: Population Dynamics - Scotch Bonnet Pepper
Date: Feb 22, 1995

N



*Fruit Trees
- Sour Sop
- Citrus
- Star Apple

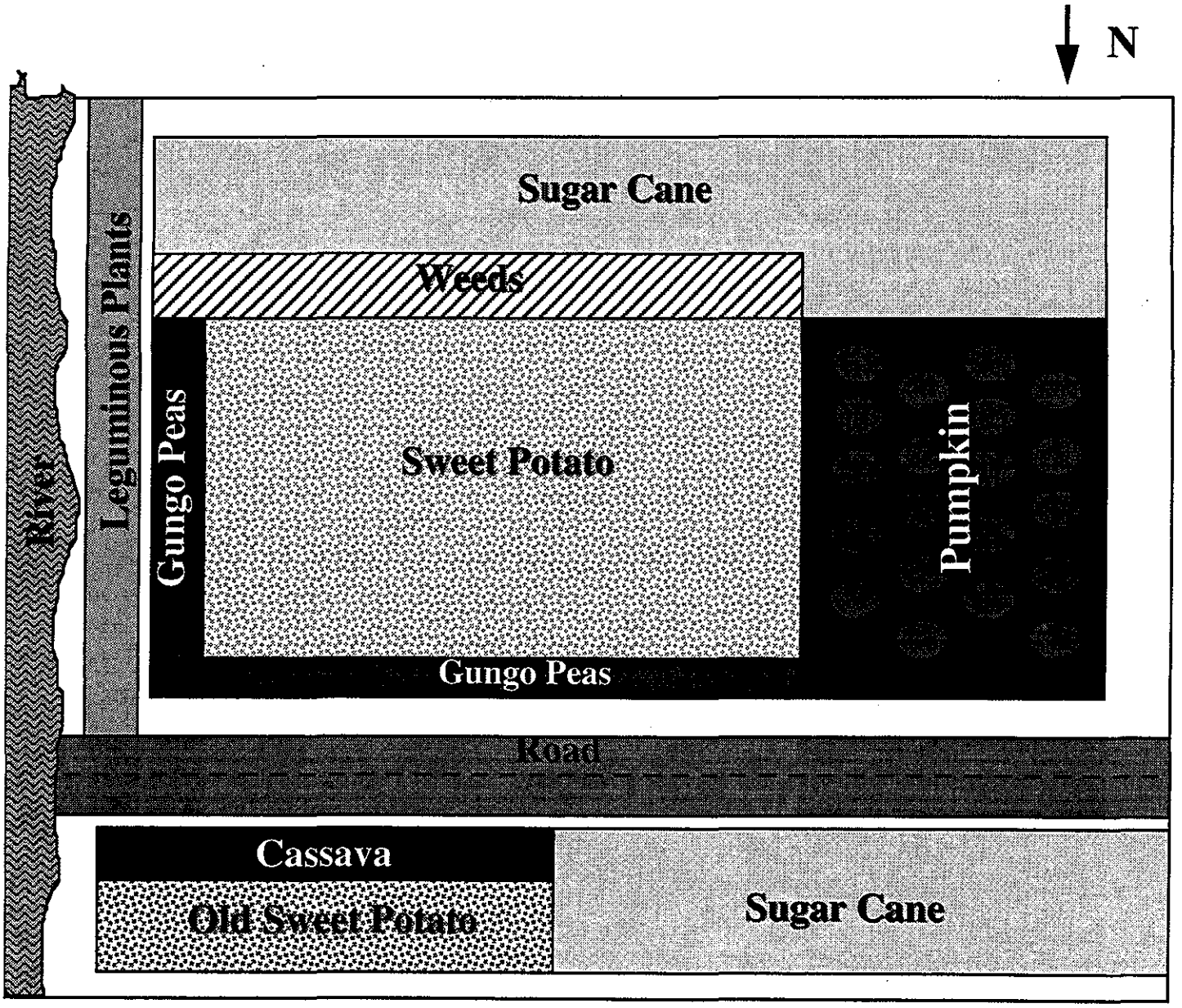
135

FARM PLAN

FARM: **SP2**
Parish: Clarendon
Area: Ebony Park

Farm Size: 12.5 ha
Area of crop being monitored: 0.5 ha

Research Activity: Population Dynamics - Sweet Potato, *Ipomoea batatas*
Date: April 26, 1995



OHIO STATE UNIVERSITY

Crop and Soil Residue and Insect Analyses

Investigators: Clive Edwards and Margaret Huelsman, Department of Entomology, Ohio State University

II. COLLABORATING SCIENTISTS

Janice Reid- Country Representative/Co Principal Investigator, Janet Lawrence (Entomologist/Site Coordinator), Dionne Clarke-Harris (Entomologist), Raymond Martin (Residue Analyst), Joseph Lindsay (Agronomist), Phillip Chung (Crop Protection Specialist, RADA), Althea Perkins (Sociologist), Peter Myers (Technical Assistant), Oral James (Technical Assistant), Donald Simpson (Technical Assistant), Jurgen von Dueszeln (GTZ Advisor), Raymond Martin (Residue Analyst, CARDI)

III. SUMMARY OF RESEARCH RESULTS

See Section V below.

IV. OBJECTIVES AND IPM CONSTRAINTS

Clive Edwards and Margaret Huelsman visited Jamaica from September 9 - 16, 1995. The aims of the visit were to review various problems in Jamaica associated with assessing pesticide residues in crops especially those for export, and recommend how the existing facilities in Jamaica, for pesticide residue analysis, could be improved extended and reinforced. In the more practical area, our plan was to take samples of hot peppers, sweet potatoes and callaloo and related soils from field experiments for pesticide residue analysis, so as to set up an index of pesticide residue contamination, against which the success of the IPM program in Jamaica can be assessed. Finally, we planned to sample pest populations, primarily on hot peppers, but also on sweet potatoes and callaloo, and assess potential links between nutrient availability and pest and disease incidence. Margaret Huelsman is doing research on IPM in peppers for her Ph.D. degree and can offer useful information on sampling techniques.

V. RESEARCH APPROACH AND OUTPUT

A. Field Sampling - Pesticide residue samples

Several farm markets in the Bushy Park / Kingston areas were visited, and crop samples from a range of growing sites purchased with the help of Raymond Martin and Peter Myers. These included eleven samples of callaloo, seven samples of hot peppers, and seven samples of sweet potatoes. All were placed in a cooler with dry ice and kept overnight in a hotel freezer before being transported to the U.S. the following day without incident. They are currently being processed for residue analyses.

Six duplicate samples of soils in which the crops had been grown were taken and frozen for transport. There was considerable difficulty in identifying the insecticides or fungicides that were most likely used on the crops and soils. After reference to documents produced by Phillip Chung and consultation with Raymond Martin and Dwight Robinson we decided to make initial residue analyses for the following compounds:

Insecticides that may be in soils and vegetables from Jamaica

1. Soils (Six duplicate samples)
   Dieldrin, endosulfan, dicofol, carbofuran, diazinon, chlorpyrifos, monocrotophos, ethoprop.

2. Sweet potatoes (seven samples)
   Carbofuran, diazinon, ethoprop, monocrotophos.

3. Hot peppers (seven samples)
   Deltamethrin, fenualerate, diazinon, dimethoate, monocrotophos, acephate, methamidophos, monocrotophos, methomyl.

For some of these chemicals pesticide standards had to be purchased. We hope to complete the pesticide residue analyses by December 1995.

B. Field Sampling - Pests

In an effort to link soil fertility with the incidence of pest and their natural enemies, six farms, three growing callaloo and three growing sweet potatoes, were sampled for insect pests and predators and soil nutrients. The three callaloo farms are located in Bushy Park, while the sweet potato farms are in Clarendon Park. At each farm we set up 10 sticky traps and 6 pitfall traps. All of the traps were left in the field for 48 hours. These sticky traps were removed and placed in zip-lock bags and placed in a cooler. The contents of the pitfall traps were removed and taken back to the lab at CARDI and then placed into vials containing ethyl alcohol. The pitfall traps at the first callaloo farm were flooded before most of the samples could be collected. All insect samples were taken back to Ohio State University to be counted.

Soil nutrient levels were measured from three 1/2lb. soil samples taken from each farm. The samples taken with a soil core 1/2" in diameter to a depth of 15 cm. The samples were kept in a cooler until they were returned to Ohio, where they were kept refrigerated until analyzed. The soil samples were analyzed at the REAL Laboratory in Wooster, Ohio for pH, P, K, Ca, Mg, NO_3 and organic matter. Because of the short duration of the trip, it was not possible to collect further soil and insect samples from all of the IPM CRSP

research sites. The staff at CARDI will collect soil and insect samples from the cooperating farms in St. Mary's Parish and send them to OSU to be analyzed.

VI. NETWORKING ACTIVITIES

A. *Meeting with Pesticide Control Authority*

The first meeting was with Paul Whylie of the Jamaican Pesticide Control Authority. We discussed problems associated with the enforcement of regulations on the registration of pesticides. Although there are regulations by which pesticides are approved for various uses in Jamaica, it is difficult to enforce these regulations partly due to staffing problems and also to the misuse of pesticides, by small farmers. A major problem is caused by the small size of many farms creating a need for purchase of small amounts of pesticides. This leads to purchase of pesticides in bulk by a group of farmers, who put small quantities in miscellaneous containers, without any proper labelling. There is a need for incentives to retailers to repackage bulk pesticides in proper containers with appropriate labelling.

There is also an urgent need for training of small farmers in the selection and safe use of pesticides. My impression from previous interviews with farmers is that they use those pesticides that are readily available, with little attention to their mammalian toxicity, or to the occasional sickness they cause; this being accepted as an occupational hazard. The AID mission is exploring the possibility of obtaining funding for small farmer education from the World Bank.

B. *Meeting with Jurgen von Dueszeln - German Agency for Technical Cooperation (GTZ)*

Dr. von Dueszeln described problems associated with the presence of pesticide residues in plant products for export. Currently, many export crops, especially to the U.S., are rejected at the point of entry because of pesticide contamination or because they have live pests. There is relatively little pressure to change this situation, since the exporter passes the losses on to the small farmer and incurs little personal loss.

The conclusion that we reached is that there is an urgent need in Jamaica for one or more pesticide residue laboratories, to analyze samples taken from crops for export. There is an ancillary need for a pesticide residue laboratory to assess pesticide contamination of crops used for indigenous consumption.

GTZ is interested in finding collaborators who would consider joint funding of one or more pesticide residue laboratory facilities. They are interested in receiving a proposal which would summarize the needs, equipment and staffing requirements as well as options for management and long-term funding for such a laboratory or laboratories.

We discussed the possibility that I (Clive Edwards) could help to prepare such a proposal, as a consultant, in 1996 and I expressed willingness to do this possibly in collaboration with one or more other people.

C. *Planning Meeting with Staff of CARDI*

We met with Janice Reid, Janet Lawrence and the CARDI staff associated with the IPM CRSP project in Jamaica, to review needs for our visit and how we could make future contributions to the Project.

D. Meeting with Officials of the Agricultural Export Services Project (AESP)

We met with Alwyn Allen (Project Manager) and Paulette Lyons (Deputy Manager) of AESP. They have set up a collaborative Task Force to deal with IPM in callaloo and hot peppers. The greatest emphasis is on callaloo and most of the work is centered at Bushy Park, which is the hub of production of this crop. They are also planning a project on IPM on sweet potatoes.

AESP is responsible for ensuring export crops are free of pests and pesticide residues. The project has problems in training their staff to identify the insects they find in export crops. They also have major problems in preventing pesticide residues in export crops, because the AID contract residue analysis agency takes too long to do the analyses to be able to stop a crop being exported if it contains pesticide residues.

The project is linked with the government pre-clearance program. There are plans to build a center at each airport and train extra staff.

Until training facilities for these staff and improved residue analysis laboratories are available this program cannot become really effective.

E. Field Visit to Research Farms

Clive Edwards, Bob Hedlund and Margaret Huelsman visited a range of research farms in the Bushy Park area accompanied by Janice Reid, Janet Lawrence and CARDI staff and identified typical damage by pests and diseases on callaloo, peppers and sweet potatoes. A number of these were photographed. Some of the research activities were described and demonstrated in the field. This was followed by useful discussions and recommendations.

F. Meeting with Hopeton Fraser (Acting Permanent Secretary of the Ministry of Agriculture)

Clive Edwards, Bob Hedlund, Janice Reid and Janet Lawrence met with the Acting Permanent Secretary, to discuss problems associated with export clearance and the development of a national IPM program.

His ultimate aim is that every parish should have an extension officer trained in plant protection and IPM. The work is currently facilitated by the Rural Agricultural Development Authority (RADA).

A major problem is a shortage of extension agents. Numbers have decreased from 400 several years ago to 130 currently. The major contribution to training through RADA is by Phillip Chung who is extremely over-extended and over-worked. The Ministry has identified four people who would be suitable for biocontrol training. They are planning an IPM network, training of a biocontrol specialist and a series of farmer extension workshops on plant protection and IPM.

There is an urgent need to sign a Memorandum of Understanding between the Jamaican Ministry of Agriculture and U.S.A.I.D. for the IPM CRSP; this could probably be handled through RADA.

G. Meeting with Dwight Robinson, (pesticide residue chemist, University of West Indies), Raymond Martin (residue chemist, CARDI), and Juergens von Duezseln (GTZ)

This meeting, which involved Clive Edwards, Bob Hedlund and Janice Reid, discussed current pesticide residue activities in Jamaica and future needs. Some monitoring of pesticide residues in rivers and coastal workers has been done. Most studies have concentrated on endosulfan, ethoprophos and dicofol.

As discussed earlier, there is an urgent need for further pesticide residue laboratories. It is not clear whether this could best be handled by one major laboratory or two or three smaller laboratories. There are three main needs for pesticide residue analyses:

- Pesticide residues in crop products - domestic and export. Could be funded by the private sector.
- Extension monitoring capability - for safe food.
- Research capability - to asses environmental contamination by pesticide.

A major problem is the training and retention of personnel for residue laboratories.

CARDI and the Jamaican Ministry of Agriculture need help in the preparation of a proposal to fund residue facilities, possibly jointly by GTZ together with other agencies e.g. World Bank, FAO, UNESCO, Swedish AID, etc.

H. Meeting with Jane Ellis (USAID) and Larry Tengan (APHIS)

This meeting which involved Clive Edwards, Bob Hedlund, Janice Reid, and Janet Lawrence, reviewed AID activities towards on effective product pre-clearance program. Although $1.3 million has been spent to date the results achieved are not dramatic. The issue is quite urgent since in two years all countries exporting to the U.S. will have to sign a phytosanitory agreement, guaranteeing freedom from pesticide and pest contamination.

Decisions are needed on how the pre-clearance program can best be implemented. For instance, some exporters would be willing to pay for a support system.

The IPM CRSP when fully implemented could make major contributions to a pre-clearance program. Some additional USAID funding could be available to support this thrust and this should be explored.

A major pest list for each commodity is a major need and Bushey Park would be a good site for a preliminary project to attain this aim.

I. Concluding Meeting

Clive Edwards, Bob Hedlund, Janice Reid, Janet Lawrence and CARDI staff met to discuss future needs of the Jamaica IPM CRSP. The following items were discussed:

- There is a need for training of a biosystematist - options for form and location of training were discussed.

- The need for residue laboratories and training for residue chemists - it was concluded that the first need was for a site review and proposal which could be submitted to funding agencies including GTZ. Clive Edwards agreed to assist in this in 1996.

- The need for a detailed timetable for visits by collaborating scientists - advance planning of visits for the whole year would facilitate interactions and maximize the economical use of resources. Janice Reid agreed to circulate collaborators and has since done this.

- There is a need to identify a central research site for each crop with a number of easily accessible ancillary sites e.g. Bushy Park for Callaloo.

- The need for an IPM CRSP vehicle - this could be leased or purchased and would eliminate the need for hiring vehicles for visits of collaborating scientists and save considerable funds.

- The May 1996 meeting of collaborating scientist - Janice Reid discussed very preliminary suggestions and plans for hold the meeting in Jamaica. This would not be much more expensive than Blacksburg, for accommodation and travel, and would allow collaborators from other sites to review IPM activities in Jamaica. It could be linked with appropriate workshops held before or after the meeting.

VII. PUBLICATIONS AND PRESENTATIONS

Clive Edwards presented a seminar, `The Role of IPM in Sustainable Agriculture', at the Nuclear Center, the University of the West Indies. This was followed by a productive discussion for an hour by a lively audience of about 50 people.

VIII. TRAINING OUTPUT

None

IX. PROJECT HIGHLIGHTS

A. Pesticide Residues

Much of the discussion related to which pesticides were used most on the three crops being studied. There is a need for a much more detailed survey of pesticide usage on these crops. We also discussed possibilities of providing Raymond Martin additional training in pesticide residue analyses. These problems were discussed in more detail later in the meeting.

B. Sampling Methods for Pests

Some of the methods currently being used by CARDI staff were reviewed and their effectiveness discussed. The potential of the use of sticky traps for sampling pests was discussed. The use of pitfall traps to catch pests and predators was also discussed. We promised to provide guidelines on these and other methods.

C. *Training in Biosystematics*

We discussed the need for training of one or more biosystematists and how this could be achieved. The training could be of several kinds:

- Training of a biosystematic specialist in all the insect pest, mite, nematode, disease, virus and weed problems associated with callaloo, hot peppers and sweet potatoes.
- Training of extension personnel in the basic identifications needed for field work and for pre-clearance inspections.
- Training small farmers to recognize key arthropod pests diseases and weeds.

Various options for training and places to send the key personnel for training were discussed. It was concluded that this could probably be achieved best by sending a staff member to the U.S. for up to six months for training at institutions such as Ohio State University, Pennsylvania State University, Virginia Tech and a specialist institution such as the Smithsonian.

LINCOLN UNIVERSITY

Establishment of Critical Nutrient Levels for Growth of Callaloo, Sweet and Hot Peppers in Two Ecological/Production Areas

Investigators: F. Eivazi, D. Marsh, D. Sasseville, Lincoln University

II. COLLABORATING SCIENTISTS

J. Lindsay, Agronomist, University of West Indies, Caribbean Agricultural Research and Development Institute (CARDI)

P. Chung, Plant Protection Specialist, Rural Agricultural Development Authority (RADA),

III. SUMMARY OF RESEARCH RESULTS

The role of available soil nutrients in plant growth, development and sustained vigor, and its relationship to pest management and disease control have been well documented.. The capacity of plants to protect themselves from diseases and insect attack is largely influenced by the health of the plants and their stage of development. Mineral elements are directly involved in all mechanisms of plant defense system. A comprehensive IPM program requires a well balanced nutritional program for crops produced. This will avoid stress caused by deficiencies of macro and micro-nutrients. Our study was designed to assess the nutritional status of soils found in two vegetable producing ecological zones of Jamaica. The information gathered was shared with the Host-Country Agronomist and will be used in third year Workplan to conduct field experiments in Jamaica using different rates, sources and application methods for nitrogen and phosphorus fertilizers.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. *Research Objectives*

- To gather the baseline information on fertility and the nutritional status of soils in the Bushy Park and Annoto Bay areas.
- To determine the nutrient contents in Callaloo and peppers.
- To establish critical nutrient levels necessary for optimum growth and yield of the target crops.

B. *IPM Constraints*

To develop a comprehensive IPM program in Jamaica, information is needed on nutritional status of Jamaican soils and the establishment of critical nutrient levels for the target crop. Our objectives have addressed this need.

V. RESEARCH APPROACH AND OUTPUTS

A. *Approach*

Soil samples were taken from 0-15 cm depth from selective farmers' fields in two ecological sites (Annoto Bay and Bushy Park) reflecting differing cultural practices used for the production of the target crops. Chemical and physical properties of the soils were determined using proper analytical procedures.

Field surveys were conducted in Jamaica and plant tissue samples were collected. Tissue samples were dried at 70° C and transported to U.S. and were analyzed for nutritional levels including micro- and macro-elements.

Using the Jamaican soils, growth chamber studies were conducted at Lincoln University to determine the nutrient rates and sources for maximum growth of crops

B. *Research Results*

Analysis of soils and plant tissue samples were completed and are summarized in Tables 1 and 2. The results indicated that Phosphorus is the most limiting nutritional constraint to crop production in Jamaican soils. Therefore, growth chamber studies were designed to determine the source, rates and method of phosphorus application. Scotch Bonnet (*Capsicum chinese*) plants were grown in Jamaican soils for six weeks. Treatments included: (1) Superphosphate and calcium nitrate as nitrogen source; (2) Superphosphate mixed with ammonium sulfate as nitrogen source; (3) Control with no fertilizer applied. Plant fresh and dry weight data were collected and shown in Table 3. The fertilizer application methods included mixing of fertilizers with soil and comparing the results with a slurry method in which fertilizer was applied in slurry form.

C. *Impacts*

The baseline information on fertility status of soils in the Bushy Park and Annoto Bay were gathered and shared with the Host-Country Agronomist, Dr. J. Lindsay. The results on phosphorus and nitrogen rates, source and application methods will be a valuable information to Jamaican agronomists in making fertilizer recommendations to farmers.

VI. NETWORKING ACTIVITIES

- F. Eivazi participated in External Evaluation Panel Review Meetings, April 26-28, 1995; and IPM/CRSP Annual Workshop and Planning Meetings, May 19-23, 1995.
- D. Marsh made two trips to Jamaica to collect soil and plant samples.
- The results from soil and plant analysis and the growth chamber studies were exchanged with Host-Country scientists.

Table 1. Chemical Analyses of Jamaican soils.

Location	sample #	*N.A.	Ca lbs/A	Mg lbs/A	K lbs/A	P lbs/A	Al ppm	Cu ppm	Mn ppm	Fe ppm	Zn ppm	*CEC	*S/W pH	*OC %	*OM %
May River	1	4	1520	408	573	39	24455	96	747	37813	109	10	5.70	1.42	3.10
(loam)	2	4	2826	579	299	19	23872	90	1148	31801	91	14	5.70	1.79	3.50
	3	3	2589	639	303	9	20900	63	700	34231	65	13	5.60	1.91	4.80
	4	10	1417	211	712	107	27279	97	818	42172	119	15	4.40	1.79	3.60
	5	8	2189	294	485	123	26135	88	951	38928	105	15	4.80	2.04	4.20
	6	5	2861	537	586	51	23231	83	589	37462	109	15	5.80	2.43	5.00
	7	5	2482	342	295	23	26229	89	1022	41195	113	13	5.50	2.01	4.00
Bushy Park	8	0	8616	1307	400	51	24276	90	1443	35295	112	27	7.10	1.75	3.40
(silty clay)	9	0	6295	780	369	39	22738	143	1281	35383	95	19	7.00	1.57	3.20
	10	0	7543	1007	702	71	22286	106	1341	31237	102	24	7.30	2.15	3.80
	11	0	6229	892	472	55	22696	100	1275	36222	107	20	7.00	1.45	2.90
	12	0	7908	704	441	29	19856	101	1155	29446	94	23	7.60	1.67	3.10
	13	0	6712	974	461	11	20050	107	1236	31450	96	21	7.00	1.53	3.20
	14	0	6428	643	301	27	18265	103	965	29509	86	19	7.40	1.21	2.50
	15	0	6500	887	414	57	16958	82	974	24887	82	20	7.20	1.52	3.40
Clonmell	16	4	9067	1340	1181	19	23940	69	440	42385	68	33	6.00	3.15	6.20
(clay)	17	2	11415	1663	615	11	27489	77	794	44038	78	38	6.40	2.69	6.20
	18	2	11010	1635	510	19	19441	56	613	30498	53	37	6.10	3.17	6.80
	19	3	9605	1599	566	7	21625	72	703	34531	65	34	6.10	3.52	8.10
	20	3	10715	1576	643	15	21483	55	533	34682	59	37	6.10	2.82	6.00
	21	4	9690	1589	860	15	23620	62	542	40731	64	35	5.70	3.03	6.20
	22	3	9717	1540	632	17	22628	67	678	36260	69	34	5.80	2.01	5.60
	23	3	10765	1365	1745	23	21147	64	496	25388	61	37	6.00	3.50	6.50
	24	4	9554	1547	1205	3	-	-	-	-		35	5.80	1.96	5.10
	25	1	10500	1355	509	35	17141	48	523	26277	51	34	6.50	2.81	14.00
	26	5	9372	1533	465	3	23016	61	628	23547	53	35	5.20	2.45	6.70
	27	5	9980	1644	736	11	22885	53	474	34369	50	37	5.80	2.65	7.40
Junopen	28	0	8332	78	252	3	13540	52	593	23422	60	21	7.50	2.15	3.80
	29	0	8924	90	285	15	7082	40	383	14817	42	23	7.70	2.35	3.60
Nitengale	30	0	5910	383	269	27	13414	63	717	21593	54	17	7.60	1.10	2.30
(clay loam)	31	0	5934	438	314	25	12941	57	712	21844	58	17	7.60	1.34	2.80
	32	0	6594	533	238	33	12453	58	709	19351	51	19	7.60	1.45	3.20
	33	5	5363	732	401	131	10878	38	946	22107	45	21	6.20	1.50	2.80
	34	0	4994	962	272	47	11718	40	920	22182	55	17	7.10	1.62	2.80
	35	1	4096	816	304	11	11072	42	1174	23021	54	15	6.90	1.73	3.00

***N.A.= meq/100g**
***CEC = cation exchange capicity per meq/100g**
***S/W pH = soil in water pH**
***O.C. %=organic matter percent**
***OC% = organic carbon percent**

Chemical Analysis of Target Crops Collected from Ecological Areas in Jamaica

Crop	Nutrient / elements						
	%P	%K	Ca	Mn	Cu	Fe	Zn
			(ppm)				
Hot Pepper (Clonmell)	0.28	9.3	25511	973	16	148	276
Sweet Pepper (Nitengale)	0.47	6.7	19393	1664	285	244	321
Callaloo (Bushy Park)	0.31	2.2	23998	638	0.29	442	276

Table 3. Effect of different treatments on fresh and dry weight of Scotch Bonnet pepper.

Treatment	Soil 1		Soil 2		Soil 3		Soil 4	
	Fresh wt.	Dry. wt.	Fresh wt.	Dry wt.	Fresh wt.	Dry wt.	Fresh wt	Dry wt.
	g		g		g		g	
Control	7.5	1.6	6.25	1.2	5.2	.95	4.25	.68
Mixed fertilizer Superphosphate $+CaCO_3$	15.5	3.6	11.5	2.3	10.2	2.3	11.3	2.7
Mixed fertilizer Superphosphate + $(NH_4)_2SO_4$	12.3	2.7	9.0	1.6	9.7	2.2	14.5	3.4

Soil 1 and 2=Annoto Bay
Soil 3 and 4=Bushy Park

VII. PUBLICATIONS

None

VIII. TRAINING OUTPUTS

C. Haenchen, M.S. student, is funded under the IPM CRSP and is making good progress in her studies.

IX. PROJECT HIGHLIGHTS

Baseline soil fertility information established.

U.S. VEGETABLE LABORATORY

Integrated Pest Management Components for Vegetable Crops.

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

II. COLLABORATING SCIENTISTS (HOST COUNTRY AND US)

Three US scientists served as collaborators on various research projects discussed in this report. Dr. P. D. Dukes, Research Plant Pathologist (retired 2 June 1995), U. S. Vegetable Laboratory, Charleston, SC, was heavily involved with much of the sweetpotato breeding research and provided technical advice on the root-knot nematode resistance research conducted on pepper. Dr. J. D. Mueller, Associate Professor of Plant Pathology, Clemson University, Edisto Research and Education Center, Blackville, SC, provided extensive on-site support for the pepper and sweetpotato research conducted at Blackville, SC. Dr. Michael Jackson, Research Entomologist, U. S. Vegetable Laboratory, Charleston, SC, provided technical advice on breeding sweetpotato for resistance to various insect pests.

No research was conducted in the host country (Jamaica) during Year 2. However, plans were developed for conducting research in the host country during Year 3. The following scientists have been identified as host country collaborators/cooperators: Janice C. Reid, CARDI; Janet Lawrence, CARDI; D. Hutton, UWI; D. McGlashan, MINAG; and P. Chung, RADA.

III. SUMMARY

Laboratory, greenhouse, microplot, and field studies were conducted to address pest and weed problems associated with production of peppers and sweetpotatoes. The existence of high levels of root-knot nematode resistance was confirmed in three germplasm lines of the Scotch Bonnet type peppers that are quite popular in Jamaica. All available accessions of the closely related Habanero type pepper, however, were found to be susceptible. The root-knot nematode tolerant cayenne pepper accession PA-136 was demonstrated not to be suitable for utilization in a rotation scheme to control root-knot nematodes, nor a suitable substitute for a resistant cultivar. The cayenne pepper cultivar Carolina Cayenne was demonstrated to have exceptional resistance to root-knot nematodes. Both Scotch Bonnet and Habanero peppers were demonstrated to be highly tolerant to the herbicide metolachlor, and the results of preliminary tests indicate that some hybrid bell-type pepper cultivars are tolerant to the herbicide bentazon. Some sweetpotato clones were demonstrated to be allelopathic to yellow nutsedge, purple nutsedge, and some annual weeds. Several advanced dry-fleshed sweetpotato clones of the type that are popular in Jamaica were confirmed to be highly resistant to both southern root-knot nematodes and *Fusarium* wilt, and to have both high yield potential and excellent culinary quality. These results indicate that the development of pepper and sweetpotato cultivars with excellent horticultural characteristics, tolerances to environmentally and toxicologically safe herbicides, and multiple resistances to pests and diseases should be readily obtainable objectives.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. *Research Objectives for this Reporting Period*

1. Characterize the intermediate and high levels of resistances to root-knot nematodes exhibited by various hot pepper cultivars.
2. Characterize the tolerance to root-knot nematodes exhibited by the hot pepper PA-136.
3. Determine what weeds are economic pests of pepper and sweetpotato in Jamaica.
4. Define herbicide use rates and application methods suitable for Jamaican pepper culture.
5. Characterize the tolerances exhibited by various hot pepper cultivars to environmentally and toxicologically safe, selective herbicides.
6. Determine the amount of weeding required for maximum yields of standard sweetpotato clones and highly competitive, allelopathic sweetpotato clones.
7. Identify horticulturally suitable, cream-fleshed clones of sweetpotato that exhibit high levels of resistances to insect pests, root-knot nematodes, and *Fusarium* wilt.

B. *IPM Constraints*

Root-knot nematodes and weeds are widely recognized as yield limiting pests of peppers. *Fusarium oxosporium, F. batafas,* insects, rootknot nematodes, and weeds are widely recognized as yield-limiting pests of sweet potato. Additionally, many weeds are known to be alternate hosts of root-knot nematodes and other plant pathogens, and the alternate host status of weeds must be considered for successful implementation of an IPM program. The major constraints being addressed by this project are the unavailability of suitable pepper and sweet potato cultivars with useful resistances to pests, the unavailability of environmentally and toxicologically safe herbicides, and the lack of adequate technical information for making herbicide recommendations for the pepper and sweet potato cropping systems used in Jamaica.

V. RESEARCH APPROACH AND OUTPUT

A. *Characterize the intermediate and high levels of resistances to root-knot nematodes exhibited by various hot pepper cultivars (Objective 1).*

Research Methods

Greenhouse Experiment

A greenhouse experiment was conducted to compare the severity of root galling and nematode reproduction of six "Scotch Bonnet Habanero" pepper *(Capsicum chinensis)* accessions and four check pepper (*C. annuum)* lines inoculated with 3000 *Meloidogyne incognita* race 3 eggs per plant. The *C. chinensis* accessions included PA398 (Jamaican Scotch Bonnet), PA-426 (Yellow Scotch Bonnet), PA-353 (Red Habanero), PA-350 (Habanero), PA-343 (Habanero), and PA-388 (Yellow Scotch Bonnet). The C. *annuum* check lines were 'Carolina Cayenne' (resistant), 'Mississippi Nemaheart' (resistant), 'Sweet Banana' (susceptible), and PA-136 (susceptible). The experimental design was a randomized complete block design with six replicates (five plants per replicate).

Seeds were planted on 24 January 1995 in the greenhouse and transplanted on 14 February 1995 to greenhouse benches containing a steam-pasteurized mixture of 2 sand: 1 soil (by volume). At transplanting, 3000 *Meloidogyne incognita* eggs were pipetted around the base

of each plant. On 15 May 1995, the entire root system of each plant was removed from the soil, washed, and scored for galling and egg mass production using a 1 to 9 scale (1 =no galls or egg masses; 9=greater than 80% of root system galled or covered with egg masses). Then the fibrous roots were clipped from the plant, cut into 1 to;2-cm pieces, and eggs were extracted from a 10-g samples of roots using 1% NaOCI. Eggs were counted using a stereo microscope.

Field Experiment I

A replicated field experiment was conducted to evaluate the fruit and yield characteristics of 11 selected rootknot nematode resistant and susceptible *C. chinensis* accessions. The resistant accessions were germplasm lines selected last year (and included in the greenhouse study described above); most of the susceptible accessions were cultivars obtained from commercial seed companies. The seeds were planted in the greenhouse on April 13,1995; transplants were planted in the field on May 31,1995. The experimental design was a randomized complete block with 9 replicates (5 plants per plot). The plots were harvested 6 times (August 16 thru September 21). Data were collected on fruit shape, fruit size, mature fruit color, number of lobules per fruit, number of fruit yield per plant, and weight of fruit per plant.

Field experiment II

Three resistant *C. chinensis* accessions (PA426, PA-398, and PA-353), three susceptible *C. chinensis* accessions (PA-388, PA-343, and PA-350), one highly resistant *C. annuum* accession (Carolina Cayenne), one resistant *C. annuum* accession (Mississippi Nemaheart), one intermediate resistant *C. annuum* accession (Keystone Resistant Giant), and one susceptible *C. annuum* accession (California Wonder) were evaluated in a field infested with a natural population of the southern root-knot nematode *(M. incognita).* The resistant *C. chinensis* accessions were germplasm lines identified last year (these lines are also included in both the greenhouse and field studies described above). The seeds were planted in the greenhouse on April 13,1995, and the transplants were planted in the field on May 31,1995. The experimental design was a randomized complete block with 9 replicates (5 plants per plot). The plots were harvested 6 times (August 16 thru September 20).

The objectives of this study included the collection of extensive data on both plant characteristics and root-knot nematode populations. The data included number of fruit yield per plant, weight of fruit per plant, gall index, *M. incognita* larvae counts of soil samples collected at planting and harvest, and counts of *M. incognita* eggs extracted from root tissue samples. The roots were scored for galling using a 1 to 5 scale, and eggs were extracted from root tissue samples as described above (Greenhouse test). A centrifugal flotation method was used to extract eggs from 400 cc soil samples.

Research Results

Greenhouse Experiment

The Scotch BonneVHabanero type accessions PA-398, PA-426, and PA-353 exhibited high resistance to *M. incognita* race 3 in the greenhouse study (Table 1). Root galling and nematode reproduction were minimal. The Scotch Bonnet Habanero type accessions PA350, PA-343, and PA388 were susceptible. Roots were moderately to severely galled and nematode reproduction was moderately high. The four C. *annuum* checks reacted to *M. incognita* as expected based on results from several previous tests. 'Carolina Cayenne' and 'Mississippi Nemaheart' were resistant and 'Sweet Banana' and PA-136 were susceptible.

Field Experiment I

The fruit and yield characteristics of each of the root-knot nematode resistant *C. chinensis*germplasm lines were comparable to those of commercially available *C. chinensis*cultivars (Table 2). Fruit size, color, and locule number characteristics were also acceptable.

Field Experiment II

An evaluation of root galling suggests that the resistances observed in the *C. chinensis* accessions PA-426, PA-398, and PA-353 in earlier greenhouse tests hold up against natural M. *incognita* populations in the field (Table 3). The level of the resistances were similar to that observed in the *C. annuum cv.* Mississippi Nemaheart resistant check, i.e., low levels of galling. The resistances were better than that exhibited by *the C. annuum cv.* Keystone Resistant Giant intermediate resistant check, but not as good as that exhibited by the *C. annuum cv.* Carolina Cayenne highly resistant check. Roots of the susceptible *C. chinensis* accessions did not exhibit the severe galling and root necrosis exhibited by the *C. annuum cv.* California Wonder susceptible check.

Examination of the yield and fruit size data collected in this test confirms the results from Field Experiment I, i.e., the resistant *C. chinensis* accessions PA-426, PA-398, and PA-353 produce acceptable sized fruits and exhibit yield potentials that are comparable to commercially available *C. chinensis* cultivars.

Impacts

Root-knot nematodes cause major reductions in yields in peppers world-wide, including the Scotch Bonnet pepper cultivars that are so popular in Jamaica. Plant resistance, if available, would be an economically and environmentally safe way to control rootknot nematodes in pepper. The results of the greenhouse and field studies discussed above confirm the existence of good levels of resistances discovered last year in *C. chinensis* germplasm lines PA-426, PA-398, and PA-353. It is noteworthy that each of these lines produces typical Scotch Bonnet type fruits, and the yield potentials appear to be similar to those obtainable with commercially available *C. chinensis* cultivars. Thus, these lines are not only valuable parental materials for use in breeding programs to develop root-knot nematode resistant Scotch Bonnet type cultivars, but they are potentially useful in commercial agricultural without any further development.

Habanero peppers, another cultivar class of *C. chinensis* peppers, are becoming a popular item with the American consumer. We evaluated all Habanero-type peppers available from commercial seed houses and heirloom seed collections, and none were identified as being resistant to the southern root-knot nematode. The *C. chinensis* accessions PA-426, PA-398, and PA-353 are excellent donor parents for development of root-knot nematode Habanero-type peppers.

Table 1. Gall indices, egg mass indices, and eggs per gram fresh root of six "Scotch Bonnet/Habanero" pepper accessions and four check pepper lines inoculated with *Meloidogyne incognita*, race 3, 1995 greenhouse test.[a]

Accession	Cultivar class	Gall index[b]	Egg mass index[c]	Eggs/g fresh root
PA-398	Scotch Bonnet	1.3	1.2	2020
PA-426	Scotch Bonnet	1.3	1.3	1473
PA-353	Habanero	1.7	1.8	3068
PA-350	Habanero	5.5	5.4	52352
PA-343	Habanero	5.5	5.4	45350
PA-388	Scotch Bonnet	6.5	6.1	46556
Carolina Cayenne	Check	1.3	1.4	935
Mississippi Nemaheart	Check	1.5	1.5	1313
Sweet Banana	Check	6.5	6.7	70659
PA-136	Check	7.5	7.6	65391
LSD (0.05)	—	0.5	0.5	12816

[a] Peppers transplanted to bench 2/14/95; inoculated with 3000 *M. incognita* eggs 3/8/95; evaluated 5/15/95. Each value is an average of 30 plants.

[b] Gall index: 1=no galls; 9=greater than 80% of root system galled.

[c] Egg mass index: 1=no egg masses; 9=greater than 80% of root system covered with egg masses.

Table 2. Field evaluation of the fruit and yield characteristics of root-knot nematode resistant and susceptible accessions of *Capsicum chinensis*, 1995.

Accession	Reaction to root-knot nematodes[a]	Commercially available cultivar	Fruit shape	Fruit dimensions (width x depth, cm)[b]	Mature fruit color	Locules per fruit	Fruit yield/ plant (no.)	Fruit yield/ plant (g)	Avg. weight per fruit (g)
						3	40	301	7.6
PA-426	Resistant	No	Bonnet	6.0 x 2.5	Yellow				
PA-398	Resistant	No	Bonnet	6.0 x 2.5	Yellow	3	38	377	10.0
PA-353	Resistant	No	Bonnet	6.0 x 3.5	Red	3	43	329	7.6
PA-343	Susceptible	Yes	Lantern	3.5 x 6.0	Orange	3	38	85	6.9
PA-350	Susceptible	No	Lantern	3.5 x 5.0	Orange	2-4	52	452	8.3
PA-274	Susceptible	Yes	Lantern	3.0 x 5.0	Orange	3	56	368	6.7
PA-295	Susceptible	Yes	Lantern	3.0 x 6.0	Orange	3	52	378	7.2
PA-337	Susceptible	Yes	Lantern	3.0 x 6.0	Orange	3-4	42	256	6.1
PA-338	Susceptible	Yes	Lantern	3.0 x 6.0	Orange	3	45	316	7.0
PA-356	Susceptible	Yes	Lantern	3.0 x 5.0	Orange	2-3	47	332	7.0
PA-395	Susceptible	Yes	Lantern	3.0 x 5.0	Orange	3-4	44	331	7.4
Miss. Nemaheart[c]	Resistant	No	Pimiento	—	Red	—	7	306	40.0
LSD (0.05)	—	—	—	—	—	—	19	NS	1.8

[a]Based on the results of a 1994 greenhouse test inoculated with *Meloidogyne incognita*.

[b]Typical fruit.

[c]*C. annuum* cultivar, resistant check.

Table 3. Evaluation of yield and resistance characteristics of selected *Capsicum annuum* and *C. chinensis* accessions grown in a field infested with a natural population of the southern root-knot nematode (*Meloidogyne incognita*).[a]

Pepper species/ accession	Cultivar class	Fruit yield/plant (no.)	Fruit yield/plant (g)	Avg. weight per fruit (g)	Gall index[b]
C. chinensis					
PA-426	Scotch Bonnet	67	570	8.6	1.84
PA-398	Scotch Bonnet	48	572	12.4	1.86
PA-353	Scotch Bonnet	60	522	8.7	1.64
PA-388	Scotch Bonnet	15	167	11.2	3.72
PA-343	Habanero	63	508	8.0	2.94
PA-350	Habanero				
C. annuum					
Carolina Cayenne[c]	Cayenne				
California Wonderd	Bell				
Keystone Resistant Giante	Bell				
Mississippi Nemaheartf	Pimento				
LSD (0.05)	—				

aThe objectives of this study also included counts of *M. incognita* larvae in the soil at planting and harvest, and coun of *M. incognita* eggs extracted from root samples. The analyses of soil and root tissue samples collected during the study will be completed during year 3 of the project.
bRated on a scale of 1 to 5; 1=no or limited galling, 5=severe galling.
cHighly resistant check.
dSusceptible check.
eIntermediate resistant check.
fResistant check.

B. *Characterize the tolerance to root-knot nematodes exhibited by the hot pepper PA-136 (Objective 2).*

Research Methods

The data reported for this objective are from a field study conducted at the U.S. Vegetable Laboratory, Charleston, S.C., and microplot and field studies conducted at the Clemson University Edisto Research and Education Center, Blackville, S.C. Egg inocula for all tests were extracted from roots of cowpea or pepper plants infected with *M. incognita* race 3. The pepper genotypes used in the tests were 'Carolina Cayenne', 'Early Calwonder', and PA-136. 'Carolina Cayenne' is highly resistant to *M. incognita,* PA136 has been reported to be tolerant, and 'Early Calwonder' is susceptible. 'Carolina Cayenne' and PA-136 are quite similar in plant habit and yield characteristics; both genotypes were selected from a 'Carolina Hot' population that was heterogeneous for resistance to *M. incognita.*

Microplot Experiment

A microplot experiment was conducted at Blackville, SC, to compare the severity of root galling, nematode reproduction, and fruit yield of 'Carolina Cayenne', PA-136, and 'Early Calwonder' plants inoculated with 0, 6000, or 12000 M. *incognita* race 3 eggs per plant. The experimental design was a randomized complete block design with treatments in a three cultivar x three inoculum level factorial arrangement with 12 replicates. Each of the 57-cm diameter microplots was fumigated with 151 g of a combination of (w/w) 98% methyl bromide (CH3Br) and 2% chloropicrin (CCI3NO2) on 13 May 1994.

Seeds were planted on 10 May 1994 in the greenhouse and transplanted on 17 May 1994 to individual cells in plastic growing trays. On 21 June 1994, a single six week-old seedling was transplanted into each microplot and 10 ml of tap water containing 0, 3000, or 6000 M. *incognita* eggs was pipetted around the base of each plant. Each plant was inoculated again on 29 June 1994 using the same procedure with the same inoculum levels. Final inoculum levels were 0, 6000, or 12000 eggs per plant. The plots were hand weeded and fertilized with 1 ON-1 OP1 OK fertilizer as needed.

Fruits were harvested on 9 Sept., 5 Oct., and 19 Oct. 1994. Fruit weights were recorded at each harvest. Six cores (2.5-cm diameter) of soil were taken to a 20-cm depth in the root zone of each plant on 21 July (mid-season samples) and 19 Oct. 1994 (harvest samples). Juveniles were extracted from 400 cm^3 soil using the centrifugal flotation method. Eggs were extracted from root fragments present in the 400 cm^3 soil sample using 1% NaOCI. Eggs and juveniles were counted in the respective samples using a stereo microscope.

All plants were dug on 2 November 1994. Shoots were cut at the base of the stem and removed. The entire root system of each plant was carefully washed, blotted dry, and weighed. Each root system was scored for galling and egg production using a 1 to 9 scale and eggs were extracted from 10g fibrous roots and counted as described above.

Field Experiment I

A field experiment was conducted at Charleston, SC, to compare the severity of root galling, nematode reproduction, and fruit yield of 'Carolina Cayenne', PA-136, and 'Early Calwonder' plants inoculated with 0, 6000, or 12000 M. *incognita* race 3 eggs per plant. The field was fumigated with (w/ w) 98% CH3Br: 2% CCI3NO2 on 31 May 1994. The soil fertility was adjusted according to Clemson University soil test recommendations. The experimental design was a randomized complete block design with treatments in a three pepper entry x three inoculum level factorial arrangement with 6 replicates. Experimental plots were three row beds established on 1-m centers with 46-cm in row plant spacing and 15 plants per row.

Seeds of each pepper genotype were planted on 23 April 1994 as described above for the greenhouse experiment. Single seedlings were transplanted into 4cm diameter Jiffy Pellets (Jiffy Products of America, Inc., Batavia, IL) on 6 May and 7 May 1994 and maintained in the greenhouse at 23° to 29°C. Four weeks later, the seedlings were moved outdoors to harden off. Due to heavy rainfall during June and July, transplanting was delayed until 20 July 1994. Ten ml tap water containing 0, 3000, or 6000 *M. incognita* race 3 eggs was pipetted around the base of each pepper seedling at transplanting. On 3 August 1994, 63 ml of tap water containing 0, 3000, or 6000 *M. incognita* eggs was poured into three 5-cm-deep holes around the base of the plant (according to previously assigned treatments). Final inoculum levels were 0, 6000, or 12,000 eggs per plant.

All harvest data and nematode data were collected from the entire center row of each plot. Mature green bell pepper fruits were harvested weekly from 6 Sept. to 7 Oct. 1994. Cayenne pepper fruits were harvested weekly as mature red fruits from 17 Oct. to 7 Nov. 1994. On 18 Oct. 1994, ten cores of soil were collected in the root zones of pepper plants from the center row of each plot and juveniles were extracted as previously described. Root systems of 'Early Calwonder' were dug on 3 Nov. 1994; root systems of 'Carolina Cayenne' and PA-136 were dug 23 November 1994. Each root system was scored for galling and egg mass production, eggs were extracted from a 20-g subsample of roots and counted as stated above.

Field Experiment II

In 1994, an experiment was conducted at Blackville, SC, to compare the severity of root galling, nematode reproduction, and fruit yield of 'Carolina Cayenne' and PA-136, in a field infested with *M. incognita* race 3. The field was infested with *M. incognita* in 1993 by inoculating a PA-136 planting with approximately 7000 eggs of M. *incognita* race 3 eggs per plant. A winter cover crop of hairy vetch *(Vicia villosa* Roth) was sown over the pepper plants on 3 December 1993 to maintain the M. *incognita* populations over the winter. The hairy vetch was plowed down on 10 May 1994. Plots were nine row beds established on 1-m centers with 46-cm in-row plant spacing with 15 plants per row. The experimental design was a randomized complete block design with and 9 replicates.

Seeds of 'Carolina Cayenne' and PA-136 were planted on 18 Apr. to 20 Apr. 1994 in flats, as described for the greenhouse experiment. Pepper seedlings were transplanted into Jiffy Pellets from 29 Apr. to 3 May 1994 and maintained in the greenhouse at 23° to 29°C. Pepper seedlings were moved outdoors to harden on 25 May 1994. The herbicide metolachlor [2chloro-N-(2-ethyl-6methylphenyl)-N-(2-methoxy-1methylethyl)acetamide] was sprayed on the soil on 1 June 1994 at 2.2 kg a.i. had and preplant incorporated. The soil fertility was adjusted according to Clemson University soil test recommendations. The peppers were transplanted into the field on 2 June 1994. On 26 July and 19 Oct.1994, ten cores of soil were collected in the root zones of pepper plants from rows two, five, and eight of each nine-row plot; juveniles and eggs were extracted from each sample as described above for the microplot experiment. Mature red fruit were harvested from five plants in rows two, five, and eight of each plot on 9 Sept., 5 Oct., and 19 Oct. 1994. On 19 Oct.1994, five plants were dug from rows one, three, four, six, seven, and nine of each plot. The entire root system of each plant was washed, each root system was scored for galling and egg production, and eggs were extracted from a 10-g subsample of roots, and counted as stated above.

Research Results

Microplot Study

'Carolina Cayenne' exhibited exceptionally high resistance to *M. incognita;* no galls or egg masses were visible on the roots, nematode reproduction was very low, and fruit yield was not reduced in inoculated microplots (Table 4). Both PA-136 and 'Early Calwonder' exhibited susceptible reactions for root galling and nematode reproduction. Fruit yield of 'Early Calwonder' plants inoculated with 12000 eggs per plant was reduced 25% ($P<0.05$). Although yields of inoculated PA-136 plants were not reduced compared to the uninoculated control, fruit yield of PA-136 plants inoculated with 6000 eggs were reduced compared to fruit yield of the related line, 'Carolina Cayenne', at all inoculum levels.

At midseason, soil samples collected from plots where 'Carolina Cayenne' plants had been inoculated with 6000 eggs per plant had 90.3% and 85.1% fewer eggs and juveniles

(P<0.05) than soil samples from PA-136 and 'Early Calwonder', respectively (Table 4). Soil samples from 'Carolina Cayenne' plots inoculated with 12000 eggs per plant had 99.4% and 99.3% fewer eggs and juveniles (P<0.05) than samples collected from PA-136 and 'Early Calwonder' plots. At harvest, numbers of eggs and juveniles in soil samples collected from plots where 'Carolina Cayenne' plants had been inoculated with either 6000 or 12000 eggs per plant were about 99% less (P<0.05) than samples collected from comparable PA-136 and 'Early Calwonder' plots. 'Carolina Cayenne' plants inoculated with either 6000 or 12000 eggs per plant had 99.8% fewer eggs per g fresh root at harvest than either PA-136 or 'Early Calwonder'. PA-136 plants inoculated with 6000 eggs per plant had greater (P<0.05) numbers of eggs per g fresh root than 'Early Calwonder' plants inoculated with the same number of eggs. Inoculation of 'Early Calwonder' plants with 12000 eggs significantly reduced (P < 0.05) fruit yield compared to the uninoculated control. Fruit yield of PA-136 plants was less (P<0.05) than 'Carolina Cayenne' when plants of both genotypes were inoculated with 6000 eggs per plant.

Field Experiment I

'Carolina Cayenne' was highly resistant in the inoculated field test at Charleston, SC. For example, roots of 'Carolina Cayenne' exhibited only very slight galling and egg masses were not observed at any inoculum level (Table 5). 'Carolina Cayenne' plants inoculated with either 6000 or 12000 eggs per plant produced 100% fewer eggs than either of the susceptible checks. Roots of PA-136 and 'Early Calwonder' plants inoculated with 6000 or 12000 eggs per plant were moderately galled (Gl=5.0 to 7.5) and had moderate numbers of egg masses (EMI=5.0 to 7.5). Numbers of eggs per g fresh root at harvest were 1.9 to 3.1 times greater (P<0.05) for PA-136 than 'Early Calwonder' at the 6000 and 12000 egg inoculum levels, respectively. Fruit yields were not significantly different at any inoculum level within cultivars, and fruit yields of 'Carolina Cayenne' and PA136 were not significantly different at any inoculum level.

Table 4. Comparison of three pepper genotypes differing in resistance to southern root-knot nematode for numbers of *Meloidogyne incognita* eggs and juveniles in soil samples at midseason and harvest, numbers of *M. incognita* eggs extracted from root samples, gall index, egg mass index, and fruit yield, 1994 microplot test.

Pepper genotye/ inoculum level[a]	No. eggs and juveniles/400 cm3 soil Midseason	Harvest	Gall index[b]	Egg mass index[c]	No. egg/g fresh root weight	Fruit yield (g/plant)
Carolina Cayenne						
	143 bd	110 b	1.0 b	1.0 b	112 c	438 c
	2028 b	208 b	1.0 b	1.0 b	191 c	379 cd
	110 b	136 b	1.0 b	1.0 b	262 c	412 cd
PA-136						
	1333 b	3681 b	1.0 b	1.0 b	124 c	347 cde
	20934 a	46223 a	8.9 a	9.0 a	138291 a	273 e
	18640 a	40121 a	8.2 a	8.2 a	124702 ab	301 de
Early Calwonder						
	205 b	17 b	1.0 b	1.0 b	154 c	617 a
	13643 a	43452 a	8.8 a	8.8 a	104416 b	559 ab
	16514 a	44412 a	8.2 a	8.2 a	111301 b	463 bc

aEach plant was inoculated with 0, 6000, 12000 M. incognita eggs. The inoculum was applied in split inoculations, one-half at planting and one-half one week later.
bGall index: 1=no galls, 9=greater than 80% of root system galled.
cEgg mass index: 1=no egg masses, 9=greater than 80% of root system covered with egg masses.
dMeans in a column followed by the same letters are not significantly different according to Duncan's multiple range test (P<0.05).

Table 5. Comparison of three pepper genotypes differing in resistance to southern root-knot nematode for numbers of *Meloidogyne incognita* eggs per g fresh root, gall index, egg mass index, and fruit yield, 1994 field test.

Pepper genotype/ inoculum level[a]	Gall index[b]	Egg mass index[c]	Eggs/g fresh root	Fruit yield (kg/ha)
Carolina Cayenne				
	1.1 cd	1.0 c	7 d	19,086 a
	1.1 c	1.0 c	6 d	17,672 a
	1.2 c	1.0 c	0 d	16,241 a
PA-136				
	1.0 c	1.0 c	8 d	16,159 a
	5.9 b	5.1 b	54,602 b	16,356 a
	6.5 ab	6.6 a	67,403 a	17,109 a
Early Calwonder				
	1.0 c	1.0 c	20 d	5,323 b
	7.0 ab	7.0 a	28,285 c	5,993 b
	7.4 a	7.4 a	21,416 c	5,564 b

a Each plant was inoculated with 0, 6000, or 12000 M. incognita eggs. The inoculum was applied in split inoculations, one-half at planting and one-half one week later.
b Gall index: 1=no galls, 9=greater than 80% of root system galled.
c Egg mass index: 1=no egg masses, 9=greater than 80% of root system covered with egg masses.
d Means in a column followed by the same letters are not significantly different according to Duncan's multiple range test (P<0.05).

Field Experiment II

Fruit yield of 'Carolina Cayenne' was 339% greater ($P<0.05$) than fruit yield of the root-knot susceptible sister line PA-136 (Table 6). At midseason, soil samples collected from plots where 'Carolina Cayenne' plants were grown had 99.4% fewer ($P<0.05$) eggs and juveniles than plots where PA136 plants were grown. At harvest, soil samples from 'Carolina Cayenne' plots had 97.3% fewer eggs and juveniles than samples from PA-136 plots. 'Carolina Cayenne' roots exhibited only slight galling (Gl=1.4) and very low numbers of egg masses (EMI=1.4). Roots of PA-136 were severely galled (Gl=9.0) and had extremely large numbers of egg masses (EMI=8.9).

Impacts

Previous observations at the U. S. Vegetable Laboratory indicated that PA-136 pepper is an excellent host plant for producing M. *incognita* inocula. PA-136 plants are capable of producing enomorous numbers of eggs, and, unlike plants of most other pepper cultivars, greenhouse cultured PA-136 plants tolerate *M. incognita* infestations and do not quickly die. Although the results of the microplot and field tests discussed above do suggest some field tolerance, PA-136 plants did result in the build-up of tremendous M. *incognita* populations. PA-136 would not be a suitable accession for utilization in a rotation scheme, nor would it be a suitable substitute for a resistant cultivar.

It should be noted that 'Carolina Cayenne' exhibited exceptionally high resistance (minimal galling and nematode reproduction and no reduction in yield) in all greenhouse, microplot, and field tests. The data from Field Tests I and 11 indicate that 'Carolina Cayenne' fruit yield is not reduced under high populations of root-knot nematode. This is the first report of the high yield potential of 'Carolina Cayenne' when grown in the presence of very high populations of *M. incognita.*

The exceptionally high field resistance of 'Carolina Cayenne' to the southern root-knot nematode should allow successful production of cayenne peppers in fields that are heavily infested with *M. incognita.* The resistance exhibited by this cultivar is highly effective and inexpensive; it is an environmentally compatible alternative to using methyl bromide and other nematicide to control root-knot nematodes in peppers. 'Carolina Cayenne' may be useful as a rotation crop in reducing root-knot nematode populations to levels that would allow production of root-knot susceptible vegetable crops both in Jamaica and the U.S.

C. *Determine what weeds are economic pests of pepper and sweet potato in Jamaica (Objective 3).*

The failure to amend the VP/USDA Task Order until late in Year 2 to reflect the full contract amount prohibited the U. S. Vegetable Laboratory from obligating money needed for a planned on-site visit to Jamaica to identify the presence of any unique weed species. However, a cooperating scientist in Jamaica (Philip Chung) did complete a survey of weed management practices and weed pests in Jamaica. The results of Mr. Chung's survey will be addressed in CARDI reports.

Table 6. Comparison of two pepper genotypes differing in resistance to southern root-knot nematode for number *Meloidogyne incognita* eggs and juveniles in soil samples, gall index, egg mass index, and fruit yield, 1994 field test

Pepper genotype[e]	No. eggs and juveniles/400 cm^3 soil Midseason[a]	Harvest	Gall index[b]	Egg mass index[c]	Fruit yiel (kg/ha)
Carolina Cayenne	330*	90*	1.4*	1.4*	15899*
PA-136					

a Only eggs extracted at midseason.
b Gall index: 1=no galls; 9=greater than 80% of root system galled.
c Egg mass index: 1=no egg masses; 9 =greater than 80% of root system covered.
* Significant at P<0.01.

D. Define herbicide use rates and application methods suitable for Jamaican pepper culture (Objective 4).

The herbicide metolachlor (Dual) is registered by the EPA for use on peppers in the United States. It is considered to be an environmentally safe herbicide due to its low toxicity and its relatively short persistence in the environment. Since insecticides are commonly used in vegetable production in Jamaica, backpack sprayers are available through grower coops. However, the application techniques are probably not precise enough to effectively use selective herbicides. Heavy rains during the summer of 1995 prevented the planting of a planned experiment at Charleston, SC, to accurately apply metolachlor and other herbicides to small plots using backpack sprayers and to evaluate the efficacy of weed control and labor reduction with selected herbicides in comparison to the hand weeding procedures currently used in Jamaican pepper production.

E. Characterize the tolerances exhibited by various hot pepper cultivars to environmentally and toxicologically safe, selective herbicides (Objective 5).

The results of greenhouse and field experiments indicated that Scotch Bonnet and Habanero pepper cultivars are highly tolerant to the herbicide metolachlor. The results of other greenhouse studies failed to confirm the differential tolerance observed in 10 pepper cultivars in a Year 1 field test to oxylfluorfen herbicide injury. Replicated greenhouse and field tests are in progress to verify recently identified tolerance in hybrid bell peppers to the herbicide bentazon. Preliminary evaluation of treatment effects suggests that commercial bell hybrids differ greatly in tolerance to bentazon. Results to date suggest that there are environmentally and toxicologically safe herbicides for utilization on pepper and sweet potato plantings in Jamaica. The identification of such herbicides and the development of low cost application methods will favorably impact the adverse effects weeds on Jamaican pepper and sweet potato yields.

F. Define the amount of weeding required for maximum yields of standard sweet potato clones and highly competitive, allelopathic sweet potato clones (Objective 6).

A greenhouse study to evaluate the allelopathic effects of 10 sweet potato clones against yellow nutsedge was completed. Preliminary examination of the data indicate that all of the clones were inhibitory to yellow nutsedge, but the clones varied considerably in their allelopathic properties. Results of other greenhouse and field studies suggest that there are also differences between sweet potato clones in tolerances to competition from purple nutsedge and annual weeds. These results suggest that it may be feasible to develop highly allelopathic sweet potato clones that require the utilization of less resources for weed control.

G. *Identify horticulturally suitable, cream-fleshed clones of sweet potato that exhibit high levels of resistances to insect pests, root-knot nematodes, and Fusarium wilt (Objective 7).*

Research Methods

The research approach being used to develop creamfleshed, sweet potato clones with high yields, multiple pest resistances, and acceptable culinary quality suitable involved many greenhouse, field, and laboratory procedures:

- During the fall of 1994, seeds were harvested from the 1994 field polycross nursery of dry-fleshed sweet potato clones.

- During October 1994, a replicated field test to evaluate the insect and disease resistance characteristics of the advanced lines and second year seedlings was harvested in Charleston, SC. The roots harvested from this test were stored and subsequently scored for disease and insect damage.

- During October 1994, a replicated field test to evaluate advanced lines and first and second year seedlings was harvested in Blackville, SC. The roots from the best yielding plots in this test were cured, evaluated for storage characteristics, and subsequently cooked and scored for culinary quality.

- In February 1995, 4,000 seedlings from the main and dry-fleshed polycross nurseries were evaluated in a greenhouse test for resistance to root-knot nematodes and Fusarium wilt. The planting was inoculated with eggs of the southern root-knot nematode and spores of the Fusarium wilt pathogen. A total of 620 white/yellow fleshed seedlings were resistant; each of these seedlings was selected and subsequently transplanted into the field for evaluation of yield and horticultural characteristics.

- A greenhouse test was conducted to confirm the nematode and *Fusarium* wilt resistances exhibited by advanced lines.

- During the spring of 1995, field tests were initiated at Charleston, SC, to evaluate 15 advanced breeding lines, 41 intermediate lines, and 41 second year seedlings of cream-fleshed clones for resistances to insects and diseases.

- During the spring of 1995, field tests were initiated at Blackville, SC, to evaluate 15 advanced breeding lines, 41 intermediate lines, and 41 second year seedlings of cream-fleshed sweet potato clones for yield and root quality.

- During the spring of 1995, a specific polycross nursery was set up at Charleston, SC, to develop dry-fleshed sweet potato lines for Jamaica with multiple resistances to insects, diseases, and wilt. This polycross included the best 13 dry-fleshed parental lines from 1994 and previous years.

Research Results

A number of cream-fleshed sweet potato clones with high yielding ability, insect resistance, nematode resistance, *Fusarium* wilt resistance, long-term storability, and good culinary quality were selected from among the many lines evaluated at Blackville, SC, and Charleston, SC. Several of the best advanced bunched and dry-fleshed clones were demonstrated to be highly resistant to both southern rootknot nematodes and *Fusarium* wilt (Table 7, Table 8), and to have high yield potential and excellent culinary quality (Table 9, Table 10).

Table 7. Reaction of advanced and check dry-fleshed sweetpotato lines to southern root knot nematodes (*Meloidogyne incognita* Race 3) and *Fusarium* wilt (*Fusarium oxysporum, F. batatas*) in greenhouse test.

	Reaction to *Meloidogyne incognita*				
Entry	Gall index[a]	Egg mass index[a]	Necrosis index[a]	Overall reaction[a,b]	*Fusarium* wilt reaction[b]
W-300	1.00	1.00	1.05	HR	R
W-308	1.00	1.00	1.05	HR	R
W-309	1.30	1.30	1.09	R	R
W-310	1.00	1.00	1.04	HR	R
W-313	1.06	1.06	1.30	HR	R
W-315	1.20	1.30	1.09	R	R
W-318	1.02	1.01	1.20	HR	R
W-320	1.01	1.01	1.10	HR	R
W-321	1.01	1.01	1.07	HR	R
W-325	1.01	1.00	1.02	HR	R
W-326	1.00	1.00	1.07	HR	R
W-327	1.03	1.04	1.06	HR	R
W-329	1.00	1.00	1.01	HR	R
Centennial	3.90	3.60	1.40	S	I
Asian sweetpotato	4.00	3.90	1.20	S	S
Nemagold	1.40	1.40	1.20	R	S
Rojo Blanco	3.50	3.20	1.20	I-S	I
Tinian	1.06	1.10	1.09	H-R	R

a. The feeder roots were washed and evaluated under 5X magnification using the standard disease index system of 1 to 5; where 1 = no evidence of galls, egg masses or necrosis and 5 = severe galling, large numbers of egg masses or severe necrosis.

b. S=susceptible (similar to 'Porto Rico'), I=intermediate, R=resistance less than 'Jewel', and HR=highly resistant (similar to 'Jewel').

Table 8. Reaction of bunch and check dry-fleshed sweetpotato lines to southern root knot nematodes (*Meloidogyne incognita* Race 3) and *Fusarium* wilt (*Fusarium oxysporum, F. batatas*) in greenhouse test.

	Reaction to *Meloidogyne incognita*				
Entry	Gall index[a]	Egg mass index[a]	Necrosis index[a]	Overall reaction[a,b]	*Fusarium* wilt reaction[b]
93-23	1.10	1.20	1.07	HR	R
93-158	1.01	1.01	1.06	HR	R
93-214	1.00	1.00	1.04	HR	R
W-304	1.01	1.03	1.06	HR	R
W-305	1.01	1.00	1.05	HR	R
Centennial	3.80	3.80	1.50	S	I
Jewel	1.80	1.80	1.30	R	R
Goldrush	3.70	3.70	1.20	S	R
Nemagold	1.60	1.90	1.40	R	S
Sulfur	4.20	4.00	1.50	S	S
Tinian	1.05	1.05	1.20	HR	R

a The feeder roots were washed and evaluated under 5X magnification using the standard disease index system of 1 to 5; where 1=no evidence of galls, egg masses or necrosis and 5=severe galling, large numbers of egg masses or severe necrosis.

b S=susceptible (similar to 'Porto Rico'), I=intermediate, R=resistance less than 'Jewel', and HR=highly resistant (similar to 'Jewel').

Table 9. Yield and baking quality of dry-fleshed advanced and bunch sweetpotato lines.

Entry	Test	TMY in lbs[a]	TMY as % of controls[b]	Baking or frying score[c]	Percent dry matter
W-300	Advanced	30.8 fg	61.3	8.5	27.6
W-304	Bunch	26.3 g	54.3	6.0	25.3
W-305	Bunch	57.1 bc	118.0	5.0	24.5
W-308	Advanced	72.1 a	143.7	7.0	23.2
W-309	Advanced	31.0 efg	61.8	6.2	30.0
W-310	Advanced	49.1 bcdef	97.8	—	27.4
W-314	Advanced	41.0 cdefg	81.7	8.0	25.4
W-318	Advanced	34.0 efg	67.7	6.0	24.3
W-320	Advanced	44.8 bcdefg	89.2	9.2	25.3
W-321	Advanced	35.7 defg	71.1	10.2	25.3
W-325	Advanced	56.8 abcd	113.3	6.5	24.1
W-326	Advanced	32.2 efg	64.1	8.5	26.0
W-327	Advanced	33.6 efg	67.0	7.0	33.7
93-158	Bunch	65.7 a	133.7	6.0	27.9
93-214	Bunch	31.1 efg	64.3	5.0	20.7
Beauregard	Cultivar	57.3 abc	—	—	—
Jewel	Control (yield)	41.2 cdefg	—	—	—
Regal	Control (yield)	60.3 abc	—	—	—
SC1149-19	Control (yield)	49.1 bcdef	—	—	—
Sumor	Control (baking)	---	—	11.0	25.7
HiDry	Control (baking)	---	—	15.0	32.9

a TMY=Average total marketable yield in pounds per 25 plant plot (4 replications), at 12 inch spacing, 120 days after planting. Data were analyzed using Duncan's multiple range test (alpha = 0.5). Means with the same letter are not significantly different. Results from the advanced and the bunch tests have been pooled.

b Calculated by TMY of sweetpotato line divided by average TMY of 3 control lines (TMY of Regal + Jewel + SC1149-19/3) multiplied by 100.

c Total food quality score, calculated by total of score for each of 7 traits, compared to Sumor and HiDry, dry fleshed cultivars. Traits were scored from 1 to 5, where 1 = excellent, 2 = good, 3 = acceptable, 4 = poor, 5 = very unacceptable.

Table 10. Yield and baking quality of dry-fleshed second year seedlings (SYS) of sweetpotato.

Entry	Test	TMY in lbs[a]	TMY as % of controls[b]	Baking or frying score[c]	Percent dry matter
93-4	SYS	57.3 abc	121.9	11.5	21.2
93-20	SYS	26.2 f	55.6	15.0	25.7
93-24	SYS	46.8 abcd	99.4	11.0	30.2
93-46	SYS	32.8 def	69.6	8.0	21.1
93-52	SYS	48.8 abcd	108.3	6.0	24.5
93-55	SYS	32.5 def	69.1	12.0	24.5
93-63	SYS	43.7 bcde	92.8	7.5	26.6
93-73	SYS	40.0 cdef	87.0	7.0	26.0
93-96	SYS	42.8 bcde	91.1	7.0	24.3
93-104	SYS	52.1 abc	110.9	7.5	28.0
93-174	SYS	28.1 edf	59.7	8.0	24.6
93-223	SYS	52.4 abc	111.5	7.0	24.0
93-238	SYS	34.0 def	72.3	12.0	27.3
93-246	SYS	32.5 def	69.1	14.5	23.1
Jewel	Control (yield)	44.5 bcd	94.6	—	—
Regal	Control (yield)	54.5 abc	115.7	—	—
SC1149	Control (yield)	42.2 bcde	89.7	—	—
Sumor	Control (baking)	—	25.7	11.0	25.7
HiDry	Control (baking)	—	32.9	15.0	32.9

a TMY = Average total marketable yield in pounds per 25 plant plot (4 replications), at 12 inch spacing, 120 days after planting. Data were analyzed using Duncan's multiple range test (alpha = 0.5). Means with the same letter are not significantly different.

b Calculated by TMY of sweetpotato line divided by average TMY of 3 control lines (TMY of Regal + Jewel + SC 1149-19/3) multiplied by 100.

c Total food quality score, calculated by total of all scores for each of 7 traits. Traits were scored from 1 to 5, where 1 = excellent, 2 = good, 3 = acceptable, 4 = poor, 5 = very unacceptable.

Impacts

It is anticipated that the first cream-fleshed clones from the U.S. Vegetable Laboratory sweet potato breeding program will be entered in the 1996 regional sweet potato trials. These trails will be conducted throughout the Southeastern U.S. and California. The ultimate release of a cream-fleshed sweet potato cultivar with resistances to rootknot nematodes, *Fusarium* wilt, and insects will address some of the major constraints facing the sweet potato industry in Jamaica.

VI. NETWORKING ACTIVITIES

- R. L. Fery and H. F. Harrison are investigators on the Clemson University/Ghana Cowpea Integrated Pest Management Project (Bean/Cowpea CRSP).

- R. L. Fery participated in the Bean/Cowpea CRSP West Africa Regional Cowpea Workshop, Accra, Ghana, October 12 - 14, 1994. After the workshop, Dr. Fery visited Clemson University's CRSP cooperators at the Savannah Agricultural Research Institute, Tamale, Ghana, and the Crops Research Institute, Kumasi, Ghana.

- R. L. Fery and J. A. Thies attended the IPM CRSP Workshop, Virginia Tech, Blacksburg, VA, 20 - 21 May 1995.

- R. L. Fery planned a workshop entitled "Core collections: A strategy for management of plant genetic resources" for the 1995 Annual Meeting of the American Society for Horticultural Science, Montreal, Quebec, Canada, 30 July - 2 August 1995. Dr. Fery presented the introduction and presided over the workshop.

- R. L. Fery represented the Clemson University Bean/Cowpea IPM CRSP project at the Second World Cowpea Conference, Accra, Ghana, September 3 - 7,1995. Dr. Fery presented an invited lead paper entitled "Cowpea genetics: A review of the recent literature." He participated in two work sessions of the Bean/Cowpea CRSP that were held during the conference.

VII. PUBLICATIONS AND PRESENTATIONS

A. *Presentations*

1. J. A. Thies presented a paper entitled "Effects of southern root-knot nematode *(Meloidogyne incognita)* on resistant, tolerant, and susceptible pepper lines" at the 1st International Symposium on Solanacea for Fresh Market, Malaga, Spain, 28 - 31 March 1995.

2. R. L. Fery presented a paper entitled "Breeding bell peppers for resistance to root-knot nematodes" at the 1st International Symposium on Solanacea for Fresh Market, Malaga, Spain, 28 -31 March 1995.

3. R. L. Fery presented a poster paper entitled "Assessment and genetic analysis of southern blight *(Sclerotium rolfsil)* resistance in pepper" at the 1st International Symposium on Solanacea for Fresh Market, Malaga, Spain, 28 - 31 March 1995.

4. J. A. Thies presented a paper entitled "Efficacy of resistance to southern root-knot nematode in Carolina Cayenne pepper" at the Tenth Biennial Texas Pepper Conference, Weslaco, TX, 1. 2 June 1995.

5. R. L. Fery presented a paper entitled "Breeding peppers for resistance to root-knot nematodes" at the Tenth Biennial Texas Pepper Conference, Weslaco, TX,1 - 2 June 1995.

6. J. R. Bohac presented a poster paper entitled *"Ipomoea* accession closely related to sweet potato" at the Annual Meeting of the American Society for Horticultural Science, Montreal, Quebec, Canada, 30 July - 2 August 1995.

7. J. A. Thies presented a paper entitled "Characterization of resistance of Carolina Cayenne pepper to southern root-knot nematode *(Meloidogyne incognita)"* at the annual meeting of the Society for Nematologists, Little Rock, AR, 6 - 9 August 1995.

B. *Abstracts*

1. Bohac, J. R., and S. Rajapakse. 1995. *Ipomoea* accession closely related to sweet potato. HortScience 30:840.

2. Fery, R. L., and P. D. Dukes. 1995. Breeding peppers for resistance to root-knot nematodes *(Meloidogyne* spp.). Abstracts of 1st International Symposium on Solanacea for Fresh Market, 29 -31 March 1995, Malaga, Spain. P. 142.

3. Fery, R. L., and P. D. Dukes. 1995. Assessment and genetic analysis of southern blight *(Sclerotium rolfsil)* resistance in pepper. Abstracts of 1st International Symposium on Solanacea for Fresh Market, 29 - 31 March 1995, Malaga, Spain. P. 157.

4. Thies, J. A., R. L. Fery, and J. D. Mueller. 1995. Effects of southern root-knot nematode *(Meloidogyne incognita)* on resistant, tolerant, and susceptible pepper lines. Abstracts of 1st International Symposium on Solanacea for Fresh Market. 29 - 31 March 1995, Malaga, Spain. P.143.

5. Thies, J. S., J. D. Mueller, and R. L. Fery. 1995. Characterization of resistance of Carolina Cayenne pepper to southern root-knot nematode *(Meloidogyne incognita).* J. Nematology 27:(in press).

VIII. TRAINING OUTPUT

No activity to report.

IX. PROJECT HIGHLIGHTS

- The existence of high levels of root-knot nematode resistance in three accessions of Scotch Bonnet type *C. chinensis* germplasm was confirmed.

- No resistance to root-knot nematodes was found in Habanero type *C. chinensis* germplasm.

- The root-knot nematode tolerant *C. annuum* cayenne pepper accession PA-136 is not suitable for utilization in a rotation scheme, nor would it be a suitable substitute for a resistant cultivar.

- The resistance to root-knot nematodes exhibited by the *C. annuum* cultivar Carolina Cayenne was demonstrated to be exceptional.

- Scotch Bonnet and Habanero peppers (*C. chinensis)* were demonstrated to be highly tolerant to the herbicide metolachlor.

- Results of preliminary tests indicate that some hybrid bell pepper cultivars *(C. annuum)* are tolerant to the herbicide bentazon.

- Some sweet potato clones were demonstrated to be allelopathic to yellow nutsedge, purple nutsedge, and annual weeds.

- Several advanced dry-fleshed sweet potato clones were confirmed to be highly resistant to both southern root-knot nematodes and *Fusarium* wilt, and to have high yield potential and excellent culinary quality.

VIRGINIA TECH

Information Systems for Participatory IPM Research and Scientist/Extension Specialist Interactions.

Investigators: F. W. Ravlin, Virginia Tech

II. COLLABORATING SCIENTISTS

J. Reid, CARDI

III. SUMMARY OF RESEARCH RESULTS

Communication and access to information is essential to successfully implementing international IPM research activities. Host country and U.S. scientists must be able to freely and regularly share ideas, documents, and data from anywhere in the world. During the last few years the Internet emerged as a technology that can address these types of communication problems. The information systems project will provide the IPM CRSP with a mechanism to rapidly share ideas, documents, and data among scientists. The objectives for the information systems project for FY 1994-95 are to:

- Develop and implement an IPM CRSP World Wide Web "homepage".
- Establish an Internet connection at the CARDI, University of the West Indies, Mona office.
- Develop and present an information systems workshop to CARDI scientists, RADA extension specialists, and other IPM CRSP collaborators for the Jamaica site in Kingston, Jamaica.
- Design data bases for field research.
- Implement a bibliographic retrieval system that is accessible anywhere in the world using the Internet.

A Global IPM Network

This project will establish a World Wide Web (WWW) CRSP "homepage"[1] that will be a part of the National IPM Network (NIPMN). The NIPMN was established in 1995 as a result of two grants written by VPI & SU entomologists together with four other universities. Funding for the NIPMN is now provided by U.S.D.A, CSREES ($50,000), the NSF Center for IPM ($20,000) at North Carolina State University (NCSU), and the IPM CRSP. During the 1994-95 fiscal year we obtained these grants, purchased the hardware and software necessary to implement the project and hired a computer programmer/analyst. Also, during this last year CARDI established an Internet connection.

[1]A "home page" is a hypertext document that serves as a primary interface to other related documents and media.

Information systems and data base development

Research data bases must be carefully planned and be able to be used by in-country and U.S. scientists. The first phase of data base development is an information systems workshop that will allow U.S. and Jamaican scientists to cooperatively develop data bases. This workshop was planned during the later half of the '94-'95 fiscal year and will be presented early in 1996.

Bibliographic retrieval

All research projects must address problems associated with bibliographic retrieval. For those projects that are based within a single laboratory this usually involves a computer-based system housed on a microcomputer. However, because of the distributed nature of the IPM CRSP a globally accessible system is needed. This portion of the information systems project involves two components. First, software and server maintenance will be provided by a digital library project coordinated by Dr. Ed Fox in Computer Science (VPI & SU). As a result, IPM CRSP collaborators will access state-of-the-art digital library tools. We have obtained permission to have access to the digital library server (available October 1995). The second component involves converting references already contained in local bibliographic retrieval systems (e.g., EndNote®) to be compatible with the WWW-based digital library. This component will be addressed in FY '95-'96.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. *Research and research support objectives for this reporting period*

1. Obtain funding to support a global IPM information network.
2. Develop and implement an IPM CRSP World Wide Web "homepage"
3. Establish an Internet connection at the CARDI, University of the West Indies, Mona office.
4. Develop and present an information systems workshop to CARDI scientists, RADA extension specialists, and other IPM CRSP collaborators.
5. Design data bases for field research
6. Implement a bibliographic retrieval system that is accessible anywhere in the world using the Internet.

B. *IPM Constraints Addressed*

1. CARDI scientists are not approved to attend the information systems workshop until after January 1, 1996 therefore, the workshop will be held after that date.
2. WWW activities delayed because funding for the NIPMN became available Oct. 1, 1995.
3. Bibliographic retrieval system server not available until October 1995.

V. RESEARCH APPROACH AND OUTPUT

A. *Research/Research Support Methods*

The goal of this project is to provide information technologies to IPM CRSP collaborators. Because this is a research support project it is essential that the end users of technology (the scientists) have direct input into the project. This is being accomplished through one-to-one information discussions and workshops using participatory methods.

B. *Research/Research Support Results*

1. During the last fiscal year, funding was not available to fully implement this project as originally conceived. Thus, during FY 1994-95 we were successful in obtaining an additional $70,000 toward the development of a global IPM network.
2. Established the National IPM Network with 5 regional servers.
3. Purchased and established workstation to serve WWW materials.
4. Hired computer programmer to manage workstation.

VI. NETWORKING ACTIVITIES

A. *Workshops You Have Helped Plan and/or Have Participated In*

1. IPM CRSP Workshop and Technical Committee meeting, May 20-22, 1995, Blacksburg, VA.
2. IPM CRSP: Jamaica research workshops, March 26 - April 1, 1995.

B. *Research Investigator Exchanges*

Accepted a Jamaican graduate student (Sharon McDonald from CARDI, Jamaica) to obtain an MS degree in Entomology at VPI. Ms. McDonald began work at VPI & SU August, 1995.

C. *Research Information and Product Exchange*

1. Impact of CRSP-produced or recommended technology
2. Assistance you have given to collaborating scientists with research equipment, supplies, and other support.
   a. Advised CARDI scientists on computer equipment.
   b. Purchased laboratory supplies for virus identification.

VII. PUBLICATIONS AND PRESENTATIONS

Videotapes

International agriculture opportunities for minorities. 7 minute video. This video features the IPM CRSP with scenes and comments from CRSP collaborators.

Presentations

Ravlin, F. W., H. Warren, and G. Seitz. International IPM at Virginia Tech and the Jamaica Experience. Department of Entomology, Blacksburg, Virginia.

Newsletters

Reports from the Field: IPM CRSP, Jamaica. The University Abroad 7 (3/4). Summer/Fall 1994.

VIII. TRAINING OUTPUT

Sharon McDonald (CARDI, Jamaica) arrived August 5, 1995 and began an MS program in Entomology.

IX. PROJECT HIGHLIGHTS

Obtained funding and established the National IPM Network that will serve as a means to globally tie together IPM scientists.

Viruses and Other Diseases of Peppers in Jamaica

Investigators: Don McGlasham, Marlene Pereira, Janice Reid, CARDI; Herman L. Warren and F.W. Ravlin, Virginia Tech; C. Pitts, Penn State

II. COLLABORATING SCIENTISTS

P. Chung, RADA

III. SUMMARY OF RESEARCH RESULTS

Virus disease limits yield of Scotch bonnet (hot) and sweet peppers in Jamaica. The incidence of viruses in pepper is nearly 100% in all fields surveyed. Virus-free seeds are required to test for specific viruses. In 1995, a seed source was obtained, planted and propagated in the greenhouse at Virginia Tech. Plants were observed for virus symptoms. No virus symptom was present in pepper plants grown in the greenhouse. Seeds obtained from mature fruits were dried and will be used to establish field plots in Jamaica and at Virginia Tech.

IV. OBJECTIVES AND IPM CONSTRAINTS

Develop baseline data on viruses of pepper and related vegetables.

V. RESEARCH APPROACH AND OUTPUT

A PA-Work Shop was conducted in Jamaica in March/April, 1995 consisting of H.L. Warren, F.W. Ravlin, and C. Pitts. In Blacksburg, Virginia Scotch Bonnet pepper seed were planted in the greenhouse and field in replicated plots. Only seeds obtained from greenhouse grown disease free plants were used in the field. Seeds were increased to test for the effect of specific viruses alone and combined on yield and quality of peppers. A computer assisted search of the literature of pepper viruses was made. An annotated bibliography of pepper viruses is being compiled.

VI. NETWORKING ACTIVITIES

- Conducted Workshop-PA in Jamaica March 26 to April 2, 1 995.
- Participated in an IPM CRSP Workshop at Virginia Tech, May 19 to 22, 1995.
- Assisted with and or obtained laboratory chemical and equipment for virus research in Jamaica.

VII. PUBLICATIONS AND PRESENTATIONS

None

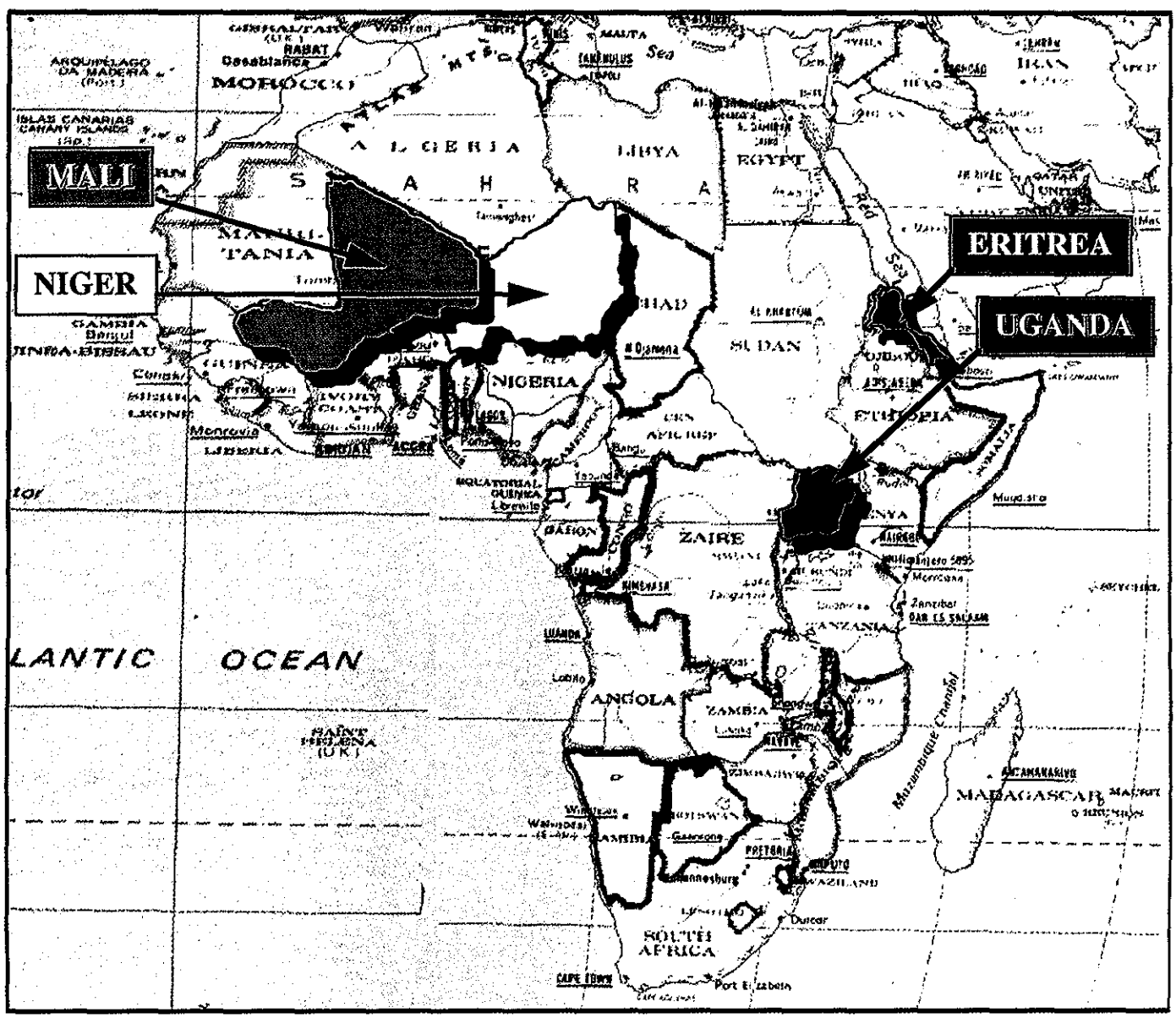
VIII. TRAINING OUTPUT

None

IX. PROJECT HIGHLIGHTS

In 1995 diseased-free Scotch Bonnet seeds were produced which may aid in identifying viruses in Jamaica.

AFRICA



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AFRICA REGION ANNUAL REPORT

Mark Erbaugh, Site Chair; Ohio State University
Florence Dunkel, Vice Chair; Montana State University
Amadou Diarra, Host Country Site Coordinator

PROGRAM DESCRIPTION

For the Sub-Saharan Africa Site, consisting of the primary site in Mali and the secondary site in Uganda, ten major objectives were targeted in the Year 2 Workplan. Progress made on each of these objectives is discussed below. In mid-May, 1995, Site Committee members and host country coordinator, Dr. Amadou Diarra met in Blacksburg for the technical committee meeting at Virginia Tech. The result of this meeting was the draft Workplan for Year 3 and budget. Finally, in early September, 1995, Dr. Diarra was given additional new responsibilities within IER. Mr. Makan Fofana was appointed as the new Malian host-country site coordinator. Mr. Fofana is an agricultural economist with much experience in farming systems and participatory research. He has been an active member of the IPM CRSP research team having served as the task force leader for the socio-economics area. He is quite familiar to Malian and USA team members, and we look forward to working closely with him in the future.

Research Activity 1. Literature Review And Secondary Data Analysis

- An annotated bibliography was produced in French and English by J.P. Amirault (John Caldwell's Graduate Student) using IPM literature from 76 reports and articles in the 1982-1991 Commission Technique annual reports and other documents obtained by Caldwell from the Sahel Institute Regional Technical Coordinating Unit for Plant Protection.

- An annotated bibliography was produced in French and English by A. Russ and R. Balakrishnan on Women, Food Security, in Mali and the Sahel. Over 80 reports and articles are included in this compilation.

- A bibliography of articles and reports relevant to postharvest loss assessment was assembled by F. Dunkel.

Secondary Data Analysis Progress: A report was prepared by Mme. Sissoko Haoua and John Caldwell in French, with an English summary by Caldwell, on the agricultural calendar based on dates of land preparation, seeding, and weeding from 69 farms with millet, 107 farms with sorghum, and 69 farms with cowpea from 1991 to 1994. In three out of four years, land preparation and seeding started in first week of July, the first weeding started 13-14 days later, and the second weeding was completed by the start of September. The length of the interval of the mean date of the first weeding was 22-38 days, indicating that farms varied approximately a month in their dates of first weeding. Variation over an interval of 11-26 days was similarly seen for second weeding. These data show an agricultural calendar for millet with a generally stable pattern from year to year, but with considerable variation from farm to farm in dates of weeding. Analysis of weed counts from 1 m^2 samples in 1991 showed that *Striga* was present before the second weeding in 5 of 7 villages. Overall weed counts were greater (107-281 m^{-2}) in the 4 southern villages than in the 3 villages in the other zones (10-46 m^{-2}).

Mme Sissoko Haoua collaborated with R. Balakrishnan to develop a manuscript on Malian Women's Role in IPM. In Malian household production, women play key production roles. They contribute to production on family fields and also manage their individual fields. A comprehensive approach to IPM that considers the totality of household crop production and the impact gender roles have on production and pests is necessary to derive sustainable solutions.

Research Activity 2. Baseline Data Collection (Socioeconomic Baseline)

In late January, 1995 team members R. Balakrishnan, D. Taylor, J. Caldwell, M. Erbaugh and graduate research associates A. Russ, J. P. Amirault, and J. Mullen met at Virginia Tech. to plan and prepare the socioeconomic baseline instrument and implementation plan.

R. Balakrishnan completed the development of two questionnaires with Malian counterparts M. Fofana, A. Diarra, and Mme. Sissoko. This team also developed the sample frame and sample identification for base line research, trained field investigators and pre-tested the instrument.

To date, all heads of households for a total of 171, have been interviewed in the five villages. Village demographic and other descriptive information have been analyzed and submitted by M. Fofana. Additional analyses are in progress that explore relationships with crop and pest management attitudes and practices. Some of the initial descriptive information about the research area is found below.

Slightly over half of the households (53%) have 10 ha. or less of land (Land refers only to cultivated crop land). Another 30% have between 11 and 20 ha, and only 16% have greater than 20 ha. There is a positive correlation between amount of land cultivated and level of equipment use (i.e. plows, oxen, donkeys, seeders). However, the impact of land and equipment possession on crop production and pests levels is still being analyzed.

Across the five villages, an average of 66% of the land area is cultivated, leaving 34% in fallow. In Mourdiah, only 15% of the land is in fallow. Historical profile analysis during the PA in Mourdiah in 1994 indicated that increased land use expansion and intensification was followed by a decline in biodiversity and increasing pressure from pests. Future analyses of baseline information will explore this relationship between agroecology, socioeconomic factors, and the incidence of pests.

Research Activity 3. Coordination And Monitoring (Biological Baseline)

Four field agents, two men and two women, were recruited, given training, and installed in pairs (one man and one woman agent) in the Sirakorola and Mourdiah areas. Prior to posting, the four agents were provided training by J. Caldwell and R. Edwards, in Mali from May 1-18, 1995, in collaboration with IER scientists M. Fofana, Mme. Sissoko Haoua, B. Dembele, K. Toure, and Mme. Gambi. This training had as its objective to enable these agents to carry out baseline data collection, select collaborators and fields for IPM trials, work with farmers to implement the trials, and carry out IPM monitoring in the trials in the research areas north of Bamako. The technical skills training program for the agents included: insect biology, control measures and entomological trial establishment, by Mme. Gambi Kadiatou Toure; *Striga* biology, control measures, and trial establishment by Bourema Dembele (using his book, Plantes parasitises des cultures et des essences forestieres (parasitic plans of crops and forest plants in the Sahel), visual aids showing *Striga*, and trial protocols); and the use of field monitoring forms developed by DRSPR

and used since 1989. The agents were also given training in participatory methods, focusing on five techniques that they will use during the course of the season to assemble information with farmers: spatial mapping and transects of crop, pest, and vegetation relationships over time; historical profile; Venn diagram of social relations between contact group farmers and organizations within and without the village; and matrix ranking for assessment of the relative importance of pest types on each crop. Each agent received a copy of the Méthode Accélérée de Recherche Participative (MARP) (Rapid Method for Participatory Research) manual on participatory methods; each pair received a set of drawings used for matrix ranking in the Mourdiah villages during the July 1994 PA, a camera for photography of insects, and materials for starting an insect collection.

Research Activity 4. Technology Screening

J. Caldwell, R. Edwards, Mme. Sissoko, Bourema Dembélé (weed science), and Justin Diabaté (entomology) held a farmers' meeting in each of the five villages (Koroma, Oussibibougou, and Dontieribougou in the Sirakorola area; Koira and Douabougou in the Mourdiah area) participating in IPM CRSP collaborative research. We met with approximately 60 farmers (of whom 10-12 were women) in the three Sirakorola villages and approximately 45 farmers (of whom 2-3 were women) in the two Mourdiah villages. Edwards provided a brief history of pest control approaches leading up to IPM, pointed out problems with pesticides, explained the process of the development of pest resistance to pesticides, and described in general terms a village-based method of neem extraction. Response by farmers and discussion followed the presentations. Edwards, Caldwell, and Mme. Gambi Kadiatou Touré developed a detailed monitoring plan for insects and plans for trial implementation.

A pre-trial implementation survey was conducted by M. Fofana to determine the potential for maize as a trap crop in the research zones. Four villages were surveyed and a total of 110 production units (extended family households) were interviewed. During the past growing season 80 percent of the farmers in these areas had grown maize indicating that it is an increasingly important crop in these areas.

Maize is most frequently grown in monoculture after a preceding crop of maize. Almost all maize (98%) is grown for food use. In three of the four villages, over 90% of the maize-producing households have their maize fields adjacent to millet fields. Only in Koira are sorghum fields adjacent to maize fields in appreciable numbers (31% of the households). This indicates that maize could serve as a trap crop if planted at a date so that it would be attractive to blister beetles prior to or at the same time when the beetles would otherwise attack millet. It was concluded that farmers are familiar with maize but we need to be cautious on its use as a trap crop so as not to compromise the farmer food objective with maize.

R. Balakrishnan and Mme. Sissoko Haoua conducted a preliminary participatory assessment in the new village, Dontieribougu, that was added to the Sirakorola research zone. In interviews with women, the main function of the neem tree was to provide shade. They were unfamiliar with neem tree products that could be used to repel insect pests. Another constraint however, is that the growth cycle of neem is synchronized with that of the Karité or sheanut (*Vitellaria paradoxa*) tree. The collection of Karité fruit is an important activity for women since it has economic value. An oil is extracted from the nut that is a valuable cooking oil that is in much demand in both rural and urban areas. If the proposed collection and processing of neem seeds using women's labor coincides with this Karité collection activity, then there is potential for labor conflict and constraint.

Research Activity 5 & 6. Implementation of Entomological Monitoring and Control Measures for Blister Beetles

Most trials were installed during the single growing season that normally begins in early July in Mali. Trials were installed latter this year, due to delayed rains, thus, their establishment occurred during the latter part of Year 2. Data will be available for evaluation in Year 3. These trials were designed to assess effects of local neem extract, azatin, and sanitation on both blister beetles and grasshoppers.

Data on the effects of three rates of azatin extract on blister beetles were analyzed by R. Edwards, J. Caldwell, and L. Bledsoe with additional input on interpretation from Mme. Gambi and F. Dunkel. These data were from the 1994 rapid impact trial carried out in five villages in the Sirakorola area. Analysis of the effects of Azatin EC on two millet varieties (souna early millet and sanio main season millet) in five villages showed that the neem extract Azatin EC resulted in a significant increase in yield of both types of millet, with no significant differences in effects between the two types of millet. The average yield, 507 kg ha^{-1}, of three rates of Azatin EC (88, 99, and 110 ml) was 53% higher than the yield of the control without Azatin, 331 kg ha^{-1}. There were no significant differences in effects among the three rates. Blister beetle (*Psalydolytta* spp.) numbers were less at the second and the last sampling dates when Azatin was applied, but the differences were not significant. Yield and a canonical variable for counts of blister beetles and head miners (*Heliocheilus albipunctella*) were negatively correlated (r=-0.25 to -0.43) at all three sampling dates, but the correlations were not significant. While Azatin improved yield in all villages, there were significant differences in the magnitude of the responses. Agronomic and socioeconomic follow-up in 1996 will seek to clarify the causes of these differences.

Bullet: Azatin EC resulted in a significant 53% increase in yield of early and main season millet, enabling farmers to obtain a yield of 507 kg ha^{-1} with Azatin EC, 176 kg ha^{-1} more than the 331 kg ha^{-1} obtained when Azatin EC was not used. The increase in millet yield obtained in these trials has significant potential to improve village food supplies, especially in drier areas more dependent on millet.

Three light traps each were installed in the four villages retained for trials (Oussibibougou was not included in the trials). Pitfall traps were also installed and sweep netting was done in the four villages. More insects of a new species, *Rhinypta infuscata*, that first entered Mali from Niger in 1994 were found than were blister beetles.

A trial comparing Azatin, local neem extract, and sanitation was implemented. Local neem extraction was done in both Mourdiah and Sirakorola, using a press obtained from the Bamako NGO "GRAT" (Group for Research and Technical Application). The local neem extract was applied to 5 main season millet fields and 3 early millet fields across the four villages.

The more common *Psalydollyta* spp. blister beetles were not present in Mourdiah this year, but blister beetles of other genera, primarily *Mylabris* spp., were observed. The causes of the apparent displacements of *Psalydollyta* spp. by *Mylabris* spp. will be investigated as the Year 2 data become available in Year 3.

Maize was planted as a trap crop of three rows around four millet fields in the villages around Sirakorola and Mourdiah. Four fields without maize were also retained for comparison. The trial was unsuccessful due to low seed vigor and low blister beetle populations.

Research Activity 7. *Striga* Control

A trial using *Striga* resistant sorghum was established by B. Dembele in 10 Sirakorola villages. A millet/cowpea integrated *Striga* management trial was established on 20 farms in both Sirakorola and Mourdiah zones. The cowpea varieties used were IT89 KD 245 and IT89 KD 374. These varieties, which are resistant to *Striga gesnerioides*, came from the International Institute for Tropical Agriculture (IITA). *Striga* identification has been delayed due to the late start of the rainy season. It is planned to begin in November.

Research Activity 8. Assessment Of Storage Damage By Pests

A participatory assessment of postharvest constraints was conducted in Mali in November 1994 by H. Warren, F. Dunkel, Mme. M. Diarra, and Mr. L. Tigana. Storage structures were examined and samples taken.

Surveys were conducted for plant diseases on sorghum, millet and cowpeas. Some sorghum fields had 40 percent yield loss due to sorghum downy mildew, and millet fields showed 30% loss due to covered smut. Grain for storage obtained from the targeted villages was plated on agar media and analyzed for fungi. Several pathogens were identified on millet including *Fusarium moniliforme* and *Aspergillus flavus.* These fungi may produce toxins which are carcinogens to humans and may cause serious problem in animals.

The research procedure used was to treat millet grain with hot water at a temperature which will kill the fungi, but not the seed embryo. Precise temperature is needed for each grain. Prior research conducted in H. Warren's laboratory at Virginia Tech has found a suitable temperature. This needs to be tested under Malian conditions. Storage pests (Fungi) were identified on millet and sorghum. Seeds were surface disinfected, blot dried, plated on potato dextrose agar, and incubated at 25° C for 4 to 7 days. Fungi were identified to species. This resulted in six storage rot fungi being isolated from millet. Of the six, two have the potential to produce harmful toxins that affect humans and animals. Three storage rot fungi were isolated from sorghum and one from cowpeas.

The hot water treatment of millet seed and the treatment of sorghum seeds with Metalaxyl (Ridomil) could reduce yield loss and improve food quality of stored grain. Determining the temperature requirements to control covered smut without affecting germination will be useful if the disease becomes a problem in the US where millet is produced.

***Bullet*:** In 1995, IPM CRSP Mali found that hot water temperature requirement for eliminating covered smut from millet seeds prior to planting without harmful effect to the embryo was effective.

Samples of stored grain were taken from 20 households and analyzed by F. Dunkel, Mme. Gambi, and L. Tigana. The results from the analysis of these samples taken in November and held in a laboratory are the following: 1) All the millet was destroyed by *Ephestia cautella, Tribolium castaneum,* and *Orysaepphilus surinamemsis.* 2) Cowpea was attacked primarily by *Callosobruchus maculatus.* 3) All millet, sorghum, and maize were infested by *Apergillus* sp.

Farmers expressed interest in using neem extract to protect food stocks in storage.

Research Activity 9. Variety Testing

The palatability trials will be conducted in January along with end-of-year evaluation of on-farm trials.

Research Activity 10. Development of Uganda IPM Activities

IPM CRSP activities were initiated in Uganda, the Africa Region secondary site, November 28 through December 13, 1994, by M. Erbaugh, H. Willson, and S. Kyamanywa. Informational meetings were held with the Ministry of Agriculture, Animal Industries, and Fisheries (MAAIF); Kwanda, Namulonge and Serere Agricultural Research Stations; Director General of the National Agricultural Research Organization; Dean and faculty of the Faculty of Agriculture and Forestry (FAF), Makerere University; USAID; Uganda National Farmers Association, Church of Uganda, and Action Aide. These initial meetings had several objectives: (1) To assess current level of IPM activities in country; (2) To determine focal crops, area, and research collaborators; (3) To determine interest in establishing a Uganda IPM Network; (4) To hold a stakeholder's meeting with those interested in working with the IPM CRSP.

The stakeholder's meeting was held on December 9, at Makerere University. In attendance were 17 people representing all the research stations, MAAIF, FAF, and three NGO representatives. Major outcomes of the meeting were: (1) Strong agreement on the need to organize an IPM coordinating body. The name chosen was Uganda IPM Network; (2) That the IPM CRSP focus initial field activities on priority cereals and legumes in eastern Uganda; (3) That a participatory IPM Workshop and field participatory assessment be held in Uganda in June, 1995, and that the field PA focus on farmers in Kumi and Iganga Districts in eastern Uganda.

Following the stakeholders meeting in Uganda, Erbaugh and Willson stopped for three days in Nairobi, Kenya and met with representatives of the Rockefeller Foundation and the International Centre of Insect Physiology and Ecology (ICIPE) to investigate potential collaboration with the IPM CRSP and IPM activities in general, in Uganda

Between July 6 and August 2, M. Erbaugh and H. Willson, and the Uganda IPM Network conducted a four day Participatory IPM Workshop, and two, five day field participatory assessments. These two activities were supported by the USAID Africa Bureau through the Integrated Pest Management Collaborative Network (ICN).

- A four day workshop was conducted between July 12 and 15 on Participatory Integrated Pest Management for 30 representatives from agricultural research and extension, faculty from Makerere University and representatives of several NGOs. Total attendance at the workshop sessions ranged between 25 -30. The workshop was opened by the Commissioner for Crop Protection, Ministry of Agriculture, Animal Industries, and Fisheries (MAAIF), and the Dean, Faculty of Agriculture and Forestry, Makerere University. Participants were exposed to IPM and Participatory Research rationales and concepts. IPM and PA methods were discussed, demonstrated, and workshop participants provided with an opportunity to use these skills. A field protocol for conduct of the participatory assessment was designed by the group during interactive sessions following presentation and demonstration of concepts and methods. The workshop was closed by Ms. Kisubika, Deputy Executive Secretary of the Uganda National Farmers Association.

- Two research areas, Iganga and Kumi Districts, were selected for the field participatory assessment and future IPM CRSP activities following discussions with Ugandan stakeholders. These two districts were viewed to be representative of the two predominant cereal/legume production systems in eastern Uganda. A decision was made to focus on cereals and legumes based on the recognition that IPM with these crops was still at a early stage of development; and, the desire to link research efforts between the primary IPM CRSP research site in Mali with the Uganda research site.

- The two PA teams conducted a participatory assessment in Iganga and Kumi Districts July 18 - 22. Each team conducted two group PAs and then visited individual farms the following day. Principal methods used were semi-structured group and individual interviews, field observation with farmers, cropping calendars, preferential rankings, matrix rankings, farm mappings, and oral historical accounts.

- For all crops a follow-up program of surveillance and monitoring is advised to better understand seasonal infestations, pest biology, and to educate farmers in understanding the concept of threshold problem identification. Additionally, in Iganga, improved trapping devices and programs may be introduced; in Kumi, information on field history, fallowing and crop rotation may be examined to better understand *striga* and its cultural control. Similar procedures being used in Mali will permit comparisons with the Uganda site.

- A proto-typical collaborative research and delivery system involving researchers, extensionists, and NGOs was demonstrated. Field work activities with farmers were well coordinated by NGO representatives and extension agents. Contact with NGOs and farmers was coordinated by the Uganda IPM Network and its representatives. All participating groups expressed great interest in follow-up activities.

- A synthesis was conducted with both teams at each site following the PAs with the Director of the IPM CRSP. The following describes crops and primary pests that will be addressed in follow-up activities:

Crops	Key Pests Selected for Research Emphasis
Maize (Iganga)	Stalk Borers and Termites
Beans (Iganga)	Aphids and Post-harvests Pests
Groundnuts (Iganga & Kumi)	Aphids and Rosette Disease
Millet (Kumi)	Weeds (Striga & Wild Finger Millet), Borers and Grasshoppers
Sorghum (Kumi)	Striga and Stalk Borers
Cowpeas (Kumi)	Pod & Flower Pest Complex
Multi-Crops (Iganga)	Mole Rat

- Proposals are being requested from collaborating research institutes and extensionists working with local farmers for follow-up activities. Proposals will be submitted to USAID, NARO, and to the IPM CRSP.

VIRGINIA TECH

Literature Review and Secondary Data Analysis and Baseline Data Collection.

Investigator: Revathi Balakrishnan, Virginia Tech

II. COLLABORATING SCIENTISTS

Mali Activity 1:
IER: Alpha Maiga, Amodou Diarra, Makan Fofana, Mme. Sissoko; Montana State: Florence Dunkel; Virginia Tech: Revathi Balakrishnan, John Caldwell, Dan Taylor; Purdue: Rich Edwards

Mali Activity 2:
IER: Alpha Maiga, Amodou Diarra, Makan Fofana, Mme. Sissoko, Youssouf M. Diarra, Soulika Boure; Virginia Tech: Revathi Balakrishnan, John Caldwell, Dan Taylor; Purdue: Rich Edwards

III. SUMMARY OF RESEARCH RESULTS

The review of literature (women-food security-IPM) was completed in part and continues for collating additional materials. The partial bibliography was shared with Mali site members. Participatory appraisal in the third Malian village along with development of inter-disciplinary research questionnaire for base line research were completed. With the assistance of Malian counterparts the following were accomplished: development of sample frame and sample identification for base line research; pretesting of questionnaire and training of field investigators . Field data collection is in progress. Two manuscripts are in progress based on the year one participatory appraisal information. Malian gender research investigator visited Virginia Tech who assisted in developing the manuscript on Malian Women's Role in IPM

IV. OBJECTIVES AND IPM CONSTRAINTS

Mali Activity 1: Literature review and secondary data analysis

Objectives: To document the current IPM related research and related activities, to formulate research hypotheses, and to guide development of questionnaire for base line data collection.

A. Research Objectives for Reporting Period

Objective: Completion of a bibliography on Mali and Sahel related review of literature on women in subsistence farming and/or related to IPM.

B. *IPM Constraints*

- The review of literature indicates that most IPM field research do not document women's role in production as relevant to IPM technology development and adoption.

- In Malian household production system, women play a key role in production in the family fields and also cultivate their individual fields to achieve food security. Thus the crop-pest system for priority crop ignores the field situation where the same pests attack women's crops. An integrated approach to IPM that considers in totality the household crops production-pest system situation and gender roles relevant to these crop culture activities would have sustainable impacts to achieve IPM goals as well as household food security.

Mali Activity 2: Baseline data collection

Objectives: Collection of data to establish a socioeconomic baseline information to assess future project impacts.

A. *Research Objectives for Reporting Period*

- Development of baseline questionnaire
- Completion of baseline study
- Completion Participatory Appraisal in third Malian village

B. *IPM Constraints*

Malian household structure is characterized by complex arrangement of inter-generation roles, responsibilities and allocation of resources. It is essential to unravel (as best one can) the gender roles by age, ethnicity, and structure to share power and resources in these households. It is essential to learn of these intra-household social dynamics to assess the mode and point of intervention to increase the probability of IPM adoption in subsistence production systems.

V. RESEARCH APPROACH AND OUTPUT

A. *Research Methods*

Mali Activity 1: Literature review and secondary data analysis

- Desk review and computer based review of literature.

Mali Activity 2: Baseline data collection

- Development of inter-disciplinary questionnaire to collect baseline data through field survey
- Translation and pretesting of questionnaires
- Training of field investigators
- Developing sample design
- Sample identification
- Field survey
- Application of participatory tools to complete the baseline qualitative assessment in village 3.

B. *Research Results*

Mali Activity 1: Literature review and secondary data analysis

Development of short bibliography by a graduate student. This was distributed to the participants of the May 1995 workshop.

Mali Activity 2: Baseline data collection

Questionnaires

Development of base line questionnaire was completed and translated in March 1995 with inputs from the US and Malian site members. Two questionnaires were developed. One would be to collect information from the chief of the production unit and the second to be administered among the male and female members active in agriculture.

Sample Definition

In Malian social organization of village households there could be multiple wives in a single family. In such a system the gender roles varies by the age and hierarchical social order among the women. The production units are organized under head whose brothers and sons could be the members of the household and participate in the production. The primary female spouse could be the decision maker while the young female spouse could be an active agriculture worker. The final decision was to include the primary wife in the sample but also identify a female spouse who is active in agricultural tasks. The sample size decided was 85 to 100 or greater of each men and women. This sample size could vary relative to the number of women to be interviewed based on the roles of women in the production system. Both men and women selected as respondents should be active in agriculture.

Field Activities

The Malian counterparts completed the pretesting, and training of field investigators. The data collection is in progress.

Village PA

Completion of participatory rural appraisal in the third village namely Dontiaribougou in the Sirakorola region.

Village PA results

1. PA Process

   Women and men's groups were interviewed separately. Twenty three men and twenty six women participated in two separate groups.

2. PA Methods

The following PA methods were used: group discussion, production systems diagrams, preferential matrix and ranking. The information collected were: major agricultural crops cultivated and other income generating activities, major pests and pest management problems, pest control measures used in the order of importance, traditional pest control measures, pest control during storage and use of neem tree products for control.

3. Summary Information from PA

The crops grown by men were millet/cowpea, sorghum/cowpea, fonio, cotton, maize, and peanut. The women identified the following crops: millet, peanut, tomato, and rice.

The men identified blister beetles (cantharide) as a major pest and the major diseases and weeds were *Striga*.. Women indicated blister beetles and birds as the major pests for millet and *Striga* as a major weed. Blister beetles are also a major pest for the okra crops grown by women. As per women problem pests in peanut were birds.

The men indicated a repelling plant called "Wonluntjoloko" as a traditional control measure. It is important to note that women in the Kroma PA (July 1994) also identified this repelling plant as a control measure for pests in their crops. This information on local plant usage (effectiveness and control elements) needs to be explored further with the help of the biological scientists.

From the gender research perspective this PA result indicates that Malian women and men who are active farmers have equivalent knowledge of control measures in the two villages where the social organization is characterized by a relatively less gender segregated division labor in agriculture.

According to the women, neem tree products (leaves, seeds, bark) were not used for either medication or neem seed oil etc. The purpose of the tree is to provide shade.

A need exists to conduct a detailed gender-age differentiated/ women's activity analysis to identify labor constraints at the village level if the IPM interventions are to be effective. The rationale is as follows, a cursory observation of the Neem tree and Karité tree flowering and fruiting cycles indicates that both will come to bear fruit at the same time. The collection of Karité fruits is an important activity of the women with both economic and social implications. This fruit has economic value, since the nuts are the raw material to produce cooking oil that is much in demand both in rural and urban areas. Karité nuts can be sold to buy grains during low stock seasons. In Malian rural households, women's task of Karité fruits collection has important livelihood and food security implications. If the proposed collection and processing neem fruits using women's labor coincides with this Karité collection activity, then there could be labor constraint issues which should be examined. Since women are also involved in preparing indigenous pest control products from other local trees, it is important that household gender role dynamics as related to crop and product processing cycles should be identified.

Gender differentiated pest problem identification matrices indicate that there are a few pests and weeds which are common to crops grown by men and women. Such a crop regime and pests/weed information suggests that Malian farmers will benefit greatly from IPM CRSP efforts with an integrated approach to deal with common pest problems across the crops grown in a mixed subsistence farm production system.

C. Impacts

Malian farmers will benefit greatly from IPM CRSP efforts with an integrated approach to deal with common pest problems across the crops grown (both by men and women) in a mixed subsistence farm production system.

VI. NETWORKING ACTIVITIES

- Conference call with US based scientists to formulate base line study.
- Meeting with US based Mali scientists to formulate interdisciplinary baseline questionnaire in January 1995.
- Travel to Mali to meet with IER social scientists for the research in February - March 1995.
- Reviewed research proposal for external funding from Mme. Sissoko Haoua and Mr. Makan Fofana.

A. Workshops You Helped To Plan and/or Participated In

- Attended IPM CRSP Workplan workshop in May 1995.

B. Research Investigator Exchanges

- Mme. Sissoko's visit to the U.S. to do secondary data analysis and to work on a gender in IPM paper.

C. Research Information and Product Exchange

- Sent the Malian Women -Food Security -IPM bibliography to Malian Colleagues.

VII. PUBLICATIONS AND PRESENTATIONS

Manuscripts in Progress

A. Journal Article

- Gendered Organization of Production and Pest Management Knowledge in Mali. Revathi Balakrishnan, Mme. Sissoko and Adam Russ

B. Books, Book Chapters and Proceedings

- Mali IPM CRSP Participatory Appraisal Report. Lead Editors: Amadou Diarra and Revathi Balakrishnan with Mali Site Members intensively involved in the PA as Co-authors .

C. Abstracts

- Gender Differentiated Constraints in Malian Subsistence Production. Adam Russ - Abstract for presentation in Feminist Research Graduate Seminar at Virginia Tech.

VIII. TRAINING OUTPUT

A US graduate student (Adam Russ) in agricultural economics at MS level is supported.

IX. PROJECT HIGHLIGHTS

- Completed Participatory Appraisal in a Malian village.
- Development of inter-disciplinary research questionnaire for base line research.
- Development of sample frame and sample identification for base line research.
- Completed pretesting of questionnaire and training of field investigators.
- Base line field data collection is in progress.
- Two manuscripts based on the Year 1 participatory appraisal information are in progress.
- Malian gender research investigator visited Virginia Tech.
- The review of literature in completed in part and continues for collating additional materials.
- A US graduate student in agricultural economics at MS level is supported.
- A need exists to conduct a detailed gender-age differentiated/ women's activity analysis to identify labor constraints at the village level if the IPM interventions are to be effective.
- From the gender research perspective this PA result indicates that in Malian villages where the social organization is characterized by a relatively less gender segregated division of labor in agriculture, women and men, as active farmers, have equivalent knowledge of control measures.
- An integrated approach to IPM that considers in totality the household crops production-pest system constraints and gender roles relevant to these crop culture activities would have sustainable impacts to achieve IPM goals as well as household food security.

Assessment of Storage Damage by Pest

Investigator: Herman Warren

II. COLLABORATING SCIENTISTS

Mme. Mariam Diarra and Mr. Lasuana Tigana, IER
Mme Toure and Mme Sissiko, IER; Florence Dunkel, Montana State University

III. SUMMARY OF RESEARCH RESULTS

A PA was conducted in Mali in November 1994 consisting of H. L. Warren and Florence Dunkel. Surveys were conducted for plant diseases on sorghum, millet and cowpeas. Some sorghum field had 40 percent of yield loss due to sorghum downy mildew, and millet field showed 30% loss due to covered smut. Grain for storage obtained from the targeted villages was plated on agar media and analyze for fungi. Several pathogens were identified on millet to include *Fusarium moniliforme* and *Aspergillus flavus*. These fungi may produce toxins which are carcinogens to humans and may cause serious problem in animals.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. Research Objectives For This Reporting Period

- Conduct a PA in three villages in Mali
- Develop methodologies to reduce disease loss through biological interventions

V. RESEARCH APPROACH AND OUTPUT

A. Research Methods

Treat millet grain with hot water at a temperature which will kill the fungi, but not the seed embryo. Precise temperature is needed for each grain. Some research has been conducted in my laboratory at Virginia Tech and a suitable temperature has been found. This needs to be tested under malian conditions. Storage pests (Fungi) were identified on millet and sorghum. Seeds were surface disinfected, blotted dry, plated on potato dextrose agar and incubated at 25° C for 4 to 7 days. Fungi were identified to species.

B. *Research Results*

Surveys of disease in Mali revealed that up to 40% of sorghum and 30% of millet grain loss was to sorghum, downy mildew, and covered smut, respectively. During the PA, it was revealed that losses to these diseases are not uncommon. Six storage rot fungi were isolated from millet. Of the six two have the potentials to produce harmful toxins that affect humans and animals. Three storage rot fungi were isolated from sorghum and one from cowpeas.

C. *Impacts*

Hot water treatment of millet seed used for planting and treatment of sorghum seeds with Ridomil could reduce yield loss and improve nutritional quality of stored grain. Determining the temperature requirements to control covered smut without affecting germination will be useful if the disease becomes a problem in the US where millet is produced.

VI. NETWORKING ACTIVITIES

- Held PA in Mali November 5 to 20, 1994.
- Gave several books, manuals, reprints, and other printed materials to host country counterpart Malian Plant Pathologists.

VIII. TRAINING OUTPUT

IX. PROJECT HIGHLIGHTS

In 1995, IPM CRSP Mali found hot water temperature requirement for eliminating covered smut from millet seeds prior to planting without harmful effect to the embryo.

VIRGINIA TECH AND PURDUE UNIVERSITY

Literature Review and Secondary Data Analysis and Evaluation of Blister Beetle Control Measures.

Investigators: John S. Caldwell, Virginia Tech (Activity 1 and 5 of Mali Workplan); Rich Edwards, Purdue University (Activity 5 of Mali Workplan)

II. COLLABORATING SCIENTISTS

A. Host Country
Mme. Sissoko Haoua Traoré (Activities 1 and 5); Mme. Gambi Kadiatou Touré (Activity 5); Makan Fofana (Activity 5); Amadou Diarra (Activity 5), IER

B. U.S.
Jean-Pierre Amirault, Virginia Tech and Larry Bledsoe, Purdue University

III. SUMMARY OF RESEARCH RESULTS

A. Activity 1

An annotated bibliography was produced in French and English by J.P. Amirault using IPM literature from 76 reports and articles in the 1982-1991 Commission Technique annual reports and other documents obtained by Caldwell from the Sahel Institute Plant Protection Regional Technical Coordinating Unit for Plant Protection.

A report was prepared by Mme. Sissoko Haoua and John Caldwell in French, with an English summary by John Caldwell, on the agricultural calendar based on dates of land preparation, seeding, and weeding from 69 farms with millet, 107 farms with sorghum, and 69 farms with cowpea from 1991 to 1994. In three out of four years, land preparation and seeding started in the first week of July, the first weeding started 13-14 days later, and the second weeding was completed by the start of September. The length of the interval of the mean date of the first weeding was 22-38 days, indicating that farms varied approximately a month in their dates of first weeding. Variation over an interval of 11-26 days was similarly seen for second weeding. These data show an agricultural calendar for millet with a generally stable pattern from year to year, but with considerable variation from farm to farm in dates of weeding. Analysis of weed counts from 1 m^2 samples in 1991 showed that *Striga* was present before the second weeding in 5 of 7 villages. Overall weed counts were greater (107-281 m^{-2}) in the 4 southern villages than in the 3 villages in the other zones (10-46 m^{-2}).

B. Blister Beetle Control Measures

J. Caldwell and R. Edwards worked in Mali May 1-18, 1995 in collaboration with IER scientists Fofana, Mme. Sissoko, and Mme. Gambi to develop a training program for four IER Field Agents supported by the IPM CRSP. Two men and two women were recruited in May 1995 as Field Agents and assigned to the Mourdiah and Sirakorola zones in man-woman pairs to carry out the research program with men and women farmers in the villages in each zone. The training had as its objective to enable these agents to carry out baseline data collection, select collaborators and fields for IPM trials, work with farmers to implement the trials, and carry out IPM monitoring in the trials. Trial themes had been chosen based on the results of the 1994 Participatory Assessment in the villages. To increase farmer understanding of IPM and involve them from the start of the season in initiating the field research program, Caldwell, Edwards, Mme. Sissoko, Bouréma Dembélé (weed science), and Justin Diabaté (entomology) held a farmers' meeting in each of the five villages (Koroma, Oussibibougou, and Dontiéribougou in the Sirakorola area; Koïra and Douabougou in the Mourdiah area) participating in IPM CRSP collaborative research. We met with approximately 60 farmers (of whom 10-12 were women) in the three Sirakorola villages and approximately 45 farmers (of whom 2-3 were women) in the two Mourdiah villages. Edwards provided a brief history of pest control approaches leading up to IPM, pointed out problems with pesticides, explained the process of the development of pest resistance to pesticides, and described in general terms a village-based method of neem extraction. Response by farmers and discussion followed the presentations. Following the village visits, Edwards, Caldwell, and Mme. Gambi Kadiatou Touré developed a detailed monitoring plan for insects and plans for trial implementation. Caldwell and Mme. Sissoko designed and carried out training for the Field Agents in monitoring and participatory research methods. Each agent received a copy of the MARP manual on participatory methods (in French), and each pair received a set of drawings used for matrix ranking in the Mourdiah villages during the July 1994 PA, a camera for photography of insects, and materials for starting an insect collection. Through the introduction of participatory methods for the Field Agents, they will be able to obtain better farmer participation in the planning of the 1996 trials, and develop rapport with farmers and knowledge of the villages needed for formation of Village Advisory Committees representative of different types of farmers and their needs for IPM research.

Analysis of the effects of Azatin EC on two types of millet (souna early millet and sanio main season millet) in five villages showed that the neem extract Azatin EC resulted in a significant increase in yield of both types of millet, with no significant differences in effects between the two types of millet. The average yield, 507 kg ha^{-1}, of three rates of Azatin EC (88, 99, and 110 ml) was 53% higher than the yield of the control without Azatin, 331 kg ha^{-1}. There were no significant differences in effects among the three rates. Blister beetle (*Psalydolytta* spp.) numbers were less at the second and the last sampling dates when Azatin was applied, but the differences were not significant. Yield and a canonical variable for counts of blister beetles and head miners (*Heliocheilus albipunctella*) were negatively correlated (r=-0.25 to -0.43) at all three sampling dates, but the correlations were not significant. While Azatin improved yield in all villages, there were significant differences in the magnitude of the responses. Agronomic and socio-economic follow-up in 1996 will seek to clarify the causes of these differences in relative response.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. *Objectives*

- To summarize the past 15 years of research results in French in Mali and make them more accessible to U.S. scientists.
- To have a better understanding of millet and sorghum production systems for planning field agent training and trial implementation.
- To assess the effectiveness of Azatin EC as a control measure for blister beetles and other insect pests.

B. *IPM Constraints*

Blister beetles were the pest ranked highest in priority for millet/cowpea association by farmers in the 1994 PA.

V. RESEARCH APPROACH AND OUTPUT

A. *Research Methods*

Azatin EC was applied on fields of millet grown by farmers in association with cowpea using their usual practices.

B. *Research Results*

Azatin EC resulted in a significant 53% increase in yield of early and main season millet, enabling farmers to obtain a yield of 507 kg ha^{-1} with Azatin EC, 176 kg ha^{-1} more than the 331 kg ha^{-1} obtained when Azatin EC was not used.

C. *Impacts*

The 53% increase in millet yield obtained in these trials has significant potential to improve village food supplies, especially in drier areas more dependent on millet.

VI. NETWORKING ACTIVITIES

A. *Research Investigator Exchanges*

Mme. Sissoko spent two of her three weeks at Virginia Tech working with Caldwell. This enabled her to strengthen her skills in statistical analysis and interpretation of research results, and meet with other IPM CRSP scientists, as well as other faculty members and students.

B. *Research Information and Product Exchanges*

- Caldwell assisted Mme. Sissoko in obtaining an advanced statistics text and a manual for SAS use.
- Caldwell assisted Diarra in obtaining cameras for the two pairs of field agents.

VII. PUBLICATIONS

Miscellaneous publications

Amirault, J-P., and J.S. Caldwell. 1995. Annotated Bibliography of IPM Literature in Mali. Virginia Tech, Blacksburg, VA (To be published as IPM CRSP Working Paper Series).

VIII. TRAINING OUTPUT

Short-term

Mme. Sissoko Haoua Traoré: Analysis of Crop Production Calendars and Farmer Practices for Millet, Sorghum, and Cowpea in the OHVN Zone

IX. PROJECT HIGHLIGHTS

In 1995, Mali IPM CRSP found that the neem extract Azatin EC resulted in a 53% increase in early and main season millet yields., and a maximum of only 19% of the variation in yield could be explained by variation in a canonical variable for insect counts.

INSTITUTE D'ECONOMIE RURALE (IER)

Preliminary Host Country Report on Socio-Economic, Entomology, and *Striga* Investigations in Mali

Investigators:

Makan FOFANA, Agricultural Economist, IPM CRSP Coordinator, Mali (from September 1995)
Mme Gamby Kadiatou TOURE, Entomologist, IER
Bouréma DEMBELE, Weed-scientist, IER
Mme Sissoko Haoua TRAORE, Agronomist, IER
Amadou DIARRA, Weed scientist, IPM CRSP Coordinator, Mali (until September 1995)

Also collaborating:

Noumoutie DIAKITE, Agronomist, OHVN
Moussa SISSOKO, Entomologist, SNPV
Lassana TIGANA, Entomologist, IER
Djénéba DEMBELE, Field agent, Mourdiah
Housséini MAIGA, Field agent, Mourdiah
Massama NIARE, Agent, SNPV, Mourdiah
Hayna SINGARE, Field agent, Sirakorola
Ibrahim SAMAKE, Field agent, Sirakorola

(English translation by Jean-Pierre Amirault)

INTRODUCTION

Year 2 was the first full season of the IPM CRSP activities in the IPM CRSP Mali site. However, the crop season was not over and data collection not yet complete at the time of writing this report. This document summarizes the preliminary results of the research activities for Year 2. The complete analysis of the available data from Year 2 has yet to be done. Data analyzed include parts of the baseline data, the entomological component, and the results of work in weed science.

OBJECTIVES

- Develop a socio-economic database to establish strategies for carrying out experiments and evaluating the impact of integrated pest management.
- Establish village contact groups in collaboration with thematic researchers prior to experimentation.
- Inform men and women farmers about all potential integrated pest management technologies proposed by researchers prior to on-farm testing.
- Conduct a literature search of Socio-economic data, especially surveys conducted in Mali which are pertinent for the above-mentioned activities.

METHODS

Participatory methods and structured interviews were combined as needed to collect baseline data. The sample villages are those which took part in the initial participatory assessment.

The data collection was based on the following aspects:

- Production data desegregated by gender and data on pest damage and food security of the households.
- Socio-economic constraints to the introduction of maize as a trap crop for blister beetles control.
- Labor use by season, by crop, and by gender in relation to the use of neem seeds for the treatment of millet and sorghum against grasshoppers.
- Use of organic fertilizer to control *Striga* on millet.
- A Socio-economic study of storage.

PRELIMINARY RESULTS

The preliminary results reported here involve data analysis from two surveys:

- Socio-economic study of the use of maize as a trap crop for the control of blister beetles
- Survey of production unit (PU) heads on the structure of the agricultural holdings.

These surveys are mainly descriptions of the Socio-economic and agro-technical context of forming in the study villages.

1. Socio-Economic Study of the Use of Maize as a Trap Crop in the Fight Against Blister Beetles.

The study focused on the agricultural holdings of four villages (Oussibibougou, Koroma, Koira and Douabougou) in the Mourdiah and Sirakorola zones. The information collected covers a wide range of topics such as types of field (common, individual), cultural practices (planting methods, fertilization, use of animal traction and rotations), farmer's production objectives (human food, animal feed, and sale), sources of inputs (market, extension services, and others), the traditional role of maize in pest control, and problems related to the production of maize in the region.

In the Mourdiah region, maize grown on bush fields is not associated with any other crop. In the Sirakorola region, maize is grown after millet, okra, or another maize crop, but in Mourdiah it is grown after millet, okra, tomato, or maize on household fields and after sorghum, okra, or maize on bush fields. Agronomically, the best crops to grow before maize are cotton and legumes. Sorghum, millet and maize are poor choices prior to a maize crop. This indicates that the rotations in effect in both regions are inappropriate.

Animal traction is used on approximately 88% (58 fields out of a total of 66 surveyed) of the fields in Sirakorola and 57% (27 fields out of a total of 51 surveyed) in Mourdiah. As for fertilization of the maize crop, it is extensively practiced in both regions with more than 95% of the PUs using organic or mineral fertilizer.

The supply of inputs continues to be one of the most important problems in agricultural production in the region studied. Overall, across the two zones, only 5% of the producers obtain inputs directly from the market, whereas the others use governmental or non-governmental extension services.

In the typical millet and sorghum-based farming systems, maize fields are normally located around the millet and sorghum fields. This constitutes an advantage, in the regions studied, in the case where maize is used as a trap crop for the control of blister beetles on millet and sorghum. Whether or not maize has been traditionally used as a trap crop for blister beetles control in the area has yet to be confirmed.

2. Survey Of the Production Unit (PU) Heads on the Structure of Agricultural Holdings

The sample size for this study was increased to five villages instead of four as originally envisioned. The Participatory Assessment was conducted in four villages, namely Douabougou and Koira (Mourdiah zone), and Oussibibougou and Koroma (Sirakorola zone). One of the determining criteria in the choice of PUs for the follow-up was the existence of individual fields (men and women managed). In Oussibibougou women do not participate very much in field work. Therefore, another village meeting the fore-mentioned criterion had to be found, resulting in the addition of Dontiéribougou. Data collection in Oussibibougou was, however, maintained in order not to discourage the villagers for further research. The preliminary results presented here were gathered from questionnaire I ["Production Unit (PU) Heads" questionnaire] which dealt with general information about the PUs. This questionnaire was answered by all PU heads in all five villages. The total population of the five sample villages was 2,680 persons distributed among 171 PUs, for an average of 536 inhabitants per village and 16 members per PU.

Entomology:

This preliminary report summarizes the work accomplished under activities selected by the IPM CRSP Project to develop control methods for the principal millet insect pests. A few general results have also been obtained in the inventory and improvement of traditional millet, sorghum, and cowpea storage methods. The Mourdiah and Sirakorola zones are the focus of this project. The results presented here are only preliminary. A complete detailed report, including statistical analysis of the collected data, will be provided at the end of the season in January 1996.

Local neem oil extract

Neem kernel harvest was conducted in the month of June in Sirakorola and Mourdiah. 90 kg of unhulled kernels were harvested in Sirakorola, corresponding to almost 40 kg of hulled kernel. In Mourdiah, 50 kg of unhulled kernels were harvested, corresponding to approximately 20 kg of hulled kernels. The kernels were well stored, protected against excess humidity.

The extraction process took place in Sirakorola and in Mourdiah with good farmer participation. An oil press provided by GRAT (Groupe de Recherche et d'Application Technique [Research and Technical Application Group]), an NGO based in Bamako, was used for this task.

Extraction

10 kg of unhulled kernels yields 0.5 liter of oil in 1 hour.
5 kg of hulled kernels yields 0.75 liter of oil in 30-40 minutes.

The first field treated was in Douabougou with a planting date of June 17, 1995. The variety used was Sanio and the neem oil extract treatment was applied on September 20, 1995. The blister beetles *Psalydolytta* spp. were not present this year in Mourdiah. The blister beetles most abundant on the heads at the time of the treatment were *Mylabris* sp. Other abundant insect species were *Mylabris nubica* and *Decapotoma affinis*. *M. nigriplantis*, *M. afzelia*, and *Pachnoda* sp., as well as aphids of the species *Nezarawrudula*., were also observed. The results of the local neem oil extract are not available yet.

One kg samples from farmers' storage facilities were taken monthly from harvest to exhaustion of stocks. Identification of the principal insects and micro-organisms were done, and damage levels were quantified.

Results

From the samples taken in November and kept in the laboratory, the principal insects observed were *Ephestia cautella* (Walk) and secondary parasitic insects such as *Tribolium castaneum* (Herbst) and *Orysaepphilus surinamensis* (L.) were also observed. Millet was 100% destroyed. Cowpea was 100% attacked by *Callosobruchus maculatus*. All millet, sorghum, and maize grains were infested by *Apergillus* sp.

Samples taken at Douabougou in August and September revealed the dominant presence of *T. castanaeum*, *O. surinamensis*, and *E. cautella*. Only the sorghum from Moussa Dembelé's granary was spared attack. Cowpea was 100% destroyed by bruchids *C. maculatus*.

General comments

Pest pressure, in general, is weak in Mali this year. High *Psalydolytta* sp. reproduction rates were not registered either in Sirakorola or Mourdiah. However, Mourdiah saw an explosion of *R. infuscata* numbers. The low *Psalydolytta* population hindered laboratory tests with the bio-insecticides MVP and M. Trak.

The farmers from both Mourdiah and Sirakorola regions are very interested in the extraction and use of neem as an insecticide and they envision its use in storage as well.

Striga Control in Sorghum and Millet

Investigators: Bourema Dembele, Mme. Sissiko, Makan Fofana, Youssouf M. Diarra, Soulike Boure, Chester Foy, Herman Warren, Brhane Gebrekidan

Weed science activities, under the Mali IPM CRSP project, focus on *Striga*. The search for varietal and agronomic control methods were the subject of on-farm research conducted in the Sirakorola and Mourdiah zone. Two on-farm trials were conducted during the 1994-1995 season. These were:

- Promising *Striga hermonthica* resistant sorghum varieties.
- Integrated control of *Striga* in a millet/cowpea associations.
- A third activity was monitoring, including identification of test plots and sampling in other trials.

The trial to identify a promising *S. hermonthica*-resistant sorghum variety was conducted on 10 farms in two villages located in the Sirakorola zone, Dontiéribouogou and Koroma. Test plots were seeded in the second trimester of July.

The trial on integrated control of *Striga* through a millet/cowpea association was conducted on 20 farms in two villages in the Sirakorola zone (Dontiéribouogou and Koroma) and two villages in the Mourdiah zone (Koira and Douabougou). Test plots were seeded in the second trimester of July.

Both cowpea varieties tested in the millet/cowpea association were resistant to *Striga gesnerioides*. These varieties, IT89 KD 245 and IT89 KD 374, have been introduced to Mali by the International Institute for Tropical Agriculture (IITA).

Progress of the season

The trial program has been carried out according to plan. The trials were initiated later than expected in the work plan due to late rains.

Seeding could not take place before the second trimester in July. This will surely have a bearing on the emergence of *Striga*, as is already the case in the rest of the country. Initial observations lead us to believe that *Striga* pressure will be low, and its flowering period delayed from last year.

Despite the late sowing, as a whole the trials are progressing well. Stand establishment and plant populations are as desired.

Uneven spacing of cowpea relative to the millet rows was observed in some farmer's plots in Mourdiah. The protocol called for 0.75 m between two consecutive rows, but this was not always the case.

Cowpea phyto-sanitary (pesticide) treatment could not be carried out because the equipment required was not purchased in time. The field agents are presently (October) gathering data on the crop and *Striga*. More extensive partial results will be available in December.

In the villages of Douabougou and Koira, in the Mourdiah area, Amadou Diarra and Brhane Gebrekidan visited a total of 11 on-farm trials on *Striga* and blister beetles during the last week of September. The *Striga* control trials, on millet, involve integrations of millet/cowpea intercropping cultural practices combined with organic and mineral fertilizers on local Souna millet and improved Striga resistant IT89KD245 cowpea variety. The area used for each trial on each farm was about $135m^2$. Both on the *Striga* and the blister beetle trials, one plot on each farm was used with each farm considered as a replication for the purposes of data analysis. At the time of the visit, the trials were, in general, well established and managed well and data collection was progressing well. One round of *Striga* count had been completed and the schedule of counting is at 15 day intervals until harvest. As expected, the plots with manure and mineral fertilizers visually seemed to have less *Striga* than the unfertilized plots.

UGANDA

OHIO STATE UNIVERSITY

Development of Uganda IPM Activities.

Investigators: Mark Erbaugh and Harold Willson, OSU

II. COLLABORATING SCIENTISTS

Samuel Kyamanywa, Makerere University

III. SUMMARY OF RESEARCH RESULTS

Stakeholders Meetings

Mark Erbaugh and Harold Willson were in Uganda, November 28, through December 13, 1994 to initiate IPM CRSP activities in Uganda. While in Uganda informational meetings were held with the Ministry of Agriculture, Animal Industries, and Fisheries (MAAIF); Kwanda, Namulonge and Serere Agricultural Research Stations; Director General of the National Agricultural Research Organization; Dean and faculty of the Faculty of Agriculture and Forestry (FAF), Makerere University; USAID; Uganda National Farmers Association, Church of Uganda, and Action Aide. These initial meetings had several objectives: (1) To assess current level of IPM activities in country; (2) To determine focal crops, area, and research collaborators; (3) To determine interest in establishing a Uganda IPM Network; (4) To hold a stakeholder's meeting with those interested in working with the IPM CRSP.

The stakeholder's meeting was held on December 9, at Makerere University. In attendance were 17 people representing all the research stations, MAAIF, FAF, and three NGO representatives. Major outcomes of the meeting were: (1) Strong agreement on the need to organize an IPM coordinating body. The name chosen was Uganda IPM Network; (2) That the IPM CRSP focus its initial activities on priority cereals and legumes in eastern Uganda; (3) That a participatory IPM Workshop and field participatory assessment be held in Uganda in June, 1995, and that the field PA focus on farmers in Kumi and Iganga Districts in eastern Uganda.

Following the stakeholders meeting in Uganda Erbaugh and Willson stopped for three days in Nairobi, Kenya and met with representatives of the Rockefeller Foundation and the International Centre of Insect Physiology and Ecology (ICIPE) to investigate potential collaboration with the IPM CRSP and IPM activities in general, in Uganda

IPM Workshop and Field Participatory Appraisal

Between July 6 and August 2, Erbaugh and Willson and the Uganda IPM Network conducted a four day Participatory IPM Workshop and two, five day field participatory assessments. These two activities were supported by the USAID Africa Bureau through the Integrated Pest Management Consultative Network (ICN). During the workshop Erbaugh conducted sessions on the evolution, methodology, and implementation of participatory assessment along with introductory sessions on the structure and function of the IPM CRSP. Erbaugh also facilitated the session on the design of the field protocol for conduct of the participatory assessment.

Two PA teams were selected to conduct participatory assessments in Iganga and Kumi Districts. Each team was composed of researchers, extensionists, NGO representatives, and an IPM CRSP scientists. Teams conducted two group PAs and then visited individual farms on the following days. Erbaugh participated in the field team that worked in Kumi District. In Kumi District separate group PAs were held with members from the Bukedea Women's Struggle Association and the Uganda National Farmers' Association. Each PA session was well attended and lasted for approximately 5 hours. Erbaugh facilitated evening synthesis sessions with the PA team. On the basis of the fieldwork, priority crops and constraints were designated.

Mali Site Committe Contributions

In late January, Erbaugh joined Mali Site members R. Balakrishnan, D. Taylor, J. Caldwell at Virginia Tech. to plan and prepare socioeconomic baseline instrument and implementation plan. In mid-May, 1995 Erbaugh joined other Site Committee members and host country chair Dr. Diarra in Blacksburg for the technical committee meeting at Virginia Tech. The result of this meeting was the draft Workplan for Year 3 and budget. Erbaugh with major contributions from Dr. Caldwell completed this draft for submission to Technical Committee Chair in July, 1995.

IV. OBJECTIVES AND IPM CONSTRAINTS

Results from the PA

Preliminary results from the PA conducted in Kumi indicate that primary cropping constraints are the result of an agricultural transition. This transition, caused by civil disturbance resulting in severe social dislocation, has disrupted the traditional farming system characterized by reliance on animal traction. Loss of oxen has resulted in labor constraints and reduced cropping acreage. In turn, this has caused a formerly extensive farming system based on long periods of fallowing to revert to more intensive activity, where fields are now kept in production for longer periods of time. Farmers maintain that this has increased the incidence of pest, diseases, and weeds. In the case of striga, farmers were aware of the relationship between continuous field cropping, declining soil fertility, and an increase in *Striga.*

A concurrent breakdown in agricultural support services has also contributed to changing crop priorities and increased incidence of generalized pest problems. For instance, cotton was formerly the most important cash crop; was used to open the rotational sequence; is no longer planted. Cassava, a formerly important food and barter exchange crop, is now being ravaged by cassava mosaic virus. Groundnut and cowpea acreage in the area has increased as a result as have pests associated with these crops. A finding of interest was the calendar spraying of insecticides, particularly on groundnuts and cowpeas. Knowledge

on the safe and effective use of these insecticides was generally not known. Men and boys were responsible for the spraying.

Agricultural support services are now returning to the area and future IPM CRSP field research needs to integrate and complement these efforts. Crop priorities derived from the PA are finger millet, groundnuts, cowpea, and sorghum. Priority constraints associated with these crops are as follows: Aphids and rosette disease with groundnuts; weeds and grasshoppers with millet; *Striga* and stalk borers with sorghum; and pod and flower pest complex with cowpea.

V. RESEARCH APPROACH AND OUTPUT

See sections IV and VI.

VI. NETWORKING ACTIVITIES

- Organized, planned, and implemented the stakeholders meeting in Kampala, Uganda, December, 1994.
- Organized, planned and implemented Participatory IPM Workshop held in Mukono, Uganda, July, 1995.
- Assisted in the organization of the Uganda IPM Network a broad based association of researchers, extensionists, and NGO committed to the exchange of ideas and results pertaining to IPM in Uganda and the region.
- Met with representatives of USAID Kampala in December, 1994 and July, 1995, regarding opportunities for additional funding for IPM CRSP activities in Uganda.
- Met with members of the Investing in Developing Export Agriculture project team July, 1995, regarding opportunities for cooperative activities.
- Met with Dr. John Lynam, Rockefeller Foundation Representative in Nairobi, Kenya, December, 1994.
- Met with Dr. William Overholt research scientist at ICIPE, Nairobi, Kenya, December, 1994.
- Received funding support from USAID Africa Bureau IPM Collaborative Network for workshop and field PA exercise in Uganda, July, 1995.
- Manual of instructional materials created for the Participatory IPM Workshop.
- Pamphlet created laying out the steps for conducting an IPM field participatory assessment. Manual distributed to participating scientist from research stations, and extensionists from MAAIF.

VII. PUBLICATIONS AND PRESENTATIONS

Participatory Appraisal: Iganga and Kumi Districts, Uganda - IPM CRSP Working Paper 95-6

VIII. TRAINING OUTPUT

Conducted PA training for twenty Ugandan IPM stakeholders.

IX. PROJECT HIGHLIGHTS

- A synthesis was conducted with both teams at each site following the PAs with the Director of the IPM CRSP. The following describes crops and primary pests that will be addressed in follow-up activities:

Crops	Key Pests Selected for Research Emphasis
Maize (Iganga)	Stalk Borers and Termites
Beans (Iganga)	Aphids and Post-harvests Pests
Groundnuts (Iganga & Kumi)	Aphids and Rosette Disease
Millet (Kumi)	Weeds (Striga & Wild Finger Millet) and Grasshoppers
Sorghum (Kumi)	Striga and Stalk Borers
Cowpeas (Kumi)	Pod & Flower Pest Complex
Multi-Crops (Iganga)	Mole Rat

Development of Uganda IPM Research Program

Investigator: Harold R. Willson, OSU

II. COLLABORATING SCIENTISTS

Mark Erbaugh, OSU; Sam Kymanywa, Makerere University

III. SUMMARY OF RESEARCH RESULTS

The Ugandan IPM project was initited in December, 1994 with a series on stakeholder meetings with Ugandan government and NGO institutions responsible for research and extension programs in pest management. The initial outcome of the meetings established the Uganda IPM Network which would coordinate planning activities of cooperative IPM activities.

In the summer of 1995, a workshop on participatory IPM was conducted at Mukono in which representatives of the Uganda IPM Network participated. Following the workshop, participatory assessments were conducted in the Uganda districts of Iganga and Kumi to demonstrate the participatory process of identifying IPM research priorities.

Potential research activities have been identified which will include the cooperative efforts of university researchers, government research and extension personnel, and farmer groups if continued IPM program support is identified.

IV. OBJECTIVES AND IPM CONSTRAINTS

- To conduct meetings with potential Ugandan stakeholders on the subject of participatory integrated pest management research and initiate organization of an Ugandan IPM network.

- To conduct a workshop on participatory IPM and conduct participatory assessments of pest management in two districts of Uganda to demonstrate the participatory approach in identifying appropriate IPM research priorities.

V. RESEARCH APPROACH AND OUTPUT

In the 1995-96 fiscal year, two tours to Uganda were undertaken by the OSU IPM CRSP co-PIs (M. Erbaugh & H. Willson). The first tour was taken from November 28 to December 13, 1994; the second was taken in July of 1995.

During the first tour, meetings were held with potential stakeholders representing Makerere University (MU), National Agricultural Research Organization (NARO) administration and research stations, Ministry of Agriculture crop protection division, and NGO groups including the Church of Uganda and the Uganda National Farmers Association. The tour was concluded with a meeting of representatives of the groups visited and an IPM advisory group was formed which initiated plans for cooperative programming of IPM research activities.

During the second tour, a four day workshop on participatory IPM was conducted in which representatives of the Uganda IPM network and grower representatives of farm organizations of two districts participated. Following the workshop participatory assessments (PA) were conducted in two Ugandan districts, namely Iganga and Kumi. The Iganga PA was conducted by H. Willson (OSU), S. Kymanywa (MU), T. Kalule (NARO, Namulonge Sta.), and local Extension and farmer organization leaders. The Kumi PA was conducted by M. Erbaugh (OSU), A. Ekwamu (MU), G. Epieru and P. Takan (NARO, Serere Sta.), and local Extension and farmer organization leaders.

In each district PA, a common format of focus group meetings and farm visits were conducted to determine crop production constraints and identify potential pest management research priorities. In the case of Iganga District, in which corn and beans were the primary crops, vertebrate pests, stalk borers and termites were identified as the key pest problems of maize, and vertebrate pests, a complex of insect pests and storage pests were identified as production constraints. Among the secondary crops of Iganga, groundnut production was identified as a key crop for pest management research since the control of aphids causing rosette disease represented a primary use of pesticides by farmers. The pest management research needs on groundnut also represents a common link to the pest problems identified in the PA conducted in Kumi district, where groundnuts, millet and cowpeas were the key crops.

Given the remote proximity of the district PA sites to Ugandan centers of research and uncertainty of continued funding for IPM research in Uganda via the IPM CRSP program, implementation of socioeconomic and biomonitoring studies using local Extension personnel to validate information derived from the PA process has been proposed to set the stage for future on-farm research trials. IPM research projects currently underway at NARO stations and MU were identified for extension into the districts if support for

implementing cooperative projects with district personnel develops. However, before such research trials are implemented at district level, the feasibility and logistics of implementing on-farm IPM studies (such as biomonitoring and agronomic field practices documentation) should be initially demonstrated.

VI. NETWORKING ACTIVITIES

To date, the major networking achievement of the project has been the organization of the Uganda IPM Network. Potential cooperation with researchers of ICIPE (conducting biological control research on stalk borers) and IRRI researchers (conducting research on banana pest management in Uganda) has been identified.

VII. PUBLICATIONS AND PRESENTATIONS

Detailed trip reports were prepared on each tour. Presentation of results of the program in other formats has not occurred to date but is anticipated.

VIII. TRAINING OUTPUT

The major training component of the project to date has been the delivery of the workshop on participatory IPM in Uganda.

IX. PROJECT HIGHLIGHTS

- Stakeholder meetings in participatory IPM were conducted in December, 1994.
- The Uganda IPM Network was established to facilitate IPM communications among IPM stakeholders.
- Workshop on participatory IPM conducted at Mukono in July, 1995.
- Participatory assessments conducted in Iganga and Kumi districts to identify IPM research priorities.

Other IPM CRSP Activities in Africa

Brhane Gebrekidan, Program Director, IPM CRSP

During Year 2, the IPM CRSP initiated and has implemented, or is in the process of implementing, a number of other activities in Africa in addition to those described under the Mali and the Uganda sections of this Annual Report. The four major activities were InterCRSP NRM in Niger, West Africa InterCRSP NRM Initiative, ICN for Africa, and IPM Training in Eritrea.

1. InterCRSP NRM in Niger

The IPM CRSP participated in the interCRSP planning discussions in May 1995, in Niger, in which the USAID Niger Mission funded three CRSPs (INTSORMIL, TropSoils, and Peanut) to implement a Natural Resources Management (NRM) InterCRSP in Niger. Using the three CRSPs interCRSP as a starting point, we discussed with the USAID Niger Mission the concept of a broader and regional NRM InterCRSP in West Africa. The USAID Niger Mission indicated interest to provide funds for bridging the linkage between the Niger based interCRSP to a West Africa interCRSP regional program.

Six West African countries with the involvement of at least six of the current CRSPs were envisaged to take part in the regional interCRSP initiative. A draft Scope of Work, for linking the current Niger interCRSPing with the regional initiative, was developed in consultation with the USAID Niger Mission.

Subsequently, the Mission gave a grant to the Lead CRSP of this initiative, the IPM CRSP/Virginia Tech, for two specific activities: a) to assemble and field a seven person team to West Africa to make a Strategic Assessment of NRM issues in the region; b) to organize and implement a regional workshop entitled "Technology Development and Transfer to Improve Natural Resource Management: Planning Collaborative Activities for West Africa".

Both of these activities were completed successfully during the year. The Strategic Assessment InterCRSP Team traveled to Niger, Mali, and Burkina Faso July 8-22, 1995 under the leadership of the IPM CRSP and submitted a comprehensive report entitled "Report of the InterCRSP NRM West Africa Strategy Assessment Team". The report is available with the IPM CRSP Management Entity, both in English and French.

The team concluded that, at each national level where multiple CRSPs are present, an interCRSP committee should be formed and a lead CRSP should be designated to serve as facilitator for the national interCRSP coordination. Also, a West Africa Regional InterCRSP Committee should also be formed and should be composed of all the National InterCRSP Coordinators, the Regional Coordinator from the Institut du Sahel (INSAH), and a representative of the IPM CRSP (as the Lead CRSP). The Lead CRSP should report to the CRSP Council and establish linkages with all the participating CRSPs, INSAH, and the West Africa Regional InterCRSP Committee. The team recommended that INSAH be the regional focal point for the regional coordination activities. The regional coordinator shall be responsible for effective and working linkages among the national interCRSP committees, as well as maintaining effective linkage with the CRSP Council and the Lead CRSP.

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Referring to the West Africa Regional NRM Workshop, it was held from September 18-22, 1995 in Niamey, Niger. There were over 70 participants representing NARSs of West African countries, all eight CRSPs, USAID, IARCs, and NGOs. The workshop had paper presentations, panel discussions, working group discussions, and plenary sessions. The proceedings of the workshop will be published by the IPM CRSP.

Some of the main recommendations and conclusions, which are relevant to the continuation of the future planning and activities of the InterCRSP NRM West Africa initiative under the leadership of the IPM CRSP, are:

- It was agreed that INSAH be the West Africa Regional Coordinating Center.
- INSAH should identify and appoint the regional coordinator and also form the regional InterCRSP Committee.
- With the assistance of the regional coordinator, the CRSPs operating in a country should form a National InterCRSP Committee and select a national coordinator.
- INSAH should facilitate the participation in the InterCRSP NRM regional activities of NARSs where there is no CRSP presence.
- It was generally agreed that the watershed management model is appropriate for NRM technology development and demonstration, however, it was also emphasized that it should be modified to suit local situations and to accommodate socio-economic issues appropriate for each location.

The IPM CRSP is to continue to serve as the Lead CRSP to implement this regional InterCRSP initiative.

2. West Africa InterCRSP NRM Initiative

In March 1995, the CRSP Council designated the IPM CRSP to be the Lead CRSP for interCRSP activities in West Africa. After this designation, the Africa Bureau of USAID indicated to the CRSP Council that it was interested in receiving a proposal for an interCRSP effort in NRM in West Africa. Consequently, the IPM CRSP, in collaboration with five other CRSPs with interest and on-going programs in West Africa, prepared a Project Proposal for NRM InterCRSP in West Africa and submitted it to the Africa Bureau on behalf of the CRSP Council. The proposal was approved to a level of $1.6 million for three years and the first year of the initiative has just started. The goal of the NRM InterCRSP in West Africa is to reduce natural resource degradation, improve soil, water, nutrient, crop and forest resources, reduce crop losses due to pests, and increase farm income to improve the quality of life for all the people of the region. This is to be achieved through mobilizing the available expertise, of the CRSPs and NARSs, and build on current knowledge and technology, existing capacity, and mandates of the CRSPS presently working in West Africa. The IPM CRSP is to lead the overall activities of the InterCRSP towards this goal. This InterCRSP initiative is planned to cover the Sahelian countries under the mandate of INSAH with the additional involvement of some non-INSAH coastal countries of the region. All eight of the currently functioning CRSPs have now expressed interest to participate in this initiative. As part of the planned regional NRM activities, IPM will be an important component.

3. ICN for Africa

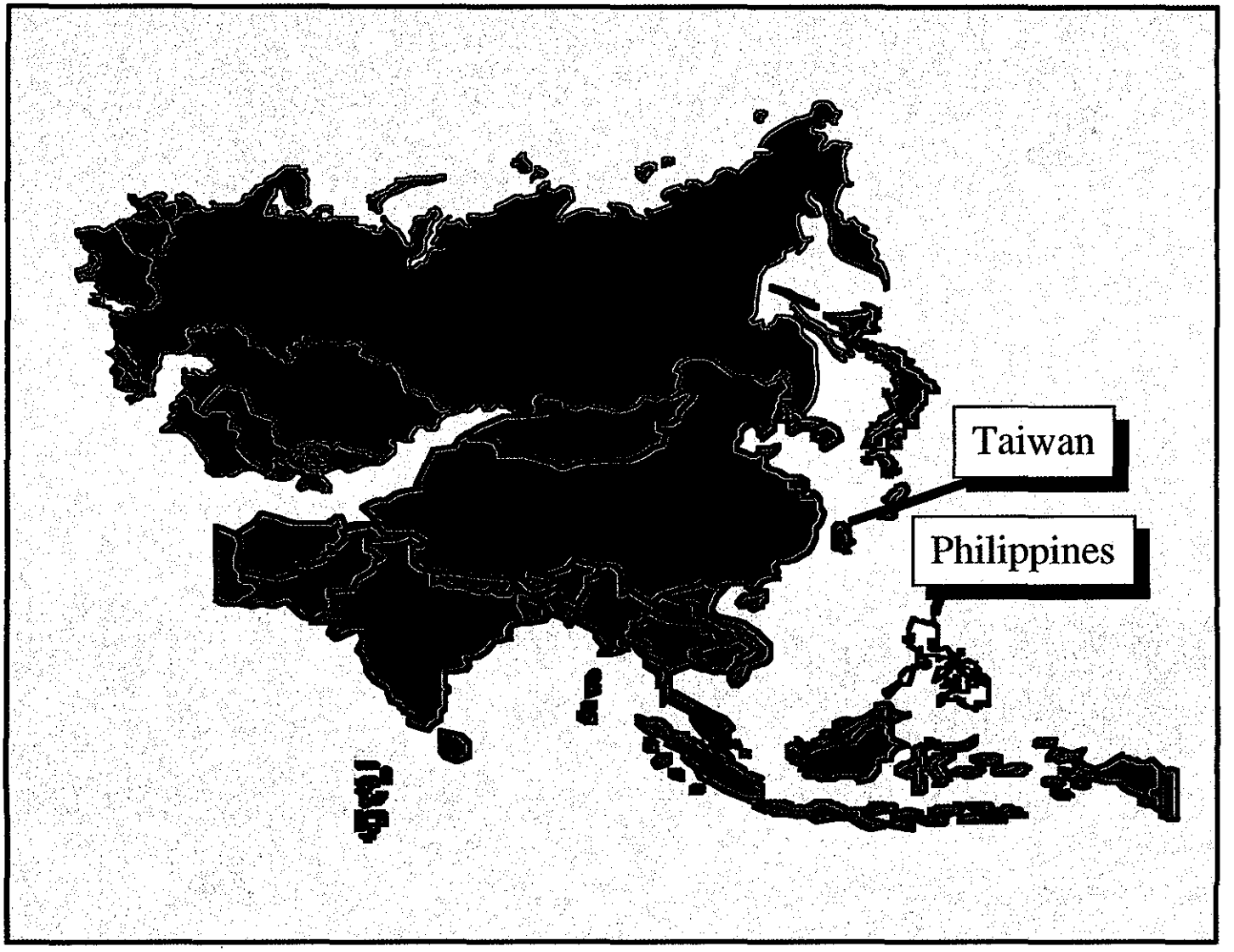
Another initiative of the IPM CRSP in Year 2 is the IPM Consultative Network (ICN) for Africa. This initiative is also funded by the Africa Bureau of USAID through a two year grant of $100,000 to the IPM CRSP/Virginia Tech. The overall objectives of the ICN are to provide IPM related advisory services to USAID and host countries, to disseminate knowledge on IPM to African decision makers, to facilitate the institutionalization of IPM in Africa, and to serve as a center of knowledge on IPM in Africa. The activities of the ICN in Uganda have been covered earlier in this Annual Report. An IPM CRSP Working Paper (95-6), entitled "Participatory Appraisal, Iganga and Kumi Districts, Uganda" by Erbaugh, Willson, and Kyamanywa, has been published and distributed.

The ICN Coordinator (Brhane Gebrekidan) and the Africa Region Site Chair (Mark Erbaugh) visited Uganda in July 1995 as part of the ICN implementation efforts. We discussed IPM with the USAID Mission and other stakeholders. Our discussions focused on the activities of both the ICN and the IPM CRSP. We explored, with Mission staff, the opportunities for USAID/Uganda support for carrying forward the ICN and the IPM CRSP activities initiated in Uganda. They expressed general support for the continuation of the activities and suggested that we follow-up details with other USAID supported activities, such as the IDEA (Investment in Developing Export Agriculture) Project, which we did. The IDEA Project encouraged us to submit a proposal to them for their possible support. A draft concept paper for such a proposal has been prepared for discussions and is awaiting further actions and developments.

4. IPM Training in Eritrea

During the year, the IPM CRSP received Field Support funds ($300,000) from USAID/Global Bureau and the USAID/Eritrea Mission for the purpose of organizing and implementing IPM training for crop protection workers and lead farmers of Eritrea. Among the major subjects that will be covered in the training are Entomology, Pathology, Rodents, Birds, Weeds, and IPM. The planned IPM/Crop Protection training program, to be collaboratively implemented by the Eritrean Ministry of Agriculture and the IPM CRSP, will focus on the major Eritrean crop pests. It has been agreed that there will be three training sessions to be completed in 1996. Sessions 1, 2, and 3 will be for Plant Protection Research Extension Staff, Agricultural Development Agents, and Lead Farmers, respectively. Each training session will last from 15 to 30 days and a total of about 300 Eritreans are planned to be trained. All the training will be conducted in strategically selected places in Eritrea and are planned to begin mid-March 1996 and should be completed by the end of the year.

ASIA



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ASIA REGION ANNUAL REPORT

George Norton, Site Chair; Virginia Tech
Ed Rajotte, Vice Chair; Pennsylvania State University
Victor Gapud, Host Country Site Coordinator

I. PROGRAM DESCRIPTION

IPM activities in the Philippines site for the past year included a balance of topics aimed at (a) achieving quick impacts through surveillance and other simple IPM techniques that will lead to reduced pesticide use, (b) developing technologies to solve pest problems of local, regional, and global significance through innovative research, and (c) undertaking a series of socio-economic research efforts aimed at identifying factors influencing pesticide use and IPM adoption and at evaluating economic, social, and gender impacts of pest management alternatives. The work was completed as a collaborative effort among scientists at the Philippine Rice Research Institute, the University of the Philippines-Los Baños, the International Rice Research Institute, the Asian Vegetable Research and Development Center, Penn State University, and Virginia Tech. In year three, The Ohio State University will become involved as well.

Research efforts are planned in the Philippines through a series of steps. The year two workplan was based on a prioritization of pests, crops, and constraints that was developed through both a participatory appraisal process and a structured baseline survey. During year two, planning for collaborative research efforts in year three took place through (a) discussions among U.S. and Philippine scientists at planning meetings in the Philippines, (b) joint host-country/U.S. scientists two-page proposals, (c) a workshop at Virginia Tech among U.S. and host-country scientists to integrate the two-page proposals into an overall plan and budget, and (d) revisions to the plan following review by the scientists, the M.E. and USAID.

Field research is located in six villages in San Jose, Nueva Ecija, about a 15-20 minute drive from PhilRice. The host country site coordinator oversees the field research activities. U.S., UPLB, IRRI, and AVRDC scientists periodically visit the sites to work with PhilRice scientists on particular research topics. Laboratory and field research is also conducted at AVRDC in Taiwan and student training is taking place at Virginia Tech, UPLB, and AVRDC.

II. IPM CONSTRAINTS RESEARCHED

A. *Key constraints*

The key constraints to IPM in the country and region that were addressed during the past year were (1) lack of specific knowledge of the severity of particular pest problems, (2) absence of specific IPM solutions for specific pest problems, (3) lack of knowledge about carry-over of pests across the rice and vegetable systems, and (4) absence of knowledge about policies, socio-cultural beliefs and perceptions, regulations, and other factors influencing pest management practices.

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B. *Research Objectives*

The Year 2 workplan contained 13 research activities aimed at addressing these constraints. Details of progress and results under each activity are presented in the quarterly reports, but a brief summary is provided here:

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

The 1994 wet season rice crop monitoring of pests was conducted on fields of eight cooperating farmers. All farmers used IR64 and transplanted at 28 days. Average farm size was 1.5 hectares. Seven of the eight farmers used a herbicide, usually Butachlor, to control weeds, applying it five days after transplanting. All farmers sprayed insecticides one to three times, with many of the applications occurring at the early vegetative stage.

Each field was monitored at the soft dough stage for incidence of insect pests, weeds and diseases and associated damage, as well as their natural enemies. Insect pest populations were very low with negligible crop damage. Among the natural enemies, *Micraspis discolor* (Coccinellidae) was the most common. Other predators observed at low numbers were *Conocephalus longipennis* (Tettigoniidae), *Cyrthorhinus lividipennis* (Miridae), *Agriocnemis* spp. (Coenagrionidae) and *Pardosa pseudoannulata* (Lycosidae).

The composition and dominance of weed species differed between Abar 1st and Sto. Tomas. The four most common weeds in Sto. Tomas were a broadleaf species, *Ludwigia perennis*, two grasses, *Echinocloa glabrescens*, *Ischaemum rugosum* and a sedge, *Cyperus rotundus*. Common weeds in Abar 1st were three broadleaf species, *Ludwigia perennis*, *Ludwigia octovalvis*, *Eclipta prostata* and a grass, *Oryza sativa* (red rice). The most common rice pests of all types are summarized in Table 1*.

Two 10 m^2 yield crop cut samples were harvested from each farmer cooperator's field. Harvested samples were threshed, winnowed, sun dried, weighed, and adjusted to 14% grain moisture. The average yield was 5.0 T/ha.

Most of the farmers grew onion as their main second crop, followed by eggplant, string beans, and garlic. During the 1995 dry season which ended March/April, we gathered data on the major and minor insect pests, diseases, weeds, and their natural enemies (Table 1). Farmers continued to view Thrips tabaci as the most important insect pest of onions. In addition, a leafminer, *Liriomyza* sp., was observed on export onion varieties (particularly yellow granex) in Palestina. The same leafminer was encountered in heavily sprayed string bean fields in Sto. Tomas, together with an associated larval hymenopterous parasitoid which seemed capable of regulating the leafminer population but apparently had not been able to because of the insecticide applications. Data for parasitoid-leafminer numbers are still being analyzed. It is very possible that this parasitoid is sufficient control for *Liriomyza* if spraying frequency is reduced.

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* **NOTE:** All Table numbers in this report refer to Tables included in Vic Gapud's (Country Coordinator) report, pages 231 to 255.

The presence of root-knot nematodes significantly changed our view of the pest situation on onions in the San Jose area. We believe that nematodes pose a serious threat to onion production not only in this area but in many onion-growing areas of the country. Dr. J.S. Prot (IRRI visiting nematologist) shared the opinion that the expansion of upland conditions and inappropriate cultural practices, including cropping patterns, will promote their spread. Being able to remain dormant within rice roots under paddy condition, they are easily activated upon conversion to upland conditions. And onions are highly susceptible to their attack. Preliminary qualitative data on their damage are shown in Table 6 and 7. A special sub-activity will focus on the development of nematode management in year three. Nematode damage, misperceived by farmers as insect damage, probably has caused insecticide applications for the wrong pest in many onion fields.

Crop production practices (Table 2), pesticide use (Table 3), and fertilizer use on onion yields (Table 4) were summarized at the end of the dry season. The local "Tanduyong" variety was the most commonly used at an average seeding rate of 329 Kg/ha in Sto. Tomas and 37 Kg/ha in Abar 1st (Table 2). It is usually transplanted at about 31 days after seeding (DAS) by dibbling on mulched unplowed moist soil. It produces two to four small red bulbs per plant and matures in 16 weeks after seeding. The variety can be stored for about six months or more. Other vegetable crops grown in the site are eggplant, tomato, bitter gourd, hot pepper, and string beans.

Farmers sprayed insecticides three to four times (Table 3). Most commonly used were methylparathion and cypermethrin at average rates of 0.72 and 0.025 kg ai/ha respectively. They spray insecticides both in application and on the presence of insect infestation or disease infection. Most farmers timed their insecticide sprayings during the early and late bulbing growth stage which may coincide with the presence of thrips, as they claimed it to be their main pest problem. Among the herbicides, glyphosate was the most commonly used (Table 3). It is a systemic non-selective herbicide usually applied three to ten days before planting to control Cyperus spp. Others used a combination of Oxadiazon and Fluazifop-butyl as early post emergent herbicide.

All farmers used fertilizers (Table 4). Most farmers in Sto. Tomas usually applied fertilizer once at the rates of 83 Kg Nitrogen (N), 20 Kg Phosphorus (P), and Potassium (K) per ha. On the other hand, farmers in Abar 1st applied higher rates of N fertilizer. The average rate used was 185 Kg N/ha usually applied two times. Most of them used basal fertilizer.

Farmers claimed that thrips is the primary pest responsible for reducing onion yields. We monitored thrips populations at early and late bulbing growth stages on eight insecticide treated farmers' fields. Preliminary counts showed that the population of thrips was quite low at five weeks after transplanting (WAT) (Table 5a). The number of thrips per bulb at eight WAT tended to increase more in farmers' fields in Sto. Tomas than Abar 1st. In the case of Milagros Salazar (Sto. Tomas), who planted onion at different planting dates, the thrips populations tended to increase with delayed planting dates. One possible way of reducing the damage caused by thrips is to alter the time of planting onion. Spodoptera litura was also observed on native onion but the damage was negligible.

Based on relative density (Table 9), the three most common weeds in onion fields were *Cyperus rotundus, Oryza sativa* (carry-over of previous rice crop), and *Cleome viscosa* in Sto. Tomas, while *Cleome viscosa, Phyllanthus amarus*, and *Cyperus rotundus* were the most common in Abar 1st, in that order of importance. The data

are still being analyzed in relation to weeding practices. The weed composition and relative dominance clearly differ between the two sites for both rice and onion crops. Factors that influence these differences will be studied.

2. Determine the potential for use of NPV and *Bt* for *Spodoptera* control in onions and string beans.

Rather than focusing on NPV and *Bt*, a decision was made by Dr. Talekar at AVRDC to obtain castor seeds from India and work on the protocol for the minimum time to plant ahead of onions. Talekar is working with Vic Gapud to import *Apanteles Africanus*, a braconid parasite on castor, into the Philippines so it can be used as a parasite for *Spodoptera*. He is also working on identifying onion ascensions with high levels of resistance to *Spodoptera*..

3. Development of measuring methods for *Maruca* pod borer and eggplant fruit and short borer.

Mr. Raul Suiza, UPLB graduate student, went to work with Talekar on this topic which is still ongoing. PhilRice also tested a sex pheromone of eggplant fruit and shoot borer. A two-component sex pheromone of this insect had been identified but never developed for field use. The purpose of the experiment was to find out which of the 27 different combinations attracted more moths.

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

Diseases noticed on eggplant after rice were bacterial wilt, powdery mildew, and leaf rust. Bacterial wilt was quite damaging in several fields. Root knot nematode galls were found on onion and the species needs to be identified. Nematode biology is such that it is killed in flooded fields in the soil zone but survives in rice roots. Once the fields are dried out the juveniles can attack new roots. The practice of direct seeding rice favors population increase as the rice fields are less flooded. Also, declining water availability in the Central Luzon favors the nematode which is then left to attack the onions. We will test various solutions, including long-term rotations, to lessen the nematode problem beginning on year three of the project.

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

Mulched onion fields were sampled for incidence of pathogens and inoculum carried in rice straw mulch.

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

Microbial organisms are being isolated from the study site and the target diseases will be bacterial wilt on eggplant and bulb rot on onion.

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

Weed species identified in Activity 1 are being studied to determine the effects on them of cropping pattern, use of mulch, and land forms in the fields. No results to report yet.

8. **Determination of the influence of weed population on insects, diseases, and natural enemies in the rice-vegetable system.**

Activity underway but no results to report.

9. **Document and extend the farmer baseline survey.**

The results of our baseline survey of 300 farmers in six villages in our San Jose site were summarized, analyzed, and presented as IPM CRSP Working Paper No. 2 (Lazaro, et. al., 1995). The baseline survey obtained information on farmer perceptions of pests and natural enemies and identified current pest management practices. Farmers' knowledge of pests and natural enemies, particularly in vegetables, was found to be limited. Pesticides were virtually the only pest control tactics used in vegetables and farmers considered pesticides to be effective at controlling pests. Farmers perceived that early spraying was necessary and would increase yields.

A follow-up baseline survey of 228 of the original 300 farmers was completed in March-April 1995 to gather information on socio-economic and other characteristics affecting pesticide and pest management practices (Tjornhom, et. al., 1995). Farmers in the San Jose area have a relatively high level of education which should help them respond to IPM training. Most are male, many own their own farms, and almost half belong to an organization such as a cooperative or village association. Over seventy percent received credit (from a variety of sources), and almost seventy percent had been exposed to IPM through a Farmer Field School on rice or through an agricultural technician.

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

This activity has four components. The first component is a statistical analysis of the baseline survey data to assess factors influencing pesticide misuse on vegetables. A logic analysis of factors affecting pesticide misuse was completed during year two. Among the factors particularly influential in increasing misuse were contacts by chemical company representatives, membership in farm organizations, visits by an agricultural technician, and use of credit. Education, access to a Farm Field School, age of farmer, and perceptions that killing natural enemies increases pest infestations all reduce the likelihood of misuse. Details of the misuse analysis are found in the masters thesis by Tjornhom, 1995. A draft manuscript has been prepared that summarizes the study.

The second component is to document household decision-making and socio-cultural beliefs and perceptions that influence pest management. A participatory appraisal (PA) of women farmers in San Jose was conducted in April as a follow-up to the July 1994 PA (see third quarter progress report for details). The results found division of labor by gender for the various agricultural tasks. Power-intensive tasks such as land preparation and threshing are completed by men while tasks that require manual dexterity and managing money are primarily completed by women. For example, women transplant, weed, sort onions, harvest, grade onions, market onions, and manage the household budget. Men generally do the pesticide spraying but women can identify the symptoms of certain pests. Most women are aware of the prevalent pests in rice and onions and are aware of some of the harmful effects of pesticide misuse. They support adoption of alternative methods of pest control in onions as a

means of reducing production costs, but are not knowledgeable about IPM in vegetables. Women's participation increases with cropping intensity, and onions are very labor intensive. For poor and landless women, planting, weeding, and harvesting are important sources of income.

A third component under this activity is to evaluate the net effects of pricing, exchange rate, and credit policies on the degree of pesticide subsidy or tax. The analysis, completed as part of the masters thesis by Tjornhom, found that the net effects of tariffs, which tax pesticides in the Philippines, and the over-valued exchange rates, which subsidize pesticides, was to subsidize pesticides six to eight percent. From an economic standpoint this net subsidy provided economic gains to producers and consumers. However, environmental and health externalities associated with the pesticides undoubtedly increased as well due to the additional incentives for pesticide use. Six to eight percent is a relatively small subsidy, however, and should not prohibit adoption of non-chemical IPM practices. The Philippines Crop Insurance Corporation provided information on role of crop insurance and its relationship to Land Bank requirements for pesticide use. Data from the second baseline survey were also used to assess the importance of Land Bank policies in influencing to adopt IPM. Only about one-fourth of the farmers receive Land Bank credit, (mostly through their cooperative) but other sources of credit also encourage pesticide use as a means of reducing production risk.

A fourth component under this activity involved development of a cost function model that will allow for analysis of pesticide regulations on farm productivity and pesticide demand. Under the leadership of Prabhu Pingali, the first of three surveys of 75 farmers was conducted to gather the necessary data for the analysis. Farmers will be surveyed again after their 1995 rice crop and after their 1996 vegetable crop (see third quarter progress report for a copy of the survey form).

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

A scientist survey form was developed for use in projecting economic impacts of the IPM alternatives being developed on the CRSP. This form will be administered in the coming year.

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

No results to report.

13. Performance testing of near-isogenic lines, pyramids, and multi-lines for resistance to bacterial leaf blight of rice.

Generally, there was a very low incidence of bacterial leaf blight during the 1995 dry season. To date, 21 isolates have been collected in the San Jose area. These leaf samples were collected from IR64. Initial DNA typing indicates that the isolates collected from San Jose belong to only one haplotype (A-1). This haplotype belongs to race 3 (PXO79). Preliminary data obtained from field experiments using clipping methods of inoculation on newly released PSB varieties also indicates that the varieties are resistant to the nine representative BLB races including race 3.

A NIL containing both Xa-21 and xa-5 has been crossed with three popular Philippine varieties during this period. F_1 derived from the crosses will be back-crossed to the three popular varieties this coming season. Molecular markers will be used to identify the line containing the highest amount of recurrent parent genotype and in selecting the lines containing both bacterial leaf blight resistance genes.

C. *Benefits of the Research*

The major surveillance activity undertaken during the year helped us ensure that we understood the key problems we are dealing with in the site. The identified pests are of importance not just in San Jose, but elsewhere in the Philippines, the region, and in some cases in other regions of the world. Success in solving the eggplant fruit and shoot borer problem, for example, may help solve a problem endemic across several countries. Even the measurement techniques being developed, such as those developed for identifying pesticide misuse or for assessing impacts of pesticide policies are applicable in other countries, including the United States.

Eventually some of the yellow granex onion production in the Philippines may have a market in the United States during the off-season. It is imperative that the crop meet the high residue standards of the U.S. market.

III. INSTITUTION BUILDING

A. *Equipment, Vehicles, and Other Support*

During the year, a computer was purchased for the IPM CRSP at PhilRice, funds were provided for long-term rental of a vehicle for the IPM CRSP at PhilRice and numerous books and articles were sent from the U.S. collaborators. More than 50% of the total Philippine site budget was provided to PhilRice and other collaborating institutions in the Philippines.

B. *Scientist Travel*

Several trips were made by U.S. scientists to the Philippines during year two and a smaller number of trips made by Philippine scientists to the U.S. Revathi Balakrishnan visited PhilRice the last week in September, 1994 to discuss gender research. She also visited IRRI and interCRSPed with SANREM scientists. Jim Litsinger traveled from January 8-22 and reviewed progress on each research activity with the Philippine scientists and with scientists at IRRI. He met with Rodger Garner of USAID and Ricardo Frohmader of ASAP (USAID Agribusiness project). Brhane Gebrekidan and Ed Rajotte visited AVRDC February 8-9 to review progress on program activities and then traveled on to the Philippines (February 10-18) where they visited Rodger Garner at USAID and attended and gave a brief presentation at the Organic Agriculture Conference in Manila. Brhane, Rajotte, Litsinger, and George Norton visited PhilRice to review ongoing project activities and interacted with Philippine scientists both on current research and on planning for year three. Brhane and Norton visited IRRI to meet with collaborating scientists on pesticide policy work. Brhane and Norton met with Frohmader of the ASAP project to discuss joint collaboration, with Tarete Calabria of the ASAP project to discuss tariff structures, and with several people at USAID. Brhane, Rajotte, and Norton met with several people from the Department of Agriculture, ADB, the Philippines Crop

Insurance Corporation, and the CIBA Foundation to discuss the IPM CRSP, and gather specific types of information required for the policy analysis part of the project.

Revathi Balakrishnan visited the IPM CRSP site and IRRI the third week in March to discuss progress on the household decision making/gender analyses of the project. She also visited the SANREM CRSP site in the Philippines.

Talekar visited the Philippines site in late February/early March to review progress on insect pest research activities in eggplant and onions and to bring sex pheromones for fruit and shoot borer of eggplant.

Vic Gapud (site coordinator) and K.L. Heong (scientist) traveled from the Philippines to the U.S. to participate in the IPM CRSP workshop and Technical Committee meeting (May 19-23). Santiago Obien traveled to Virginia Tech to participate in the IPM-CRSP board meeting (June 13-14). George Norton traveled to the Philippines (June 19-30) to discuss research progress and plans with scientists and administrators at PhilRice, IRRI, and USAID/Manila. Meetings were held with collaborators as well at UPLB and with Ricardo Frohmader of the ASAP project in the Philippines and Frank Cornejo, Director of the Philippine Fertilizer and Pesticide Authority.

C. *Human Resource Development*

Student training in the Philippine site involves a three-part strategy. The first part includes graduate student training at our collaborating university in the Philippines (UPLB), through which students there write theses or dissertations on IPM-CRSP topics, coordinating with PhilRice. The second part involves sending UPLB graduate students, after they have completed their coursework, to receive additional training at AVRDC in Taiwan, working with N.S. Talekar. These students may or may not work on a thesis while at AVRDC. The third part involves M.S. or Ph.D. training of either U.S. or Philippine students at a U.S. university. Thus far, we have sent one student to AVRDC for six months training with Talekar, have funded one U.S. masters student who completed her M.S. thesis on the CRSP in September at Virginia Tech, and have funded one Ph.D. student from the Philippines who began her program in agricultural and applied economics at Virginia Tech in August. She is required to return to either PhilRice or UPLB upon completing her degree. The year three plan includes provisions for sending a second student to AVRDC, an entomology student to Penn State, and a weed scientist from PhilRice to UPLB to complete a Ph.D. with some additional short-term training at Virginia Tech. The primary constraint to additional student training is lack of funds.

IV. NETWORKING ACTIVITIES

Networking is accomplished at the local level and county level through institutional collaboration between PhilRice, UPLB, and other agricultural colleges in the Philippines. PhilRice is part of the Department of Agriculture (DA) and the DA has a national IPM program that the IPM CRSP coordinates with. The DA has an extension service that the CRSP can use to help reach farmers. Locally, the CRSP has a community advisory council made up of three village captains, three counselors, two onion traders (one Farm Fresh and one head of the onion growers association), one Land Bank representative, one municipal agriculturalist, one NGO representative, three PhilRice scientists, two IRRI scientists, and one representative from the Department of Social Welfare and Development.

The first official meeting was held in 1995. Additional networking occurs through visits to PhilRice by visitors from other countries. For example, during the past year, our IPM CRSP field sites were visited by scientists from Bangladesh.

Both IRRI and AVRDC play key roles in networking with other countries in the region. Scientists on the IPM CRSP from both institutions work throughout the region and can spread research results through visits to other countries through regional meetings, and other network activities. As other USAID missions develop interest in IPM and are willing to fund IPM CRSP activities, more intensive interactions will occur between CRSP scientists and host country scientists in other countries in the region. Interactions have also taken place between IPM CRSP scientists and commodity organizations in the Philippines such as the onion growers association. Contacts have also been made with private companies.

V. RESEARCH ACCOMPLISHMENTS

Many of the research accomplishments for year two were summarized briefly in the research results section above, but the following is a list of the key accomplishments:

1. Building on the stakeholders meeting, participatory appraisals, farmer baseline survey, and other activities in year one, farmer field sites were made fully operational in year two and a coordinated set of research activities were initiated that included both (a) crop-pest-natural enemy surveillance to refine our view of the key pest problems and (b) experimental work on insect, weed, and disease problems. Results of these efforts have led to (a) a focusing on the nematode problem in the rice-onion system, (b) identification of which sex-pheromone combinations attracts eggplant fruit and shoot borer moths, and (c) identification of *Spodoptera litura* as the key *Spodoptera* pest in onion and the testing of a particular castor bean trap crop. Many other experiments are underway.

2. Completion and analysis of the results of the two baseline surveys found that pesticide misuse on vegetables was increased by membership in agricultural organizations, by use of credit, by contacts with Department of Agriculture technicians and with chemical company representatives, and by lack of knowledge about natural enemies. Education, access to the Farmer Field School training program, and age all reduced pesticide misuse. The implication is that increased IPM training for farmers is needed as well as increased IPM training for Department of Agriculture technicians. This training needs to be focused on younger farmers.

3. A detailed analysis of pricing and exchange rate policies in the Philippines found that the net effects of these policies are to subsidize pesticide use, but the subsidy is only six to eight percent and hence should not provide a major barrier to IPM adoption.

4. Results of the PA efforts focused on women farmers identified their key role in decision making with respect to their budget, including pest management decisions, even though males are usually the ones to spray pesticides. Any IPM solutions to weed problems on onions that involves reduced hand weeding, will free up women's time for other activities but may also affect an important source of income for the poorest women.

PHILRICE

Surveillance, Monitoring, and Control of Arthropods, Diseases, Weeds, and Natural Enemy Occurence in Rice Vegetable Systems and Other IPM CRSP Activities in the Philippines

Country Coordinator - V. P. Gapud, PhilRice

Investigators in Philippines (PhilRice, NCPC/UPLB, IRRI): G. Amar, G. Arida, A. Baltazar, A. Baria, B. Canapi, M. Casimero, A. dela Cruz, V. Gapud, E. Gergon, K.L. Heong, E. Martin, D. Mathias, C.L. Mulling, S. Obien, L. Padua, T. Paris, P. Pingali, J. Prot, J. Rillon, J. Rosario, L. Sanchez, L. Sebastian, R. Suiza, I. Tanzo, A. Watson

COLLABORATING SCIENTISTS

Taiwan (AVRDC): N.S. Talekar; **U.S.**: R. Balakrishnan, S.K. De Datta, J. Litzinger, G. Norton, E. Rajotte, J. Tjornhom

SUMMARY OF RESEARCH RESULTS

Research activities focused largely on monitoring and surveillance of pests, weeds and diseases of rice-vegetable systems in San Jose, Nueva Ecija, using farms of four farmer cooperators in each of the three barangays (Palestina, Abar 1st, Sto. Tomas). Farmer surveys were continued to extend the farmer baseline survey, as well as, evaluate the factors affecting pest management practices of farmers growing vegetables after rice.

1. Surveillance and monitoring of arthropods, diseases, weeds and natural enemy occurrence in rice-vegetable systems.

1.1. October 1994 - May 1995, Dry Season

Prioritization of major/key arthropod pests, diseases and weeds in rice-vegetable systems was based on surveillance and monitoring activities which began in October 1994 up to April 1995 and is summarized in Table 1.

1.1.1. Insect Pests

As has been the case for Central Luzon, the yellow stemborer *(Scirpophaga incertulas)* and the green leafhopper *(Nephotettix virescens)* were considered the most important insect pests of rice in San Jose during the 1994 wet season. With only one rice crop a year, however, they did not pose any serious threat to the crop.

The farmers' perception that *Thrips tabaci* is the most important insect pest of both native and export onions was confirmed during the monitoring activities. Based on preliminary estimates of its population density (Table 5a), the thrips population was low

at five weeks after transplanting (WAT) and increased at eight WAT in Sto. Tomas more than in Abar 1st. In the case of Milagros Salazar, who planted onions at different dates, the thrips population tended to be higher in late-planted onions. One possible way of reducing the damage caused by thrips is to plant early. One hypothesis that will be tested in year three is the possibility that thrips are higher in onions grown under straw mulch than on those grown after rice hull burning and land preparation. The previous sampling technique will be improved upon in year three in relation to thrips management.

The common cutworm, *Spodoptera litura*, was more serious on Yellow Granex onions than on native (Tanduyong) onions very likely because Yellow Granex onions have broader leaves. Equally visible was the damage caused by the leafminer fly, *Liriomyza* sp., on Yellow Granex onions but not on native onions. The same leafminer fly was observed in high numbers on leaves of stringbeans that were heavily sprayed with insecticides in Sto. Tomas. However, many individuals of a hymenopterous parasitoid emerged from the leafminer larvae collected from the field and cultured in the laboratory (Table 5b). Despite the heavy insecticide exposure, parasitism ranged from as low as 4% to as high as 38.9%, with a mean of 22.1%. A number of leafminer pupae failed to emerge and were presumed dead. The total pupal mortality ranged from 8.8% to 78%, part of which may have been caused by insecticide spray. It is very likely that the level of parasitism would have been much higher and effective enough to contain *Liriomyza* populations had the fields been left unsprayed against this pest.

The eggplant shoot and fruit borer, *Leucinodes orbonalis*, continued to be the single most important pest of eggplant. The minute green leafhopper, *Amrasca biguttula*, may be a potential pest, causing the leaves to curl when it occurs in high numbers. No additional natural enemies other than those previously reported were observed during this period. Likewise, the bean pod borer, *Maruca testulalis*, remained the most destructive pest of stringbeans. No new natural enemies were observed.

1.1.2. Diseases

Sheath blight and Tungro were the most important diseases of rice during the 1994 wet season crop. However, the rice root-knot nematode, *Meloidogyne graminicola*, on onions became a serious concern when it was discovered as early as December 1994.

The presence of root-knot nematodes, *Meloidogyne graminicola*, significantly changed our view of the pest situation on onions in San Jose. During the year, monitoring in other onion-growing areas within Nueva Ecija now shows that the nematode problem is more extensive than previously realized and a potentially serious threat to onion production throughout the country. Dr. J.S. Prot (IRRI visiting entomologist) shared the opinion that the expansion of upland conditions and inappropriate cultural practices, including cropping patterns, will promote the spread of these nematodes. Being able to remain dormant within rice under paddy condition, they are easily activated upon conversion to upland conditions. Preliminary qualitative data on their damage (Tables 6 and 7) show that the nematodes attack both Yellow Granex and Tanduyong onions. A special sub-activity will focus on the development of nematode management in year three. Nematode damage, misperceived by farmers as insect damage, has caused insecticide applications for the wrong pest in many onion fields, without solving the problem.

1.1.3. Weeds

The paddy rice weed composition sampled one week before harvest (last week of October) differed between Sto. Tomas and Abar 1st during 1994 wet season (Table 8). While more grasses *(Echinocloa glabrescens, Ischaemum rugosum)* were dominant in Sto. Tomas, broadleaf weeds were more common in Abar 1st *(Ludwigia octovalvis, Eclipta prostrata)*. The most dominant weed for both barangays, however, was the broadleaf species, *Ludwigia perennis*. The sedges, *Cyperus rotundus* and *C. difformis*, were greater in Sto. Tomas than in Abar 1st.

During the onion-growing season starting December, the weed composition similarly differed in the two barangays (Table 9). In contrast to ricefields, the onion fields were dominated by *Cyperus rotundus* in Sto. Tomas and *Cleome viscosa*, *Phyllanthus amarus*, and *Trianthema portulacastrum* in Abar 1st. In both barangays, *C. rotundus* was common and, at the same time, more broadleaf species occurred than in ricefields. If left unweeded for some time, *C. rotundus* took over as the most dominant weed in onion fields. These differences in weed dominance may be attributed to several factors, such as weeding practices and schedules before and after sampling, herbicide use and water supply. These factors will be studied further.

1.1.4. Farmers' Practices in Onions

Onion crop production practices (Table 2), pesticide use (Table 3), and fertilizer use and onion yields (Table 4) were obtained through the end of the dry season. In both barangays Abar 1st and Sto. Tomas, the local "Tanduyong" variety, grown under rice straw mulch, was the commonly used at an average seeding rate of 329 Kg/ha in Sto. Tomas and 375 Kg/ha in Abar 1st (Table 2). It is usually transplanted at about 31 days after seeding (DAS) by dibbling on mulched unplowed moist soil. It produces two to four small red bulbs (cloves) per plant and matures in 16 week after seeding (WAS). The variety is usually stored for six months or more. Other vegetables grown in the site are eggplant, tomato, stringbeans, hot pepper and bitter gourd.

Farmers sprayed insecticides three to four times (Table 3). Most commonly used were methyl parathion and cypermethrin at average rates of 0.72 and o.o25 Kg ai/ha, respectively. They sprayed insecticides upon observing the damage caused by cutworms (*Spodoptera litura*) and thrips. Most farmers times their spraying during the early and late bulb formation stage, which may coincide with the presence of thrips, which they claimed to be their main pest problem in Sto. Tomas and Abar 1st. In Palestina, however, where most farmers grow Yellow Granex onions, the most important pest to them is *Spodoptera.*

The most commonly used herbicide was glyphosate at a rate of 0.57 Kg ai/ha (Table 3). A systemic non-selective herbicide, it is applied usually three to ten days before transplanting (DBT). A few used a combination of Oxadiazon and Fluazifop-butyl as early post-emergent herbicide.

Fertilizer levels in onion fields differed considerably among farmer cooperators (Table 4). Most farmers in Sto. Tomas applied fertilizer often once and at the average rates of 83 Kg Nitrogen (N), 22.5 Kg Phosphorus (P), and 22.5 Kg Potassium (K) per ha. On the other hand, farmers in Abar 1st applied higher rates of N (average of 185 Kg/ha), but much lower P and K (9.25 Kg/ha). Normally, the yields from fields with higher N levels were expected to be higher as in Abar 1st. It appears, however, that second application of very high N fertilizer contributed greatly to higher yields. The yield

differences can also be attributed to the extent of damage caused by insect pests and diseases, as well as, competition from weeds.

1.2. June 1995 - October 1995, Wet Season

1.2.1. Farmers' Practices in Rice

During the wet season (1995), most farmers planted rice, while a few grew eggplant and stringbeans. The common rice variety was IR64 which was transplanted as early as July 3 and as late as August 15 (Table 10), with a seeding rate ranging from as low as 51 Kg/ha to as high as 250 Kg/ha, with an average rate of 142 Kg/ha. The average age of seedlings before transplanting was 31.2 days, slightly older than normal (21 days) to minimize feeding by the golden apple snail.

As was observed in the onion crop, fertilizer levels for ricefields differed considerably among farmer cooperators between and within barangays (Table 11). Four out of twelve farmers practiced split application. Emil Aquilo had the highest total N application (203 Kg N/ha), followed by Milagros Salazar (129 Kg N/ha), while Aida Fajardo applied the lowest (14 Kg N/ha) who also obtained the lowest yield (2.6 t/ha, Table 14). While relationships between fertilizer levels and yields may appear positive, the data will be further studied.

Four of 12 farmer cooperators used cypermethrin against insect pests, two used Etofenprox, while four used individually different insecticides (Table 12). Three farmers did not spray. Insecticides were usually applied only once, most probably against leaf feeding worms. Farmers who sprayed appear to have done so in response to their perception of pest avoidance (prophylactic) and/or pest presence (as needed), which could explain the varying time of application from 3 DT to 50 DT. Based on the results of our monitoring of rice insect pests and their natural enemies, however, pest populations were generally low and did not pose any serious threat to farmers' crop (Tables 13a-d). This is the expected trend in rainfed lowland rice, where rice is grown only once a year, which does not allow opportunity for pest population buildup. This trend being consistent, insecticide application against leaf feeding insects is not necessary because plants can compensate for damage and these insects have enough natural enemies to contain them.

Butachlor was the commonly used herbicide which was applied within the week after transplanting at an average rate of 0.57 Kg ai/ha (Table 12). Only one farmer applied Butachlor before transplanting while another applied the herbicide during transplanting. One farmer combined Butachlor and propanil and another combined Piperophos with 2,4D.

1.2.2. Rice Insect Pests

Arthropods of ricefields of IPM CRSP farmer cooperators were monitored during the season using net sweeps, to estimate the relative numbers of the common species. While pest populations were generally low (Tables 13a-d), three trends were apparent. First, the green leafhoppers (GLH), *Nephotettix* spp., were the most numerous, followed by the whitebacked brown planthopper (WBPH), *Sogatella furcifera*, and the green horned rice nymphalid, *Melanitis leda ismene*. The brown planthopper (BPH), *Nilaparvata lugens*, appeared to be negligible in number. Of the predators, spiders were dominant in all the sampled fields, followed by the lady beetle, *Micraspis*, and coenagrionid damselflies. Of the few insect parasitoids monitored, the braconids, mainly *Cotesia* species, were the most numerous. Table 13d shows us a good combination of pests,

predators and parasitoids in any given farmer's field. The sampling procedure will be refined for next year's rice crop, using suction samplers. Second, more GLH and WBPH adults occurred in late-planted fields (planted on or after July 25), as in farms of Aida Fajardo, Alfredo Pascua, Edna Rigos, Domingo Hipolito and Milagros Salazar. Since GLH adults are vectors of the serious disease, Tungro, their presence in high numbers increases the chances of tungro transmission and infection from nearby fields which grow rice two times a year. Third, regardless of the time of planting, the yellow stemborer population and consequent crop damage in terms of whitehead levels were negligible, which is expected in areas where rice is grown only once a year.

1.2.3. Variety, Fertilizer, Stemborer Damage and Rice Yields

The relationships among variety, fertilizer level, stemborer damage and yield have yet to be studied more carefully (Table 14). Based on the current data, stemborer damage may have a negligible effect on yield. Among farmers who used IR64, the yields they obtained could have been largely affected by the fertilizer level and time of application. In the case of Aida Fajardo, who applied the lowest fertilizer level (14 N-14 P- 14 K), the lowest yield (2.6 t/ha) was obtained. However, in the case of Bartolome dela Cruz, who applied 82 N-38 P -28 K, the yield was about the same (2.7 t/ha). The highest yields (5.4 t/ha and 5.2 t/ha) were obtained from fields which received lower N than that of Bartolome dela Cruz. These data will be studied further with the inclusion of other possible factors affecting yield levels.

1.2.4. Rice Diseases

Of the rice diseases monitored in IPM CRSP farmer cooperators' fields during the rice-growing season, sheath blight and rice blast were the most common (Table 15). Lack of irrigation water was identified as the most important limiting factor to production during the wet season which favored the widespread occurrence of rice blast, a common disease of upland rice. This year, tungro did not occur at our sites.

1.2.5. Weeds of Rice Fields

Weed dominance observed in farmer cooperators' rice fields this wet season differed from that of last years rice growing season in Sto. Tomas and Abar 1st. Data for Palestina were obtained for the first time as additional study area for the project.

For this year, the three dominant weeds in Sto. Tomas were *Echinocloa glabrescens, Cyperus rotundus*, and *Ludwigia octovalvis*, while *Ischaemum rugosum, Monochoria vaginalis*, and *Echinocloa glabrescens* were the most common in Abar 1st (Table 19). In contrast, last year (Table 8), the most common weeds in Sto. Tomas were *Ludwigia perennis, Echinocloa glabrescens*, and *Ischaemum rugosum*, while *Ludwigia perennis, L. octovalvis*, and *Eclipta prostrata* were the most common in Abar 1st. In Palestina this year, the most common weeds were *Cyperus rotundus, Oryza sativa* (red rice), and *Echinocloa glabrescens*. The dominance of *Cyperus rotundus* in Palestina is probably associated with intermittent irrigation due to lack of water in the ricefields. All these differences in weed dominance may be attributed to several factors, such as weeding practices and schedules before and after sampling, herbicide use and water supply. A closer monitoring of weed management schedules of farmers will be done in next year's rice season.

1.2.6. New Records of Natural Enemies of Insect Pests

The ichneumonid, *Trathala flavoorbitalis* (Cameron), a larval parasitoid of the eggplant shoot and fruit borer, *Leucinodes orbonalis* (Guenee), has been recovered from field samples of infested fruits. However, it appears to be rare in the field. This same parasitoid is known to parasitize rice stemborers in tropical Asia. Eggplant growers will be asked to leave portions of their fields unsprayed to find out if its population will build up.

In the meantime, a farmer's eggplant field monitored during the rice growing season showed high infestation of Leucinodes, with as much 56% of plants (n=55) at outer row with damaged/wilted shoots and 40% of plants (n=72) at inner row with damaged shoots. In one monitoring schedule, the farmer piled up a good 200-300 damaged fruits on the ground as evidence of farmer's loss due to this insect.

Several individuals of a braconid, tentatively determined as *Dolichogenidea* sp., a larval-pupal parasitoid of the bean pod borer, *Maruca testulalis* (Geyer), emerged from samples taken from heavily sprayed fields in Sto. Tomas (Bartolome dela Cruz). Also, a *Cotesia* species was retrieved from the same samples. The farmer has been asked to leave a portion of his field unsprayed to find out if these parasitoids will build up in his field. Attempts to multiply them in laboratory culture will be made and later released.

2. The potential use of NPV and *Bt* for *Spodoptera* control in onions and stringbeans.

Dr. Leo Padua of UP Los Banos (BIOTECH) started work on mass-rearing of *Spodoptera litura* in August and has maintained his culture up to the fourth generation. In addition to the NPV strain received from Dr. Talekar of AVRDC, he is currently testing a local strain against *Spodoptera* cultures. He is also testing the effectiveness of commercial *Bt* products against this insect.

Dr. Talekar obtained castor seeds from India and sent these to Vic Gapud at PhilRice for planting in nearby onion fields. Castor plants will serve as trap crop for *Spodoptera*. Talekar is also working for the importation of *Apanteles africanus*, a parasitoid of *Spodoptera*, to the Philippines for use in the site. He is also identifying onion accessions with high levels of resistance to *Spodoptera*.

3. Development of mass-rearing methods for Maruca pod borer and eggplant fruit and shoot borer.

Mr. Rhoel Suiza, UPLB graduate student, is currently assisting Talekar in developing artificial diets for *Maruca* and eggplant fruit and shoot borer, *Leucinodes*, for mass-rearing purposes. PhilRice entomologists have tested trial formulations of a sex pheromone for *Leucinodes*. The two-component pheromone continues to be tested prior to field use. Out of the 27 different combinations, two showed promise in attracting the moths of *Leucinodes*. Mr. Suiza is also working with Talekar on eggplant resistance to the green leafhopper, *Amrasca biguttula*, which Talekar believes is a potentially serious pest of the crop. Other host plants of this leafhopper are cotton, okra and potato.

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

Important diseases which are carried over from rice to vegetables and back to rice are sheath blight caused by a fungus, *Rhizoctonia solani*, and the rice root-knot nematode, *Meloidogyne graminicola.*

4.1. Sheath Blight

As mentioned previously, sheath blight appears to be widespread during the rice growing season in Abar 1st and Sto. Tomas (Table 15). The same disease is easily carried over to vegetable crops after rice. Considering the polyphagous nature of the fungus, *Rhizoctonia solani*, often one of the causal organisms of damping off in eggplant, tomato, and possibly onion, it has to be contained. Our monitoring activities show that all fields in Abar 1st and Sto. Tomas previously planted to Tanduyong onions under straw mulch had varying levels of sheath blight incidence. In contrast, fields in Palestina planted to Yellow Granex onions after rice hull burning and land preparation showed no sign of sheath blight at all. Sanitation and careful selection of the quality of rice straw to be used as mulch are suggested to contain the spread of this disease.

Other diseases noticed on eggplant after rice were bacterial wilt, powdery mildew, and leaf rust. Bacterial wilt was quite damaging in several eggplant and pepper fields.

4.2. Rice Root-Knot Nematode

Of serious concern is the ever-increasing presence of the rice root-knot nematode, *Meloidogyne graminicola*, not only in the San Jose site, but also in other towns of Nueva Ecija, e.g., Sto. Domingo, Bongabon. The declining irrigation water availability in Central Luzon has favored the spread of this nematode which easily transfers to other crops after rice, particularly onions. An on-going survey of the host range of this species clearly cuts across families of a wide variety of crop plants (Table 17). Even its mere presence in a crop plant in insignificant numbers is alarming enough. Its host range among the weeds is currently being studied, among which the most common weed, *Cyperus rotundus*, is a host.

Samples taken in October from ricefields of many farmer cooperators showed varying population levels of the nematode (Tables 18a, 18b). Data on whether nematode levels are higher in fields subjected to rice straw mulch or to rice hull burning are being analyzed.

As a result of these data, possible nematode management options will be tested, such as organic amendments and long-term crop rotation, to suppress the nematode population in the field.

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

Preliminary observations point out the high probability of the significant role of straw mulch in the spread and increase in incidence of sheath blight in the rice-vegetable systems (Tables 15, 16). The extent of this role is being studied. Mulched onion fields have been sampled for incidence of sheath blight and other diseases and cultured.

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

Microorganisms, such as *Trichoderma, Bacillus*, and *Pseudomonas* have been isolated and tested for control of sheath blight. Other microorganisms are being isolated for possible control of bacterial wilt on eggplant and onion bulb rot.

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

Weed species composition and dominance have been studied in activity 1 and are being studied to determine the effects of cropping patterns, rice hull burning, use of straw mulch and land forms on them. The work is ongoing.

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

Activity underway but no results to report.

9. Document and extend the farmer baseline survey.

The results of our baseline survey of 300 farmers in six villages in our San Jose site were summarized, analyzed and presented as IPM CRSP Working Paper No. 2 (Lazaro, et al., 1995). The baseline survey obtained information on farmer perceptions of pests and natural enemies and identified current pest management practices. Farmers' knowledge of pests and natural enemies, particularly in vegetables, was found to be limited. Pesticides were virtually the only pest control tactics used in vegetables and farmers considered pesticides to be effective in controlling pests. Farmers perceived that early spraying was necessary and would increase yields.

A follow-up baseline survey of 228 of the original 300 farmers was completed in March-April 1995 to gather information on socio-economic and other characteristics affecting pesticide and pest management practices (Tjornhom, et al., 1995). Farmers in San Jose have a relatively high level of education which should help them respond to IPM training. Most are male, many own their farms, and almost half belong to an organization such as a cooperative or village association. Over seventy percent received credit (from a variety of sources), and almost seventy percent had been exposed to IPM through a Farmer Field School on rice or through an agricultural technician.

10 & 11. Socioeconomic determinants of pesticide use and adoption of improved management practices of rice-vegetable system.

Sub-project a. Identification of the constraints to adoption of alternate (more judicious) pest management for rice-vegetable

Sub-project b. Ex-ante impact assessment, both economic and social including gender, of prospective IPM interventions for rice-vegetable systems

Sub-project c. Household decision-making and management of resources (land, labor, capital, time) and socio-cultural beliefs, perceptions, that influence crop choice and pest management

ACCOMPLISHMENTS (Subprojects a and b)

Household surveys were already conducted last April and May 1995 after pre-testing the questionnaires. Fifteen respondents for each of the 3 IPM-CRSP barangays, Sto. Tomas, Abar 1st and Palestina were chosen. Forty-five farmers were interviewed. Seven of the 45 respondents are female (head of households).

Another 35 farmers surveyed in 1988-90 were also interviewed. These farmers are in barangays Kalaocan, Sibut, Malasin, Manicla, Tayabo and Rigos Block. The data are currently being edited and inputted in the computer.

The remaining respondents with rice production during the dry season were interviewed on June 14-16. A follow-up PRA involving 6 women in Palestina and 8 women in Sto. Tomas was conducted in July 5-6. Around 90% of data for a total of 77 households, consisting of production, credit, and other income have been inputted. Some of the preliminary findings from the survey are presented here.

Area Planted

The average area planted during 1994 Wet Season was 1.65 hectares, while that for the 1995 Dry Season was 1.17 ha. The difference is that part of the farm which is usually left fallow during the dry season. Some farmers also allow other farmers or relatives and friends to plant in parts of their farm during the dry season. Aside from onions, some farmers also plant eggplant, chillies, bitter gourd, and beans in smaller plots.

Among the three IPM CRSP barangays, Sto. Tomas has the biggest average area planted while Abar 1st has the smallest (Table 20a). During the dry season, none of the farmers interviewed in Abar 1st grew rice. All the farmers interviewed in Abar 1st grew the same onion variety, Tanduyong. They use pumps to irrigate their fields during the dry season.

Onion Yield

The main varieties of onions grown in the selected barangays are Tanduyong, Yellow Granex (Sibuyas na Puti), Red Creole (Sibuyas na Pula), Red Pinoy, Batanes, Giant Batanes, Asgrow (also Yellow Granex) and Keystone. The predominant variety grown is Tanduyong. The respondents in the IPM CRSP barangays planted a total of 17.73 ha to this variety, which corresponds to 75% of the total area planted to onions. The average onion yield is 10,003 Kg/ha. Average yield by variety is shown in Table 20b.

Chemical Application

Herbicide application in the IPM CRSP barangays ranged from 1 to 2 applications, with an average of 1.37 appplications. Highest number of herbicide applications was observed in Palestina (1.62), while the lowest was observed in Abar 1st (1.07). About 66% of the respondents in the IPM CRSP sites apply herbicide only once and the remaining 34% appply twice.

The number of insecticide applications for onions ranged from 0 to 10, with an average of 4.48 applications. Highest average was observed in Palestina with 5.93 applications, while the lowest was in Sto. Tomas with 2.62. About 61% of the respondents in the three barangays apply insecticides 5 times or less, and the remaining 39% apply more than 5 times.

Choice of Variety

Tanduyong was a preferred variety because of relatively less land preparation requirements and they can use their own seeds/planting material. Seeds of the other varieties are imported and command a higher price (e.g., up to P1,600 per can of 0.5 kg Yellow Granex). Furthermore, other varieties also require daily watering for up to 40 days.

Pest Problems

Thrips was mentioned as the main problem in onion growing. They observe that the leaves become white as early as two weeks to one month after transplanting. They spray Folidol or Lannate to control thrips. Spraying was done either by their husband, son or hired labor. Usually, the husband informs the wife what brand to buy, and if unavailable, they consult the pesticide store or technician.

Another problem mentioned was the reddening of the leaves attributed to improper use or timing of irrigation. They spray Sevin to solve this problem. Some mentioned the use of Tide along with the chemical that is sprayed. One said he had been using Tide for 10 years.

Damping is attributed to overwatering. They mentioned the need to test the soil by removing the mulch and getting a handful of soil.

The women considered spraying as a "man's job" because the sprayer is heavy. Although they are aware that some women in Lupao, Nueva Ecija do the spraying, they believe this to be due to the lack of men in the family.

Weeds and Herbicides

Roundup was sprayed before transplanting, and also before mulching, because the onions will die if it is done after transplanting. Onecide, Ronstar and Goal can be sprayed even after the onions have been transplanted. Oneside was used for the grassy type of weeds like "Malit" ("mahabang damo"), while Ronstar and Goal was used for broadleaves ("bilog ang dahon").

They claim that handweeding is still necessary because not all the weeds can be controlled by herbicides. Even if handweeding is done everyday, they still find weeds, because they believe the seeds of weeds remain under the mulch.

Irrigation

Frequency of irrigation depends on the soil type. For sandy soil, irrigation is done about 5-6 times, usually every 8-9 days. For clay soils, irrigation is 3-5 times. In Sto. Tomas, two soil types exist. They even plant onions in clay soil ("bana") because they say there is not enough land.

ACCOMPLISHMENTS (Subproject c)

Collection of qualitative information through PRA. Informal interviews were conducted to elicit women's participation in rice-vegetable systems. Participatory methods such as changing trends, activity analysis, gender disaggregated seasonal calendar of activities, case study were used to collect qualitative information.

Collection of quantitative information through the use of questionnaires. Sex disaggregated labor data on onion production as well as income contributions of male and female members were already collected from 80 households in 9 villages.

HIGHLIGHTS OF THE PRA

Year calendar of activities (Seasonal chart)

The crop calendar and seasonal activities of men and women in the production systems are discussed below. The dominant cropping pattern is rice-onion and rice-other vegetables such as chili, eggplant and pechay. The 2 barangays surveyed are both rainfed areas and rely on pumps for supplementary source of water especially during the dry season.

Rice

Activities for rice production begin in June and ends in December when rice is harvested. Land preparation and spraying of pesticides are exclusively done by the men. Transplanting and harvesting are jointly done by men and women, however, more women than men participate in these activities. Threshing is done with the use of the machine while winnowing and gleaning are tasks exclusively done by women.

Onion

Activities for onion begin as early as November as soon as rice is harvested. Spraying of chemicals and watering the onions are exclusively done by the men. Women participate more than men in separating the seedlings, planting, weeding by hand and harvesting. While women prepare the seedlings, men prepare the land for onions.

Vegetables

Eggplant and chillies, planted in different plots are usually planted in January. Eggplant is harvested in March while harvesting of chillies starts in March and can continue until August.

Activity profile (Who does what?)

Rice

Land preparation	M only Family
Seedbed preparation	M Family
Pulling of seedlings	W > M Hired > Family
Planting	W > M Hired > Family
Spraying chemicals	M only Family
Application of fertilizer	M only Family
Weeding	W > M Family
Harvesting	W > M Hired > Family
Threshing (machine)	M Family

Onions

Mulching	M only	
Sorting of bulbs	W > M	Hired > Family
Planting	W > M	Hired > Family
Spraying	M only	Family
Weeding	W > M	
Piling/Hauling	M only	Family
Harvesting	W > M	Hired > Family

Calendar of Landless Female Workers

Table 21 shows the use of hired labor in onion production. Of the total labor in onion production, about 60% is contributed by female laborers . The calendar of activities of landless female workers is presented as follows:

January	Plants onions for up to 3 weeks
February	Works in other fields weeding for about a week
March	Harvests onion for 3 weeks
April	Start of harvesting of chilli peppers (1 week)
May	Harvests chilli (2 weeks)
June	Harvests chilli (1 week)
July	Harvests chilli (1 week)
August	Harvests chilli for 1 week and plants rice for 2 weeks
September	Plants rice for 5 days
October	Rest period
November	Plants onion (1 week)
December	Plants chilli (3 weeks)

Working as hired laborers in onion and vegetable farming is a major source of income of female landless laborers and women from poor households. When received P50.00/day for 4 up to 7 days a week depending upon the activity. Other landless workers rent land to farm during the dry season.

Pest ranking and control (What do women know about pest and how do they control them?)

Women farmers ranked Thrips as the major pest in onions, can detect the symptoms, can relate the occurrence of pests in relation to irrigation, and the extent of damage of the pest.

Women farmers and wage laborers in both Abar 1st and Palestina ranked Thrips as the major pest in onions. Thrips incidence is detected by the "reddening" of leaves, followed by whitening, until the leaves stiffen and deteriorate. The female farmers in Abar 1st commented that they start to notice thrips during the third irrigation, and usually after a drizzle. Once they notice the above symptoms on the onion leaves, they immediately spray the onions to control this pest and prevent damage to their crop. The damage could be as high as 100% if they don't spray on time. The damage on the leaves will prevent the development of the onion bulbs.

An old practice of controlling the insects was to make a smoke in the morning to drive away the thrips. They say that the smoke reduced the number but did not totally eradicate all the insects. They find spraying an easier and more effective way to get rid of thrips.

The second major problem mentioned is "Damping". The woman farmers attribute this problem to wrong timing of irrigation. Unlike in the thrips problem, the leaves wither. Their solution to this problem is to spray chemicals which promote bulb formation ("pampalaman") like Crop Giant. They believe that the effect on yield is lesser compared to thrips.

Focused interview (case study of one female farmer)

Edna Rigos has one hectare of which she grow rice during the wet season. During the dry season, she only plants in a part of that area (0.63 hectare) to onions and vegetables. Her relative cultivates in the remainder of the field. The onions (variety Tanduyong) and chilies are planted at the same time in a 0.5 hectare area, while the eggplant is planted in 0.13 hectare area. She uses her own pump to irrigate her field.

Chilli is planted on the same plot as the onions, in alternate furrows. Chilli provides additional income especially after the onions have been harvested. Chilli is planted in December and harvested from April until July before preparation for rice begins.

Eggplant is planted on a separate plot. It is planted in November and harvesting begins in December and lasts until early July. From December 1994 to April 1995, she harvested about 2,300 kg of eggplant at a value of about P11,500. Price of eggplant ranged from P3 to P10 per kilo, depending on the month. Price is highest in the month of December when the supply is still low.

Except for fertilizer application and irrigation, she relies on hired labor for her farm operations. Table provides a summary of labor use by operation for onion production. Hired female labor accounts for more than half of total hired labor. The bulk of labor provided by the women is in transplanting and harvesting. They are usually paid at a rate of P50/day, which is the same rate for male workers.

For the particular variety of onion that she plants, there is no land preparation involved. The bulb (of the "Tanduyong" variety), which is in clusters is separated before it is sown. It stays in the seedbed for about 30 days before the seedlings are pulled, the bulbs separated, and then transplanted. It takes another 90 days before it is harvested. During this period, she irrigates her field about 6 times, and sprays insecticide twice. She hires a male worker to spray her field at P50/day. The rate is based on a daily rate even if the operation takes only 3 hours.

Expenditures for onion production consists of seeds, fertilizer, pesticides, mulch, fuel and oil for pump, and hired labor. For other farmers, this could also include land rent and pump rental or irrigation fee. For her farm she was able to use her own funds to purchase inputs. She keeps a record of the expenditures in onion production for the 5,000 sq. m.. They are as follows:

Seeds	5,000
Labor	225 (5 people)
Planting	1,250 (all hired- 18 female; 7 male @P50/d)
Cleaning	600
Fertilizer	1,440
Thiodan	130 (3 days @ P50/d) hired male
Weeding	225 (4 females/ one day)
Machete granules	375
Ties	100
Rice straw	400

Piling	400 (6 males)
Harvest	1,000 (20 people; 15 female;5 male @P50/d)
Watering	330
Total harvest	2,556 kilos at P8/kg.

The approximate gross returns is P20,448. With the net income from onion production she was able to remodel her house each year.

Changing Trends/Historical Profile

(Interview with Palestina Farmers)

For selecting a time frame, farmers chose the inception of Masagana 99 and the Land Reform program in the 1970's as a point of comparison. The farmers considered the availability of credit in terms of inputs, and increased access to machinery as an important factor in increasing total production, and in enabling the farmers to grow onions in a larger (commercial) scale.

Crop protection

When traditional varieties were still being planted, and before the use of chemical pesticides, a farmer mentioned the use of "madre de cacao" leaves and "talahib", a type of grass to fight against a pest locally known as "kotalo". The "madre de cacao" leaves are thrown into the rice field, allowed to soak in the water, until it rots and give out a bad smell. The young leaves of the "talahib" grass is also thrown into the field.

Marketing

A recent development in the area, is the availability of an alternative marketing scheme with the introduction of a contract growing arrangement for a particular variety of onions ("sibuyas na puti"). There are 2 companies (TP and Farm Fresh) providing this scheme. The companies provide the inputs and technical advice, and the farmers are assured of a ready market. They find it difficult however, to dispose of the onions which do not meet the standard size of the company.

Carabao population

A reduction in the number of carabaos is evident with the introduction of the hand tractor, but the farmers claim that the carabao is still needed for some operations such as hauling.

Gender Issues in Rice-Vegetable System in Cabanatuan, Nueva Ecija, Philippines

Activities which are power intensive (land preparation, threshing, etc.) are done exclusively by men while control intensive activities which need skills and judgement (transplanting, weeding onion fields, sorting onion seedlings, harvesting, grading onions) are predominantly done by women.

Women's role in rice-vegetable farming is crucial. Aside from their labor in planting and postharvest activities in rice and vegetable activities, they are responsible for managing the family budget, raise credit from informal sources for both farm and household and make decisions related to the marketing of onions and vegetables.

Although women are not involved in actual spraying of chemicals on rice and onions, women can identify the symptoms of certain pests, can relate the occurrence of pest in relation to irrigation. Most women are aware of the prevalent pests in rice and onions and are aware of the harmful effects of the misuse of pesticides. As custodians of household cash, they are quite keen in adopting alternative methods of pest control to reduce the expenses in chemicals particularly for onions. However, they are not knowledgeable that there is IPM in vegetables.

Women's participation increases with cropping intensity. Rice-vegetable is very labor intensive particularly tasks such as weeding, sorting onion seedlings, harvesting, grading onions. Labor is intensive for farms which intercrop onions and chilies. Planting, weeding, harvesting operations are important sources of livelihood of poor and landless women.

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

No results to report.

13. Performance testing of near-isogenic lines, pyramids, and multi-lines for resistance to bacterial leaf blight of rice.

Generally, the incidence of bacterial leaf blight in the 1995 dry season was low. Twenty one isolates from IR64 have been collected from San Jose. Initial DNA typing indicates that San Jose isolates belong to only haplotype A-1, which belongs to race 3 (PXO79). Preliminary data from field experiments using clippind methods of inoculation on newly released PSB varieties also indicate that the varieties are resistant to the 9 representative BLB races including race 3.

A NIL containing both Xa-21 and Xa-5 has been crossed with three popular Philippine varieties. F_1 derived from crosses will be back crossed to the 3 popular varieties this coming season.

Table 1. Key pests of crops in San Jose, Nueva Ecija, 1994-95

PEST/DISEASE	RICE	ONION	EGGPLANT	BEANS	GARLIC
Scirpophaga (stemborers)	XXX				
Nephotettix (Green Leafhopper, GLH)	XX				
Nilparvata (Brown Planthoppers, BPH)	X				
Thrips		XXX	X	XX	XX
Leucinodes orbonalis (Shoot/Fruit borer)			XXX		
Maruca testulalis (Bean Podborer)				XXX	
Spodoptera litura (common cutworm)	X	XX	X	XX	
Liriomyza sp. (Leafminer)		XX		XX	
Amrasca biguttula (GLH)			XX		
Empoasca spp. (GHL)				XX	
Meloidogyne graminicola (root-knot nematodes)	XX	XXX	X	XX	XX
Tungro (RTV)	XXX				
Sheath blight	XXX				
Wilt			XX		
Rusts				X	
Mildews				X	
Bulb rot		XXX			
Cyperus rotundus		XXX	XXX	XXX	XXX
Echinocloa glabrescens	XXX	X	X	X	X
Echinocloa colona	XX	XX			
Ludwigia	X	XX	XX	XX	XX
Macroptilium lathyroides		XX	XX	XX	XX

Note: X = minor; XX = potential; XXX = major pest/disease

Table 2. Rice farmer cooperators in IPM CRSP sites growing onions (Tanduyong), DS 1995, San Jose, Nueva Ecija

Farmer Cooperator	Date Planted ('94)	Area (ha.)	Seed Rate (kg/ha)	Seedling Age (days)	Other Crops
Sto. Tomas					
Domingo Hipolito	24 Dec	0.60	267	28	Ampalaya
Leonardo Flores	18 Nov 30 Nov	0.26	326	25	None
Milagros Salazar	14 Nov 23 Nov 03 Dec	0.75	347	30	Eggplant Tomato String beans
Bartolome d. Cruz	10 Nov 26 Nov	0.55	375	30	None
Mean		0.54	329	29	
Abar 1st					
Alfredo Pascua	29 Nov	0.15	500	35	Eggplant Garlic
Roberto Domingo	07 Dec	0.45	425	30	Eggplant Pepper
Edna Rigos	19 Dec	0.50	280	30	Eggplant Pepper
Emil Aquilo	22 Dec	0.75	293	35	Eggplant
Mean		0.46	375	33	

Table 3. Pesticide inputs of IPM CRSP farmer cooperators on onions, DS 1995, San Jose, Nueva Ecija

Farmer Cooperator	Herbicide			Insecticide		
	Name	Rate[1]	Time[2]	Name	Rate[1]	Time[2]
D. Hipolito	*Fluazifop-P-butyl*	0.10	10 DBT	*Profenophos* *Methyl Parathion*	0.15 0.21	14 40
L. Flores	*Glyphosate*	0.79	5 DBT	*Methyl Parathion* *Deltamethrin*	0.48 0.02	15,22 29,36
M. Salazar	*Glyphosate*	0.41	3 DBT	*Cartap mixed Mancozeb*	0.22	36,42,49
B. dela Cruz	*Glyphosate* *Fluazifop-P-butyl*	0.51 0.19	2 DBT 30 DAT	*Cypermethrin* *Same mixed with Chorpyrifos+BPMC*	0.03 0.20	30,55
A. Pascua	*Oxadiazon +* *Fluazifop-P-butyl*	0.41 0.25	10 & 17 DAT	*Methyl Parathion*	0.80	20,27,34
R. Domingo	*Butachlor G* *Glyphosate*	12.0 0.41	Basal Basal	*Monocrotophos* *Methyl Parathion*	0.60 1.00	45,52 59,66
E. Rigos	*Glyphosate*	0.41	7 DBT	*Cypermethrin* *Lambdacyhalotrin*	0.25 .125	33,48 56
E. Aquilo	*Glyphosate*	1.37	3 DBT	*Cypermethrin mixed with foliar fertilizer*	.017	10,20,30,40

[1]Rate of application, kg a.i./ha.
[2]Time of application: DBT/DAT, Days Before/After Transplanting.

Table 4. Farmer cooperator's fertilizer use and onion yields, DS 1995, San Jose, Nueva Ecija

Farmer Cooperator	Fertilizer Rate (kg/ha)			Time (DAT)	Yield (t/ha)
	N	P	K		
Sto. Tomas					
Domingo Hipolito	39	18.0	18.0	35	4.20
Leonardo Flores	67			Basal	2.34
Milagros Salazar	70	0.0	0.0	Basal	
	67	37.0	37.0	20	2.70
Bartolome d. Cruz	88	35.0	35.0	15	1.60
Mean	83	30.0	30.0		2.71
Abar 1st					
Alfredo Pascua	14			Basal	
	210			20	18.00
Roberto Domingo	42			Basal	
	158			30	17.50
Edna Rigos	126			30	17.75
Emil Aquilo	37	37.0	37.0	Basal	
	126	0.0	0.0	28	
	28	0.0	0.0	65	4.40
Mean	185	12.3	12.3		14.40

Table 5a. Relative density of onion thrips on Tanduyong variety, DS 1995, San Jose, Nueva Ecija.

Farmer Cooperator	Date Planted	No. of Thrips/plant[1]		
		5 WT	8 WT	10 WT
Sto. Tomas				
Domingo Hipolito	24 Dec	0.50	0.30	1.50
Leonardo Flores	18 Nov	0.30	0.30	--
	30 Nov	0	0	--
Milagros Salazar	14 Nov	0	1.40	--
	23 Nov	0	5.70	--
	03 Dec	0.20	7.80	--
Bartolome d. Cruz	10 Nov	0	7.40	17.30
	26 Nov	0.20	4.30	
Abar 1st				
Alfredo Pascua	29 Nov		0.20	0.80
Roberto Domingo	07 Dec	0.20	0.42	1.20
Edna Rigos	19 Dec	--	1.30	1.70
Emil Aquilo	22 Dec	--	1.50	1.70

1 Count based on 10 plants sampled from field of each farmer cooperator (removal sampling).

Table 5b. Levels of parasitism in *Liriomyza* pupae collected from heavily sprayed stringbean field, Sto. Tomas, January 1995 (per leaf basis).

No.of Pupae/leaf	Emerging Parasitoids	Percent Parasitism	Dead Pupae	Total % Mortality	Emerging Adult Flies
January 10 collection					
50	2	4.0	37	78.0	11
42	4	9.5	0	9.5	38
34	3	8.8	0	8.8	31
20	4	20.0	0	20.0	24
25	3	12.0	7	40.0	15
30	9	30.0	0	30.0	21
19	6	31.6	0	31.6	13
39	12	30.8	0	30.8	27
12	4	33.3	0	33.3	8
18	7	38.9	1	44.4	10
23	4	17.4	0	17.4	19
34	7	20.6	4	32.3	23
32	5	15.6	5	31.2	22
36	5	13.9	14	52.8	17
January 18 collection					
31	5	16.1	19	77.4	7
75	16	21.3	3	25.3	56
57	20	35.1	0	35.1	37
37	5	13.5	6	29.7	16
23	8	34.8	0	34.8	15
21	6	28.6	0	28.6	15
18	5	27.8	1	33.3	12
	MEAN	22.1%		34.5%	

Table 6. Occurrence of nematodes on Tanduyong onions in San Jose, Nueva Ecija, DS 1995

Site	Cultural Practice	Date Transplanted	Damage Rating[1]
Sto. Tomas	straw mulched	21 Nov 94	severe
Sto. Tomas	straw mulched	03 Dec 94	moderate
Sto. Tomas	straw mulched	18 Nov 94	slight
Sto. Tomas	straw mulched (onion-tomato)	14 Nov 94	moderate
Abar 1st	straw mulched	29 Nov 94	moderate
Abar 1st	straw mulched	19 Dec 94	slight curling of roots; no galls
Abar 1st	straw mulched		severe
Abar 1st	straw mulched		no root damage

[1]Damage rating based on visual inspection.

Table 7. Occurrence of nematodes on onions in Palesting, San Jose, Nueva Ecija, DS 1995.

Cultural Practice	Variety Planted	Damage Rating
Burned rice hull	Red Creole (seedling)	Severe
Burned rice hull	Asgrow 429 (seedling)	Slight
Less burned rice hull	Asgrow 429	Severe
Well burned hull	Asgrow 429	Moderate
Uneven burned hull	Asgrow 429	Moderate
Even burned hull	Asgrow 33	Severe root curling
Even burned hull	Yellow Granex	Severe root curling

Percent Damage	Description	Damage Rating
0%	No curling and gallings in roots	Healthy
1% - 25%	Roots with gallings; curlings	Slight
26% - 50%	Roots with gallings; curlings	Moderate
51% - above	Roots with gallings; curlings	Severe/Heavy

Table 8. Weeds sampled one week before harvest from study sites, rainfed lowland rice, WS 1994, San Jose, Nueva Ecija.

Weed Species	Sto. Tomas			Abar 1st		
	Density (m^2)	Dry Wt (m^2)	SDR (%)	Density (m^2)	Dry Wt (m^2)	SDR (%)
Grasses:						
Echinocloa glabrescens	0.17	22.02	19.705			
Ischaemum rugosum	0.67	18.80	18.145	0.113	3.29	2.790
Echinocloa colona	1.00	0.93	3.335			
Echinocloa crus-galli	0.17	2.43	2.555	0.13	4.71	3.885
Digitaria ciliaris	0.50	0.97	2.110	1.25	2.34	4.470
Leersia hexandra	0.17	1.17	1.455			
Digitaria setigera				0.75	1.33	2.625
Eleusine indica				0.50	1.61	2.310
Oryza sative (red rice)				0.25	11.05	9.025
Broadleaves:						
Ludwigia perrenis	8.17	1.60	21.990	3.75	18.14	21.955
Ludwigia octovalvis	1.67	1.20	5.260	6.88	8.70	21.390
Eclipta prostrata				4.50	4.41	13.015
Macroptilium lathyroides				2.38	1.04	5.880
Monochoria vaginalis				0.50	2.06	2.655
Murdania nudiflora				0.13	0.75	0.840
Sedges:						
Cyperus rotundus	2.33	2.33	8.145	1.13	1.65	3.675
Cyperus difformis	2.33	2.33	7.840	0.25	1.09	1.370
Cyperus compressus	1.33	1.33	4.110	0.38	0.93	1.510
Cyperus iria	1.00	1.00	3.790			
Fimbristylis miliacea	0.33	0.33	1.555	0.50	1.99	2.595

SDR = Summed Dominance Ratio

Table 9. Relative Density (RD) of weeds at different stages of onion crop, DS 1995, San Jose, Nueva Ecija

Weed Species	Sto. Tomas			Abar 1st		
	Early	Middle	Late	Early	Middle	Late
Grasses:						
Echinocloa colona			3.22		2.13	11.2
Oryza sativa	33.33	7.92	0.65	6.67	2.13	
Cynodon dactylon			5.16		2.13	
Digitaria ciliaris					4.25	0.8
Eleusine indica			0.65		2.13	
Broadleaves:						
Vleome viscosa	33.33		4.52	33.33	29.79	20.8
Phyllanthus amarus			1.29	13.33	23.40	25.6
Trianthema portulacastrum			3.87		8.51	10.4
Galinsoga parvif ora			1.93	6.67	2.13	1.6
Cassia tora				10.00	2.13	0.8
Ipomoea triloba			0.65	10.00	2.13	
Macroptilium lathyroides			0.65	6.67		
Crotolaria sp.			3.22			8.8
Helioptropium indicum			1.29		6.38	0.8
Strachytarpheta jamaicensis						4.8
Mimosa pudica						1.6
Sedge:						
Cyperus rotundus	33.33	92.08	72.9	13.33	12.77	12.8

Table 10. IPM CRSP Farmer-cooperators' practices in rainfed lowland transplanted rice, wet season 1995.

Farmer Cooperator	Variety	Area Planted (ha.)	Date Planted	Seeding Rate (kg/ha)	Seedling Age (days)
Palestina					
1. Rodrigo Bautista	IR64	1.0	July 3	150	30
2. Resituto Estabillo	IR64	1.5	July 3	133	30
3. Aida Fajardo	IR64	0.5	July 25	125	22
4. Encarnacion Rafael	IR64	1.4	July 12	107	27
		[Mean: 1.1]		[Mean: 129]	[Mean: 27]
Abar 1st					
5. Roberto Domingo	IR64	2.0	July 5	125	33
6. Alfredo Pascua	IR64	0.7	August 8	214	36
7. Emil Aquilo	IR64	0.5	July 23	250	30
8. Edna Rigos	IR64	1.2	August 15	167	30
		[Mean: 1.1]		[Mean: 189]	[Mean: 32]
Sto. Tomas					
9. Domingo Hipolito	RC14	2.0	July 29	125	30
10. Bartolome dela Cruz	IR64	1.0	July 16	104	30
11. Leonardo Flores	RC10	0.6	July 25	150	30
12. Milagros Salazar	IR64	0.75	August 10	51	40
		[Mean: 1.09]		[Mean: 108]	[Mean: 33]

Table 11. Fertilizer inputs of IPM CRSP farmer-cooperators in rainfed lowland transplanted rice, wet season 1995.

Farmer Cooperator	Fertilizer Level (kg/ha)			Application Time (DT)
	N	P	K	
Palestina				
1. Rodrigo Bautista	90	21	21	15
2. Restituto Estabillo	43	53	0	15
3. Aida Fajardo	14	14	14	35
4. Encarnacion Rafael	71	43	15	10
	6	7	0	25
Abar 1st				
5. Roberto Domingo	42	0	0	25
6. Alfredo Pascua	43	14	14	15
7. Emil Aquilo	90	21	21	15
	113	21	21	40
8. Edna Rigos	33	42	0	15
Sto. Tomas				
9. Domingo Hipolito	60	14	14	12
	17	0	17	36
10. Bartolome dela Cruz	82	38	28	15
11. Leonardo Flores	40	50	0	20
12. Milagros Salazar	9	9	9	Basal
	120	28	28	10

Table 12. Pesticide inputs of IPM CRSP farmer-cooperators in rainfed lowland

Farmer Cooperator	Insecticide			Herbicide		
	Name	Rate (kg/ai/ha)	Applied (DT)	Name	Rate (kg/ai/ha)	Applied (DT)
Palestina						
1. Rodrigo Bautista	Chlorpyrifos	0.16	3	Butachlor	0.45	3
2. Resituto Estabillo	Cypermethrin	0.02	50	-	-	-
3. Aida Fajardo	No Spray	-	-	-	-	-
4. Encarnacion Rafael	Cypermethrin	0.02	14	Piperophos + 2,4D	0.36	7
Abar 1st						
5. Roberto Domingo	No Spray	-	-	Butachlor	0.75	0
6. Alfredo Pascua	Methyl Parathion	0.18	23	Butachlor	0.21	4
7. Emil Aquilo	Monocrotophos	0.15	17	Butachlor	1.00	2DBP
8. Edna Rigos	Etofenprox Etofenprox	0.02 0.02	12 20	Butachlor	0.42	3
Sto. Tomas						
9. Domingo Hipolito	Cypermethrin	0.13	24	-	-	-
10. Bartolome dela Cruz	Cypermethrin	0.13	30	-	-	-
11. Leonardo Flores	No Spray	-	-	Butachlor + propanil	0.58	6
12. Milagros Salazar	Decamethrin	0.16	47	Butachlor	0.60	5

Table 13a. Mean number of arthropods in rainfed lowland ricefields of Palestina farmer coperators, wet season 1995, San Jose, Nueva Ecija. (replicated 3 times)

PESTS/NATURAL ENEMIES	MEAN NO. OF ARTHROPODS/30 SWEEPS					
	Bautista		Rafael		Fajardo	
	30 DT	45 DT	30DT	45DT	30DT	45DT
Pests						
Nephotettix spp.	6.67		5.00			37.00
Sogatella furcifera	1.33		19.33			25.67
Nilaparvata lugens	1.00		0			0.33
Recilia dorsalis	0.66		0.33			0
Scirpophaga incertulas moths	-		-			0.66
Melanitis leda ismene	1.67		0.66			7.33
Pelopidas spp.	-		-			0.66
Naranga aenescens	-		-			1.00
Rivula atimeta						
Leaffolders			1.00			
Oxya spp., others	0.66		1.33			0.33
Predators						
Metioche, Anaxipha	0.66		11.00			3.67
Ophionea						0.33
Coenagrionids			1.33			5.67
Cyrtorhinus lividipennis	0.33		0.66			0.66
Micraspis	2.67		12.67			11.00
Pardosa, other spiders	2.00		27.00			56.00
Others	0.33		3.33			3.33
Parasitoids						
Braconids	0.66		4.67			9.67
Ichneumonids	-		0.33			3.00
Dryinids	-		-			-
Others	1.33		1.67			1.67

Table 13b. Mean number of arthropods in rainfed lowland ricefields of Abar 1st farmer cooperators, wet season 1995, San Jose, Nueva Ecija. (replicated 3 times)

PESTS/NATURAL ENEMIES	MEAN NO. OF ARTHROPODS/30 SWEEPS					
	Pascua		Aquilo		Rigos	
	30 DT	45 DT	30DT	45DT	30DT	45DT
Pests						
Nephotettix spp.	16.33	37.67	7.33	9.33	7.67	36.33
Sogatella furcifera	50.00	32.00	6.33	17.00	28.33	21.00
Nilaparvata lugens	0	2.33	0	0	0.33	3.00
Recilia dorsalis	0	0.33	0	0	1.33	2.33
Scirpophaga incertulas moths	-	-	-	-	-	-
Melanitis leda ismene	14.00	3.33	4.33	2.00	2.33	3.33
Pelopidas spp.	1.67	0.33	0.33	-	-	-
Naranga aenescens	1.67	1.00	-	-	-	-
Rivula atimeta						
Leaffolders						
Oxya spp., others	1.00	1.00	4.67	0.66	3.33	5.67
Predators						
Metioche, Anaxipha	1.67	1.00	2.33	1.33	3.00	4.0
Ophionea	-	0.33	0.33	1.00	-	-
Coenagrionids	4.33	6.00	1.67	2.67	9.33	14.00
Cyrtorhinus lividipennis	0	1.33	3.00	1.67	1.00	4.00
Micraspis	3.33	1.33	1.67	5.00	5.33	4.67
Pardosa, other spiders	27.33	17.67	11.33	27.33	30.00	17.67
Others	2.00	0.33	5.33	2.67	-	3.67
Parasitoids						
Braconids	7.33	9.00	5.33	3.33	9.00	11.33
Ichneumonids	0.33	1.67	0.33	1.00	-	2.00
Dryinids	-	-	-	-	-	-
Others	6.00	-		1.67	0.66	-

Table 13c. Mean number of arthropods in rainfed lowland ricefields of Sto. Tomas farmer cooperators, wet season 1995, San Jose, Nueva Ecija. (replicated 3 times)

PESTS/NATURAL ENEMIES	MEAN NO. OF ARTHROPODS/30 SWEEPS					
	Flores		Hipolito		Salazar	
	30 DT	45 DT	30DT	45DT	30DT	45DT
Pests						
Nephotettix spp.		14.67	13.67	48.33	57.00	
Sogatella furcifera		9.67	12.33	35.00	32.33	
Nilaparvata lugens		0	0.33	7.33	1.33	
Recilia dorsalis		0	0	0.33	1.00	
Scirpophaga incertulas moths		1.67	0.33	-	1.00	
Melanitis leda ismene		-	-	5.33	4.00	
Pelopidas spp.		-	-	0.33	-	
Naranga aenescens		-	-	0.33	-	
Rivula atimeta						
Leaffolders					0.33	
Oxya spp., others		2.67	1.33	2.33	1.33	
Predators						
Metioche, Anaxipha		1.00	1.00	0	0.66	
Ophionea		1.33	0.66	0	0	
Coenagrionids		4.00	3.67	2.00	9.00	
Cyrtorhinus lividipennis		0.66	0.66	1.33	3.33	
Micraspis		8.33	6.67	2.00	0.33	
Pardosa, other spiders		21.00	19.67	15.33	14.00	
Others		3.33	2.33	0.33	0	
Parasitoids						
Braconids		1.00	3.67	7.00	10.00	
Ichneumonids		0.66	0.66	0.33	1.33	
Dryinids		-	-	-	-	
Others		2.00	4.33	3.67	3.00	

Table 13d. Summary of mean no. of arthropods in rainfed lowland ricefields of IPM CRSP farmer cooperators in San Jose, Nueva Ecija, wet season 1995. (based on 3 replications for each farmer's field)

ARTHROPODS	MEAN NO. OF ARTHROPODS/30 SWEEPS					
	Pests		Predators		Parasitoids	
	30DT	45DT	30DT	45DT	30DT	45DT
Palestina						
Rodrigo Bautista	11.99		5.99		1.99	
Encarnacion Rafael	27.65		55.99		6.67	
Aida Fajardo		72.98		80.66		14.34
Abar 1st						
Alfredo Pascua	84.67	77.99	38.66	27.99	13.66	10.67
Emil Aquilo	22.99	18.32	25.66	41.67	5.66	6.00
Edna Rigos	43.32	71.66	48.66	48.01	9.66	13.33
Sto. Tomas						
Leonardo Flores		28.88		39.65		3.66
Domingo Hipolito	27.99	99.31	34.66	20.99	8.66	11.00
Milagros Salazar	98.32		27.32		14.33	

Table 14. Fertilizer inputs, % stemborer WH/hill and rice yields in IPM CRSP farmer-cooperators' rainfed lowland transplanted rice, wet season 1995.

Farmer Cooperator	Variety	Fertilizer (kg/ha)			Time Applied (DT)	% YSB WH/hill	Yield (t/ha)
		N	P	K			
Barangay Palestina							
1. Rodrigo Bautista	IR64	90	21	21	15	0.81	4.95
2. Resituto Estabillo	IR64	43	53	0	15	0.61	5.40
3. Aida Fajardo	IR64	14	14	14	35	2.86	2.60
4. Encarnacion Rafael	IR64	71	43	15	10	1.36	5.20
		6	7	0	25		
Barangay Abar 1st							
5. Roberto Domingo	IR64	42	0	0	25	0.80	3.70
6. Alfredo Pascua	IR64	43	14	14	15	1.41	4.10
7. Emil Aquilo	IR64	90	21	21	15	1.10	4.95
		113	21	21	40		
8. Edna Rigos	IR64	33	42	0	15	1.99	3.00
Barangay Sto. Tomas							
9. Domingo Hipolito	Rc14	60	14	14	12	1.30	3.40
		17	0	17	36		
10. Bartolome dela Cruz	IR64	82	38	28	15	2.38	2.70
11. Leonardo Flores	Rc10	40	50	0	20	2.15	4.30
12. Milagros Salazar	IR64	9	9	9	Basal	no data	3.54
		120	28	28	10		

Table 15. Rice diseases observed from IPM CRSP farmer cooperators' rainfed lowland ricefields, WS 1995, San Jose, Nueva Ecija.

BARANGAY/FARMER	VARIETY	DISEASES OBSERVED
Palestina Rodrigo Bautista	IR64	Narrow brown leaf spot*
Aida Fajardo	IR64	Rice blast**
Encarnacion Rafael	IR64	Narrow brown leaf spot*
Abar 1st Roberto Domingo	IR64	Sheath blight**, Rice blast*, Narrow brown leaf spot**, Bacterial leaf streak*
Alfredo Pascua	IR64	Sheath blight, Rice blast
Emil Aguilo	IR64	Sheath blight**, Rice blast*
Edna Rigos	IR64	Sheath blight*, Rice blast, Bacterial leaf streak*, Leaf scald*
Sto. Tomas Domingo Hipolito	RC14	Sheath blight***, Rice blast***, Leaf scald**
Bartolome dela Cruz	IR64	Sheath blight**, Narrow brown leaf spot*
Leonardo Flores	RC10	Sheath blight***, Bacterial leaf blight*, Bacterial leaf streak*, Leaf scald*
Milagros Salazar	mixed	Sheath blight*, Rice blast***, Leaf scald*

Disease incidence: * = Low, ** = Intermediate, *** = High

Table 16. Sheath blight disease severity in rainfed lowland rice in San Jose, 1995.

SITE / FARMER	FARMER'S PRACTICE	RICE VARIETY	DISEASE RATING*
Palestina			
R. Bautista	Rice hull burning	IR64	none
A. Fajardo	Rice hull burning	IR64	none
E. Encarnacion	Rice hull burning	IR64	none
Abar 1st			
E. Rigos	Straw mulch	IR64	1
A. Pascua	Straw mulch	IR64	2
P. Puerto	Straw mulch	IR64	2
E. Aguinaldo	Straw mulch	IR64	2
Sto. Tomas			
D. Hipolito	Straw mulch	PSBRc14	4
L. Flores	Straw mulch	PSBRc10	6
M. Salazar	Straw mulch	mixed	1
B. dela Cruz	Straw mulch	IR64	2

*Rating scale: 1-3, Resistant; 4-6, Intermediate; 7-9, Susceptible

Table 17. Average number of *M. graminicola* from 3 gm of roots of different field crops.

FAMILY/SPECIES	CULTIVAR	Nematode Count/ 3 gm roots
Alliaceae		
Allium sativum	Garlic (Ilocos white)	150 ns
	Garlic (Batangas)	161 ns
	Garlic (Laguna)	329 ns
Cucurbitaceae		
Cucumis sativus	Cucumber (Pilmaria)	1 *
	Cucumber (Cu 6)	5 *
Cucurbita moschata	Squash (La Preciosa)	1 *
Lagenaria siceraria	Bottle gourd (1042-1)	320 ns
	Bottle gourd (Tambuli)	1 *
Luffa cylindrica	Patola (Talisay)	1 *
Momordica charantia	Bitter gourd (Sta. Rita)	4 *
Cruciferae		
Brassica pekinensis	Pecahy (Pavo)	4678 ns
	Pechay (B. Behi)	6579 ns
Brassica chinensis	Chinese cabbage (Corazon)	5007 ns
Brassica napiformis	Mustard (Chinese)	6762 ns
Raphanus sativus	Radish (60 days)	7 *
Graminae		
Oryza sativa	Rice, UPLRi5 (Control)	8768 -
Triticum sativum	Wheat (CM 47369-5)	371 ns
	Wheat (SWM 4871-1)	6047 ns
	Wheat (UPL W-2)	7377 ns
	Wheat (WNTA #7)	7382 ns
	Wheat (WNTA #1)	9291 ns
	Wheat (C676-4)	11285 ns
	Wheat (UPL W-3)	11437 ns
	Wheat (C1667-4)	12345 ns
	Wheat (Acc. 43686)	28061 **
	Wheat (Acc. 51001)	28297 **
Zea mays	Corn (IPB Var 1)	2*
	Corn (Yelllow CN 2)	5*

Table 17. Continued . . . . .

FAMILY/SPECIES	CULTIVAR	Nematode Count/ 3 gm roots
Leguminosae		
Arachis hypogaea	Peanut (?)	1 *
	Peanut (IPB PN 82-82-25)	1 *
	Peanut (IPB Pn 82-70-64)	1 *
	Peanut (IPB Pn 82-71-26)	2 *
Cajanus cajan	Pigeon pea (Melchores)	0 *
Glycine max	Soybean (PI 459024)	2846 ns
	Soybean (TK # 5)	5087 ns
	Soybean (PI 230970)	6060 ns
Phaseolus limensis	Lima beans (J. Wonder)	54 *
Phaseolus vulgaris	Dry beans (PAC - 3)	3 *
	Snap beans (BSU selection #1)	6 *
Pisum sativum	Garden Pea (BSU)	4988 ns
	Garden Pea(Chinese darkgreen)	13275 ns
Psophocarpus tetragonolobus	Winged bean(Batangas,medium)	11291 ns
Vigna radiata	Mungbean (M 350)	14 *
Vigna sinensis	Bush sitao #3 (Light green)	0 *
	Bush sitao #6 (Dark green)	4 *
	Pole sitao (Tender long)	0 *
	Pole sitao #1 (Dark green)	0 *
	Pole sitao (PSB-PS1)	17 *
Vigna unguiculata	Cowpea (CES 18-6)	1 *
	Cowpea (CCD-8)	3 *
Malvaceae		
Hibiscus esculentus	Okra (4025 B)	17 *
	Okra (Smooth green)	327 ns
Solanaceae		
Capsicum frutescens	Pepper (Yolo wonder)	6 *
Lycopersicon esculentum	Tomato (Marikit)	1632 ns
Solanum melongena	Eggplant (Dumaguete L.P.)	1 *

** = significant at 1% level (LSD = 11417)
* = significant at 5% level (LSD = 8675)
ns = not significant

Table 18a. Samples for nematode studies from farmers' rainfed lowland ricefields, WS 1995 (October, 1995), San Jose, Nueva Ecija.

Field No.	Sample No.	Barangay/Farmer	Variety	Growth Stage
		Palestina		
1	1	Rodrigo Bautista	IR64	Stubble (2 weeks)
2*	2*	Restituto Estabillo*	IR64	Stubble (2 weeks)
3*	3*	Aida Fajardo*	IR64	About to harvest
4	4	Encarnacion Rafael	IR64	Stubble (2 weeks)
5	5	Romeo Abella	IR64	Stubble (2 weeks)
6*	6*	Danny Ondovilla*	IR64	Stubble (2 weeks)
		Abar 1st		
7	7	Roberto Domingo	IR64	About to harvest
8	8	Alfredo Pascua	IR64	Nov. 8 harvest
9	9	Emil Aquilo	IR64	Stubble (1 week)
10	10	Edna Rigos	IR64	Nov. 15 harvest
		Sto. Tomas		
11	11	Domingo Hipolito	RC14	About to harvest
12	12	Bartolome dela Cruz	IR64	Stubble (1 week)
13	13	Leonardo Flores	RC10	Stubble (1 week)
14	14	Milagros Salazar	IR64	Flowering sstage
15	144	Ed de Guzman	IR64	Stubble (1 week)
		San Agustin		
16*	15*	Jose Abellera*	IR64	About to harvest
17*	16*	Marcelino Lazaga*	IR64	About to harvest

* = Fields burned after rice; to be planted to Yellow Granex onion; others with Red Creole onion

Table 18b. Average number of plant parasitic nematodes from rice root and soil samples collected from farmers' fields, in transition from rice to onion, San Jose, Nueva Ecija, Oct 1995.

Field No.	NUMBER/3 GM ROOTS*			NUMBER/200 CC SOIL*			
	Meloido-gyne	Hirsch-maniella	Praty-lenchus	Meloido-gyne	Hirsch-maniella	Helicoty-lenchus	Cricone-mella
1	11	10	0	0	1	0	0
2	63	0	0	0	0	0	0
3	14	2	0	0	1	0	0
4	13863	0	0	2	3	0	0
5	779	3	0	16	3	0	0
6	369	0	0	0	0	0	0
7	3120	29	1	1400	66	43	2
8	17640	10	1	23	14	10	1
9	6080	0	0	89	3	29	0
10	8480	1	0	58	19	7	1
11	44	0	0	2	3	7	0
12	7940	0	0	1050	4	2	0
13	67	0	0	3	14	8	0
14	53	4	1	9	2	0	0
15	20	4	0	1	17	0	0
16	2046	0	1	39	0	1	0
17	8660	0	0	429	0	1	0

Table 19. Weeds and their dominance ratio (%) in IPM CRSP farmer cooperators' rainfed lowland ricefields, 1995 wet season, San Jose, Nueva Ecija.

Weed species	Sto. Tomas		Abar 1st		Palestina	
	[a]Early	[b]Mid	[a]Early	[b]Mid	[a]Early	[b]Mid
GRASSES						
Echinochloa glabrescens	5.53	44.41	27.74	10.51	0	16.31
Paspalum distichum	2.94	0	1.31	2.52	3.71	8.17
Eleusine indica	5.88	0	0	0	0	0
Ischaemum rugosum	0	0	0	24.53	17.84	0
Oryza sativa (red rice)	0	0	0	0	9.85	22.29
SEDGES						
Cyperus rotundus	16.97	26.32	14.88	7.61	23.02	43.29
C. iria	3.85	0	7.64	3.24	9.41	10.12
C. difformis	15.59	0	0	0	0	0
C. compressus	0	0	0.79	3.05	0	0
Fimbristylis miliacea	0.41	0	0	0	0	0
BROADLEAVES						
Ludwigia octovalvis	21.93	29.27	5.16	4.93	1.67	0
L. perennis	0	0	0.57	3.03	0	0
Sphenoclea zeylanica	5.63	0	21.64	6.28	31.08	0
Ipomoea aquatica	1.19	0	0	0	0	0
Trianthema portulacastrum	20.08	0	0	0.99	0	0
Eclipta prostrata	0	0	3.13	1.53	3.42	0
Monochoria vaginalis	0	0	15.29	22.35	0	0
Phyllanthus amarus	0	0	0.81	0.99	0	0
Ipomoea triloba	0	0	0.19	0	0	0
Hedyotis biflora	0	0	0.85	6.62	0	0
Commelina diffusa	0	0	0	0.69	0	0
Alternanthera sessilis	0	0	0	1.11	0	0

a =Taken during 30-45 days after transplanting (DAT); b =Taken during 60-70 DAT

Table 20a. Average area planted to rice and onions in selected barangays, San Jose, Nueva Ecija, WS 1994 and DS 195.

Area (in hectares)	IPM CRSP Barangays	Non-IPM CRSP Barangays	Both Groups
Area planted during WS 1994	1.78	1.51	1.65
Area planted during DS 1995	1.28	1.04	1.17
Area planted to Onions	0.69	0.68	0.68
Area planted to Rice	0.54	0.33	0.44
	IPM CRSP BARANGAYS		
	Sto. Tomas	Palestina	Abar 1st
Area planted during WS 1994	2.61	1.47	0.86
Area planted during DS 1995	2.25	0.80	0.38
Area planted to Onions	1.04	0.54	0.32
Area planted to Rice	1.19	0.17	0

Table 20b. Onion yield in selected barangays, San Jose, Nueva Ecija, DS 1995.

VARIETY	YIELD (Kg/ha)		
	IPM CRSP Barangays	Non-IPM CRSP Barangays	Both Groups
Tanduyong	7,746	10,095	8,725
Yellow Granex (Sibuyas na Puti)	7,547	23,497	15,522
Red Creole (Sibuyas na Pula)	17,500	-	17,500
Batanes	10,440	8,043	9,641
Giant Batanes	10,375	15,700	13,925

Table 21. Hired labor inputs in onion production (person/ha), San Jose, Nueva Ecija.

	1993-94			1994-95		
	Total	Female	%	Total	Female	%
Hired Labor						
Seedbed	10					
Mulching	8			8.0		
Planting	50.0	36	25	64.0	40	17
Sorting (incl. planting of pepper)	18.0	18	12	22.5	15	15
Insecticide spraying	1.5			1.5		
Weeding	8.0	86	25	25.0	11	
Piling/Hauling	9.0			36.0		
Harvesting	40.0	30	21	80.0	60	25
Total person days	144.5	92	64	237.0	140	59

PENN STATE

Overview of Entomology, Plant Pathology, and Nematology Activities in the Philippines IPM CRSP Site

Investigator: Edwin G. Rajotte, Penn State University

II. COLLABORATING SCIENTISTS

Taiwan (AVRDC): N.S. Talekar; **U.S.**: J. Litzinger, S.K. De Datta, G. Norton; **Philippines**: A. Baltazar, J. M. Casimero (Weeds); V. Gapud, D. Arida, E. Martin (Entomology); L. Sanchez, A. dela Cruz, J. Rillon, G. Amar, N. Orolaza (Plant Pathology); L. Sanchez, M. Costello, J. Prot, E. Gergon, D. Mathias (Nematology); S. Francisco, I. Tanzo (Socio-economics)

III. SUMMARY OF RESEARCH RESULTS

This report summarizes my activities for the IPMCRSP in 1994 and 1995. It is primarily a summary of the project from October 1994 to September 1995, but also alludes to activities in the 1995-96 growing season which is just beginning. My role in the CRSP is assistant site coordinator for the Philippines site and entomologist.

As assistant site coordinator part of my role is to help coordinate the experimental portions of the IPM research as well as act as a source of entomological expertise. In this section I will briefly summarize project activities as part of my coordinator role. At this point in the project we are well into the surveillance activities which include documenting the severity and range of pest problems in rice and vegetables. As part of this surveillance certain critcal problems have been described and need to be addressed. These include:

Nematodes (from a report by PhilRice staff)

Preliminary assessment of the onion farmers' fields revealed that most fields were infested with various degrees of rootknot nematode (*Meloidogyne* spp. probably *graminicola*), the same species infesting rice under irrigated lowland and rainfed conditions. Under these circumstances (where there is a continuous rice-vegetable system which simulates a rainfed area, and under which *M. graminicola* thrives best), it seems that the nematode population has become endemic in the area at this point in time, and may in the future, reach epidemic proportions.

IRRI collaborators, surveying rice fields in Nueva Ecija found other nematode species also. Besides *Meloidigyne* the most numerous species included *Hirschmaniella, Helicotylenchs* and *Pratylenchus*. A general survey of vegetables in the same region showed measurable nematode infestations on a broad variety of vegetables including garlic, cucumber, squash, bottle gourd, patola, bitter gourd, pechay, chinese cabbage, mustard, radish, soybeans, peas, winged bean, okra, pepper, tomato and others.

Surveys of nematodes in different cultural conditions also showed that they were widespread. Varying infestations were found in straw mulched and burned rice hull fields indicating that these practices may have no effect on nematode management.

Insects

Spodoptera

The armyworm (*Spodoptera*) is a pest that feeds on a number of vegetable species. In our work it is mainly a pest of onions and beans. We are trying a number of control approaches which, if proven and adopted, could reduce yield loss and pesticide use. One approach is the use of pheromone traps to monitor population changes. Presently, farmers spray insecticides partly because they are not sure whether a pest is threatening or not. Pests are not always a threat nor do pests invade at precisely the same time year after year, so there are some opportunities to refrain from pesticide use if these non-threatening situations could be determined with some degree of accuracy. By trapping male moths with an artificial sex lure (pheromone), pest invasion timing can be pinpointed. To date several component mixtures of pheromone chemicals have been tested and promising mixtures will go into field testing the next growing season.

Another non-chemical approach that will be in trial is planting a castor bean trap crop in the vicinity of the vegetable crop. According to Dr. Talekar who has observed this practice in India, the trap crop will attract the armyworms early in their flight where they can be sprayed without getting insecticide residues on the marketable crop. By carefully managing sprays, the trap crop also affords biocontrol agents a better chance to establish. This approach will be tested in small plots behind the PhilRice station in the next growing season.

Biocontrol offers another avenue of control that could be tested, and surveillance studies have turned up some parasitoids. Cooperator onion fields as well as our small plots will be monitored for parasitoids.

Dr. Talekar is also participating in testing onion cultivars for *Spodoptera* resistance. Some resistance to *S. exigua*, a closely related species, has been found in AVRDC testing.

Thrips

Thrips are probably the most wide spread insect pest of onion, however, their specific effect on yield and hence their true economic importance, has yet to be determined. Surveillance in the last growing season determined that there were large numbers of thrips in many export-destined onion fields. In the coming growing season various trapping methods will be tried. These include blue sticky cards and chemical lures.

Maruca pod borer

Some preliminary observations of *Maruca* have been made in stringbean fields. The most significant results revolve around the discovery of parasitoids in some of the collected larvae.

Eggplant fruit and shoot borer

In eggplant, according to our surveillance studies over the past season, the most significant pest is the eggplant fruit and shootborer (EFSB). In worst case situations this pest is sprayed 30-50 times in a single season. We think that better spray timing information can help reduce sprays especially in the beginning of the growing season. To this end, pheromone tests, similar to those described for *Spodoptera* above, are being carried out. Moreover, several parasitoids have been found for EFSB also.

Diseases

Several plant pathology research activities were carried out in the spring of 1995. Preliminary assessment of the onion farmers' disease problems revealed that several onion fields had symptoms typical of rotting pathogens, but only in the Red Batanes variety. Soil and plant samples were collected for isolation in the laboratory and identification of causal organisms. To this point *Alternaria* spp., a bulb rotting fungus has been identified.

Pepper and eggplant diseases include the scattered incidence of powdery mildew and possibly bacterial wilt *Pseudomonas solanacerum.*

In the next growing season closer attention will be paid to diseases of the seedbed where substantial loses may be occurring due to soil borne diseases.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. *Research Objectives for Reporting Period*

1. Surveillance of arthropod disease and weed pests and natural enemy occurrence within and between the crops in rice-vegetable systems in Nueva Ecija.
2. Determing the potential for use of NPV and *Bt* for *Spodoptera* in onions and stringbeans
3. Development of measuring methods for *Maruca* pod borer and eggplant fruit and shoot borer

B. *IPM Constraints*

1. Most research and extension work in central Luzon has revolved around rice production and protection. As vegetables become a more important part of the local economy, similar efforts need to be made in the new crops. Basic knowledge of pest complexes, timing, biocontrol agents and many other basic aspects of the pest situation need to be determined. Only then can rational management approaches be tried.
2. Local pest management decisions are made in the context of several factors outside of the farm gate. These factors include economic and social policy, community-based attitudes and traditions and local business relationships. Pest management approaches that do not take these forces into account may find themselves to be irrelevant.
3. Education and communications will quickly become inadequate as more sophisticated pest management approaches become available and are demanded. Most of the tactics being researched in IPMCRSP are information-based approaches. Results of the research, in order to be properly utilized, must be accompanied by education programs and rapid information systems. In the absence of these accompanying efforts, the benefits of the research may not be fully realized.

V. RESEARCH APPROACH AND OUTPUT

Field Site Description

The field sites include several farmers' field in Nueva Ecija, Philippines specifically in barangay around the city of San Jose. These plots are maintained by the farmers and periodically monitored by project personnel from PhilRice. In many cases, farmer implemented practices such as rice hull burning and mulching are manipulated to test IPMCRSP hypotheses. In the next year, farmer field observations will be augemented with small plot experiments at the PhilRice station.

Research Results

Surveillance activities resulted in many observations that allowed us to create hypotheses for field testing in the 1995-6 growing season. These results are outlined above.

VI. NETWORKING ACTIVITIES

Trips

Spring 1995

I visited the Philippines site in February, 1995. On the way I stopped in Taiwan to visit Dr. Talekar at the Asian Vegetable Research and Development Center (AVRDC). Dr. Talekar and I discussed various entomological projects and details that were on-going in the Philippines site. He also gave me a tour of AVRDC so I could appreciate the facilities and expertise offered there.

I joined Drs. Norton, Litzinger and Gebrekidan in Manilla. In addition to our normal CRSP activities at PhilRice and IRRI, we also addressed the Philippine Organic Farmers Association convention and consulted with representatives of the floriculture industry concerning pest management technology and the activities of the CRSP.

Establishment of bibliographic service

The demand for published information about crop and pest problems in the Philippines and other sites prompted us to establish a bibliographical service for the IPM CRSP. Moreover, many of the crops and pests are common to several of the sites so a centralized literature seaching facility should be very efficient. The service includes searching bibliographical databases by request. Maintaining an electronic database specifically for the CRSP and communicating the results of bibliographic analyses to all CRSP cooperators.

Bibliographic searches are made at the request of CRSP scientists and staff. A request form has been distributed to each site and cooperator. The form asks for search subject, key words and other information that will help narrow the search. Searches take place through the Penn State Library, but databases around the world can be accessed. When search results are obtained a report is sent to the requestor. The report lists publications pertinent to the search parameters. In return the requestor may ask for copies of the actual literature which will be provided also. The references obtained in the search are also entered into an IPM CRSP electronic bibliographic database using the software Endnote Plus, and any papers requested are copied and filed at Penn State also. The end result is that Penn State has a growing repository of literature pertinent to IPM CRSP projects. This literature is

available to all sites no matter who requested it. Another portion of the service allows us to electronically update literature files at each site. For example, we purchased a copy of Endnote for the Philippines. We periodically send computer files to be added to Endnote. That way the Philippines site has a locally searchable literature database that improves with each request made from any site. This system can also be set up in the other sites if requested.

VII. PUBLICATIONS AND PRESENTATIONS

IPM CRSP activity presentation to the Philippines Organic Farmers Association Convention.

VIII. TRAINING OUTPUT

Jessica committee

I served on the graduate committee of Jessica Tjornholm who completed her degree in 1995 at Virginia Tech. This service included acting as an advisor on the biological aspects of her economic analysis of the Philippines IPM situation.

Nematode Training

Given the discovery of widespread nematode infestations in rice and vegetables in Luzon and the lack of nematological facilities at PhilRice, part of John Halbrendt's activity on his sabbatical will be to improve the capacity for PhilRice to research nematode problems. Part of this effort will include training of PhilRice staff by Dr. Halbrendt in collecting, sorting, identifying and controlling nematodes.

IX. PROJECT HIGHLIGHTS

Key results

Key results of the project so far have included establishing a good working relationship with our research partners in the Philippines and organizing a logical approach to IPM research in Luzon. The first part of this research approach involved familiarizing everyone with the farming system of Luzon and methodically surveying the pest problems faced by the farmers of the region and what their current pest control practices have been up to the present. Along with the expected insects and disease problems we found some significant problems that were not widely recognized locally.

Nematodes

Nematodes were found in abundance on a wide variety of vegetable crops and rice and appeared to be a pest that could cause crop loss if left unchecked. In response to this problem several labs in the Philippines began surveying widely for nematode problems and documented the species involved and the extent of the problem. A major effort towards studying the nematode problem was arranging for a five month sabbatical leave by an experienced nematologist to work on this problem at PhilRice and train PhilRice staff in research techniques for nematodes. This sabbatical began in early November, 1995 and will continue until the end of March, 1996 which coincides with the vegetable growing season in Luzon.

Diseases

Onion bulb and seedling rotting fungi were found to be significant in preliminary surveys of onion fields. Infestations, especially in seedbeds caused the loss of many seedling before they could be transplanted to the field. Since these are soilborne fungi, the management of the seedbed has to be manipulated to prevent these diseases. This will be one of the focusses of research over the next several months.

Potential for pheromone use

Pheromones have potential at least as monitoring tools for both *Spodoptera* and the eggplant fruit and shoot borer. Better monitoring will mean better predictablility concerning the timing of pest infestation which will afford the farmer the opportunity to eliminate pesticides sprays when the pests are not a threat. In the past pesticides were overused because the farmer was not sure if the pest was invading or not and he sprayed just in case.

Bibliography service

As explained above, the bibliographic service should provide a CRSP-wide resource that will improve with every search requested. Potentially, all sites could have electronically searchable literature databases at the local level.

VIRGINIA TECH

Evaluate Economic, Social and Gender Impacts of Pest Management Alternatives.
Document and Extend the Farmer Baseline Survey
Socio-Cultural Beliefs and Perceptions and Other Factors Affecting Pest Management Practices in the Vegetable Rice System.

Investigator: Revathi Balakrishnan, Virginia Tech

II. COLLABORATING SCIENTISTS

K.L. Heong, T.Paris, I. Tanzo, G. Norton, and P. Pingali

III. SUMMARY OF RESEARCH RESULTS

During a visit coordinated with SANREM CRSP activities, I met with Mrs. T. Paris and her research assistant who have indicated to me that participatory research is in progress. As per Dr. Norton's July Trip Report, they have completed the PA and doing analyses. Fed interviews with selected few women farmers are also in progress. The preliminary PA results from Rice-Vegetable Systems in Cabanatuan, Nueva Ecija, Philippines are summarized below.

Activities which are power-intensive (land preparation, threshing etc.) are done exclusively by men while control-intensive activities which require manual dexterity and judgment (transplanting, weeding onion fields, sorting onion seedlings, harvesting, grading onions) are predominantly done by women. Women's crucial roles in rice-vegetable farming are manifested as their responsibilities in managing the household budget, raising credit from informal sources for both farm and household use and making decisions related to the marketing of onions and vegetables. In general men spray chemicals. But women can identify the symptoms of certain pests and relate the occurrence of pests to irrigation. Most women are aware of the prevalent pests in rice and onions and are aware of harmful effects of the misuse of pesticides. They support adoption of alternative methods of pest control in onion crops as a measure to decrease production cost to the end benefit of increase in economic returns. In general women are not knowledgeable about IPM in vegetables. Women's participation increases with cropping intensity. A rice-vegetable system is very labor intensive, particularly for tasks such as weeding, sorting of onion seedlings, harvesting, and grading onions. Onion-chilies inter-cropping system requires intensive labor. For poor and landless women, the important sources of income are planting, weeding, and harvesting operations. Two companies have introduced alternative marketing system which provides the inputs and technical advice, and the farmers are assured of ready market. But in reality farmers find it difficult to dispose the onions which do not meet the size standards set by the company.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. *Research Objectives for Reporting Period*

1. Evaluate project impacts of IPM practices on household income, labor use, economic benefits to society, welfare distribution by gender, and other factors.
2. Establish the baseline data on the socio-economic characteristics of the farmers an for follow-up technical questions. The data including the socio-economic and gender variables will be used in analyses of factors affecting pesticide use and misuse.
3. Identify attitudes, perceptions, and indigenous knowledge influencing adoption of pest management practices.

B. *IPM Constraints*

Socio-economic constraints, such as gender and social class, differentiated access to resources and information influence adoption of IPM strategies.

V. RESEARCH APPROACH AND OUTPUT

I anticipate that the Philippines Site Coordinator's report will provide the needed information for these activities.

Research Methods

Participatory approaches and survey methods.

VI. NETWORKING ACTIVITIES

1. Travel to Philippines to meet with IRRI gender research scientists in March 1995 (Coordinated with SANREM CRSP activities).
2. Reviewed research work completed by IRRI research assistant.
3. Mrs. T. Paris, her research assistant and Mrs. Tanzo were invited to participate in Participatory research forum organized under the auspices of SANREM CRSP.

A. *Workshops Attended*

Attended IPM CRSP Workplan workshop in May 1995.

B. *Research Investigator Exchanges*

None

C. *Research Information and Product Exchange*

Research graduate student has developed a preliminary IPM bibliography for the site.

VII. PUBLICATIONS AND PRESENTATIONS

None

VIII. TRAINING OUTPUT

A US graduate student in agricultural economics at MS level is supported and focuses on the Mali site.

IX. PROJECT HIGHLIGHTS

- PA completed.
- Two focus surveys completed.
- Men do exclusively the activities which are power-intensive (land preparation, threshing etc.).
- Women carry out control-intensive activities which require manual dexterity and judgment (transplanting, weeding onion fields, sorting onion seedlings, harvesting, grading onions).
- Women's participation increases with cropping intensity.
- Most women are aware of the prevalent pests in rice and onions and are aware of harmful effects of the misuse of pesticides. But are not knowledgeable about IPM in vegetables.
- Women support adoption of alternative methods of pest control in onion crops as a measure to decrease production cost to the end benefit of increase in economic returns.
- Two companies have introduced alternative marketing system which provides the inputs and technical advice, and the farmers are assured of ready market. But in reality farmers find it difficult to dispose the onions which do not meet the size standards set by the company.

Document and extend the Farmer Baseline Survey
Access policies, socio-cultural beliefs and perceptions, regulations, and other factors affecting pest management practices in the rice-vegetable system
Evaluate economic, social, and gender impacts of pest management alternatives

Investigator: George Norton, Virginia Tech

II. COLLABORATING SCIENTISTS

T. Paris, V. Gapud, R. Balakrishnan, I. Tanzo, A. Rola, S. Francisco, J. Tjornhom

III. SUMMARY OF RESEARCH RESULTS

The results of our baseline survey of 300 farmers in six villages in our San Jose site were summarized, analyzed, and presented as IPM CRSP Working Paper No. 2 (Lazaro, et. al., 1995). The baseline survey obtained information on farmer perceptions of pests and natural enemies and identified current pest management practices. Farmers' knowledge of pests and natural enemies, particularly in vegetables, was found to be limited. Pesticides were virtually the only pest control tactics used in vegetables and farmers considered pesticides to be effective at controlling pests. Farmers perceived that early spraying was necessary and would increase yields.

A follow-up baseline survey of 228 of the original 300 farmers was completed in March-April 1995 to gather information on socio-economic and other characteristics affecting pesticide and pest management practices (Tjornhom, et. al., 1995). Farmers in the San Jose area have a relatively high level of education which should help them respond to IPM training. Most are male, many own their own farms, and almost half belong to an organization such as a cooperative or village association. Over seventy percent received credit (from a variety of sources), and almost seventy percent had been exposed to IPM through a Farmer Field School on rice or through an agricultural technician.

The results of the two baseline surveys were used to conduct a logic analysis of factors affecting pesticide misuse on vegetables. Among the factors particularly influential in increasing misuse were contacts by chemical company representatives, membership in farm organizations, visits by an agricultural technician, and use of credit. Education, access to a Farm Field School, age of farmer, and perceptions that killing natural enemies increases pest infestations all reduce the likelihood of misuse. Details of the misuse analysis are found in the masters thesis by Tjornhom, 1995. A draft manuscript has been prepared that summarizes the study.

An analysis of the effects of Philippine tariffs, exchange rates, and credit policies on the degree of pesticide subsidies or taxes (and, hence, incentives to adopt IPM) also was completed as part of the masters thesis. The net effect of tariffs, which tax pesticides in the Philippines, and the over-valued exchange rates, which subsidize pesticides, was to subsidize pesticide use approximately six to eight percent. This relatively small subsidy should not post a major constraint to IPM adoption.

Two other information gathering activities were undertaken during the year with analysis to occur in year 3. The first of these activities was a follow-up participatory appraisal (PA) focused on women farmers. The second was the first of three structured surveys of farmers to provide data for an analysis of the effects of land tenure, pesticide regulations, and other institutional factors on farm productivity, the demand for pesticides, and IPM adoption. The survey was administered to 75 farmers at the end of the vegetable season.

Other activities completed this year include: design of a scientist survey form for use in projecting economic impacts of IPM alternatives being developed on the CRSP and completion of an IPM CRSP Working Paper (site committee, 1995) that summarizes the PA conducted in year 2.

IV. OBJECTIVES AND IPM CONSTRAINTS

A. Research Objectives For This Reporting Period

- Identify factors influencing pesticide misuse on vegetables in the Philippines
- Analyze the effects of tariff, exchange rate and credit policies on the degree of pesticide subsidy or tax in the Philippines

B. IPM Constraints

- Social and economic factors constraining development and adoption of IPM programs and practices in the Philippines

V. RESEARCH APPROACH AND OUTPUT

A. Research Methods

Data from the first baseline survey of farmers' pest management practices were combined with data from the second survey of farmers' social and economic characteristics and logic analysis was conducted in which pesticide misuse (defined based on timing of applications) was regressed on the social and economic characteristics. This analysis allowed us to assess the relative importance of different factors that influence pesticide misuse.

Formulas for calculating the effective rate of protection and the equilibrium exchange rate were developed and used to assess the net subsidy or tax on pesticide used by vegetable farmers in the Philippines. Data were collected on quantities and prices of pesticide and technical imports, retail prices of pesticides, exchange rates, and several other variables necessary to complete the calculations.

Data from the second baseline survey were also used to assess the importance of Land Bank policies influencing incentives to adopt IPM as a result of a requirement for farm plans that include pesticides. Finally, a cost function model was developed and the first of three surveys of 75 farmers was conducted. Application of this model will allow for analysis of pesticide regulations on farm productivity and pesticide demand.

B. Research Results

Pesticide misuse on vegetables if positively associated with contacts by chemical company representatives, membership in farm organizations, visits by an agricultural technician, and use of credit. Education, access to a Farmer Field School, age of farmer, and perception that killing natural enemies increases pest infestations all reduce the likelihood of misuse.

The net effect of tariffs, which tax pesticides in the Philippines, and the over-values exchange rates, which subsidize pesticides, was to subsidize pesticides six to eight percent. From an economic standpoint this net subsidy provided economic gains to producers and consumers. However, environmental and health externalities associated with the pesticides undoubtedly increased as well due to the additional incentives for pesticide use. Six to eight percent is a relatively small subsidy, however, and should not prohibit adoption of non-chemical IPM practices.

C. Impacts

Identifying factors that influence pesticide misuse is the first step in designing policies and programs to reinforce factors that reduce misuse and nullify factors that increase misuse. The effects of Farmer Field Schools in rice on reducing pesticide misuse in vegetables implies a need for farmer training. Pesticide misuse can also be influenced through directly targeting the information provided by cooperatives, village organizations, and Department of Agriculture technicians. The results of our research will help focus our training efforts so we can realize the impacts from the IPM techniques developed on the project.

The exchange rate and tariff policies to a large extent offset each other. The implication is that the Fertilizer and Pesticide Authority can focus its efforts on regulating the most hazardous chemicals without undue interference from tax and subsidy policies.

VI. NETWORKING ACTIVITIES

- Helped plan and participate in the May workshop at Virginia Tech in which co-investigators on the project developed the year 3 workplan and budgets.

- Made two trips to the Philippines of one week (February) and two weeks (June) in duration to review progress on the project, discuss administrative issues, plan future research, collect data, and discuss our social service research component with co-investigators at PhilRice, UPLB, and IRRI.

VII. PUBLICATIONS AND PRESENTATIONS

A. Publications

Tjornhom, Jessica D., "Assessment of Policy and Socio-Economic Factors Affecting Pesticide Use in the Philippines," M.S. thesis, Virginia Polytechnic Institute and State University, Blacksburg, VA, September 1995, 135 pp.

Philippines Site Committee, "Participatory Appraisal for IPM Research Planning in the Philippines," IPM CRSP Working Paper 95-1, Virginia Polytechnic Institute and State University, Blacksburg, VA, September 1995, 130 pp.

Lazaro, A.A., K.L. Heong, B. Canapi, V. Gapud, and G.W. Norton, "Farmers Pest Management Knowledge, Attitudes, and Practices in San Jose, Philippines: A Baseline Survey," IPM CRSP Working Paper 95-2, Virginia Polytechnic Institute and State University, Blacksburg, VA, October 1995, 118 pp.

B. Presentations by George Norton

April 26, 1995, "Philippines Site Report: Progress in Year 1," presented to External Evaluation Panel meeting, Blacksburg, VA.

May 20, 1995, "Philippine Site Report: Progress in Year 2," presented to IPM CRSP workshop, Blacksburg, VA.

VIII. TRAINING OUTPUT

See Training Section below for description of two graduate students: Jessica Tjornhom and Leah Cuyno.

XI. PROJECT HIGHLIGHTS

In 1995, the IPM CRSP in the Philippines found that pesticide misuse on vegetables was increased by membership in agricultural organizations, by use of credit, by contacts with Department of Agriculture technicians and with chemical company representatives, and by lack of knowledge about natural enemies. Education, access to the Farmer Field School training program, and age all reduced pesticide misuse. The implication is that increased IPM training for farmers is needed as well as increased IPM training for Department of Agriculture technicians. This training needs to be focused on younger farmers.

The net effects of tariff and exchange rate policies in the Philippines are to subsidize pesticide use, but the subsidy is only six to eight percent and hence should not provide a major barrier to IPM adoption.

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 second year of its operation, this CRSP provided full or partial financial support for ten 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 second year, four of the ten students are from the four regions this CRSP is working in. All the graduate students do their research in our four regions.

One of the graduate students, Jessica Tjornhom, completed her training and submitted, to Virginia Tech, her M.S. thesis entitled "Assessment of Policies and Socio-Economic Factors Affecting Pesticide Use in the Philippines". A portion of Jessica's research has also been written as IPM CRSP Working Paper 95-3, "Farmers' Socio-Eonomic Characteristics and Attitudes Relevant to Pest Management in San Jose, Philippines". Two other IPM CRSP Working Papers based on graduate student research and written during the year are:

- IPM CRSP Working Paper 95-4, "IPM in Non-Traditional Export Agriculture in Guatemala: The Case of Chilasco, Baja Verapaz"
- IPM CRSP Working Paper 95-5, "Corn Stalks Influence Patchy Distribution of White Grubs in Broccoli Fields"

Both of these working papers are based on Anne Dix's research in Guatemala.

In the future, as the IPM CRSP investigators establish stronger linkages and identify more potential graduate students from the host countries, the number of foreign students is expected to increase. Six of the ten 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 seven and Lincoln University, Ohio State University, and the University of Georgia each has one graduate student.

Table 1. Year 2 (1994-95) IPM CRSP Student Training Participants

Student Name	*Sex*	*Nationality*	*Discipline*	*Site*	*Degree*
C. Haenchen	F	U.S.A.	Agronomy	Jamaica	M.S.
H. Morales	F	Guatemalan	Entomology	Guatemala	Ph.D
J. Mullen	M	U.S.A.	Ag Econ	Mali	Ph.D
J. Tjornhom	F	U.S.A.	Ag Econ	Philippines	M.S.
A. Dix	F	U.S.A.	Entomology	Guatemala	Ph.D
J. Amirault	M	Canadian	Horticulture	Mali	M.S.
S. Mwangi	M	Kenyan	Plant Pathology	Kenya	Ph.D
L. Cuyno	F	Philippines	Ag Econ	Philippines	Ph.D
Adam Russ	M	U.S.A.	Ag Econ	Mali,Philippines	M.S.
S. McDonald	F	Jamaican	Entomology	Jamaica	M.S.

Start Date	*Comp. Date*	*IPM Fund*	*CRSP 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	IPM in Horti- G. Welbaum	Virginia Tech cultural Crops
Jun. 95	Dec. 97	25%	H. Warren	Maize Diseases in Kenya	Virginia Tech
Aug. 95	Sep. 98	100%	G. Norton	Environmental Impacts in IPM	Virginia Tech
Jan. 95	May 96	100%	R. Balakrishnan	Gender Differential Constraints: Implications on IPM and Food Security	Virginia Tech
Aug. 95	Sep. 98	100%	F.W. Ravlin	IPM of Pepper Crops	Virginia Tech

LIST OF ACRONYMS

ADB	Asian Development Bank
AESP	Agricultural Export Services Project
AEZ	AgroEcological Zone
AGRILAB	Agriculture Laboratory
AID	Agency for International Development
ALCOSA	Alimentos Congelados, S.A.
ALTERTEC	Technología Alternativa
APHIS	Animal and Plant Health Inspection Service
ARF	Agricultural Research Fund
ASAP	USAID Agribusiness Project
AVRD	Asian Vegetable Research and Development
AVRDC	Asian Vegetable Research and Development Center
BoD	Board of Directors
BP	Bushy Park
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
CSREES	Cooperative State Research, Education, and Extension Service
DA	Department of Agriculture
DAS	Days after seeding
DRSPR	Department Recherche sur les Systémes de Production Rurale
EEP	External Evaluation Panel
EP	Ebony Park
EPA	Environmental Protection Agency
FAF	Faculty of Agriculture and Forestry
FAO	Food and Agricultural Organization of the United Nations
FY	Fiscal Year
GEXPRONT	Gremial de Exportadores de Productos No Tradicionales
GIS	Geographic Information Services
GRAT	Group for Research and Technical Application
GTZ	German Agency for Technical Cooperation
HAP	Hillside Agriculture Project
IARC	International Agricultural Research Center
ICIPE	International Center for Insect Physiology and Ecology
ICN	IPM Consultative Network
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
INRAN	Institut National des Agronomiques du Niger
INSAH	Institut du Sahel
INTSORMIL	Sorghum/Millet CRSP
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

MAAIF	Ministry of Agriculture, Animal Industries, and Fisheries
MARP	Méthode Accélérée de Recherche Participative
ME	Management Entity
MINAG	Ministry of Agriculture
MINAM	Jamaican Ministry of Agriculture and Mining
MOU	Memorandum of Understanding
MR	May River
MU	Makerere University
NARO	National Agricultural Research Organization
NCPC	National Crop Protection Center
NCSU	North Carolina State University
NET/AED	NIS Exchanges & Training Program Academy of Education Development
NIPMN	National IPM Network
NIS	Newly Independent States
NGO	Non-governmental Organization
NRM	Natural Resource Management
NSF	National Science Foundation
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
PL	Public Law
PPMP	Pest and Pesticide Management Project
PSU	Pennsylvania State University
PU	Production Unit
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
US	United States
USA	United States of America
USAID	United States Agency for International Development
USDA-APHIS-IS	USDA Animal & Plant Health Inspection Service-International Services
USDA/ARS	United States Dept of Agriculture/Agriculture Research Service
USDA/FAS	United States Dept of Agriculture/Foreign Agricultural Service
UWI	University of West Indies
WAT	Weeks After Transplanting
WWW	World-Wide Web