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SUMMARY

Integrated Pest Management (IPM) or Integrated Crop Protection (ICP) is a concept of managing pest populations. It is made up by many components, all of which taken together provide the knowledge and data base necessary to implement an ecologically sound pest management system. It does not eradicate the pest species but allows a population of these to exist at a very low level. It is a containment strategy, not an eradication strategy. IPM maximizes the effect of natural enemies (parasites, predators, pathogens) on the pest population and reduces the number of pesticide applications needed during the growing season. Chemical (pesticide) control is an integral part of an IPM system. The artificial control measures (cultural, chemical, etc.) are applied judiciously and only when economically and ecologically justified. However, chemical control is still the only alternative to some pests. IPM is effective in reducing the costs of crop production and can give long-term and effective pest control.

The team in its deliberations and judgment makes the following recommendations:

1. One of the basic principles for application of an IPM program is the positive identification of the causative agent—the

pest. CAP countries did not have a regional or national center where specimens could be sent for quick, accurate identification. The development of a centrally located, regional diagnostic center was of high priority.

2. In-depth training in the various components (entomology, plant pathology, weed science, etc.) of an IPM system was weak or lacking. Training and practical experience in integrated crop protection programs was for the most part nonexistent. RPMS-coordinated workshops and training programs have been beneficial in upgrading the level of knowledge in IPM strategies. There is a need to emphasize the integration of the IPM components--the team approach--for an effective IPM program. To correct this problem, continued and increased support for training programs, workshops and an IPM practical demonstration is recommended.

3. Research and field laboratories in the CAP countries visited were for the most part inadequate, short on operating funds, trained personnel, equipment and facilities. It is possible that extramural grants could be obtained to upgrade many of the facilities. The team recommends that the ministries and administrators be informed of the necessity of stability in operational funds and that assistance be given to them for the preparation of effective project proposals to other funding sources or for outright grants to the CAP countries seeking funds for IPM programs.

4. Enforcement of pesticide laws is nearly nonexistent. If crops grown in CAP countries are to be exported to the U. S., an understanding of the EPA pesticide regulations and tolerances

is essential. Training programs on pesticide use and management are recommended to reduce the wanton use of pesticides and excessive pesticide residues on export crops and crops consumed in CAP countries.

5. Technical information needed for crop protection programs was nonexistent or limited to one or two professional journals. An excellent library exists in CATIE that is accessible for a fee to outside researchers, teachers and fieldmen. However, the fees for reproduction of library materials are often beyond the resources of the CAP country scientists. The team recommends that this important source of information be more widely used and made available through the use of PL 480 funds or allocations of regional funds to CATIE for distribution of technical information.

6. An inventory of the pests in the CAP countries is needed. A list of 1500 insects attacking 40 food crops, presently available through Dr. Saunders of CATIE, is the first step toward an inventory of the pests (insects, weeds, plant diseases, nematodes, rodents, etc.) attacking food crops in CAP countries. Encouragement and support for publication of the list and a more comprehensive book on the biology and ecology of the insect pests are recommended.

7. Postgraduate in-depth training in IPM and its various components is available in many U. S. and Latin American institutions. Scholarships and grants to support outstanding CAP country students are limited. Other resources such as the East-West Center, United Nations, private foundations, etc., should be investigated.

8. The RPMS position was established three years ago to help develop a regional integrated crop protection program. A number of regional IPM workshops and training programs were developed and coordinated by the RPMS. These programs established a nucleus of energetic trainees and created an awareness within the region for IPM. Interest in integrated crop production has been expressed by ministers, researchers, teachers, extension agents and farmers. Some of the larger coffee and cotton producers, and technical personnel are reluctant to give it a try. However, the smaller farmer, who does not have the resources to purchase pesticides or pay for labor to trim his trees, is eager to try it.

Because of the low world market prices for coffee, cotton, sugar, etc., and the high costs of pesticides, fertilizers, etc., many farmers have been forced to change their farming practices. Banks are not financing loans to farmers because of the probability of losses. Large and small farmers are looking for economical alternatives for pest control and crop production.

In order to develop a regional IPM system, it is necessary to have the basic knowledge and understanding of the importance of integration of the various components of the crop production system. The cadre of nationals with training in IPM have not had a lot of practical experience and do not realize the total commitment of time and effort required to make it work. A strong leader to offer encouragement, guidance and assistance in the development of an IPM regional program is needed. The

RPMS who has had IPM research and practical experience is crucial to development and operation of an integrated crop protection program. The team recommends that the RPMS position be continued and perhaps become a permanent position in ROCAP.

INTRODUCTION

In Central America and Panama agricultural pests are a serious limiting factor in crop production. The control of these pests has depended almost entirely on pesticides. The excessive use of pesticides in rice, cotton, coffee and vegetables in CAP is well documented. The inflationary effect of oil price increases has made agricultural inputs costlier to the farmers to the point where their profit margin in many crops has dwindled to a negative value. In the case of coffee and cotton the profit realized three years ago has declined in the last two years, resulting in a negative balance in the export-import trade of the region.

CAP countries need to reduce the use of pesticides in order to maintain a profit margin in agricultural production. Integrated Crop Protection Methodologies (IPM) can contribute positively to the solution of the crisis faced by the region's agriculture. Gross estimates suggest that sound IPM practices in rice production alone in Panama could reduce to half the amount of pesticides used annually in this crop, representing more than $5 million in savings.

If IPM practices are established for crops that use pesticides excessively, CAP countries can save a good portion of the foreign exchange used to import pesticides. Hard currency savings in Costa Rica could amount to $5 million, while in Guatemala, El Salvador, Nicaragua and Honduras, IPM practices in cotton could save more than $30 million annually.

The introduction of new pests in the region, such as sugarcane smut and rust, the coffee bean borer, coffee rust, the coconut eriophyd mite in Costa Rica, is a problem of concern that could better be handled by the use of IPM methodologies.

The current misuse of pesticides and the magnitude of environmental contamination with its effects on animal and human health must be curbed. Establishment of IPM practices in the major agricultural crops of the region is environmentally sound and economically advantageous to every country.

Integrated Crop Protection involves many components which as a whole provide the technology and foundation for the implementation of ecologically sound and economically profitable pest management programs in agriculture. These components are:

1. Identification of problems in crop protection.
2. Research development directed at problem solving.
3. Technology transfer and delivery systems to effectively reach the farmer.
4. Adequate number of trained personnel to accomplish 1, 2 and 3.
5. The necessary equipment and supplies to provide back-up for components 1 through 4.

The delivery systems are the key to success in IPM methodology. Therefore, a sound extension program is necessary to convey new techonology to the farm sector and to relay new protection problems to the research component. Superimposed on these is the complex economic, social and political climate which when favorable can do much to provide the support needed to sustain IPM programs in LDC countries.

The national university system of CAP emphasizes the humanistic aspect of education to the detriment of science and technology. This

narrow approach shortchanges a student in agriculture in not providing him with sufficient background and technology to recognize and solve the problems at the farm level. Most of the universities of the region orginated as offshoots of church-related educational facilities during colonial times. The national universities began as law schools and developed their strength in the humanities. It was not until the decade of the 50's that room was made for the technical schools in fields such as agriculture.

The University of Costa Rica is the only national university that began as an agricultural faculty in 1930. The faculties of agriculture were created in Guatemala in 1950, in Panama in 1959, and in Honduras in 1968.

The land grant system of the United States, on the other hand, is over 150 years old. Curricula at all institutions visited are being evaluated and revamped to meet the challenges of today's agricultural technology. We hope greater emphasis will be placed on IPM specialties to meet future requirements in crop protection.

An organism is not a pest until it is proven to be a pest. Identification of the crop protection problems at the farm level is a serious constraint for the CAP countries. There is a lack of trained personnel and well-equipped diagnostic laboratories to confirm field diagnoses. The positive identification of the causative agent is basic to all sound IPM decisions. These weaknesses are primarily in the correct identification of insects, viruses, bacteria, fungi and nematodes. Weed problems are better known. Honduras lacks the national laboratories within the Ministries of Agriculture to identify plant pathogens or insect pests. Costa Rica, Guatemala and Panama have some laboratory facilities but improvements are needed.

A CATIE entomologist has compiled a list of insects which, although limited, covers some 1500 species that attack 40 different food crops in the region. About 10 percent of the insects are identified by the national staffs at the Ministry of Agriculture or University with three percent identified by CATIE. Most countries send specimens to the USDA Systematic Entomology Laboratory at Beltsville, Maryland, for identification. Living insects, nematodes, fungi, bacteria and viruses are not sent out for identification since quarantine regulations hamper free exchange of live biological material. It is more difficult to identify some fungi, bacteria, viruses, nematodes, etc., from dead material.

An inventory of the pests of economic crops for the region is of prime importance to the development of an IPM program. The insect list is a beginning, but weeds, plant pathogens, nematodes and other pests should also be included. The compilation of information on the biology, ecology and distribution of the pests in the CAP countries into a manual or book for researchers and field practitioners should be a long-term goal for the regional IPM program.

The need for a regional diagnostic laboratory to serve as a repository of information and a center for identification of pests for the region was clear.

There is a need for the integration of the various disciplines (entomology, plant pathology, weed science, nematology, etc.) of IPM for a dynamic successful program.

A crop is rarely confronted with a single pest problem, but more commonly a complex of pest problems--several kinds of insects, disease-causing organisms, nematodes, slugs, rodents and other pests attacking the plant. An understanding of the actions, interactions, and reactions

between the pests and the crop to be protected is necessary to develop a sound pest management system. For this reason it is obvious that there must be an integration of the pest control technologies for the various components of the agro-ecosystems. Recommendations for insect control should not evolve independent of plant disease or weed control. This lack of understanding of the importance of an integrated team approach in solving crop protection problems is evident in all countries, and is a serious deterrent to the development of viable IPM programs.

The great majority of the region's agriculturists refer to biological control of insect pests as IPM while in reality this is only one small component of IPM. Training and demonstration in the basic concepts of IPM is needed to illustrate the integration of disciplines and to convince them that IPM works.

In general, research support areas (facilities, equipment, supplies) were found to be poor and inadequate. Often transportation to support research crews was difficult or nearly impossible to obtain. If transportation was available, the lack of funds to purchase gasoline made the vehicles useless. Many vehicles and equipment were inoperative because they lacked spare parts. Upkeep of scientific equipment was inadequate due to the lack of technicians who could repair microscopes, chromatographs, centrifuges, etc. It is regrettable that an experiment should fail because the institution or agency could not afford gasoline or minor repairs of equipment. In addition, it appeared that some agencies were not interested in whether or not the researcher went to the field.

The data collected during the survey of the national and regional organizations and institutions, including availability of trained personnel, support available, research in progress and major pest problems of the

region, are presented below.

COSTA RICA

Costa Rica, with an area of 50,893.5 sq. km. and a population of 2.185 million, has a relatively low population density of 42.8/sq. km. It borders with Nicaragua on the north and Panama to the east. It is a mountainous country with both Pacific and Caribbean coastlines. Two mountain ranges comprise most of the central part of the country. Coffee rust and the coffee bean borer are not present in the country.

The leading export crops are coffee and bananas. Coffee is primarily grown by small farmers located in the mountainous central part of the country at elevations of 609-1371 meters. Bananas are grown primarily in the low coastal areas. Other important crops are rice, beans, cacao, peach palm and African oil palm. Domestic fruit crops include mangoes, oranges and papayas.

The livestock industry, beef and dairy cattle, is well-developed and considered to be among the best in Central America.

Costa Rica has an irrigation development scheme covering some 125,000 hectares in the flood plains of the Tempisque River province of Guanacaste. Most of this area will be used for sugar, sorghum, rice and corn; however, due to the irrigation, pests may become more serious in the dry season. The Minister of Agriculture and Animal Husbandry (MAG) is interested in IPM for its beneficial impact on the environment. He is also interested in the possible savings in exchange currency if pesticide imports are reduced as the result of IPM. It is hoped that IPM will be an essential part of this agricultural scheme.

Trained Personnel

Trained personnel (Appendix 1) in any of the IPM specialties are

relatively few with about one-half working in private industry as pesticide salesmen. Costa Rica has six Ph.D. and seven M.S. in Entomology; only three M.S. are presently in MAG positions, while others are with the University of Costa Rica and CATIE, and half with the private sector. There are four Ph.D. and seven M.S. in Plant Pathology; three of the M.S. are with MAG. There are only two M.S. in Weed Science, one of whom is with MAG (see Appendix 1).

There are a number of ingenieros agrónomos with many years of practical experience: five are entomologists, five are plant pathologists, and two are weed scientists. Most of these technicians work at MAG.

Costa Rica seems to have a well-developed extension system for IPM technology transfer, with 60 extension offices served by eight regional centers for diagnostic determinations on pests. However, the regional laboratories are deficient in equipment and adequately-trained personnel to provide effective technology to the small and medium-sized farms.

The University of Costa Rica, Faculty of Agriculture, has three academic programs: plant production, animal production and agricultural economics. There are about 25,000 students at the San Jose Campus with 3,300 in agriculture, of whom 800 are in the plant science option. IPM courses in entomology, plant pathology, weed science, nematology and plant breeding are shown in Appendix 2. About 100 Ing. Agrónomos graduate each year (50 in Plant Production, 30 in Animal Production, 20 Agricultural Economics). The courses appear to be of high quality, but laboratory facilities, equipment upkeep and repair are serious problems. Graduate programs leading to the M.S. degree are available in plant production, animal production and forestry. The graduate program is offered in cooperation with professional entomologists, plant pathologists, and others,

at CATIE in Turrialba. Beginning in the fall of 1982, a selection process will be initiated so that only the top academic students in agriculture will continue beyond the first semester. After four semester credit hours have been passed, those below the established level will be dismissed.

Two associated interdisciplinary schools, Agricultural Engineering and Food and Technology, have been established. The Faculty of Mechanical Engineering participate in the engineering curriculum.

A private donor in Iowa, in cooperation with Iowa State University, supports workshops and training programs in soils, animal science, food science and technology, agricultural economics, and plant protection (corn diseases).

Support Available for IPM

Costa Rica apparently receives ample outside support for IPM.

1. FAO provided $50,000 for equipment and for training technicians in the diseases of coffee.
2. PROCODEPA, a Swiss Government organization, has supported research to improve production in potato through CIP, Peru.
3. GTZ, a German government organization, provides support for pesticide analysis, registration, epidemiology work, technology transfer, and training abroad for technicians and plant quarantine personnel. This program is providing funding of $200,000 for a mobile plant disease diagnostic laboratory, equipment and infrastructure. If extended for another two years, total funding will reach $2 million.
4. USAID/Costa Rica Loan Project T027 supports technical assistance in coffee and traditional crops, providing up to Colones 300,000 ($5-6,000) loans for small farms.

Library and Computer Facilities

The University of Costa Rica has a sizable library facility that maintains exchange of technical information with CATIE and other libraries in the Hemisphere. Libraries in many of the other organizations are poor and have meager or inadequate information on crop protection, production, and harvesting.

The agricultural library at CATIE is perhaps the best in the region, but it is not readily accessible. Agriculturists and researchers in the region must pay for the use of library information. CATIE charges a service fee to handle the reproduction of technical material, which is beyond the means of underpaid agriculture technicians. The meager budgets of the agricultural research section of MAG do not provide for such expenses. There is a possibility that PL 480 funds could help solve this problem.

Computer facilities are scarce in the CAP countries. The University of Costa Rica, CATIE, and IICA have access to computer; however, their use in crop protection programs is limited.

Ongoing Research

The areas of ongoing research are presented in Appendix 3. The following comments cover the highlights of the survey.

The team spent time with Dr. Federico Dao, Director of Plant Health, and the Deputy Director of IICA, discussing the advantages and disadvantages to the proposed merger of the International Regional Office of Plant and Animal Health (OIRSA) with the Plant Health Program of IICA. Since the IICA programs in plant and animal health are independent of one another, the Plant and Animal Health Program of OIRSA would necessarily be divided in this merger. Another disadvantage would be the decrease in accessibility of OIRSA to the needs of CAP because of the complex bureaucracy of IICA. The advantage of the merger

is that IICA will be able to secure the needed funds to cover the annual budget of OIRSA, and OIRSA will be better managed. OIRSA needs a new director with managerial acumen capable of providing the required leadership. Programs that are outdated should be eliminated and the budget trimmed. OIRSA should create a Regional Diagnostic Laboratory that would serve as a center for information on crop protection for the CAP region. An inventory of the agricultural pests of economic importance to CAP farmers should be one of the responsibilities of this laboratory. Workshops and training of technicians in IPM crop protection methods and technologies would be the long-term goal of the laboratory.

The plant protection program of IICA has three basic objectives:

1. Train and update technical staff of national plant protection services.
2. Improve the physical infrastructure available to national plant protection services.
3. Standardize plant protection and pesticide legislation in Central America and the Caribbean.

IICA works with the national universities, research institutions and the plant protection services to 1) conduct training programs and workshops in pesticide use, legislation and management; 2) promote the exchange of IPM information among CAP and Caribbean countries, publish bibliographies in crop protection and a newsletter; 3) promote technology transfer and documentation of research information to agriculturists and researchers; and 4) compile an inventory of pests for the CAP countries and the Caribbean.

The Program on Coffee Rust IICA-PROMECAFE/ROCAP will be managed by Jorge Hernan Etcheverry. PROMECAFE management learned slowly how to

handle this multimillion dollar program, due to their lack of experience in business administration. The contracting of technical personnel has been slow, but is improving. Panama, Honduras, and Guatemala have had changes of Ministers of Agriculture and Animal Husbandry, which have placed political constraints on the ROCAP program No. 596-0090. The proposed activity in pesticide analysis was discussed and changes will be made to allow participation of ICAITI, CENTA and the quality control laboratory of the University of Miami School of Medicine in this program. The head chemists of CENTA and ICAITI will be trained by J. B. Mann in the analysis of residues of new pesticides used in coffee to control rust and the coffee bean borer.

Iowa State University and the Ministers of Agriculture are cooperating in a five-year project to assist the small farmer to increase production in livestock and agronomic crops. This project does not have an IPM component, but it is strong in animal husbandry and crop improvement.

MAG personnel are rearing Trichogramma spp., an egg parasite of the sugarcane borer Diatraea, for release in the field. Entomologists at Texas A&M are assisting in the identification of the parasites.

Dr. J. Saunders, CATIE, has developed a checklist of 1,500 insect pest species of forty annual food crops, scheduled for publication within four months. Cotton and tobacco are not included.

Dr. Saunders and his colleagues hope to develop a book on the Insect Pests of Food Crops in Central America in the style of Metcalf and Flint, including pictures and biological data. The cost of English and Spanish editions may be $33,000 or higher. ODA may support half the costs of publication.

IICA is developing a computerized retrieval system to handle data base information for crop protection which could be the heart of a regional diagnostic center. This program will provide information on what to do for a given insect pest on a given crop and should be expanded to include plant pathogens and weeds.

The USAID/Costa Rica RDO indicated that support for a regional pest management program can be spearheaded with PL 480 funds now available in Costa Rica. Training courses in plant disease diagnostics and IPM can be offered in Costa Rica. PL 480 funds can be used to finance country participant expenses. The ROCAP project can provide grant money to contract with CICP for the technical staff needed for this program. PL 480 funds could also be used to pay service fees for CATIE library information.

The major pests of concern in Costa Rica are:

Insects and Mites

Sugarcane borer (*Diatraea* spp.) - corn, sorghum, sugarcane.

Spittlebugs (*Aeneolamia* spp.) - sugarcane.

Plant hoppers (*Sogatodes* spp.) - rice, sugarcane.

Fall armyworm (*Spodoptera frugiperda*) - grains, vegetables.

Mites (*Eriophyes guerreronis*) - coconut.

Diseases

Black sigatoka (*Mycosphaerella fijiensis*) - bananas, plantain.

Rice blast (*Pyricularia orizae*) - rice.

Moniliosis of cacao (*Monilia rorei*) - cacao.

Sugarcane rust (*Puccinia melanocephala*) - sugarcane.

Sugarcane smut (*Ustilago scitaminea*) - sugarcane.

Weeds

Paja peluda (*Rottboellia exaltata*) - rice.

Slugs

Babosa (*Vaginulus plebeius*) - beans.

PANAMA

Panama has an area of 77,096 sq. km. with a population of 1.96 million of which 40 percent are actively engaged in agriculture and related activities. Panama borders Costa Rica on the west and Colombia on the east, and it forms the narrow isthmus that links North and South America. A central range of mountains which forms the continental divide are highest at the Costa Rican border and become progressively lower as they extend eastward to the canal before rising again to moderate heights at the Colombian border. Humidity and temperatures are usually high with the exception of the highland areas. Nearly 30 percent of the land area is in agriculture-related use, but only seven percent is used for crop production. Aquaculture, the rearing of shrimp in saltwater estuaries, is a fast-growing industry. The principal exports are bananas, sugar, beef and shrimp. Other important crops grown primarily for local consumption are rice, beans, sorghum, corn, plantains, tobacco, coffee, citrus and other miscellaneous fruits and vegetables. Coffee rust and the coffee bean borer are not present in Panama.

Smut of sugarcane apparently has not caused economic losses in Panama's large plantations because the susceptible varieties have been replaced; however, small producers still grow the susceptible variety Cristal B-49-119 and this should be replaced. Losses due to sugarcane rust were huge the first year the disease was introduced into Panama. The variety B-4362 suffered losses from 25 to 60 percent. The best smut resistant varieties come from the Barbados Islands, Brazil and Cuba. B-57150

is a smut resistant variety from Barbados.

The state-operated sugar company has about 22,000 ha. which are divided among four sugar mills: Victoria with 6,500 ton capacity; Felipillo with 7,200 ton capacity; Alanje with 8,000 ton capacity and Azuero with a 2,500 ton capacity. These plants average 165 lbs. sugar per ton of cane. The production ranges from 60-90 tons of cane per hectare.

Vegetable production systems of Panama, primarily in the areas of Boquete, Cerro Punta, Province of Chiriqui, use pesticides excessively without regard to safety or residue tolerances on marketable products.

Panama's greatest constraint in pest diagnosis is the lack of adequate laboratory facilities. IDIAP laboratories are in the planning stage. Laboratories at the University have space but meager support for operations and equipment. Sanidad Vegetal has recently been allocated some funds for basic needs and for a microscope. Continued support for the program is needed. An electron microscope located at the Santo Tomas Hospital can be used in virus research by IDIAP. This arrangement is recent and little use has been made of the facility for the study of plant viruses.

A general diagnostic regional laboratory to assist in the identification of pest problems would be of great benefit to Panama. Presently there is no central location to obtain information quickly. Workshops and training programs on determination of infestation levels, economic thresholds, pesticide use, safety and management, and stored product pest management are of high priority.

Extension programs appeared to be non-existent in Panama, making the transfer of technology to the farmer very difficult. The delivery

system is the lifeline of any pest management program, and without a viable extension component it might be useless to try to implement an IPM program.

Trained Personnel

Trained personnel (Appendix 1) in IPM areas of specialization are relatively few, the majority being with private or regional organizations. The University of Panama College of Agriculture has personnel with doctorate degrees in entomology, plant pathology, nematology and plant breeding. The faculty includes individuals with M.S. degrees in all IPM specialties, including weed science, and a number of Ing. Agrónomos with practical experience in IPM specialties. Joint research and teaching programs are conducted with the natural sciences faculty of the Smithsonian Institution and the Gorgas Memorial Institute.

The University of Panama Faculty of Agriculture is being transferred to Chiriqui where new facilities have been constructed, and the faculty presently fly to Chiriqui to teach the classes. The whole faculty will be at Chiriqui by 1984. The new school has abundant space for field research and expansion of the College of Agriculture, whereas space was very limited in Panama City. The IPM courses for the Ing. Agrónomo degrees (see Appendix 2) are of high quality and credits are comparable to those of U. S. educational institutions. The graduate program for the M.S. degree in Medical Entomology, offered on the main campus (Panama City), was developed three years ago through a bilateral agreement with WHO. The thesis is primarily ecologically-oriented. A M.S. degree in Agricultural Entomology -- Crop Protection -- is expected to be fully developed by 1984 and will incorporate IPM concepts and methodologies in more detail. Operational and equipment funds are meager or nonexistent.

Library and Computer Facilities

The University of Panama has a fine library although technical information is limited. Library facilities at the Smithsonian and Gorgas Memorial Institute are available and both are used by MAG personnel.

Computer facilities are available at the University. Access to the computer for IPM programs is being considered, but computer modeling expertise is wanting. It will be some time before an IPM computer program will be developed.

Support Available For IPM

1. All agencies contacted were in support of pest management programs. The Corporation Azucarera, La Victoria, with support from IDIAP, has cooperated in the rearing of *Apanteles flavipes*, a parasitic wasp that attacks the sugarcane borer.
2. The Interamerican Development Bank has provided a loan of $3,200,000 to the University of Panama for infrastructure and $500,000 for equipment and furniture for the new agriculture school at Chiriqui.
3. USAID has approved a loan of $5,000,000 for agricultural technology development in Panama, of which $100,000 is allocated to IPM. It will be used to acquire specialized equipment for biological control, a pesticide analysis laboratory, and to conduct educational programs, including the adaption of existing IPM materials to Panamanian conditions and the dissemination of these materials. Short-term technical assistance and training in IPM concepts and methodologies are included.
4. PROCODEPA, a Swiss governmental agency, has supported a research program toward the improvement of production of Irish potatoes.

The major emphasis is the evaluation of various cultivars for nematode and disease resistance.

Ongoing Research

The major ongoing IPM research projects are listed in Appendix 3. One interesting program discussed with IDIAP concerns field studies of a fungus, *Paecylomices lilacinus*, a potato cyst nematode pathogen. Researchers at the International Potato Center (CIP) in La Molina, Peru, found this fungus effective in greenhouse tests in controlling the nematode *globodera rostochiensis*. In Panama the pathogen is being tested in the field for nematode control. A new strain of *Metarrhizium* fungus is being tested by IDIAP for its effectiveness in the control of the spittlebugs (*Aeneolamia* spp.) in sugarcane.

The major pests of concern in Panama are:

Insects

Fall armyworm (*Spodoptera frugiperda*) - corn, rice, sorghum.

Spittlebugs (Froghoppers) (*Aeneolamia* spp.) - rice, sugarcane.

Sugarcane borer (*Diatraea* spp.) - corn, sorghum, sugarcane.

Planthoppers (*Sogatodes* spp.) - rice, sugarcane

Giant sugarcane borer (*Castnia licoides*) - sugarcane.

Diseases

Black sigatoka (*Mycosphaerella fijiensis*) - banana, plantain.

Cercospora leaf spot (*Cercospora cofeicola*) - coffee.

Rice blast (*Pyricularia orizae*) - rice.

Sugarcane rust (*Puccinia melanocephala*) - sugarcane.

Sugarcane smut (*Ustilago scitaminea*) - sugarcane.

Weeds

Paja peluda (*Rottboelleia exaltata*) - rice.

Nematodes

Cyst nematode (Globodera rostochiensis) - Irish potato.

HONDURAS

The Republic of Honduras is the second largest Central American republic, with a total area of 112,088 sq. km., of which approximately 80 percent is mountains. The major crops of the country are bananas, coffee, beans, corn, cotton, tobacco, rice, sugarcane, pineapple, and vegetables.

Deep concern was expressed by all agencies contacted about environmental pollution and accidental poisoning from the indiscriminate use of pesticides. The problem is serious, especially in the cotton growing areas. Honduras has a large number of small farms in basic grains and coffee, but only about seven percent of these use pesticides. In general, the total amount of pesticides applied per unit area is less than in neighboring countries.

New laws that regulate the importation, sale and use of pesticides are being promulgated. The country, as well as other CAP countries, has begun implementing the pesticide labeling system approved by all CAP countries on September 8, 1981, at the Contadora meeting in Panama. This system uses colored stripes on the label to classify the toxicity level of the pesticide: Red = Class I and II, Yellow = Class III, Blue = Class IV, and Green = Class V. The red-stripe labeled pesticides will be restricted and sold only to licensed dealers for use only by certified applicators. Sanidad Vegetal personnel will provide the training and examinations for the pesticide dealers and applicators. All pesticide salesmen must be registered with Sanidad Vegetal. The company representing a particular pesticide has exclusive rights to sell it and assume responsi-

bility for its misuse. It is hoped that this regulation will prevent the repackaging and sale of pesticides without proper labels by unauthorized individuals.

There is a countrywide shortage of technical personnel to actively implement IPM programs. A number of the scientists contacted were supportive but discouraged because of the lack of support personnel, operational funds, and laboratory facilities. There is a great need for workshops and intensive short-term training programs in IPM concepts and methodologies to obtain a cadre of people to implement IPM programs. The Ingeniero Agrónomo degree curriculum is weak in IPM technologies.

The need for a national diagnostic center that can assist in identification and offer information on the pest problems of the country was supported by all agencies contacted. The country has seven regional laboratories for animal health that are not utilized to their maximum efficiency. It is unfortunate that an individual who has postgraduate training (Ph.D.) in an important crop protection speciality is unable to maximize his/her potential in solving pest problems because of the lack of suitable laboratory space. These national laboratories could also serve as diagnostic centers at the local level for Honduras.

There was great interest and support by the Interamerican Development Bank (DIB) in integrated crop protection programs and in cooperating with AID and other agencies in supporting workshops and training programs in Honduras and other CAP countries.

Only one institution, the Pan American School of Agriculture (EAP), was thought potentially suitable for IPM training programs.

Trained Personnel

The National University of Honduras School of Agriculture, created

in 1968, is located at La Ceiba. The agricultural school was not visited but we met with the Dean of the School, a chemical engineer, Ing. Soto. The staff appears weak in IPM specialties and very few of the faculty members have M.S. degrees. There are three Ph.D's in the school, although none are in an IPM-related field. There is one M.S. in entomology.

The list of IPM courses and trained personnel is presented in Appendices 1 and 2. The research department staff of Standard Fruit Company, La Ceiba, serve as part-time instructors in the School of Agriculture.

The crop protection curriculum, a component of the Ingeniero Agrónomo degree, includes General Entomology (4 Cr.), Economic Entomology (3 Cr.), Weed Science (3 Cr.), Introduction to Plant Pathology (4 Cr.) and Plant Breeding (4 Cr.). These are considered IPM courses. Most of the instructors lack training beyond the B.S. or Ingeniero Agrónomo degree. The courses are different from other institutions we visited. As an example, the General Entomology course consists of two lectures, one three-hour laboratory and one three-hour field practical experience. Meager information was available on course content. The faculty is young and undergoing growing pains. The number of students was reported to be 2,000, with half in forestry and half in agronomy. It appears that the school is trying to emulate EAP.

The Secretariat of Natural Resources, Department of Human Resources, supplied us with information on individuals supported by AID scholarships for advanced training. Eight (one Ph.D, six M.S., and one B.S.) have completed their training. Nine other students are working toward degrees in pest management. Six of the graduates (one Ph.D. and five M.S.) are employed by the Ministry of Agriculture and Natural Resources. Among the

students abroad, a Ph.D. and two M.S. students are employed by CURLA and four M.S. students are employed by IHCAFE. The specialities are divided: Entomology - one B.S., nine M.S.; Plant Pathology - four M.S., two Ph.D.; Crop Protection - one M.S.

The Panamerican School of Agriculture (EAP) Zamorano is a private, autonomous technical agricultural school established in 1941. Director Simon E. Malo described plans to increase the size and quality of the school, and to change the school from a three to a four-year college. New facilities are already under construction.

Student enrollment is approximately 450 at present, and 1000 students are expected by 1985. Approximately 150 students are selected for admission by examination and interviews each year. The average age is 19-20, and students younger than 17 or older than 21 are not admitted. The students represent 20 countries located in the Central American and Latin America areas. Student attrition at the end of three years ranges from 35-50 percent. Tuition has increased to $2,400/year.

A faculty of 36 (12 Ph.D., 15 M.S., nine Ing. Agrónomos) presently teach at Zamorano. The faculty is expected to increase to 68 by the time student enrollment reaches 1000. The curriculum has three options: Horticulture (Forestry), Agronomy and Animal Science, with a fourth option, Agriculture Mechanics, added in 1982. A total of 225 credits (185 classwork, 45 practical field work) are necessary for the 33-month Agrónomo degree. Additional training for the Ingeniero degree is possible at the University of Del Valle in Guatemala. Upon graduation students are also accepted as third or fourth year students in agriculture at the University of Florida. Students spend half of the day in classroom instruction and half in practical agricultural operations in the selected option.

Plans are underway to develop an integrated crop protection or IPM curriculum within the next biennium. Entomology and plant pathology courses are offered in the agronomy and horticulture options. Weed science and nematology courses are needed. EAP has expanded its agreement with the University of Florida so that seniors, graduate students, and professors may travel to Honduras for one year of experience in a tropical environment. The students may earn as many as 60 credits toward their degrees. Through this exchange program a nematology course may be added by the end of 1982.

Laboratories were crowded and research facilities were less than optimum. Once the new facilities are completed and the old ones renovated the problem may be alleviated. Laboratory equipment for IPM specialties was limited and in need of maintenance. The facilities were designed primarily for teaching, research being secondary. Many of the graduates have continued their postgraduate education toward a M.S. or Ph.D. degree, or are employed in responsible positions. It is our opinion that the best agricultural training in Honduras may be obtained at EAP.

The director encouraged professors from the U.S. to apply to spend their sabbaticals teaching and conducting research at EAP.

The Honduras Coffee Institute (IHCAFE) includes two M.S. degree personnel in each of the IPM disciplines of entomology and plant pathology. These individuals are evaluating resistance of various coffee varieties to coffee rust. They are also evaluating the effectiveness of the newer systemic fungicides aiming at reducing the number -- usually six -- of applications per season. The entomologists are working on the biological control of the coffee bean borer. Researchers are also analyzing and studying the socio-economic impact of coffee production in Honduras, affected by the

increased costs and use of pesticides for Broca del Cafe and roya control. IHCAFE is very supportive of IPM programs with regard to reduction of pesticide costs in coffee production and pesticide residues in coffee exported to the U.S.

The Ministry of Agriculture and Natural Resources has one Ph.D. and two M.S. in plant pathology, and six M.S. and one B.S. in entomology. One M.S. has had experience in weed science. The individuals are well-trained in the basics of their areas of specialization but many need more in-depth training in IPM concepts and methodologies. There is a need for workshops on field diagnostic and sampling techniques, economic thresholds, integrated team approach to pest problems, etc. The workshops presented in these areas by the RPMS have been as excellent.

Support Available For IPM

Honduras has received outside support for crop protection from many sources.

1. USAID has provided scholarships for postgraduate training at universities outside Honduras. Funds have also been given to IHCAFE for 15,000 small backpack sprayers, fungicides and pruning to manage coffee rust. AID is encouraging the use of fertilizers, pruning, etc., for improved cultural practices to increasing yields rather than purchasing expensive pesticides, which is gaining acceptance by the small farmers.
2. GTZ, a German governmental organization, has supported IHCAFE in purchasing meterological equipment for their coffee research.
3. PROCODEPA, a Swiss government organization, has supported research in the improvement of potato culture in the CAP

countries. Major emphasis is on disease and nematode resistant cultivars of Irish potatoes.

4. Interamerican Development Bank (BID). Conversations were held with Mr. Miguel A. Monzon, Agricultural Sector Specialist, and Dr. Ramon A. Vega, Animal Health Specialist, of BID. Past history has shown that the bank has financed primarily animal health programs. The first national program in Honduras was a cattle tuberculosis and brucellosis control program and is about to be terminated. A new program is being supported to control Torsalo and ticks of cattle. Dr. Harrington, USDA, has been supportive and is participating in the development of the program. The bank financed the seven animal health laboratories in Honduras and has indicated that the national government should be ready to take over the animal health programs.

BID is interested in financing agriculture plant production loans. The bank has granted scholarships to Ingenieros and physicians for enrolling in pest management workshops and training sessions at Colima, Mexico. The bank officials were very interested in and supportive of integrated pest management programs at the regional and national levels. In order for the bank to offer scholarship grants or loans, an IPM proposal should be submitted to the bank by the Ministers of Agriculture or Directors of Sanidad Vegetal in the CAP countries. We suggested that the ministries of Central American republics approve IPM programs in their August 1982 meeting. If the Ministers approve the proposals, the bank will be in a position to make a survey for financing the program. Presently the bank has three loans in each of the CAP countries. BID helped finance the new agriculture school in Chiriqui, Panama. The time

is opportune to obtain grants or loans for national and regional IPM programs. Closer ties between the bank and USAID may be worthy of consideration in the development of crop protection programs.

Library And Computer Services

The University of Honduras has a library that is weak in agricultural and IPM technology. The EAP library is probably the best but is also weak in IPM. Many of the specialists have only their own scientific journals as resource material. A regional diagnostic center that could send research information to the field researchers is of high priority. The private sectors, United Brands, IHCAFE, etc., have resource material on the commodities they are producing. Whether these agencies would assist other researchers in the country by sending copies of research reports from their libraries is a moot question.

Computer facilities for IPM are, for all practical purposes, nonexistent. IHCAFE has a small computer that is used in normal business operations. The Ministry of Agriculture and Natural Resources has purchased a Radio Shack TRX 80 for research with plans to add a word processor to the basic unit very shortly.

Ongoing Research

Research in crop protection is being conducted by IHCAFE, EAP, and the Secretariat of Agriculture and Natural Resources. The major projects are listed in Appendix 3. IHCAFE personnel are evaluating new fungicides and resistant varieties for control of coffee rust. Tests are being conducted to evaluate systemic insecticides against the coffee bean borer. Hot water baths, steam cleaning or fumigation of the sacks used to transport coffee cherries will reduce the chances of spreading the scolytid beetle to uninfested areas. Research on the coffee borer is

limited because endosulfan (thiodan) has provided good control. Three sprays are applied during the growing season, the first when the coffee berry is beginning to ripen.

Sanidad Vegetal has a coffee rust and coffee bean borer control program. The coffee bean borer program will be curtailed at the end of the year. The majority of the small farmers do not spray for either pest. They recommend harvesting all the berries on the tree and picking up all the berries on the soil. Infested berries will float and can be separated and buried. It is difficult to get the farmers to destroy the plant residue and to practice sanitation. The plant quarantine or plant protection laws do not mention sanitation nor require the removal of plant residue that may contain the pest. Such a program cannot be enforced. There is a very old law requiring destruction of cotton plant residue, but it has never been enforced.

Dr. Keith Andrews at EAP, Zamorano, has studied the biology and ecology of babosa, the slug in beans. Nighttime observations and baited pitfall traps were used to determine population densities of the slug at various distances from a source infestation. Damage to seedlings and yield of dry beans were recorded. Plant stand in a square meter was reduced by 20 percent with one active slug. Yield was reduced as much as 16 percent. In the presence of bean seedlings the slugs move short distances. In their absence, the slug was reported to move as much as 40 m. in a straight line at night.

Dr. Andrews also reported on the use of granular phoxim 2.5G at a rate equal to 0.04 to 0.07 grams per whorl of corn for control of the fall armyworm. This chemical is not sold in the U.S. The rate of application is much less than that recommended and used by the farmers.

He also developed a granular applicator that can easily be made by a small farmer. It is constructed of bamboo, wire, tin from a soft drink can and a piece of inner tube rubber. Although this appears to be a clever development, the small grower could hand pick the larvae in the whorl and control the pest without the use of pesticides.

Biological control of the fall armyworms, Spodoptera frugiperda, by an egg parasite Telenomous remus and two predators, the earwig Doru taniateum and the vespid wasp Polybia occidentalis, were discussed. The work is in cooperation with entomologists at Texas A&M. The effectiveness of these biological agents is not known to date. The vespid wasp reduces the population of second to fourth instar larvae. The earwig feeds on eggs and small larvae of armyworm, and in tests has reduced the egg masses in corn by 30 percent. The egg parasite, T. remus, has not been released in Honduras, although entomologists are trying to increase the laboratory stock population. British entomologists reported 70 percent parasitization of fall armyworm egg masses by T. remus.

Dr. Caceres, Sanidad Vegetal plant pathologist, has one of the smallest and cleanest research laboratories visited. He is working on the diseases of beans, corn, rice and sorghum. Dr. Caceres reported the bacteriology workshop conducted by the RPMS to be excellent, and he now feels confident of his ability to diagnose the common bacterial diseases. He believes that seed of the red variety of bean grown in Honduras is linked to susceptibility to common mosaic bean virus. His research indicates there may be as many as five races of bean rust in Honduras. Identification of this rust is difficult.

Beans are grown from September on, frequently on recently harvested corn fields where the vines use the corn stalks for support. Rust is

the worst problem for small farmers who cannot afford the cost of chemicals. Dr. Caceres would support a modern national diagnostic center with the capability for distributing information to the researcher and farmer.

The major pest problems in Honduras are:

Insects

Fall armyworm (*Spodoptera frugiperda*) - corn, rice, sorghum, sugarcane.

Sugarcane borer (*Diatraea* spp.) - sorghum, sugarcane.

Picudo del frijol, Bean Weevil (*Apion godmani*) - beans.

Broca del Fruto del Cafe - Coffee Bean Borer (*Hypothenemus hampei*) - coffee.

Rice Chinch bug (*Blissus leucopterus*) - rice.

Torsalo - Human Bot Fly (*Dermatobia hominis*) - cattle.

Cattle ticks (*Boophilus* spp.) - cattle.

Slugs

Babosa (*Vaginulus plebeius*) - beans.

Diseases

La Roya - Coffee Rust (*Hemileia vastatrix*) - coffee.

Black Sigatoka (*Mycosphaerella fijiensis*) - banana, plantain.

Common Bean Mosaic Virus - beans.

Bean Rusts (*Urmyces viciae fabae*) - beans.

Blue Mold of Tobacco (*Peronospora tabacina*) - tobacco.

Weeds

Paja peluda (*Rottboellia exaltata*) - corn, sugarcane.

Nutsedge (*Cyperus rotundus*) - beans, corn.

GUATEMALA

Guatemala is the third largest Central American republic, with an

area of 108,899 sq. km. Approximately 60 percent of the country is mountainous. The major crops are corn, cotton, beans, rice, coffee, sugarcane, cardamomo, temperate zone fruit, and vegetables.

The complex of insects, fungi, bacteria, nematodes, viruses, vertebrates, and weeds, through direct feeding or competition, tend to reduce the yields of crops that form the major cropping systems for the small grower. The small farms, as in Honduras, are located on steep slopes, and land preparation, planting and cultivation are done by hand. These farmers do not have funds to purchase expensive pesticides and must rely on cultural methods for pest control. In the flatter lands oxen, hand hoeing, or disc plowing prepare the land.

Pest control methods vary considerably with location, crop value, and resources available to farmers of small land holdings. Ordinarily, the small growers do not use pesticides because the cost is beyond their means. Although chemical pesticides are used in vegetable production, they are often misused in type, dosage, timing and safety. Pesticide usage by the small growers is greatest near the cotton-growing areas where the large growers are concentrated. This points to the need for an integrated pest management approach to the pest problems for the large as well as the small growers. The cost of pesticides has increased so much that the larger cotton growers are losing money. If cotton can no longer be grown economically, thousands of people will be unemployed and the resulting socio-economic problems will be horrendous. It is possible through integrated pest management to reduce costs of pest control in cotton and to keep agriculture production a viable enterprise. DDT use on cotton has been banned in Guatemala.

There is a nucleus of people trained in IPM-oriented disciplines

at the University of San Carlos, the Institute of Agriculture, Science and Techonology (ICTA), the Valley University of Guatemala and the Guatemalan Association of Integrated Pest Management (AGMIP). The association has a membership of forty who have participated in ROCAP-sponsored IPM workshops. Some of these individuals can be used to train a supportive cadre of technicians.

A new pest of sugarcane, chinche hedionda, Scaptacoris talpa (Order: Hemiptera, Family: Cydnidae) was reported in 1980 in the San Marcos district, near the Mexican border and the Escuintla area. This root-feeding species inflicts serious injury to young plants. A literature search indicated the insect was found in the same areas in 1934 by F. A. Bianchi. The species was described by G. C. Champion in 1900 from specimens collected in Capetillo, Guatemala. The insect at that time, as it is now, was scarce and concentrated in two small areas. Little information is available on the biology of the pest. In the heavily infested areas, the insects were found on the roots of the sugarcane stool in the upper foot of soil. The nymphs and adults produce a repugnant odor when disturbed. Larvae of an elaterid beetle were reported feeding on Scaptacoris adults and immatures by Bianchi. It appears that Scaptacoris is not a serious pest.

The combined efforts of Mexico and Guatemala continue to combat the medfly under the MOSCAMED cooperative agreement.

The greatest constraint to IPM programs in Guatemala is the lack of adequate laboratory facilities, equipment, and operational funds to carry out crop protection programs. There is virtually no capability to identify insects, viruses, or nematodes. For this reason, a national

diagnostic laboratory is of top priority to quickly identify pest problems and serve as a central point for IPM information.

Both national and private organizations contacted were very supportive of pest management programs to reduce the wanton use of pesticides. A basic problem, which was common to other CAP countries as well, is the lack of a team approach in developing the essential components of an IPM program.

An extension arm is available in the Ministry of Agriculture to assist in the transfer of IPM technology from the researcher to the farmer.

The new color labeling of pesticides, as discussed in the section on Honduras, is also being implemented in Guatemala. Although the color indicates the hazard and toxicity level of the pesticide, the farmers and applicators usually ignore the label. Many believe that if the material is registered in Guatemala it can be used on any crop. They neither understand nor have information on the tolerances of pesticides registered on crops to be exported to the U.S. Workshops on pesticide management should be developed to inform the producer that his crop cannot be exported to the U.S. if pesticide residues are in excess of the tolerance approved by EPA, or if the pesticide used is not registered in the U.S. Pesticide registration, labeling, and enforcement is still a problem in many CAP countries.

Trained Personnel

Guatemala has the largest cadre (76) of nationals in the CAP countries visited, as shown in Appendix 1. There are 47 individuals (nine Ph.D., 38 M.S.) who have had postgraduate training in one or more of the basic

disciplines in IPM.

The University of San Carlos Faculty of Agriculture has one Ph.D. entomologist and one M.S. specialist on the faculty of the national University of Guatemala. They are primarily concerned with teaching and conducting a small amount of research.

The college offers an Ingeniero Agrónomo degree in Agriculture and Renewable Natural Resources. Two hundred and thirty-five credits (197 required courses, 45 electives) are needed for the Agriculture major. The IPM courses in the curriculum are presented in Appendix 2. The college also has 21 hectares for field work practice. Experiment station facilities are available at Escuintla and Bulbuxya in the San Miguel Panan district. General Entomology, Economic Entomology, Plant Pathology I and II, Plant Breeding and Pest Control are required courses for the Ingeniero Agrónomo degree in Agriculture Production. A course on pesticides is offered as an elective.

Approximately 500 students enter college each year. The 100 Ingenieros Agrónomos graduating each year are employed in governmental or private agricultural industries.

Degrees in the crop protection are not possible in the national university system. The courses are of poor quality, and laboratory practices are especially weak. Additional in-depth training in entomology, plant pathology, and weed science is needed to produce a knowledgeable and productive IPM specialist.

The Del Valle University in Guatemala City is a small private school with a student body of 1007 students, of which 90 are in the Ingeniero Agrónomo degree program. Two hundred thirty-nine credits are required for the Ingeniero Agrónomo degree. The courses in entomology

are taught by the Department of Biology staff, which consists of two Ph.D.'s in entomology and one M.S. in Plant Pathology. The basic courses, General Entomology, Pest Management, Pesticide Management, and Plant Pathology I and II (summer session), are required for the Ingeniero Agrónomo degree. Additional training in Entomology (Medical Entomology, Insect Physiology, and Forest Entomology) can be secured through electives. A "licenciatura" in biology, with emphasis in entomology, is possible. The school is small but we were impressed with the quality of the faculty and students. The plant pathologist is developing a grant on cardomon virus in cooperation with Dr. Dennis Gonsalves, New York State Experiment Station, Cornell University, Geneva, New York.

The Guatemala Association of Integrated Pest Management (AGMIP), formally organized on March 3, 1982, is a group of 40 individuals (Ph.D.-M.S.-Ing. Agrónomos degrees) who have participated in the IPM short courses given by CICP in the CAP region and the workshops developed by the RPMS in ROCAP. The group consists of 15 entomologists, six plant pathologists, four weed scientists, one nematologist, and the remaining 14 are mixtures of experience in IPM and pest control. All are employed by governmental or private organizations. Their goal is to reduce the number of pesticide applications on cotton. They meet with the cotton farmers on Saturdays to discuss IPM and the deleterious effects the indiscriminate use of pesticides has on the environment. Two farmers have agreed to allow AGMIP members to monitor their operations in order to learn the current IPM practices. Once this phase is completed they hope to monitor the crop pest levels and reduce the number of insecticide applications. This dedicated group can be a cadre of instructors for workshops to train other technicians or farmers. This group hopes to receive a grant to conduct field demonstrations

to show the farmers that IPM works. Few farmers are interested now but if the high cost of pesticides again eliminates their profits, they may listen and show more interest in IPM.

Sanidad Vegetal has a very knowledgeable, energetic direction. There are two M.S.'s in entomology on the staff working in Mosca Med control programs. Sanidad Vegetal is vitally interested in the development of a national diagnostic service center to aid in quick identification of pest problems. This national center could be a clearing house for insect and plant pathogen identification for the regional diagnostic center that will operate in four agricultural regions of the country. Insects that could not be identified at the local level would be sent to the proposed CAP regional diagnostic center or forwarded to USDA, ARS. Each of the centers should have a medium-sized reference collection, appropriate literature, and full-time curator/identifier in a permanent position, plus a rotating position for a postdoctoral insect systematist and a full-time technician to assist in pinning, packaging, and maintenance of the collection.

The Institute of Agricultural Science and Technology (ICTA) is a public agency developed in 1973 with the responsibility to promote and conduct scientific investigations in the agriculture sector. ICTA investigators study means of removing the constraints to agricultural production. They promote agricultural technology utilization by the producers. ICTA programs function in collaboration with governmental offices for Economic Planning and Development, the Agricultural General Services Directorate, National Agrarian Development Bank, and the National Institute for Agricultural Utilization.

ICTA has organized all commodities so that maximim effort can be

concentrated in certain areas. The staff includes three M.S. (plant pathology) and five additional M.S. in agricultural production systems and other related IPM components. Three Ingeniero Agrónomos assist in their research programs. ICTA operates eight experiment stations throughout the country. These serve as bases for both research and technology transfer. Several million small farmers need the assistance of a strong efficient extension system. The instability of the political situation in many of the CAP countries makes the transfer of technical information to the small farm very difficult.

NATIONAL COFFEE ASSOCIATION (ANACAFE) - We visited with Ing. Aguirre, Assistant Technical Manager, and discussed integrated pest management in relation to coffee production. One Ingeniero is responsible for the various research programs of ANACAFE.

ANACAFE is a private organization whose programs are financed by coffee producers, who are taxed 1.05 quetzales per quintal (100 lbs) of coffee exported. It is generally believed that ANACAFE is well-off, but that is far from reality. This year the organization is short one million quetzales because a million quintales of last year's coffee has not been sold to date. This is a very critical period for coffee producers in Guatemala because the world price is so low. ANACAFE is a member of the International Coffee Organization (OIC), and Guatemala is authorized to sell 50 percent of its quota at the price set by the Coffee Commodity Exchange in New York. The remaining 50 percent of Guatemala's coffee production can be sold at a lower price to countries not belonging to OIC. The price to non-OIC countries is 40 quetzales/quintal while the market price in New York is 70 quetzales/quintal. The cost of production ranges between 70-85 quetzales/quintal. Producers are losing money and

local banks are not financing loans for coffee growers this year.

Pests of coffee have become very serious, approaching epidemic levels, for the farmers do not have funds to pay for pesticides, labor, or application equipment.

The major pests are coffee rust and the coffee bean borer. The rust is not being controlled by the medium to large-sized coffee growers. Few of them spray and within 14 months the disease became widespread. The disease probably will not affect this year's crop very much. It usually takes two or more years to cause serious damage. Copper fungicides and application equipment were given to the small farmers to treat their coffee. Any costs to the small growers were absorbed by the Mexico-Guatemala cooperative program to control la roya, concentrated in the coffee-growing areas along the Mexican border.

The coffee bean borer has developed to epidemic proportions. Because of low world coffee prices, farmers were unable to pay labor to harvest all the coffee berries, thus allowing for a population explosion of Broca in the unharvested berries.

Coffee in Guatemala is grown under sunny and shade conditions. Most producers grow coffee under shade conditions. Shade trees were not pruned in the medium to large-size coffee fincas and the increased humidity and lack of ventilation resulted in increased plant diseases (anthracnose, American leaf spot of coffee, cercospora leaf spot) and the leaf miner on coffee.

ANACAFE personnel have been evaluating coffee varieties for resistance to coffee rust and using a fungal disease on the coffee bean borer. They are very supportive of IPM programs that will reduce the costs of

coffee production. Comments were made on the problems associated with aerial spraying of malathion in the MOSCAMED program. Malathion causes defoliation of the shade trees and is ineffective in controlling the Mediterranean fruit fly as well as the coffee bean borer. They wondered if there was an insecticide that would effectively control both pests. They were pleased that attention is being given to the coffee problems of CAP countries. Coffee production is not limited to large plantations. The small growers are the largest segment of the population of Guatemala.

ANACAFE has one man with a Barcenas Agriculture School degree in charge of the research program. There are no funds for hiring an entomologist or plant pathologist. They expressed the need for assistance from entomologists and plant pathologists at the doctorate level to help solve the coffee rust and coffee borer problems.

Support Available For IPM

Financial support for crop protection programs in Guatemala is from sources similar to those reported for other CAP countries visited.

1. USAID has provided scholarships to ICTA personnel for postgraduate training in universities outside of Guatemala.
2. The Swiss government organization, PROCODEPA, has supported research on potato variety selection for disease and nematode resistance.
3. Mexico-Guatemala Coffee Rust Campaign. The Mexican government was concerned about the spread of coffee rust into Mexico, and the two countries allocated one million dollars each to develop a coffee rust control program. The funds were used to purchase copper fungicides and application equipment. Governmental personnel provided free fungicides, sprayers and proper application

instructions for control of coffee rust to 40,000 small coffee producers. The campaign is concentrated in the coffee growing areas along the border of Mexico. The medium-size and large producers are not covered by this program.

4. ROCAP-PROMECAFE Coffee Rust-Broca Program will establish a Broca control and research laboratory and provide green house facilities in finca Buena Vista, in the Huehuetenango region.

Library And Computer Facilities

The University of San Carlos, the Del Valle University, and the Institute of Agricultural Science and Technology have library facilities that are weak in technical information needed for IPM program development. Computer facilities were lightly discussed and considered to be a development for the future. Other priorities have replaced computers for the present.

Ongoing Research

Sanidad Vegetal personnel and the sugarcane plantations are concerned about the new root-attacking pest of sugarcane, chinche hedionda, Scaptocoris talpa. In two years, the pest occupied a small area, totalling approximately 30 sq. km. in two sites, Escuintla and San Marcos. Infestations are localized. Heavy infestations can retard plant growth, and 80 percent loss of young plants has been recorded. The sugarcane finca personnel are cooperating with Sanidad Vegetal on the problem. Information on the biology, ecology and damaging potential of this insect is unknown in Guatemala, although this pest was first reported in the country in 1934.

ANACAFE has been evaluating coffee varieties for resistance to coffee rust. Tests have shown that Catimor Hybrid 5259 is partially resistant to the rust, leaf infection reaching only two percent. The

locally grown Caturra variety is highly susceptible to the rust, and in the same test it experienced an 80 percent leaf infection. ANACAFE-OIRSA have a joint program on biological control of the coffee bean borer utilizing Beauveria bassiana, and report that field applications of the laboratory-grown fungus provide good broca control.

The major pests of concern in Guatemala are:

Insects

Fall armyworm (Spodoptera frugiperda) - corn, sorghum, sugarcane.

Broca del cafe (Hypothenemus hampei) - coffee.

Gallina ciega (Phyllophaga spp.) - corn, vegetables.

Chinche hedionda (Scaptocoris talpa) - sugarcane.

Mosca del Mediterraneo, medfly (Ceratitis capitata) - coffee.

Sugarcane borer (Diatraea spp.) - corn, sorghum, sugarcane.

Diseases

Black sigatoka (Mycosphaerella fijiensis) - bananas, plantain.

Coffee rust (Hemileia vastatrix) - coffee.

Rice blast (Pyricularia orizae) - rice.

Cardomon mosaic virus - cardamon.

Cucumber mosaic virus - cucumbers.

Bacterial wilt (Pseudomonas solanacearum) - potato, tomato.

APPENDIX No. 1

TRAINED NATIONAL PERSONNEL IN IPM-RELATED FIELDS IN CAP COUNTRIES

	COSTA RICA			PANAMA			HONDURAS			GUATEMALA		
	Ph.D.	MS	ING 20 YR. EXP.	Ph.D.	MS	ING. 20 YR. EXP.	Ph.D.	MS	ING. 20 YR. EXP.	Ph.D.	MS	ING. 20 YR. EXP.
ENTOMOLOGY	6	7	5	3	4	2	0	4	1	6	15	5
PLANT PATHOLOGY	4	7	5	4	4	7	2	3	N.A.*	2	12	7
WEED SCIENCE	0	2	2	0	2	6	0	0	N.A.	0	1	2
PLANT BREEDING	1	2	--	1	2	--	1	2	--	1	10	15
T O T A L	11	18	12	8	12	15	3	9	1	9	38	29

* INFORMATION NOT AVAILABLE.

APPENDIX No. 2

CROP PROTECTION COURSES OFFERED TO ING AGRONOMOS AT CAP NATIONAL UNIVERSITIES

COURSE NAME	UNIVERSITY OF PANAMA 5 YEAR 181 CREDIT HRS FOR ING DEGREE (SPECIALIST PLANT PROTECTION)	UNIVERSITY OF COSTA RICA 5 YEAR ING DEGREE 177 CREDITS	UNIVERSITY OF SAN CARLOS-GUATEMALA 235 CREDIT HRS FOR ING. DEGREE	UNIVERSITY OF HONDURAS C U R L A 210 CREDIT HRS FOR DEGREE	UNIVERSIDAD DEL VALLE GUATEMALA (ING. DEGREE 239 CREDIT HRS.
General Entomology	2L, 1 (3) LAB, 3C	2L, 2 ( ) Lab, 4C	3L, 1 (2) Lab. 4C	2L, 1(3) LAB, 1(3) P, 4C	3L, 1(3) Lab, 4 C
Economic Entomology	3L, 1 (3) LAB, 4C	2L, 2 ( ) Lab, 3C	3L, 1 (2) Lab. 4C	2L, 1(3) P, 3C	
Introduction to Plant Pathology	2L, 1 (3) LAB, 3C	2L, 2 ( ) Lab, 3C	3L, 1 (2) Lab. 4C	2L, 1(3) LAB, 1(3) P, 4C	3L, 1(3) Lab, 4 C
Advanced Plant Pathology	2L, 1 (3) LAB, 3C	4L, 2 ( ) Lab, 3C	2L, 1 (2) Lab. 4C		Summer Session 4L, 1(4) Lab, 4 C
Weed Control	3L, 1 (3) LAB, 4C	2L, 2 ( ) Lab, 4C	3L, 1 (2) Lab. 4C	2L, 1(3)P, 3C	
Nematology	2L, 1 (3) LAB, 3C	2L, 2 ( ) Lab, 3C			
Plant Breeding Advanced Plant Breeding	2L, 1 (3) LAB, 3C	2L, 2 ( ) Lab, 4C	3L, 1 (2) Lab. 4C 3L, 1 (2) Lab. 4C	2L, 1(3) LAB, 1(3) P, 4C	
Integrated Pest Management			3L, 1 (2) Lab. 4C		3L, 1(3) Lab, 4 C
Pesticide Management					3L, 1(3) Lab, 4 C

Appendix No. 3

INTEGRATED PEST MANAGEMENT

RESEARCH IN PROGRESS

COUNTRY	WHAT	WHERE	WHOM
COSTA RICA	1. Biological control of *Diatraea* spp. affecting sugar cane.	Guanacaste	MAG Entomology Department
	2. Control of Cacao Moniliosis, cultural and chemical	Atlantic Coast	GTZ Personnel
	3. Control of Rice Pests	Guanacaste	MAG Entomology and Plant Pathology Department
	4. Control of Tropical Fruit post harvest decay	University of Costa Rica	Plant Pathology with Delmonte Co. support
	5. IPM of Cotton Pests	Guanacaste	MAG
PANAMA	1. Biological control of *Diatraea* spp. with *Parateresia parisipalpis* and *Apanteles flavipes*.	Santa Rosa Plantation, Santiago.	Ing. Luis Narvaez
	. (800 pairs /ha to reduce index from 6.9 to 5)	Victoria SugarMill.	Ing. Julio Villaloz
	2. *Xylosandrus compactus* spp.	Coffee and Cacao, Santiago pruning and sanitation.	Ing. Efrain de Gracia MIDA.

COUNTRY	WHAT	WHERE	WHOM
	3. Sogatodes oryzacola	Biological control with Rupella spp.	1 Prof , Diego Navas, University of Panama
	4. Selection of rice varieties resistant to Blast and Sogatodes spp.	University of Panama, Tucumen Agricultural Experimental Station.	Mr. Ezequiel Espinoza.
HONDURAS	1. La Roya - Coffee Rust Selection of resistant varieties fungicide efficacy tests.	Coffee Institute of Honduras IHCAFE	Field personnel.
	2. Broca del cafe - a program is being developed on this scolytid beetle.	IHCAFE, Sanidad Vegetal	Field personnel.
	3. BABOSA - Vaginulus plebeius Biology - ecology - control	Panamerican School of Agriculture (EAP) Zamorano	Dr. Keith L. Andrews.
	4. Fall armyworm - Spodoptera frugiperda. Biological control. Determining effectiveness of egg parasite Telenomus remus (Scelionidae), predacions earwig Doru taniateum, vespid wasp Polybia occidentalis. Economic injury levels of fall armyworm.	Panamerican School of Agriculture (EAP) Zamorano	Dr. Keith L. Andrews. In cooperation with Texas A&M
	5. Bean rust. These may be 5 races of rust in Honduras: Common Bean Mosaic Virus may be linked to the seed of the susceptible red bean variety grown in Honduras.	National Agr. Research Program Sanidad Vegetal Danli, Honduras	Dr. Jacobo Caceres.

COUNTRY	WHAT	WHERE	WHOM
GUATEMALA	1. Cardamon Virus Study	Valley University of Guatemala.	Julio Tejada, Plant Pathologist in cooperation with Dr. Dennis Gonsalves, Cornell University.
	2. Biological Control of Coffee Bean Borer with the fungus Beauvaria bassiana.	ANACAFE experimental planting.	ANACAFE personnel.
	3. Evaluation of coffee varieties for resistance to coffee rust.	ANACAFE experimental plantings.	ANACAFE personnel.

APPENDIX No. 4

INSTITUTIONS AND PERSONS CONTACTED

1. COSTA RICA

A. Ministerio de Agricultura y Ganaderia. Departments of Plant Pathology and Entomology of MAG (OIRSA, MOSCAMED LAL SAN JOSE).

Ing. Carlos A. Soto S.
Plant Pathologist-Administrator.

Ing. Santos Herrera C.
Head of Coffee Rust Department of Sanidad Vegetal.

Ing. Juan Jose Gomez R.
Plant Protection.

Dr. Gerhard Jurgens GT2-MAG.
Plant Pathologist.

Ing. Rodolfo Amador P.
Department of Plant Pathology.

Ing. Jose Francisco Rodriguez R.
Department of Plant Pathology.

Ing. Jose Francisco Alvarez B.
Department of Plant Pathology.

Ing. Evaristo Morales.
Department of Entomology.

Lic. Alberto Freer Jimenez.
Plant Sanitation.

Ing. Gregorio Leandro.
Department of Plant Pathology.

Ing. Edith Chaverry Ch.
Department of Plant Pathology.

Lic. Rolando Delgado Morera.

Biologist, Department of Entomology MAG.

B. MAG HEADQUARTER.

Ing. Alvaro Cordero.
Vice-Minister of Agriculture and Animal Husbandry.

C. IICA

Dr. Federico Dao, Director.
Hemispheric Plant Sanitation Program IICA.

Dr. Quinton West, Sub-Director IICA.

Dr. Joseph L. Saunders.
Entomologist CATIE.

Ing. Jorge Hernan Etcheverry
Plant Pathologist in charge of PROMECAFE Coffee Rust Project.

D. UNIVERSITY OF COSTA RICA - SCHOOL OF AGRICULTURE.

Dr. Gilberto Fuentes, Acting Dean.
Entomologist.

Ing. Melvyn Alvarado Soto, Professor.
Nematology.

Ing. Sergio Umana Marin, Professor.
Plant Pathology.

Ing. Luis Felipe Arauz Gavallini, Professor.
Plant Pathology.

Ing. Dennis Mora Acedo, Professor.
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Dr. Elemer Bornemisza S.
Soils

Sr. Merle Dormond H.
Acarology.

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E. CAFESA

Ing. Ag. Ivo Hilje Q.
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Dr. Ricardo A. Rodriguez M., Director.
Research Department, ASBANA.

Ing. Franklin Aguilar A.
Head Research Sugar Cane Department, MAG.

Ing. Rolando Gonzalez G.
Research Department.
Association of Basic Grain Producer.

Ing. Gilberto Moreira R.
Ing. Jose M. Alpizar
Member of the Coffee Office of MAG.

Ing. Gerardo Hidal, Sub Director.
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Agr. Jose Antonio Guzman C., Jefe de Direccion
Diversificacion Agricola ASBANA.

F. USAID/CR

Mr. Erhardt Rupprecht.
Acting RDO.

2. PANAMA

A. IDIAP

Dr. Alejandro Ferrer (Ph.D. Florida).
Plant Pathologist.

Dr. Alberto Perdomo (Ph.D. Florida).
Entomologist.

Dr. Cesar A. Polanco S. (Ph.D. Monterrey).
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Ing. Gisela Rangel, Director.
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Dr. Santiago Rios Arauz.
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B. CORPORACION AZUCARERA LA VICTORIA (STATE RUN SUGAR COOPERATAIVE)

Ing. Jose Mendezlay (M.S. Monterrey, Mexico).
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Ing. Pedro Buitrago.
Technician Arquimedes Fernandez.
Azucarera Nacional, S.A., Agua Dulce.
Santa Rosa (Sugar Mill).

C. AZUCARERA NACIONAL, S.A.

Ing. Luis Narvaez (M.S. Peru).

Ing. Efrain E. de Garcia H.
Jefe de Programa de Sanidad Vegetal.
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D. LA VICTORIA SUGAR MILL, SANTIAGO

Ing. Julio Villalaz.

E. NATIONAL DIRECTORATE OF AGRICULTURE PRODUCTION MIDA SANTIAGO.

Ing. Jose del Rosario Concha B. (M.S. Monterrey).
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Ing. Fabio Cubillos.
Extension Specialist in Agriculture Production.

F. UNIVERSITY OF PANAMA GRADUATE SCHOOL.

Ing. Diego Navas (M.S. Arkansas).
Entomologist and Director for Research.

Ing. Baltazar Gray.
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Dr. Cheslavo Korytkosskey (Ph.D. Peru).
Assistant Director for Graduate Program in Medican Entomology.

Ing. Juan Miguel Osorio (M.S. Delaware).
Nematologist.

Ing. Luis Carlos Salazar (M.S. Oregon).
Weed Science.

G. USAID/PANAMA.

Dr. L. Harlan Davis/RDO.

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3. HONDURAS

A. HONDURAS COFFEE INSTITUTE (IHCAFE).

Ing. Franklin Antonio Osorio.

B. SECRETARIAT OF NATURAL RESOURCES (SRA).

Ing. Regino Quezada, Vice-Minister.

C. NATIONAL DIRECTORATE OF AGRICULTURAL OPERATION (SRN).

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Mr. John Gordon Smith, Chairman Board of Trustees (Guatemala).

E. NATIONAL AGRICULTURAL RESEARCH PROGRAM DANLI.

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G. INTERAMERICAN DEVELOPMENT BANK.

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G. HONDURAS NATIONAL UNIVERSITY.

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Chemical Ing. Jorge I. Soto M.
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H. NATIONAL COFFEE RUST - COFFEE BORER CONTROL PROGRAM.

Ing. Norberto Urbina.
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Bessy de Acosta.

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Brian Rudert, Consultant AID.

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A. USAID, Guatemala
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Mr. Larry Blair, Acting RDO.

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Ing. Edgar Enrique Rios Munoz
Ingenio Concepcion
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Ing. Victor Hugo Garcia Morales.

Ing. Luis Alberto Escobedo Martinez.

E. NATIONAL COFFEE ASSOCIATION.

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Guatemala City, Guatemala

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APPENDIX No. 5

ABBREVIATIONS AND ACRONYMS

AID	Agency for International Development Agencia para el Desarrollo Internacional
ANACAFE	Asociacion Nacional del Cafe National Coffee Association (Guatemala).
ARS	Agricultural Research Service Servicio de Investigaciones Agricolas.
ASBANA	Asociacion Bananera Banana Association of Honduras.
BID	Banco Interamericano de Desarrollo Interamerican Development Bank (Honduras).
CAP	Central America and Panama Centro America y Panama.
CATIE	Centro Agronomico Tropical de Investigacion y Ensenanza. Tropical Center for Research and Teaching of Agronomy (Turrialba, Costa Rica).
CENTA	Centro Nacional de Tecnologia Agropecuaria National Agriculture Technical Center
CICP	Consortium for Internatinal Crop Protection Consorcio para la Proteccion Internacional de Cultivos.
CURLA	Centro Universitario del Litoral Atlantico Atlantic Coast University Center.
EAP	Escuela Agricola Panamericana Pan American School of Agriculture (Zamorano, Honduras).
FAO	Food and Agriculture Organization of the United Nations. Organizacion de las Naciones Unidas para la Agricultura y Alimentacion.

ICAITI	Instituto Centroamericano de Investigacion y Tecnologia Industrial Central American Research Institute for Industry.
ICTA	Instituto de Ciencias de Tecnologia Agricola Scientific Institute of Agricultural Technology.
IDIAP	Instituto de Investigacion Agropecuaria de Panama Agricultural Research Institute of Panama.
IICA	Instituto Interamericano de Ciencias Agricolas Interamerican Institute of Agricultural Sciences, (San Jose, Costa Rica).
IHCAFE	Instituto Hondureno del Cafe Honduras Coffee Institute.
MAG	Ministerio de Agricultura y Ganaderia Ministry of Agriculture and Livestock.
MOSCAMED	Comision Mixta Mexico-Guatemala, para la Prevension y Control de la Mosca de la Fruta del Mediterraneo. Mexican-Guatemalan Joint Commission for Mediterranean Fruit Fly Control.
OAS	Organization of American States Organizacion de los Estados Americanos.
ODA	Overseas Development Administration Administracion para el Desarrollo en Ultramar.
OIRSA	Organismo Internacional Regional de Sanidad Agropecuaria. International Regional Organization for Plant and Animal Protection (Mexico-Central America & Panama).
PROCODEPA	Programa Cooperativo de Papa Cooperative Potato Program.
ROCAP	Regional Office for Central American Programs Oficina Regional de Programas para Centro America.
RPMS	Regional Pest Management Specialist Especialista Regional en el Manejo de Plagas.

UC/AID	University of California, Agency for International Development (Contract) Universidad de California, Agencia para el Desarrollo Internacional (Contrato).
UH	University of Hawaii Universidad de Hawaii.
USAID	United States Agency for International Development Agencia del Desarrollo Internacional de los Estados Unidos de America.
USDA	United States Department of Agriculture Departamento de Agricultura de los Estados Unidos.