THE CROP PROTECTION SITUATION IN GUATEMALA, HONDURAS, NICARAGUA, COSTA RICA, PANAMA, AND GUYANA

A Multi-Disciplinary Study Team Report

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Note

Usually the geographic name Central America is applied to the group of countries formed by Guatemala, El Salvador, Honduras, Nicaragua, and Costa Rica. Since we did not visit El Salvador, when we use the name Central America in this report we refer to the named countries with exclusion of El Salvador.

Foreword

The information herein presented was prepared for the UC/AID Pest Management and Related Environmental Protection Project. It was gathered during a 6-week visit (16 October to 26 November, 1972) to Guatemala, Honduras, Nicaragua, Costa Rica, Panamá, and Guyana by the undersigned. Our comments pertain to the countries visited, although some of them would apply to other LDCs that are in comparable situations with respect to crop protection problems.

This report would not have been possible if the more than one hundred persons interviewed during our assignment had not been willing to share with us their time and knowledge. To all of them -- listed in Appendix I -- we express our sincere appreciation. To those USAID Rural Development Officers and their staffs who helped us to develop contacts and solve logistic problems in the countries visited go our additional expression of gratitude.

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Acronyms used in this report

ALAF	Asociación Latinoamericana de Fitotecnia (Latin American Association of Plant Technology).
ANACAFE	(Guatemala) Asociación Nacional del Café (National Association of Coffee Growers).
BNN	(Nicaragua) Banco Nacional de Nicaragua (National Bank of Nicaragua).
CIAT	(Colombia) Centro Internacional de Agricultura Tropical (International Center of Tropical Agriculture).
CIMMYT	(México) Centro Internacional de Mejoramiento de Maiz y Trigo (International Center of Improvement of Maize and Corn).
CTEI	(Costa Rica) Centro Tropical de Enseñanza e Investigación (Tropical Center for Teaching and Research).
DESARRURAL	(Honduras) Dirección General de Desarrollo Rural (General Directorate of Rural Development).
DIA	(Guatemala) Dirección de Investigaciones Agrícolas (Directorate of Agricultural Research).
DIGESA	(Guatemala) Dirección General de Servicios Agrícolas (General Directorate of Agricultural Services).
EAP	(Honduras) Escuela Agrícola Panamericana (Panamerican School of Agriculture).
ENAG	(Nicaragua) Escuela Nacional de Agricultura y Ganadería (National School of Agriculture and Animal Husbandry).
IICA	Instituto Interamericano de Ciencias Agrícolas (Interamerican Institute of Agricultural Sciences).
IPPC	International Plant Protection Center.
MAG	Ministerio de Agricultura Ministerio de Agricultura y Ganadería (Ministry of Agriculture) (Ministry of Agriculture and Animal Husbandry)
MRN	(Honduras) Ministerio de Recursos Naturales (Ministry of Natural Resources).
OIRSA	(El Salvador) Organismo Internacional Regional de Sanidad Agropecuaria (International Regional Organization for Plant and Animal Protection).

PCCMCA	Programa Cooperativo Centroamericano para el Mejoramiento de Cultivos Alimenticios (Central American Cooperative Program for the Improvement of Edible Crops).
UNAN	(Nicaragua) Universidad Nacional Autónoma de Nicaragua (National Autonomous University of Nicaragua).

Introduction

The objectives of this team were to assess pest control programs in the countries visited, to identify problem areas, and to propose changes that could result in improved pest management practices and crop protection. Each of us gave attention to his own discipline, but we were constantly aware of the fact that plant protection should be crop production oriented, not discipline oriented.

We recognized two kinds of problems in pest control: those derived from a temporary lack of knowledge -- such as caused by a newly introduced pest or by one not previously recognized and studied -- and those derived from a failure to recognize problems and an inability to seek their solutions in a desirable manner. In order to develop sound pest management practices and a productive agriculture in the countries visited, we feel that it is imperative to correct the conditions that lead to the latter kinds of problems. We believe that it is a grave mistake to attempt to solve isolated problems without providing a simultaneous, or better yet a preliminary background information and training that will make possible not only the effective solution of a specific problem, but also the proper approach needed to solve any pest control problem in any crop in any situation.

The supporting information upon which we base our arguments was obtained in interviews and discussions with 113 individuals engaged in crop protection: research and teaching personnel, government officials, pest control operators, farmers, manufacturers and distributors of pesticides, officers of organized farmer groups, lawyers, physicians, and students (see Appendix I). We are aware that the number of people interviewed is minimal, and the amount and kind of information obtained is not exhaustive. We have tried to eliminate the obvious inaccuracies, but we are doubtful that we have succeeded in this attempt. We are also aware that we may have committed errors of our own which we hope have not distorted our analysis or unduly biased our recommendations.

Analysis of Pest Control Policies and Programs

A common denominator in the countries visited is the lack of minimal financial support to government and university agricultural activities in general, and to plant protection programs in particular. It seems that it is only when the presumed impact of a pest has an immediate, financially disastrous effect on cash, export crops that the governments take the necessary steps to remedy the situation. Witness the case of the coffee bean borer (broca del café), *Hypotenemus* (=*Stephanoderes*) *hampei* in Guatemala. This pest, considered to be one of the more damaging to coffee, was found for the first time in Central America in a restricted area in Guatemala in 1971. Immediately funds were available to harvest, buy and destroy the green crop, to compensate the growers at the rate of 1.5 times

the normal price, to buy and apply enough insecticide to spray the 28,894 ha (70,154 acres) infested, and to deploy army personnel to insure that the campaign was carried out as planned. The Asociación Nacional del Café, ANACAFE (National Association of Coffee Growers), the Ministry of Agriculture, the Army, and the Universidad de San Carlos joined together in an effort to eradicate the pest. ANACAFE estimates on the total cost of this operation in 1971 reach Q 228,000.00 (Q1=US$1). It appears that the effort failed. In contrast, no one in decision-making positions seem to care about losses like those due to pests of basic grains (beans, corn, rice, sorghum) in storage, and yet these losses due to these pests are probably greater than those projected for the coffee borer.

The inadequacy of within-country support to agricultural research and extension is evident in most of the institutions visited. There is shortage of personnel, both of researchers and of supportive personnel (technicians); there is lack of acceptably equipped laboratories and greenhouses; in too many cases transportation for research personnel to conduct field work is limited, often reaching totally unacceptable low levels; libraries are small and obsolete. These conditions, coupled with generally low salaries and no other type of recognition to compensate for them, set the stage for low quality, ineffective research. It is our belief that no changes in programs will result in improved pest management research if this situation is not changed. In addition, the inadequate status granted research people results in failure to stimulate further development of research.

A commonly found situation in pest control research is a lack of continuity of programs, this is especially true in the Ministerios de Agricultura. The causes of this are multiple. One that is readily identifiable is the frequency of change of personnel at top policy-making levels (Ministros, Vice-Ministros, Directores Generales, Directores de Departamentos); these changes, more often than not, result in a redirection in research programs. Another is the frequent loss of comparatively better trained and effective research personnel from the public institutions to the private sector. The primary reason that research and extension personnel leave public agencies is a valid one: they are seeking better salaries. In some countries the salary of a pest control specialist working for private institution or in industry is twice as much as that of one working for the Ministerio. Industry seeks out well trained persons who have demonstrated a capacity to plan and execute research programs; this practice tends to leave less effective people in public agencies.

Research on pest control is done mostly in the Ministries of Agriculture and in the universities. Rarely did we find coordination and cooperation between these groups; instead we found that, in too many cases, there is competition and duplication of efforts, not to reach higher levels of excellence, but to "prove the others wrong." On several occasions we met university people who told us that research in the Ministry of Agriculture is not good because "there is too much politics." On the other hand, people in the Ministry frequently say that no useful research is done in the university because "they are out of touch with the agricultural realities of the country." We are aware that this kind of rivalry between universities and government agencies exists also outside the LDCs, but while wealthier countries can afford this luxury, the LDCs cannot. There is some truth in the criticism levied by both sides, but no useful purpose is served, rather

the chances for effective cooperative research and extension are reduced.

In general, there are inadequate numbers of trained scientists in all the disciplines that are necessary to produce sound, usable results in pest control research. In most countries there are larger, although still inadequate numbers of entomologists than of plant pathologists, nematologists and weed scientists. In some countries the "specialists" in these fields have had no formal training in these disciplines; they become specialists by appointment. They usually discharge their duty without proper guidance.

In some countries there are a number of pest scientists that have received higher training in universities abroad; so one can find Ph.D.s and/or M.S.s in entomology, plant pathology, and nematology, but as far as we know no one has received training in weed science. Some of these specialists are conducting valid research which could grow into programs that could have impact in within-country training of more specialists.

Invariably in all countries visited we were informed that the extension service is deficient. Extension people, we were told, are ineffective in aiding the small farmer solve pest control problems. The large farmer either decides by himself what to do, or gets the advice of a chemical company representative. Large companies like the United Fruit Company or the Standard Fruit Company develop and conduct their own research programs oriented towards solving their own pest control problems. The ineffectiveness of extension programs in this field is undoubtedly derived from limited research in pest control, and apparently to a lack of concern for the small farmer who desperately needs the benefits that can be derived from good extension service.

We also noticed a lack of adequate reference materials (libraries, herbaria, insect collections) in most institutions, although there are notable and refreshing exceptions. We saw good libraries at the Escuela Agrícola Panamaricana in Honduras, at the University of Costa Rice, and an exceptionally good one at the Centro Interamericano de Documentación e Información Agrícola of the Instituto Interamericano de Ciencias Agrícolas in Turrialba, Costa Rica. In some libraries the available material is seldom used, as can be judged by the loan date records and by the new, untouched condition of the volumes.

Inadequate research and extension in crop protection, and a pressing need to control pests, especially on cash crops, has resulted in misuse of pesticides. In general the formulation, commercialization and use of pesticides is not effectively controlled by either agriculture, commerce or public health authorities. In most countries there is legislation that regulates the importation, formulation, sales and use of pesticides, but more often than not this legislation is not enforced. We had several opportunities to witness the use of toxicants under totally unacceptable conditions or following objectionable practices.

When we tried to determine the importance of pests we found that there is only scanty quantitative information on the different crops. Invariably the people that made best use of the statistics available were those in the chemical industry. We met only a few individuals that had this information at the tip of their fingers.

Need to Change Policies in the Pest Control Sector

Although it is difficult to procure figures on the losses due to agricultural pests in the countries visited, it is rather easy to sense that a

large quantity of food and fiber is lost to pests. Inquisitive visits to local markets, inspections of vegetable fields (beans, corn, potatoes, sesame) or of orchards (oranges, avocado) led us to the conclusion that pests are taking an untolerably large toll of these crops. If the programs to improve and stimulate crops like basic grains and other edible crops for domestic consumption are successful, the importance of pests will be necessarily greater. Crop protection will have to be more effective not only because there will be larger areas planted to a single crop, but because the finished products will be marketed differently: undoubtedly they will be transported longer distances in larger quantities, a longer shelf life will be demanded of perishable crops, and different, probably higher quality standards will be required.

To reduce the losses now being sustained in basic grains and other edible crops, and to insure that the expertise in crop protection will be available when the expansion of these crops takes place, it is imperative that aggressive pest management programs be instituted in all the countries we visited, and in all other countries in a similar situation.

General Recommendations for Pest Management Programs

The successful implementation of a pest management program depends on the availability of well trained personnel. It is obvious to us that such people are in very short supply in the countries visited. It is also obvious that most of the schools of agriculture do not train their students to become specialists in pest management; this is not their aim. It is then necessary to establish new programs to train specialists in the various disciplines that are essential in pest management, i.e., entomology, nematology, plant pathology, and weed science. There should be specific programs designed to train either researchers, extensionists, or supportive personnel (technicians).

We visualize these programs as organized by out-of-country teams of pest management specialists, who will be the trainers, in cooperation with counterparts in each of the countries where a program is instituted. The programs should be aimed at solving problems in the field. The degree of participation of the trainers will vary according to the level of expertise of the counterparts; in some cases coaching could be minimal, limited to suggesting methodology, while in others it would be necessary to teach "by doing." The stress should be placed in identifying kinds of pests and their importance, determining losses, and applying the available methods of control. We feel that by implementing these kinds of programs it could be shown that by introducing some rather simple changes in the current pest control practices a dramatic change could be achieved. These results should be extended as soon as possible to larger numbers of farmers. This, we feel, would result in a greater self-confidence among the nationals participating in the program, and a faster acceptance of the multi-disciplinary approach to pest control among farmers.

This first step would also serve to identify among the national counterparts, those individuals that have greater ability, sense of responsibility and enthusiasm. These selected individuals that have been "proved in the line of fire," should then receive further training. This training should be provided at two different levels of expertise: one at the support personnel level (field technicians), and another at the research personnel level.

Field technicians could be trained at centers in each of the participating countries. They should be given instruction on sampling pest populations, on the use of pest control equipment and chemicals, on how to recognize the more common and important pests, on how to take and keep field data, on the why and how of field experimentation. This kind of training would be aimed at the "perito" personnel or at others having a comparable level of professional background.

Research personnel training could be organized so that the trainees could get specialization courses in their own fields in national universities, and further training in pest management at regional centers. The outstanding individuals in this group could be given the opportunity to pursue studies towards higher degrees (M.S. or Ph.D.).

We feel that this progressive program would train pest managers, extensionists, and researchers that would be able to look at pest problems with a more realistic attitude which ought to render their performance more productive for their countries, and more rewarding to themselves. We question the wisdom of exposing people that have no solid grasp of the crop production problems in general, and of pest problems in particular in their own countries, to more advanced, sophisticated centers of higher learning where they will become acquainted with scientific techniques and environments that they could not possibly duplicate at home.

The Pest Management Center for Central America and Panamá could be advantageously located at the Centro Tropical de Enseñanza e Investigación, CTEI (Tropical Center for Teaching and Research), of the Instituto Interamericano de Ciencias Agrícolas, IICA (Interamerican Institute of Agricultural Sciences), at Turrialba, Costa Rica. This center has adequate laboratory facilities and a very good library. We feel that an agreement could be reached with CTEI-IICA so that the regional pest management training program could be conducted on a collaborative basis, not as an integral part of CTEI.

For Guyana, and possibly for some English-speaking Caribbean countries, a similar center could be organized at the University of West Indies in Trinidad.

The programs for field technicians could be organized and offered at the following institutions:

Guatemala:	Departamento de Extensión Agrícola, DIGESA. The extension center at the Agricultural Experiment Station in Quezaltenango currently offers training for small farmers on different aspects of crop production. It would be relatively easy to add a program on pest management for field technicians.
Honduras:	Escuela Agrícola Panamericana at El Zamorano. This is a well known international school that has good facilities for the kind of program here suggested.
Nicaragua:	Escuela Nacional de Agricultura y Ganadería, MAG, Managua.
Costa Rica:	Facultad de Agronomía, Universidad de Costa Rica, San José.
Panamá:	Facultad de Agronomía, Universidad de Panamá, Panamá.

Guyana: Guyana School of Agriculture, Mon Repos, East Coast Demerara.

Within-country training for researchers and extensionists could be organized at the Universidad de San Carlos in Guatemala, at the Departamento de Biología of the Universidad Nacional Autónoma de Nicaragua at León, at the Facultad de Agronomía of the Universidad de Costa Rica, San José, and at the Facultad de Agronomía of the Universidad de Panamá.

Means should be available to provide at least for minimal laboratory and library facilities at the centers where pest management research, teaching and/or extension is conducted.

Trained personnel alone will not be the answer to pest management problems. The high rate of change in research personnel seriously limits the possibilities of success of any long term agricultural research program at Ministries of Agriculture and universities. Most of this personnel are lost, after only a short time, to the private sector; some leave the country for better positions, and some are lost to administrative positions in their own institutions. Some mechanism must be found to insure that productive research personnel are retained by other means than by "promoting" them to administrative positions. We realize that this would entail a structural reorganization in the MAGs and universities which may prove very difficult or even impossible to attain. In some countries (Guatemala, Nicaragua, Costa Rica) there are moves towards reorganizing their MAGs, universities, and private institutions. The programs should be so organized as to insure their permanency independently of the individual(s) in charge of them.

Dissemination of research results should be encouraged, and application of new techniques of pest management in the field should be stimulated. Here the extension service should play an important role in demonstrating these techniques to farmers. All information of scientific value should be published in reputable journals, preferably of international or regional circulation.

It is our conviction that to achieve the changes needed to improve pest management programs in the LDCs the desire to change has to come from within these countries. Foreign aid organizations can, and should, serve as catalysts to bring about this attitude, and to help implement the changes needed by providing initial expertise and equipment. The magnitude of the new pest management programs must be commensurate with the capabilities of each of the participating countries to continue these programs once the out-of-country support is terminated.

Entomology, Plant Pathology, Nematology, and Weed Science in the Area Visited

Entomology. In the majority of the countries visited we found crop protection specialists with at least some academic training in entomology. The Ingeniero Agrónomo curricula normally include a course in General Entomology and one in Economic Entomology. The entomologist positions are usually occupied by professionals holding an Ingeniero Agrónomo title. Several entomologists have received training and earned higher degrees in American universities.

In general entomologists pay much more attention to insect pests of cash, exportable crops (cotton, coffee, sugar cane) than to those of food crops (beans, corn). Some well trained, capable entomologists are in administrative positions; this leaves them little opportunity for research. Some others are engaged in basic research of apparently no immediate value to solving pest problems. It is our impression that, although there are comparatively more trained entomologists than plant pathologists, nematologists and weed scientists in the area visited, their number is very small.

Most of the entomologists we met confessed themselves as supporters and practitioners of the integrated control philosophy, but rarely did we see proof of these claims. The interdisciplinary, crop centered approach to pest control is nowhere practiced.

Only rarely did we find good reference insect collections. In a few institutions serious attempts to build such collections are being made, but only as a result of the initiative and personal commitment of individuals, not as a result of them being recognized as important parts of the institutions that house them.

In most institutions entomological libraries were modest, a few were totally inadequate; very few of them had general reference publications like the Review of Applied Entomology. Reprint collections were usually not in evidence, neither in libraries nor in entomologist's shelves.

Extension in entomology -- in crop protection in general -- is limited. In most cases the farmer, especially the small one, gets the recommendations on the use of insecticides from salesmen or fellow farmers. Recommendations for use on food crops are mostly the result of extrapolation of performance data on similar problems abroad, and not the result of experimentation with the insect pest in the country involved.

The use of insecticides is generally not restricted. Some countries have regulations on the kinds of pesticides imported, but in general there is no restriction on the marketing and use of toxicants. Very seldom were we able to obtain information on amounts and kinds of pesticides imported and on amounts actually used. We obtained only limited specific information on intoxication of humans with pesticides, but the problem seems to be an important one in countries where cotton is grown. There is no monitoring of pesticide residues in produce for domestic consumption in any of the countries visited, but there is monitoring in meats for export. In most of the countries visited there was a consensus among crop protection people that the importation, formulation, storage, marketing and use of pesticides should be regulated. In those where there is such legislation there is growing interest in obtaining the means to enforce it (laboratory equipment for analyses and trained personnel to operate it, and adequate enforcement personnel).

The more important insect pests are relatively well known, especially those that are pests of cotton, coffee, sugar cane, rice and corn. Less is known about insect pests of beans, potatoes, and vegetables in general. Very little is known about alternate host plants, especially weeds of crop pests, and the importance of weed control as a means of alleviating some insect pest problems. The systems weed-virus-insect vector-crop have not been studied and their importance has not been determined. In cotton growing areas the

cotton whitefly, Bemisia tabaci, is considered as a vector of disease causing viruses; apparently this whitefly breeds to large numbers in the weed commonly known as "escobillo", Sida sp. (Malvaceae), but no experimental proof was presented to us that the virus infecting "escobillo" is the same as the one infecting cotton, and that the whitefly transmits it. In fact we saw some cotton fields with high populations of whitefly and various weeds, including "escobillo"; some of these weeds showed symptoms of viruses, but we did not see any cotton plant with such symptoms. Much more work is needed in this area.

In some countries there are lists of insect pests and their host plants; this kind of information should be developed in all countries.

Although most entomologists told us that they are "all for biological control," their knowledge of the natural enemies of the common insect pests, and their role as controlling factors is inadequate. Those entomologists that are trying to study natural enemies are confronted with the problem of getting them identified.

Plant Pathology. The scarcity of professionally trained plant pathologists in government agencies and universities is common to all countries visited. The shortage is more acute in some countries, e.g., there are no trained plant pathologists working in public service agencies of Guatemala and Honduras, whereas in Costa Rica there are at least five with an M.S. or Ph.D. degree in plant pathology. There are only four plant pathologists with Ph.D. degrees in the region, and all but one have university appointments. Many individuals with an Ingeniero Agrónomo title use the title "Plant Pathologist," although they may have had little or no formal training in plant pathology other than being exposed to one or two courses in plant protection which may have been offered in a Facultad de Agronomía.

There has been a large turnover of professionally trained plant pathologists in most of these countries. Many plant pathologists who return to their countries after receiving formal training abroad leave their public service posts for more secure and higher paying positions in the private sector. A high percentage of those who remain with government agencies are no longer actively engaged in their specialty.

The plant pathology research programs in a majority of the public service agencies have been oriented toward solving the disease problems of export crops, like coffee and cacao. There has been a gradual trend in some of these countries in recent years to initiate research programs in the diseases of important food crops, such as corn, beans and rice. However, most of these programs have made little progress due to lack of trained personnel, funds, and facilities. Little is known about the etiology, biology or control of many serious diseases affecting food crops. This lack of knowledge is particularly true of the virus diseases which infect many of these crops. Disease surveys are needed to determine the occurrence, distribution and importance of diseases of food crops. This kind of information is very useful in assigning research priorities. Some important diseases of food crops are presented in Appendix II.

Although losses in food grains, fruits and vegetables are high subsequent to harvest, little or no research is being devoted to the study of postharvest diseases in the countries visited.

A wide variety of fungicides, including some of the newer systemics, are available in all countries visited. The major use of these chemical compounds is on cash and export crops. Very little research is being done by plant pathologists in public service agencies to study chemical control of important diseases of food crops. At times, testing of new fungicides on food crops is done by chemical company representatives who are often very knowledgeable about the diseases of these crops.

The laboratory facilities assigned to plant pathologists in most public service institutions of the region are grossly inadequate. This is particularly so of the facilities available in many Ministry of Agriculture experiment stations. Some laboratories lack essential equipment and supply items, such as dissecting and compound microscopes, petri dishes, and agar media. The laboratories in the plant pathology departments of some universities, like the University of Costa Rica, are modern and well equipped. However, this is an exception rather than a rule. Most institutions do not have adequate greenhouse facilities nor means for sterilizing soil. The areas devoted to field studies are often poorly maintained and inadequately managed.

In most countries visited, there appears to be very little contact between plant pathology personnel in various government agencies, especially the Ministries of Agriculture and the universities. This lack of communication often results in a duplication or overlapping of research programs.

There are some successful cooperative research programs between plant pathologists in government agencies of the countries visited and international research centers like CIMMYT (Centro Internacional de Mejoramiento de Maiz y Trigo), and CIAT (Centro Internacional de Agricultura Tropical), and regional programs of PCCMCA (Programa Cooperativo Centroamericano para el Mejoramiento de Cultivos Alimenticios) in corn, wheat, rice and beans. Germ lines of different basic grains are being screened at various locations within each country for agronomic characteristics and resistance to diseases and insect pests. Scientists from the centers make periodic visits to each country to advise and train local personnel. Plant pathologists from the cooperating countries can receive additional training at the centers on diseases of particular crops. Another successful cooperative program is between a plant virologist from the University of Costa Rica and the Ministry of Agriculture of El Salvador to study the virus problems of beans and other food crops in El Salvador and to train young scientists from that country in virology. More cooperative programs of this nature are needed among countries of the region.

In several educational institutions of the countries visited which offer an Ingeniero Agrónomo degree, the only exposure students have to plant pathology is one course that may be given in plant protection and/or entomology. Some agricultural colleges do not have a plant pathologist on the staff. The University of Guyana does not have a Faculty of Agriculture. However, there are at least two universities (Costa Rica and Panamá) which offer two courses in plant pathology and require most students in plant science to take both courses. These courses are taught by full-time professors who have Ph.D. degrees in plant pathology. None of the agricultural schools in the region offer advanced training in plant pathology.

Many trained plant pathologists find it difficult to keep abreast of the

new developments in their specialty due to inadequate and out-dated library facilities. Of the institutions visited in Central America, Panamá, and Guyana, there were only three that maintained libraries with recent reference texts and review journals useful to crop protection specialists. These were at the Escuela Agrícola Panamericana, El Zamorano, Honduras; Centro Tropical de Enseñanza e Investigación, Turrialba, Costa Rica; and the University of Costa Rica, San José. The only way some plant pathologists in this region have access to reference material is personally to subscribe to one or more scientific journals and to purchase new reference texts on their own. Most trained plant pathologists are members of the American Phytopathological Society and receive the Society's journal "Phytopathology."

There are local, regional and international publications where plant pathologists from the countries visited can publish their research results. Most plant pathologists in these countries have been very lax about publishing research data and recommendations in local government and/or university publications, bulletins or pamphlets. Most of the information published locally by plant pathologists pertains to diseases of cash or export crops. Very little published information is available in these countries on diseases of food crops. There needs to be a more frequent updating and revising of information contained in printed material, especially that which deals with disease control recommendations.

There is no scientific journal in Central America, Panamá, or Guyana which is devoted solely to plant pathology. There is an excellent journal entitled "Turrialba" which is published periodically by the Instituto Interamericano de Ciencias Agrícolas (IICA) from Turrialba, Costa Rica. Articles in different disciplines of agriculture are published in English or Spanish. It has a wide distribution in Latin America. Only a few plant pathologists from the countries visited, most of them from Costa Rice, publish in this journal, or in regional and international periodicals. The research papers presented by plant pathologists in Central America and Panamá on diseases of corn, rice, sorghum and beans at PCCMCA regional meetings are published annually.

None of the countries visited have their own society of plant pathologists. Most professionally trained plant pathologists in these countries belong to the Caribbean Division of the American Phytopathological Society. Many of them also belong to other professional societies in Latin America, such as the Asociación Latinoamericana de Fitotecnia (ALAF). Plant pathologists from some of these countries often find it difficult to attend scientific meetings which are held outside their countries due to lack of travel funds.

Nematology. The observations made upon the levels of research in nematology in the countries visited are concerned primarily with nematology as it applies to basic food crops, rarely did we consider nematode problems in other crops. The banana exporting companies, and to a lesser degree the coffee associations have supported effective applied research programs on the nematode problems of these export crops. They employ trained nematologists and have in the past employed professionally trained nematologists from abroad on both short and long term assignments to develop nematode control procedures specific to these particular crops.

Aside from the research activities in nematology supported by private

companies concerned primarily with export crops the overall activity and interest in nematode problems of basic food crops is either non-existent or very minimal in the countries visited. At the moment there are no persons with technical training at the level required to successfully plan and carry out meaningful research in nematology. There have been in some countries surveys directed toward determining the presence of parasitic nematodes on food crops. However, these appear poorly planned and in the majority of instances no use has been made of the scanty information obtained in the surveys.

It appears that the stimulus for initiating surveys for the presence of plant parasitic nematodes is most always associated with out-of-country contacts and that identifications of the nematode species collected are made by outside-of-country specialists. This procedure obviously fails to provide within-country training in nematode identification. We met several individuals engaged in nematode-related activities; none had sufficient basic knowledge in nematology to enable them to make identifications of common plant parasites to the species level. Further, we found no evidence of any attempt by any of these individuals to improve their knowledge in this area by securing literature and working with the nematode faunas present in their countries. There is little or no attempt to send specimens to outside specialists in taxonomy. We believe that sometimes not enough emphasis is placed upon the necessity of making correct identification of species as a basis for conducting research on control of nematodes, particularly when investigating the possibility of using crop rotations and resistant varieties as practical control measures. It also seems apparent that some individuals, perhaps a majority, are now involved in nematology because indicating an interest in nematodes increased their chances of receiving financial aid for study in foreign institutions.

We have been particularly concerned with the apparent lack of knowledge or understanding of simple techniques of applying nematocides for demonstrating possible crop losses due to nematodes. The training and exposure of these individuals to techniques in applied nematology seems to have induced the attitude that meaningful applied research cannot be accomplished in the absence of sophisticated equipment. We suggest that more attention be given to the simple alternatives that can be successfully employed when expensive and complicated equipment is not available.

In those few instances where there is any attempt to control nematode pests we have observed that there is a definite tendency to select those nematocidal materials that can be applied in granular dry forms. These are in general mediocre nematocides for field application, and the results obtained tend to lead to erroneous conclusions concerning the effect of nematodes upon crop yields.

Weed Science. Personnel engaged in weed science research in the public sector agencies (universities and ministries of agriculture) in Central America and Panamá (CA&P) have not been trained professionally in weed science. Most researchers have an Ingeniero Agrónomo (IngAgr) degree; one held a Master of Science degree from a university in the United States; and one has European training. None of these academic experiences were in weed science. These researchers hold limited memberships in professional organizations in weed science or other associated disciplinary areas. Most incumbents have a tenure of 1 to 3 years in weed science positions. Only one was

involved in weed control projects in 1966, on a part-time basis then and now. Most of those engaged in weed science research have additional research responsibilities. The less than total and professional grasp these workers have of weed science and its role in overall food crop production probably is related to a high personnel turn-over rate in the public agencies.

It is doubtful that the average person engaged in weed science in the private and industrial sector is better trained, but it is obvious that he has greater motivation.

Personnel now active in weed science in CA&P have been trained pragmatically through experience, their capabilities and qualifications are neither uniform nor adequate for strong weed science programs.

Basic weed science research programs were neither observed nor reported. Applied weed research in public agencies is oriented toward specific crops. Some countries have weed control projects in the ministries of agriculture (MAG) and in the universities or "facultades de agronomia."

Duplication of effort is occasional and a relatively high degree of interagency cooperation was noted. Applied weed research programs become markedly discontinuous under frequent personnel shifts. Programs appear national; no international programs were observed except for the Oregon State University International Plant Protection Center AID contract (IPPC) in support of and coordinating national programs. The IPPC program has had a modest effect in attacking weed problems. This program has provided chemicals, equipment, and some practical training. The national efforts fall short of desirable goals and can become successful only when directed through trained persons with reasonable tenure.

Agrichemical companies appear willing to assist the public agencies by providing commercial and experimental herbicides and, in some cases, limited equipment. Weed science activity carried on by agribusiness is oriented mainly towards the practical demonstration-experiments designed to provide a basis for and to generate sales.

Information on the acreage and scale of food crop production was not readily available. Few public agency interviewees had a complete understanding of production needs and crop inputs.

Weed control experiments have been conducted in many food crops: dry bean, corn, peanut, potato rice, sesame, sorghum, soybean, wheat, yuca, carrot, crucifers, cucumber, onion, and tomato. Much applied research has been sporadic and inadequate to provide widely applicable data or recommendations.

Invariably, research facilities and equipment are modest and consist of a chemical storage/workroom, measuring and dispensing laboratory utensils, a small-plot sprayer supplied by IPPC, and back-pack, hand-pumped commercial sprayers. Few field sprayers are available. The IPPC CO_2-powered, small-plot sprayer is used generally for experiments, and the field plot layout and design are compatible with the sprayer. The methodology is adequate for replicated small-plot yield experiments. Yield and other performance data are taken generally, while organoleptic evaluations are recorded only occasionally. Library facilities are modest.

Most universities have herbaria, some facultades do not. Few research units have more than modest weed collections. Botany, including systematics, and plant physiology and agronomy, including weed control, are normal offerings in the IngAgr curriculum. Costa Rica (UCR) offers a course in weed control.

Few countries have a recent or a relatively complete flora. Most of CA&P have been explored thoroughly by National, North American and European botanists and numerous monographs have been published. Available weed flora tend to consist of brief and incomplete lists, often poorly organized, of weed plants. A handbook on the weed flora of Central America is in preparation apparently under the coordination of IPPC. Interviewees generally had inadequate knowledge of the weed flora pertinent to their food crop and research areas. A few ubiquitous, important weeds in CA&P are listed in Appendix III.

Researchers in several countries are developing data on cultivation (weed-free period) requirements and on crop loss through weed competition. Essentially no information is available on crop losses attributable to weed competition. Most researchers were aware of the possible relationships between weed hosts and crop plants and could cite "white fly virus" symptoms, but none of the interviewees could cite specific information. Data on the incidence of "smut" on nutsedge inflorescences and a leaf-boring larva on nutsedge as possible biological controls have not been obtained from natural field infestations.

Statistics on herbicide importation and field use were difficult to obtain. Only agrichemical businesses seemed to have information on amounts imported and commercial application rates and methods. Experimental and field data for food-crop herbicides generated by public agencies appears inadequate for sound recommendations and extension activity. Information on herbicide carryover and soil residues, weed tolerance, weed population shifts, and other herbicide use problems is minimal. Hard data and weed science or weed control publications are few and incomplete. Extension activity, as with field development, is more within the purview of agribusiness than within public agencies. Some chemical practices effective in food crops and suggested or recommended have dubious legal status in countries which regulate agrichemical usage.

Crop Protection in Central American Countries, Panama and Guyana

The above discussion represents our views of the crop protection sector as we see it in the area visited as a whole. Discussions pertaining to crop protection in each of the countries visited follow.

Guatemala

The most important crops in Guatemala are coffee and cotton; sugar cane and bananas are also sources of foreign exchange. Corn is the major food staple, but beans, potatoes, and rice are becoming of importance. The majority of pest control efforts are devoted to cotton and coffee. Cotton is relatively a newcomer in Guatemala's agriculture, modern cultural practices to grow cotton were implemented for the first time in 1947. In 1971 cotton produced a revenue of Q 40,000,000. In 1972 there were 128,000 manzanas (89,600 ha, 217,600 acres) planted to cotton. Coffee is the main export and produces 46% of the exports. In 1971 the value of coffee exports reached Q 100,562,000.

Crop protection programs center around cotton and coffee. Little attention is given to pests of other crops.

It is possible that in the near future the Instituto de Ciencias y Tecnología Agrícola, ICTA (Institute of Agricultural Sciences and Technology), will be a reality. This institute will be semi-autonomous; it will coordinate all research in agriculture, but the emphasis will be on corn, beans, rice, wheat and sorghum.

Entomology. There are two trained entomologists in Guatemala active in entomology: one with the Universidad de San Carlos, and one with the Asociación Nacional del Café (ANACAFE). There is no trained entomologist in the Ministry of Agriculture (MAG), the entomological work is being carried on at the Dirección de Investigaciones Agrícolas (DIA) by a Perito Agrícola and a student in agronomy hired by MAG. In spite of the limitations under which they operate we found these two "workers" are quite knowledgeable of the entomological problems of basic grains and vegetables. They are studying insect pests of corn, soybean, rice and cotton. Their aim is to determine the economic importance of the various phytophages associated with these crops and the influence of different cultural practices (single crops vs. associated crops) on their incidence. This research, conducted in cooperation with the Washington University, St. Louis, Mo.,was impaired by inability to cultivate the experimental plots in a proper manner, by the inadequacy of the equipment used, and by the lack of experience of the researchers in this type of work.

The facilities for entomological work at DIA are very modest; the laboratory is in very inadequate quarters and has only very minimal equipment. We were told that the library (it was not shown to us) contains a very limited number of publications. We did not see any reference insect collection.

Additional information on pests of basic grains is obtained at the various "programas" in the DIA (beans, rice, corn, sorghum). Important insect and mite pests of beans are Phyllophaga sp., Agrotis sp., Empoasca fabae, Apion godmani, Cholepus signaticollis, Tetranychus sp., Acanthoscelides obtectus, Diabrotica sp., Colaspis sp., Bemisia tabaci, Estigmene acrea, and Agromyzidae. On rice, stem borers are not very important; Sogatodes sp. is found but it does not reach pest status. Corn that is cultivated at low elevations is attacked by various insects: stalk borer (Diatraea sp.), Spodoptera frugiperda, and white grubs. Sorghum is attacked mainly by midges, S. frugiperda, and Diatraea sp. In spite of the importance of these pests, the pest control efforts in Guatemala are directed towards protecting cotton and coffee.

Pest control practices in cotton seem to be heading for disaster. In the late 1940s only 8 treatments were sufficient to control pests; now up to 40 treatments are required each season. About 70% of all insecticides used in Guatemala are for control of cotton pests. In 1971 a total of 125 million kilograms of insecticides were imported at a cost of $29,500,000. Although these figures do not represent the actual use of insecticides annually -- it may have been imported for more than one year -- it gives an idea of the intensity with which insecticides are used.

Recommendations on the use of pesticides on cotton are in the hands

of pesticide companies, pesticide applicators, and fellow farmers. The Ministry of Agriculture or the National Cotton Council are not involved directly in research to develop recommendations for pest control. The unrestricted use of toxicants has caused a large number of cases of pesticide intoxications among humans. In 1971 a total of 1100 cases of pesticide intoxications were treated in hospitals in Guatemala. More than 50% of these cases were moderate to severe poisonings. According to information obtained at DIGESA, about 400 persons die annually because of pesticide poisoning.

In coffee the important problem is the coffee bean borer, Hypothenemus (=Stephanoderes) hampei, a pest apparently of African origin, that was discovered in Guatemala for the first time in 1971. At that time this pest was not known to occur in Central America, Panamá or Mexico; but recently (September 1972) it has been found in southern Mexico. When the borer was found in Guatemala an eradication campaign was started. ANACAFE, MAG, the University of San Carlos, and the Ministry of Defense joined forces in this campaign which cost U.S. $228,000. The attempt seems to have failed, but apparently the borer populations were reduced to very low levels. In the 1972 season the coffee fincas were treated twice with endosulfan; the infestation reached less than 0.5 percent. Some persons feel that treatments with endosulfan for two seasons have induced a greater incidence of coffee leafminers, Leucoptera coffeela and L. meyricki.

The importation, formulation, marketing and use of pesticides is regulated by Law (Decreto) No. 446 of 25 October 1955, but for all practical purposes this law has been suspended or ignored. There is no control of the quality of pesticides, fertilizers and other agro-chemicals, including drugs used in veterinary medicine. There is total lack of control of pesticide residues on vegetables and other agricultural products for domestic consumption. This is not a problem yet because pesticides are very seldom used in vegetable crops, beans and corn, but if the programs to intensify and expand these crops are successful, it is inescapable that pesticides will be used increasingly and, most likely, residues will become a problem. According to our information, Guatemala has no operating facilities and trained personnel to enforce Decreto 446.

Plant Pathology. There are no professionally trained plant pathologists working in government in Guatemala. In the Departamento de Parasitología Vegetal of MAG there is one Ingeniero Agrónomo who works on diseases of food crops. He is planning to study for a Master's degree in plant pathology at Chapingo, Mexico next year. In the same Departamento there are also two 4th year students from the Facultad de Agronomia, Universidad de San Carlos; they work part-time on diseases of food crops. Both were knowledgeable about the diseases of these crops in different areas of Guatemala. Comparable enthusiasm and interest in plant pathology was seldom encountered among other plant pathologists in the countries visited. A Ph.D. plant pathologist who had worked for MAG for several years, resigned last year, and is now working as an agricultural consultant in Guatemala.

The laboratory facilities of the Departamento de Parasitología Vegetal were inadequate. The library was small and lacked most of the more recent reference texts and journals in plant pathology and related disciplines.

With a lack of trained personnel, funds and facilities, very little

progress can be expected from MAG research programs in food crop pathology.

The basic food grains (granos básicos) projects of MAG are cooperative with CIMMYT, CIAT and PCCMCA; their objective is to locate improved lines of beans, corn, sorghum, rice and wheat which are resistant to important diseases. The screening of germ plasm for disease resistance is done mainly by agronomists.

Most of the fungicides imported into Guatemala are used in controlling diseases of export crops like coffee, cotton and bananas. Chemicals are seldom used to control diseases of food crops.

There are no trained plant pathologists in the staff of the Facultad de Agronomía in the Universidad de San Carlos. The Facultad does not offer a course in plant pathology. Students are exposed to plant pathology in a course in plant protection.

Nematology. There is only limited information on the nematode pests of food crops in Guatemala. The Ministry of Agriculture has published the results of a plant disease survey and some information on nematodes is included. This is superficial and largely concerns root-knot nematodes. These nematodes are reported from cabbage, celery, coffee, cotton, beans, kenaf, okra and tomato. In conversations with personnel of the Ministry of Agriculture and the School of Agriculture, tomato was indicated to be the only crop severely damaged by root-knot nematode, but there have been no attempts to control this pest. It was indicated that root-knot was not an important pest of cotton or coffee. There is no information concerning crop losses caused by nematodes and only casual mention was made of control experiments involving a nematocide. Information concerning the results was not available.

Other records of plant parasitic nematode species are: *Radopholus similus*, burrowing nematode on bananas, *Rhadinaphelenchus cocophilus*, red ring disease of coconut palm, *Pratylenchus* sp. in coffee, and *Xiphinema* sp. in coffee.

The meager information available does not permit a reasonable evaluation of the effect of plant parasitic nematodes upon production of basic food crops. There are no individuals in Guatemala with training or experience working in nematology at the present time.

Little or no information concerning nematodes is presented in any of the courses taught in the university. One student from Guatemala is presently at California Polytechnic Institute in San Luis Obispo, California for a year's training in nematology. It remains to be seen whether the situation in nematology will improve upon his return.

It is our opinion that the low level of research activity in all areas related to food crops will discourage potential initiative in any individual faced with the limitations of facilities, equipment and financial support that are now available in the University or Ministry of Agriculture.

Weed Science. Team discussions with Ministry of Agriculture officials and managers of the coffee and cotton growers association demonstrated that these persons do not consider weed control an important input in food crop production. The value of chemical weed control methods in the more important cash and export crops -- coffee, corn, cotton, sugarcane -- and pasturage was acknowledged. An interviewer noted that one worker applying herbicides with

a back-pack sprayer could accomplish as much weed control as ten workers with machetes. Abundant, inexpensive agricultural labor facilitates decisions favoring the use of labor and using available cash or credit for other production roles.

Weed science research input in Guatemala is limited. Basic information on the crop-weed-herbicide complex is not sufficient for food crop management programs. Facilities and equipment are equally limited and appear to include manual sprayers useful for small field plots. Chemical supplies of coded experimental and commercial herbicides are readily available through the numerous U. S. and European agrichemical companies operating in Guatemala. Apparently, public agency weed science research is conducted only by the Ministry of Agriculture through one Ing. Agr. assisted by an undergraduate student. It is likely that a minimum of ten agrichemical company employees conduct on farm herbicide trials, particularly in export crops. It should be noted that the weed science training and formal experience of these persons is minimal.

A staff botanist at the University of San Carlos maintains a national herbarium. Apparently, weed science is not curriculum material in the Ing. Agr. educational cycle. The Ministry of Agriculture program in weed science currently consists of field experiments located widely at experiment stations in the several Guatemala crop/climate zones. The trials are designed to evaluate herbicide performance in dry bean, corn, potato, rice, sesame, sorghum and wheat. Both pre- and postemergence-applied chemicals are under evaluation. Specific weed species response is rated. Additional experiments are directed toward control of "coyolillo," Cyperus rotundus. Prior research was conducted by the University alone, but the current program is supported by the Oregon State University International Plant Protection Center/USAID Contract (IPPC). The IPPC provides technical advice, experimental weed control equipment and chemicals, and some visual and training aids through a Central American coordinator based at the OSU/USAID mission in El Salvador.

Guatemala's diverse geographic/climatic zones promote a diverse weed flora. Quantitative data on specific crop loss through weed competition and consequent economic loss are not known. Specific weed hosts for diseases, insects, nematodes, or viruses attacking local food crops have neither been evaluated or catalogued. Specific weeds important in some crops have been noted. Other than the ubiquitous nutsedge "coyolillo," most of these weeds are among the Compositae, the Euphorbiaceae, or the Gramineae. "Flor amarilla," a name commonly applied to a yellow-flowered composite in both high- and low-lands, may represent as many as three distinct species and/or genera. It is probable that the prevalence of "flor amarilla" in wheat (and pastures) is a result of general use of chlorophenoxy herbicides (2,4-D like). Increased populations of herbicide-tolerant Euphorbiaceae and Gramineae in several crops appear associated with repeated commercial herbicide usage. The flora in coffee plantations weeded with periodic applications of paraquat and 2,4-D has shifted toward species tolerant of those chemicals. Unfortunately, observations of plant population changes have not been recorded.

Herbicides constitute an important agrichemical input in Guatemala but accurate statistical information does not appear to be readily accessible. No published information or recommendations for herbicide use are available from the public agencies and herbicide norms based on national research are lacking. A sound extension program is not possible under these conditions.

Herbicide development has been most active by commercial interests for the export crops -- coffee, cotton, and sugarcane -- where established commercial herbicides are applied by manual and tractor equipment. Corn plantings receive the bulk of food crop herbicides, the large plantings use aerial and tractor application methods. Rice also is a major food crop grown under tractor-applied herbicide programs. Apparently chlorophenoxy herbicides have been long established in wheat while chemical weed control methods are being explored in sorghum. Chemical weed control usage in dry bean and potato appears limited. Weed control in a large, but ill-defined acreage of pasture is obtained through rotary mowing or tractor-sprayer application of chlorophenoxy herbicides.

There is no current evidence that herbicide residue carryover from treated crops has affected succeeding crops. Regulatory activities pertinent to herbicides -- including those prescribed by law -- appear inoperative.

Persons active in applied weed science lack professional training and knowledge.

Honduras

The economy of Honduras is predominantly agricultural. The more important crops that provide the country with foreign currency are bananas, coffee, sugar, tobacco, cotton. Important food crops for domestic consumption are beans, corn, and sorghum. Cotton has declined in importance in the past few years; in 1967 there were some 12,500 ha (31,000 acres) planted to cotton, while in 1972 there were only some 8,000 ha (19,768 acres). The Honduran Ministry of Natural Resources through Desarrural (Department of Rural Development), and other institutions that participate in the government plan for agricultural development -- such as the National Development Bank, the National Agrarian Institute, and the National Planning Council -- are emphasizing the improvement of food crops and animal husbandry. Honduras has favorable conditions to grow beans, especially the black and red varieties. Desarrural is carrying on a cooperative program with IICA and PCCMCA on bean improvement; the selection work is done at IICA in Turrialba and the lines are field tested in Honduras.

Desarrural is also stimulating the growing of rice, especially of upland rice, which would be grown by small growers. The testing of varieties, cultural practices (sowing vs. transplanting), and use of herbicides is being conducted at the Agricultural Experiment Station at Comayagua. This work is being done in cooperation with the Taiwanese Mission. Under the leadership of Ing. Felipe Fa-Pen-Lin, a group of Taiwanese agronomists and field technicians are demonstrating the art of growing rice to the Hondurans. We had the opportunity to meet with several of the Taiwanese at Comayagua and we were favorably impressed with their approach in their program. It was evident that they had studied the Honduran possibilities and limitations for growing rice and had organized their program accordingly. It seemed to us that it was an interesting case of teaching by doing. The Taiwanese are also demonstrating the growing of vegetables like radishes, broccoli, cabbage, etc.

The problems of export crops, mainly bananas, are well taken care of by the foreign fruit companies -- United Fruit Company, and Standard Fruit

Company -- which have well trained personnel and modern laboratory facilities. We did not make any effort to obtain information on banana problems.

Training in agriculture is offered at the Escuela de Agricultura, Universidad Nacional Autónoma, in La Ceiba, on the Caribbean coast, and at the Panamerican School of Agriculture in El Zamorano. The graduates from the Escuela de Agricultura earn the professional degree of Ingeniero Agrónomo, while the students at the Panamerican School of Agriculture get training at the Perito Agricola level. No research is done in any of these schools.

Entomology. Honduras is another country where the lack of trained personnel in agricultural sciences in general, and in crop protection in particular, is very obvious. At Desarrural we met an entomologist who doubles as a nematologist. Apparently he is the only professional in Desarrural that does some research in entomology. We get the impression that there is a very superficial knowledge on the insects and mites that attack crops, and that there is little, if any, experimentation on pest control technology. The limitations that cause this state of affairs are common to many of the countries in similar situations: lack of resources, both human and material.

At the Panamerican School of Agriculture, a 3-year private school, high school graduate boys from Latin American countries receive practical and academic training in agriculture. In the 1962-1971 decade, out of 527 graduates 126 (23.9 percent) were Hondurans. Training in crop protection is limited to obtaining practical knowledge of insect pests and diseases in the first year, and to elements of Morphology, Physiology, Identification and Control of insects and mites in the third year. The program is centered around the insect pests that occur in the school's farm. Insect and mite pests of corn, beans, tomatoes and other vegetables, mangoes, avocados and citrus are known and are controlled following label recommendations but no experimentation is done.

There are no laws that regulate the importation, formulation, sales and use of pesticides in Honduras. No one knows whether there are critical problems derived from misuse of toxicants. The fact that cotton is declining in importance in Honduras, and as a consequence insecticides are not applied as massively as before, may account for fewer cases of acute intoxications. But insecticides are handled carelessly. We were informed that persistent insecticides are used on leafy vegetables. Insecticide residues on vegetables for domestic consumption are not monitored. It is a common practice to import toxicants in large containers and repack them in smaller containers. These smaller packages consist of plastic bags or bottles of various kinds and sizes. The name of the compound is not printed on the label on the small packages; it is commonly penciled on the container with a felt pen. We saw several of these packages with the name faded or wiped off to the point of making it impossible to identify the contents.

Astro-Agricola is a private company that has the exclusive representation of several manufacturers of pesticides for Honduras. Among these manufacturers are DuPont, Rom and Haas, Dow Chemical, American Cyanamid and Ciba-Geigy. According to figures provided by Astro-Agricola this company sold 70 percent of the insecticides, 80 percent of the fungicides, 95 percent of the nematocides, and 80 percent of the herbicides used in Honduras in 1972, excluding those used

by the United Fruit Company, Standard Fruit Company and the Cotton Co-op. Their projections of the value of these chemicals consumed in Honduras in the next four years is presented in Appendix IV.

Extension work on the use of pesticides is left to the private companies. Publication of literature on the use of toxicants for the small farmer is negligible. (We were told that the majority of the small farmers are illiterate.) Usually extension work is done verbally at farmers meetings, but this is not effective because the farmers "just do not follow advice."

Plant Pathology. There is an extreme shortage of trained crop protection personnel in public service agencies of Honduras. There are no professionally trained plant pathologists working in the Ministry of Natural Resources, MNR, or the university. The laboratories are poorly equipped and the library facilities lack current reference texts and review journals in crop protection.

The large banana companies (United Fruit and Standard) on the north coast of Honduras have well equipped research facilities and several Ph.D. plant pathologists on their staff. The companies maintain their own reference libraries which are small but very adequate.

Within MRN, DESARRURAL has a fairly active program in cooperation with PCCMCA to test bean germ plasm lines in various regions of Honduras. Plant pathologists from the University of Costa Rica and the U. S. Department of Agriculture, Puerto Rico, have made disease surveys in the bean growing areas of the country and have helped to screen the germ plasm trials for disease resistance.

The Escuela Agrícola Panamericana at El Zamorano offers a 3-year course of study in applied agriculture to young men from various Latin American countries. Students are given one or more courses in entomology and plant protection, but no course is offered in plant pathology. EAP will have a plant pathologist on the staff next year. In their field work students are taught the proper use of pesticides. The school also maintains an excellent reference library which contains recent reference texts and current subscriptions to several journals of plant pathology including "Phytopathology" and "Review of Plant Pathology."

The Facultad de Agronomia of the National University was established four years ago in La Ceiba on the north coast of Honduras. The facultad will graduate its first class of Ingenieros Agrónomos next year. There is no professionally trained plant pathologist on the staff and no course is offered in plant pathology.

Nematology. There is one trained nematologist in Honduras. He spent about three years studying nematology at Rothamstead Experiment Station in England. Since his return to Honduras in 1971 he has not been active in nematology. However, he indicated that root-knot nematodes were a problem on tomato, pepper and papaya. Also he believes that citrus nematode, *Tylenchulus semipenetrans*, was present on citrus and that reniform nematode, *Rotylenchus reniformis*, was present on papaya, although he had not seen them.

In a vegetable market, root-knot nematode was observed on Irish potato and carrots. It is obvious that there have been no active programs of research on nemas in Honduras, that practically nothing is known of the nematode species that are parasitic upon food crops, that there is no reliable information on damage to crops by nemas, and that no attempts have

been made to control nematodes where they are recognized to be an important pest, e.g., tomato.

We noticed that this Honduran nematologist has limited knowledge of nematode taxonomy; he indicated that he could not identify the species of root-knot nematode. He was familiar with the common nematocides, but had not used them to control nematodes. Lack of facilities, financial problems, and other assigned duties (entomology) make it very likely that he will not be able to engage himself in research in nematology. It is very possible that this field will remain at its present level in Honduras for the foreseeable future.

Weed Science. Honduras does not have trained weed science personnel in the public sector and it is probable that the private sector lacks trained technicians as well. The Escuela Agrícola Panamericana, EAP, at El Zamorano does have a trained agronomist who instructs in weed science as well as a trained botanist.

Weed science input in food crops by the public sector is minimal and is cooperative with the Oregon State University International Plant Protection Center (IPPC) program for Central America based in El Salvador. Use of chemical weed control methods in food crop production is part of the EAP teaching and sustenance programs. Private chemical companies have conducted some herbicide demonstrations in "exportable" food crops like corn and rice.

There is no national flora, and the only effective herbarium seems to be that at EAP. A publication of EAP contains line drawings and descriptions of 40 weeds important to El Zamorano area. Major weed problems of Honduran food crops and production areas have not been determined. Information on weed competition and economic losses have not been developed. Weed host information appears limited to observations of cotton insect pests on "escobillo" (*Sida* spp.) and a rice "inch worm" on smooth and spiny "bledo" (*Amaranthus* spp.).

Numerous herbicides are imported into Honduras. One agrichemical importer projects that the use of herbicides in Honduras will increase from $US212,500 in 1972 to $US250,000 in 1976 (see Appendix IV). Prices of herbicides offered for sale appear reasonable by U. S. standards.

Information basic to the sale and rational use of herbicides is not apparent. Recommendations for herbicide use and other weed science publications do not appear to be available from either public or private sources except for specific food crop uses in the EAP weed identification bulletin mentioned above. Weed science extension is very limited and most appears conducted by agrichemical company technicians. This corporate activity is directed mainly toward export crops or those grown on a large scale like cotton, rice, and sugarcane and pastures.

Personnel responsible for weed science research lack professional training and capability.

Nicaragua

About 70 percent of the value of Nicaragua's exports come from agriculture.

Cotton, coffee and sugar are the more important exportable crops. Cotton and rice are the most "technified," while in other edible crops (corn, beans, sorghum) a rather primitive technology is used.

Efforts are being made at MAG to establish a program to develop the agricultural sector in Nicaragua. Should these efforts be successful they will have "repercussions" on the country in general, as a large percentage of the Nicaraguan population live in the rural areas and get their income from agriculture. The plan consists in the consolidation of higher education, research and extension in agriculture which will result in greater efficiency in each of these activities at MAG. In education the goal is to "improve the quality of the professionals graduating from ENAG;" continuing education aimed at farmers is contemplated in this plan. In research the emphasis will be placed on crops that are of nutritional importance; these are corn, sorghum, rice, beans, sesame, and vegetables. Research will be organized so as to improve the genetics, agronomical practices and crop protection for each of the crops. Research will also be done in animal husbandry. The extension service will be organized so as to make available the results of research to the farmers.

It is expected that "if all goes well," this plan will be in full operation by 1976. The total cost over these five years will be some $US23,122,000. Of these, the Nicaraguan government will provide $US17,007,000 (73.8%) while the rest, $US6,045,000, will be requested from foreign granting agencies.

This national plan was the result of studies by a National Committee and a group of advisers from IICA.

Entomology. In Nicaragua the pest control scene is dominated by the current program on integrated control of insect pests of cotton that is being carried on jointly by MAG, the Banco Nacional de Nicaragua (BNN), the Universidad Nacional Autonoma de Nicaragua (UNAN), and FAO.

Another program is being aimed at controlling insect pests of stored products, mainly grains. This program is being conducted at MAG Seccion de Productos Almacenados in cooperation with the Foreign and Commonwealth Office of the Overseas Development Administration, U.K., through the Tropical Stored Products Centre, London.

Recently (September 1972) a 4-year study on insect pests of rice was completed. This work was conducted under the auspices of the BNN by an entomologist from the Louisiana State University.

In 1971 an FAO report was published on the insects that attack *Pinus caribaea* in northeastern Nicaragua. This work was done with aid from FAO.

This rather intensive entomological activity indicates that there is an awareness of the importance of entomological problems in Nicaragua. Yet, we found that the number of well trained personnel at all levels is minimal: in general, the training of entomologists at MAG, UNAN, and BNN appears modest. According to one source there are only three individuals in Nicaragua that have received formal training in entomology and are doing entomological research; according to another source this number may reach 10.

A program on the integrated control of insect pests of cotton is being

conducted by Nicaraguan personnel from MAG, BNN and UNAN with Dr. Rainer Daxl as an FAO consultant-in-residence, and the periodic supervision of Dr. L. A. Falcon, a UCB entomologist and FAO consultant. This program is considered successful, and the results have been presented in various progress reports and extension bulletins.

We met with various individuals that are working on this project. It is evident that the Nicaraguan personnel is enthusiastic and fervently convinced of the virtues of integrated control. This attitude has spread to other persons interested in crop protection who would like to start similar programs on all crops if resources were available. We believe that this attitude is commendable, but perhaps premature. Very often we were told, both by research personnel and by students, of their plans to carry on some piece of complicated research such as the "population dynamics of cotton agroecosystems," or "the population dynamics and control of pests of vegetable crops." We feel that these persons, although well intentioned, were putting the cart before the horse. There is dire need for a lot more entomologists considerably better trained before embarking in any kind of sophisticated entomological or ecological research.

Academic training of most entomologists in Nicaragua does not extend beyond the two courses -- General Entomology and Economic Entomology -- offered in the Ingeniero Agrónomo curriculum at ENAG. A course in Pest Management has been offered once a year for the last two years by the UNAN at Leon. In this course -- supported by FAO, OAS, BNN -- the principles and practices of ecologically sound pest control are taught. The course is intended mainly for pest control practitioners.

Research in entomology at MAG is carried on by two entomologists, one working on insect pests of field crops, and one on insect pests of stored products. A number of entomologists with either BNN or UNAN are doing research on integrated control of pests of cotton. The only native Ph.D. in entomology we met in Nicaragua is working for the BNN on pests of rice.

Intoxication of humans because of misuse of insecticides is a problem of growing public concern in Nicaragua. During our stay in that country rare was the day that a case of intoxication or other deplorable situation derived from use of pesticides did not make the news. Reportedly in Nicaragua there were 356 cases of poisoning by insecticides treated in hospitals in 1971.

Misuse of insecticides because of ignorance or temerity may be compounded because of erroneous or unwarranted information in the recommendations. For example, re-entry to cotton fields to evaluate the effectiveness of treatments (parathion is the insecticide most commonly used) is done after two days, and even after only 1-1/2 days! We feel that under the conditions of extremely dense foliage and tall plants (over 6 feet) this re-entry period is too short. Chemical company representatives told us they felt this period was adequate because under the prevailing high temperatures very little insecticide remains on the foliage after two days. But this has not been demonstrated experimentally. As far as we were able to determine, cholinesterase levels of pest surveyors is not periodically checked.

The importation, marketing and use of insecticides in Nicaragua is regulated by MAG. Any chemical used in agriculture has to be registered

in the country of origin in order to be registered in Nicaragua. The chemical content must conform with the label. This is checked by analyzing random samples in the laboratories at the Centro Experimental Agropecuario La Calera, or at the Centro Experimental de Posoltega. Performance data are not always required.

The value of insecticides imported to Nicaragua in 1971 reached US$9,446,188.86; this is the value of formulated materials and technical insecticides for formulation in the country, inert materials and solvents are not included. The kinds and amounts of insecticides imported from 1965 to 1971 are presented in Appendices V to XIX.

According to a physician in the Ministry of Public Health, the medical profession in Nicaragua has no influence in the formulation of policies to regulate the marketing and use of insecticides. Analyses of agricultural produces for domestic consumption to determine pesticide residues are not performed in Nicaragua. The Instituto de Fomento Agricola y Ganadero monitors pesticide residues only in meats for export. At the Ministry of Public Health we were informed that milk is highly contaminated with pesticides because dairy cows are allowed to feed on stubble of crops that are heavily treated with toxicants.

Recently the Ministry of Public Health has expanded the training of medical technicians to include academic subjects like entomology, pesticides and their use, and diagnosis of cases of intoxication. These technicians will not have the authority to treat intoxicated patients, but only to refer them to hospitals or to private physicians. Many of these technicians will perform their duties in rural clinics where their skills are most needed.

Nicaragua is the only one of the countries visited that has an active program to control pests of stored products. This is being conducted with aid from the United Kingdom Technical Assistance Program. There is an experienced entomologist from the Tropical Stored Products Centre working with a Nicaraguan entomologist from MAG as a counterpart. The laboratory facilities they are using are those that MAG can afford. The aim of the program is to find satisfactory ways for the small farmers to store their basic grains (beans, corn, rice, sorghum) in such a way and following such procedures as to minimize losses from stored product pests. Information on losses caused by these pests in Nicaragua is not available, but judging by the high degree of infestation of these grains by bruchids, weevils and moths that was observed in the local markets and supermarkets, they must be very high.

Rice (paddy) is a crop that is becoming very important in Nicaragua. The BNN is financing research in all aspects of rice culture. The entomological problems were studied by an LSU entomologist who worked in Nicaragua from October 1968 to September 1972. He identified the main pests and their natural enemies, and insecticides were tested to control the pests. Apparently he developed a satisfactory insect control program for paddy rice. A list of arthropod pests and parasites and predators on rice is presented as Appendix XX.

Plant Pathology. In Nicaragua the Ingeniero Agrónomo degree is only awarded at ENAG. A course is given in plant pathology by a part-time professor who has an M.S. degree and two full-time assistants who have

B.S. degrees from U.S. universities. The duties of professors at ENAG appear to be primarily teaching with little time being devoted to research. Laboratory facilities are minimal with little equipment and supplies. Greenhouse space is inadequate. The library at ENAG lacks current reference texts and review journals in plant pathology and in crop protection in general.

It was difficult to obtain reliable or accurate information from the staff at ENAG on the occurrence, distribution and importance of diseases affecting food crops. Disease surveys which were made several years ago need updating.

There are no scientists currently employed full-time at MAG who have an M.S. or Ph.D. degree in plant pathology. There appears to have been a very large turnover of personnel in recent years. Those who were sent abroad for additional training or advanced degrees in plant pathology are no longer working for MAG. A number have found employment in their specialty outside Nicaragua.

Virus diseases are very important and serious on many food crops in Nicaragua. The frequency and severity of these diseases appear to vary with the time of the year and location. Information is lacking on the identification, host range, vector-virus relationships, alternate host, and control of these virus diseases.

MAG technicians are cooperating with the PCCMCA in their programs on beans, rice, corn and sorghum. Some progress is being made in screening bean lines for desirable agronomic characteristics and resistance to various diseases. A red-seeded local variety of bean, which is resistant to one of the important bean viruses prevalent in Central America, has been found by MAG personnel.

Very little research has been done in Nicaragua on chemical control of foliar or soil borne diseases which affect food grains and vegetable crops. Use of chemicals to control diseases is generally restricted to export and cash crops, such as cotton, coffee, rice and bananas.

There is a need to have more printed information in the form of pamphlets, bulletins, or news letters on various food crops, including pest problems and control recommendations, which can be distributed to agricultural technicians, extension agents, and farmers. Very little information of this type is available from MAG.

Nematology. There appears to be a complete absence of information concerning nematodes in this country. We did not meet any individual that was aware of any specific problem involving plant parasitic nematodes and there seems to be no publication containing reference to nematode problems. Some interest in nematodes was expressed by an agrónomo who recently had been a student at the California Polytechnic Institute in Pomona, California. However, he has no basic knowledge of nematodes and his stated interest might have been the result of questions posed by the team.

Any program in nematology in Nicaragua would have to be initiated by training one or more individuals in the fundamentals of this science.

Weed Science. Nicaragua lacks personnel trained in weed science in its public agencies; it is probable that some technicians in the private

sector and in agricultural support organizations -- like the Banco Nacional -- may have had exposure to some training.

Public agency input in applying weed science to food crops is modest and is cooperative with the Oregon State University International Plant Protection Center (IPPC) Central American program. National agrichemical distributors and international chemical companies are active in applied weed science on-farm experiment-demonstrations, particularly in the export "cash crops" and "exportable" food crops.

A course in general botany -- including taxonomy -- and an agronomy course which includes weed control are part of the Ing. Agr. Curriculum at ENAG. Botany, including plant systematics, appears to be offered at UNAN at Leon. Apparently there are several herbaria; all are said to be in poor condition. There is no single national flora but numerous national and foreign publications have catalogued Nicaraguan plants. A listing of the most common weeds of annual crops, pastures, irrigation canals and forests has been prepared by MAG personnel and is used in ENAG courses. The major weed problems of Nicaraguan food crops have not been evaluated adequately; weed competition and economic loss data are not available for cash or food crops. Information on specific relationships between weed host plants and other food crop pests is lacking; observations of viral and other problems in dry bean and tomato, as well as cotton, have not been followed-up. A common pasture weed induces fatal paralysis when ingested by cattle; yet, there is little evidence of serious experimental or commercial control effects.

Herbicides are used commonly in Nicaraguan export and large-scale food crops; virtually all irrigated rice is weeded with herbicides. Herbicide sales and use appear to be based on on-farm demonstrations conducted by agribusiness personnel. Herbicide use recommendations and other weed science publications were not offered by either public or private agencies. Most weed science extension appears to be associated with agribusiness activity although MAG results are available, along with consultation, upon request to MAG personnel. Corporate activity is geared to the large-scale, income-generating export crops.

The level of professional training and knowledge of personnel engaged in applied weed science is modest.

Costa Rica

Agriculture contributed 24.1 percent of Costa Rica's CNP in 1969; coffee and bananas accounted for 21.8 and 20.6 percent of the total output of the agricultural sector. The value of the agricultural production has steadily increased from US$89.2 million in 1950 to US$249.4 million in 1969. But this increase is due mainly to an increase in banana production, to better yields and higher prices for coffee, and to an improvement in cattle production. At the same time there are certain crops that have decreased in importance, corn and beans among others. In other words, the cash, exportable crops grown by larger farmers are produced efficiently, while the basic grains grown by small farmers are declining. The Government of Costa Rica is embarked in a program of agricultural development aimed at "a) increasing the small farmer's income and improving the standard of living in the rural areas, and b) to make the contribution of this sub-

sector to the national development a more dynamic one." The program will have a cost of US$37,375,000, of which the Government of Costa Rica will finance US$17,375,000, and US$20,000,000 will be loaned by AID. The duration of the program is five years. The following crops will be included: (1) basic grains (corn, beans, rice), (2) tropical crops (cacao, plantain, coconut), (3) livestock (pork, dairycattle, chicken), and (4) others (fruits, vegetables, flowers, spices, seeds). Coffee, bananas, cotton, sugar cane and beef cattle (the latter at least temporarily) are not included in the program "mainly because these crops already have sufficient public and private support, and the marketing possibilities are doubtful except in the case of bananas."

Agricultural research at MAG, Direccion de Investigaciones Agricolas, is essentially of an applied nature and includes all crops with emphasis on edible crops. The realization of MAG's research program depends upon the availability of "technical and economic means."

Crop protection activities at MAG are carried on in all departments of the Directorate of Agricultural Research. Research proper is carried on in the Departments of Agronomy, Entomology, Plant Pathology and Coffee. Services and "campañas," national or regional campaigns against a particular pest, are carried on at the Department of Plant Protection and Department of Quarantine and Registration. Research in the Departments of Agronomy and Coffee is crop oriented, while that at the Departments of Entomology and Plant Pathology is discipline oriented. According to the MAG experts we met, there is a shortage of trained people and adequate facilities in crop protection. A proposal to build new laboratories for entomology and plant pathology has been submitted for funding. The new facilities will include in a common nucleus the laboratories of entomology, including biological control, plant pathology and nematology. The cost will be some US$250,000. Granting agencies such as AID, Rockefeller Foundation and Ford Foundation will be approached and funds will be solicited.

The Department of Plant Protection conducts programs of pest control of regional, national or international importance, such as campaigns against the langosta voladora (migratory locust), Schistocerca paranensis Burm., field mice, leaf-cutting ants, Atta sp., moko disease on bananas, and monitoring of med-fly (this in cooperation with OIRSA).

The Department of Quarantine and Registration enforces quarantine regulations applicable to imports and those applicable to restricted areas within the country. Internal quarantine is being applied to curb the dispersal of moko disease and of virus "Y." Special attention is being paid to pests that have not yet been reported from Costa Rica such as the golden nematode (it is in Panamá), the coffee bean borer (it is in Guatemala), coffee rust, hoof and mouth disease. Quarantine against this latter disease is being applied in cooperation with the Department of Animal Protection and OIRSA. The registration of all chemicals used in agriculture is the responsibility of the Section on Registration of Pesticides and Feritilizers.

The importance of crop protection is realized at MAG and efforts are being made to utilize the available resources to the fullest, and to bring in new resources. Losses due to pests (including diseases) are estimated at US$37.0 million annually (see Appendix XXI); although the accuracy of this estimate may be questioned, it indicates the economic magnitude of the problem created by pests.

Entomology. It seemed to us that entomology in Costa Rica is in "better shape" than in the other countries we visited. Although there is need for more trained personnel at both the university and MAG, those entomologists we met are carrying on significant research mostly aimed at solving pest problems in edible crops. At the Department of Entomology there are 5 Ingeniero Agrónomos; at least one of them has had specialized training abroad. At the Facultad de Agronomia there are three entomologists; all of them received advanced training in U.S. universities, one of them has a Ph.D. in entomology. At CTEI there are two entomologists; both of them have had advanced training abroad.

Facilities at the Facultad seem adequate, with respect to both space and equipment. There is a very good general insect collection representing the insect fauna of Costa Rica. There are exhibits of uncommon quality designed to acquaint the general public with various aspects of insect life. The library at the University of Costa Rica is good in general, but there are some important entomological publications that are missing. Entomologists at UCR seem to have adequate personal libraries.

Research efforts at MAG are directed to control insect pests of important crops. Some of the programs are:

- Insect resistance in rice and corn varieties.
- Biology of corn stalk borer, Zeadiatraes lineolata.
- Control of insect pests of tobacco.
- Survey, evaluation and control of insect pests of vegetables and fruit trees.
- Prediction and control of insect pests of coffee.
- Chemical and integrated control of insect pests of cotton.

At the Facultad de Agronomia research in entomology is more basic in nature. Some of the subjects are morphology and phylogeny of Hymenoptera, survey of mites of Costa Rica, biology of a newly discovered potato tuberworm, Scrobipalpa sp.

At CTEI research is being conducted on mass culturing of med fly, and on the biology and control of the pyralid Hypsipyla grandella, a borer on cedar and mahogany. These two projects are financed by AEA and AEC respectively.

It seems to us that research is too discipline oriented and the integrative, multidisciplinary is not apparent.

It seems that problems derived from misuse of insecticides are not as grave as in some of the other countries visited. The importation and marketing of insecticides are regulated by law which is enforced by MAG. All pesticides, imported or manufactured in the country, must be registered. In 1971 a total of 7,501,347 kg of pesticides were imported. The kinds of pesticides and their respective quantities were not available.

MAG is supposed to check on the quality of the pesticides marketed in Costa Rica, but it has no capabilities to do so. The Department of Quarantine and Registration has submitted a proposal to establish a laboratory to analyze pesticides and fertilizers. Should this laboratory become a reality MAG will be in a position not only to analyze the quality of pesticides, but also to determine residues in agricultural products. This latter aspect will become essential if the Public Health Law, which is being considered by the Costa Rican Congress, passes. The cost of such a laboratory is estimated at US$80,000 and MAG is trying to get these funds from sources within or outside the country.

Plant Pathology. Costa Rica has the best trained staff of plant pathologists in the public service agencies of the countries visited. In the Department of Plant Pathology, MAG, there are eight staff members working in plant pathology or nematology and at least two have M.S. degrees in plant pathology.

The office and laboratory space of the Department of Plant Pathology where it is presently located are inadequate for the size of the staff. Due to space limitations, laboratory equipment and supplies are not being utilized fully and there is an inefficient use of the plant disease clinic which the department operates as a public service.

Investigations on the diseases of basic food crops, except beans, is the responsibility of MAG. There is a strong and effective research program on coffee, but that of food crop diseases needs to be strengthened and expanded. Surveys are needed to assess the importance of diseases of food crops, and additional research is required on control of limiting diseases by chemical, cultural and genetical means. More printed information needs to be published and distributed to interested individuals in the agricultural community on plant pest problems of food crops. Several informative publications have been prepared on the insect pests and diseases of coffee.

The Facultad de Agronomia, Universidad de Costa Rica, has an excellently trained staff of three plant pathologists, two of whom have Ph.D. degrees in plant pathology from the U.S. The Department of Plant Pathology in the Facultad has adequate office, laboratory and greenhouse facilities for the present number of staff and students. Most students enrolled in the plant science curriculum take two courses in plant pathology -- "Principles of Plant Pathology" and "Diseases of Crops." In the course on "Diseases of Crops" students spend much of their time in the field observing the occurrence, distribution, symptoms and damage caused by plant diseases.

For several years personnel in the Department of Plant Pathology, University of Costa Rica, have been engaged in an active and progressive research program in bean improvement. Cooperating with PCCMCA bean program, plant pathologists have made surveys of the occurrence and severity of bean diseases in Central America. The virologist in the Department has made periodic visits to El Salvador to advise and train personnel in MAG at the Santa Tecla Research Center in virus diseases of beans and other food crops. This has been a very successful and productive working arrangement. Personnel from El Salvador MAG are also receiving additional training in plant pathology at the University of Costa Rica.

One of the better reference libraries in Latin America is located at the Centro Interamericano de Documentación e Información Agricola, IICA, in Turrialba. Also in Turrialba is the Centro Tropical de Enseñanza e Investigación, IICA, which has well equipped research facilities and offers

a graduate program leading to an M.S. degree in different disciplines of agriculture. Due to a lack of trained personnel, funds and administrative difficulties, no courses are offered in plant pathology. Currently, there is a Ph.D. in genetics who is carrying on an active program on cacao improvement; special attention is being paid to the cacao pod rot and other cacao diseases.

Nematology. Investigations in nematology are carried on in both MAG and the University of Costa Rica. In the latter institution Ing. Luis A. Salas teaches a course in nematology and does a very limited amount of research. He does not, however, do any applied research and he has made limited surveys of the nematode pests of food crops. These records are for the most part concerned with the genera of the nematodes encountered. Ing. Salas is primarily an entomologist and devotes his major attention to teaching and research in acarology. There is no evidence that he will devote more time to nematology. His laboratory is reasonably well equipped for teaching nematology.

At MAG Ing. Adrián Figueroa M. and Alvaro Ramirez, both former students of Ing. Salas, are engaged in nematode research. Figueroa is presently studying the population dynamics of the burrowing nematode, Radopholus similis, in banana. He is interested in the effect of nematocide treatments upon both soil and root populations. He is doing a reasonably good job and is enthusiastic about his work in nematology. Ramirez is testing nematocides on both lettuce and tomato. These investigators are also conducting surveys to determine the species of plant parasitic nematodes associated with vegetable and some horticultural crops. The laboratory facilities and equipment for nematology are minimal. There are no adequate microscopes, but there is adequate equipment for extracting nematodes from soil and plant pests. Both of these people need additional training in nematology. They are particularly weak in identification of plant parasitic species. They do not have access to literature and they have made no attempts to secure reprints of current literature.

Although the level of technical skill in nematology is rather minimal, it is far above that encountered in other Central American countries. There is tendency to conduct research on export crops, although in both coffee and banana there is active research supported by industry. However, the base for improved research is present at MAG and the prospects are good for continued research in nematology. Some additional training would greatly enhance the productivity and technical skills of the personnel currently working in nematology.

Weed Science. The two Costa Rican weed science researchers in public agencies have not been trained in weed science; it is likely that private sector training is deficient also.

Food crops weed science input by the public agencies is modest and increasing, although one program (MAG) has been curtailed by shifting the researcher to more general responsibilities in rice research. Both the MAG and University of Costa Rica weed science research programs were cooperative with the Oregon State University International Plant Protection Center Central American program. Apparently MAG is no longer in that program. Private chemical companies conduct herbicide demonstration experiments in food crops with export possibilities.

A course in weed control is taught at UCR. The Inter American Institute

for Agricultural Sciences (IICA) has conducted some herbicide trials on food crops at Turrialba but they have no real program in weed science or trained personnel.

As in other Central American countries, only minimal herbicide performance data is available.

Data on crop acreage and farm size will be updated from the 1963 levels when the 1973 decennial agricultural census is taken. Private sources indicate that Costa Rica imports almost 40 percent of the herbicides entering Central America and Panamá, as based on value. Herbicide imports into Costa Rica apparently exceeded $2,000,000 in 1969. The second largest herbicide importer is Panamá which accounts for half that amount. Most of the Costa Rican herbicide imports are destined for coffee and rice.

A national herbarium is housed at the Museo Nacional and a herbarium is maintained at UCR, but the IICA herbarium has not been actively worked in recent years. Comprehensive weed flora listings are not available for MAG or UCR but a partial listing of individual weeds and suggested controls is used in the UCR weed control course. Information on effects of and economic losses attributable to specific or general weed infestations in Costa Rican food crops has not been developed. The relationships between weeds and other plant pests have not been explored beyond general observations and references to apparent viral symptoms in crops and weeds. A small insect larva is said to attack the foliage of nutsedge, "coyolillo," and bore down through the leaves into the basal corm. The larva apparently kills the basal corm and affects biological control; it is not known whether the larva is active also on nutsedge tubers. Unfortunately, larvae were not collected and/or preserved and the insect was not reared to the adult stage -- hence, no identification is available.

Sale and use of herbicides in Costa Rican food crops appears based more on older experiments and commercial "extension" activity than on recent research. A few publications listing recommendations are available and users of herbicides appear guided by agrichemical business, public agency information and experience.

The weed science research effort in Costa Rica appears stronger than in the rest of CA and at least one man has full-time responsibility for the UCR weed control research and teaching activities. There is a very harmonious relationship among MAG, UCR and other autonomous governmental agencies like the Consejo Nacional de Producción. MAG and UCR personnel also are cooperating in the development of a Central American weed identification publication by EAP botanist Molina under the IPPC program. Many MAG Agronomy Department researchers are interested in chemical weed control methods for crops under their responsibility and appear to conduct limited field trials.

Persons active in applied weed science research in Costa Rica have not had professional training in this discipline.

Panamá

Panamá's foreign economy is not primarily based on agriculture,

although about 50 percent of the population is engaged in agriculture, at a subsistence level. However, the government is promoting programs aimed at improved efficiency in agricultural production. Recently the International Development Bank granted the Panamanian Institute of Economic Development a 34-year loan of US$1,300,000 to "help the small farmers and ranchers to acquire equipment, livestock (hogs, poultry) and to make the necessary improvements to grow rice, corn, beans, tomatoes and other crops."

Research in agriculture is active at the Facultad de Agronomia, University of Panamá. The Programa de Investigaciones Agropecuarias, which is being carried on by personnel of the Facultad, include work on plant breeding (corn, sorghum, rice, edible legumes), soils and fertilizers, crop protection, irrigation and water-management, and animal husbandry.

MAG is engaged in some research in agriculture which is crop oriented and is carried on by the agronómos or peritos who are located in each of the agricultural zones in which the country is divided. Research is done in all aspects of crop production with emphasis on rice, corn, beans, onions, potatoes, comatoes, soya and sesame. It seems to us that research at MAG is very little more than extension work. There is the usual lack of trained specialists and economic means which makes it very difficult to implement any program involving a multidisciplinary approach.

There is no formal coordination between programs at MAG and the Facultad, but there is good communication at the personal level between personnel at both institutions. A Coordinating Committee for Agricultural Research, consisting of representatives of the University of Panamá, MAG and the Institute of Economic Development, is in the process of being formed. It is hoped that this committee will find ways to increase cooperation, on a more formal way, between agricultural research institutions.

Education at the Ingeniero Agronomo level is the responsibility of the Facultad de Agronomia de la U. de Panamá, while that at the Perito Agricola level is offered by MAG.

There are two curricula at the Facultad de Agronomia: the crop production curriculum, and the animal husbandry curriculum. In the crop production curriculum five courses that are directly a part of crop protection are offered (General Entomology, Economic Entomology, General Plant Pathology, Plant Disease Control, and Weed Control), while only three are offered in the animal husbandry curriculum (General Entomology, Economic Entomology, and General Plant Pathology).

Entomology. There is only one entomologist that has graduate training in entomology in Panamá. He is with the Facultad de Agronomia. He is in charge of teaching the courses in entomology and leads the seven projects in entomology currently being carried on under the Program of Agricultural Research, U. of Panamá. The projects are the following:

- Economic injury levels of *Diabrotica balteata* on corn
- Chemical control of *Spodoptera frugiperda*
- Incidence of parasitism on field populations of *S. frugiperda*, *Sogatodes orizicola* and *Rupella albinella*

- Fluctuation of insect populations in rice fields

- Economic injury levels of species of Diatraea on sugar cane

- Economic injury levels of Spodoptera frugiperda on sugar cane

- Life cycle of insects of economic importance

It is obvious that there is a critical shortage of trained entomologists in Panamá. Although entomological problems may not be as important as those in other agriculturally more developed countries, one individual cannot cope effectively with so many projects as has the entomologist at the University of Panamá. Students at the Facultad do not normally participate in research work.

We have the impression that the entomological problems of Panamá are well understood by the researchers at the Facultad, but it seems that research is discipline oriented. We were not informed of any current research towards the integrated control of crop pests, either at the Facultad or at MAG.

Problems caused by use of insecticides are either not important or not recognized as such. One of our interviewees expressed the opinion that the lack of problems caused by use of large quantities of insecticides is due to the fact that cotton is not an important crop in Panamá. In general not much pesticides are used in Panamá; only about $2.2 million worth of pesticides are imported each year. Parathion is practically not used. The insecticides more commonly used are endrin, malathion and sevin.

The manufacturing, importation, formulation, marketing and use of pesticides is regulated by Decreto 384 of December 11, 1967. In order to market a pesticide in Panamá, it must be registered at MAG. Registration is preceeded by chemical analysis that is performed at the Chemical Laboratory of the Facultad de Ciencia y Farmacia of the University of Panamá. We were told that although Decreto 384 specifically indicates that MAG should regulate the "use of a pesticide," this is not at all enforced. Most recommendations on the use of insecticides, pesticides in general, emanate from the companies that distribute these chemicals. There is no legislation to regulate pesticide residues on edible crops.

Plant Pathology. The number of professionally trained plant pathologists in the public service agencies of Panamá are inadequate. There are no trained plant pathologists in MAG who are actively engaged in their profession. Research programs in MAG on diseases of food crops are being carried out by agricultural personnel who are not trained in plant pathology. The rate of turnover of professionally trained personnel in MAG is high due to a number of reasons, e.g., inadequate facilities, low salaries, instability of positions and lack of continuity of research programs. The salaries paid to scientific personnel by the University of Panamá and by private pesticide companies are often 2-3 times higher than those paid by MAG.

On the staff of the Facultad de Agronomia, University of Panamá, there is one plant pathologist with a Ph.D. degree. Until recently his main responsibilities were teaching and research. Now a portion of his time is devoted to administrative duties since his recent appointment as Vice-Dean of the Facultad.

The curriculum of the Facultad was reorganized in 1970. Under the

old system, one course in plant pathology was offered. Now students in the plant sciences are required to take several courses in crop protection, including two in plant pathology.

The Department of Plant Pathology is also engaged in a research program which is aimed at learning the effect of grafting tomato varieties that are susceptible to bacterial blight (Pseudomonas solanacearum) on eggplant and Solanum diversifolium root-stocks in the hot lowlands where the disease is severe. Disease incidence and mortality of non-grafted tomatoes on infested land is often 100 percent, whereas with tomatoes grafted on eggplant or S. diversifolium rootstock, the disease incidence is usually less than 10 percent. Several students have written their Ingeniero Agrónomo theses on research, which they did, on this subject. The economics of the grafting procedure are also being studied to determine whether it will pay small growers to utilize the technique during the season when prices of tomato on the local market are high.

The Facultad also has an active research program on improving cultivation of cowpeas (Vigna sinesis) in the hot lowlands where they are better adapted to these areas than beans (Phaseolus vulgaris). Although diseases and insect pests often limit the production of this crop, cowpea lines are being screened for resistance to important pest problems.

There appears to be a lack of communication and cooperation between plant protection personnel of MAG and the University of Panamá which often results in an overlapping and duplication of research efforts in some areas of food crop production.

Nematology. There is some concern about plant parasitic nematodes in Panamá. The finding of Heterodera rostochiensis, the golden nematode of potato in the principal potato growing area in 1967 and the impact of both local and exterior quarantine measures have brought about an increased interest in this and other nematode problems. Some good basic research on Pratylenchus zeae, a root lesion nematode pest on corn, sorghum and rice, has been undertaken and the results published by Rodrigo Tarte (M.S. in nematology, University of California, Riverside, presently at Cornell University for a Ph.D. in nematology).

Within MAG in addition to administering quarantine regulations concerned with golden nematode, some trials with Dutch potato varieties resistant to this nematode were conducted in 1971. The results of these trials were not available.

When Mr. Tarte completes his Ph.D. studies at Cornell and returns to the University of Panamá, the prospects are good for establishment of an active well-directed research program on the nematode pests of food crops. There are adequate facilities at the University for research and teaching in nematology. Additionally the staff of the College of Agriculture and the Assistant-Dean of the College indicated enthusiastic support for teaching and research in nematology.

Weed Science. The public agricultural research sector in Panamá does not employ full-time, trained personnel in weed science research. The private sector lacks trained technicians also but conducts much of the field research demonstration plot work. Two public agency persons are involved, one with MAG and one with the University of Panamá; both on a part-time basis since

they have other food crop responsibilities.

The public sector research effort in food crop weed control is minimal and is cooperative with the Oregon State University International Plant Protection Center (IPPC) South America program. Apparently, the IPPC coordinator also conducted some weed science research, personally, in Panamá.

Statistical information on crop acreages and production units was not offered.

A herbarium is maintained by the UP Facultad de Ciencias. A weed flora for Panamá is not available, but many important local weeds are listed in "Tropical Weeds" by Doll, Reyes, and Cardenas of the IPPC South America program.

Some information has been developed on yield response of corn and rice to cultivation schedules and weed competition. Economic loss data was not available. No specific crop-pest/weed-host relationships have been explored.

Many herbicides are imported into Panamá for rice and other large acreage, high value crops and for pasture. Importations in 1969 apparently exceeded $1,000,000. Information for sale and use of herbicide has apparently been developed by the agrichemical industry. Herbicide prices appear reasonable by U.S. standards. Public agency recommendations may be found in occasional publications and performance information is available in annual reports.

Persons conducting applied research have not had professional weed science training.

Guyana

Guyana's agriculture centers around sugar cane and rice, which are planted in large holdings using modern technology. Other crops like edible legumes and vegetables are planted in very small pieces of land, sometimes in backyard gardens, by subsistence or sub-subsistence farmers who consume most of what they grow; they sell the surplus in the local markets.

Rice growers are organized in the Rice Corporation. Improvement of rice industry, both in the technological and commercial aspects, is handled by the corporation. Most of the sugar cane in Guyana is grown or processed by Bookers Corporation. Agronomic and technological improvement of the sugar cane industry is carried on at the Sugar Experiment Station.

The Ministry of Agriculture and Natural Development is conducting a program to stimulate the production of edible legumes, corn and other vegetables, pineapples and coconuts. Financial aid to small farmers will be provided by the Agricultural Bank which is scheduled to start operating in January 1973. In order for MAG's program to be fully implemented, more trained personnel permanently appointed will be necessary. As it is now, with many of the research personnel hired on short-term contracts, the programs necessarily suffer from lack of continuity.

MAG has experienced difficulties in attracting and maintaining scientific personnel due to low salaries, budget restrictions, and minimal to inadequate research facilities. In the last few years, there has been a fairly

high turnover of senior research personnel at the Central Agricultural Station, MAG. The Guyanese government is attempting to attract scientific personnel (Guyanese and other nationalities) through a "Remigration Scheme" which offers a candidate certain financial and fringe benefits if he agrees to remain an employee for a specified period of time, usually four years. Several of the senior scientists in crop protection at the Central Agricultural Station were hired under this scheme.

Instruction in agriculture is given at the MAG's Guyana School of Agriculture, a 2-year professional school. There is no College of Agriculture at the University of Guyana. Higher training in agriculture is obtained abroad, mainly at the University of the West Indies in Trinidad and U. S. universities.

Crop protection is discipline oriented. Research in crop protection, which is predominantly applied, is conducted at MAG at the Sugar Experiment Station and at the Rice Corporation. Extension is done by chemical company personnel who, we were informed, have very limited technical knowledge on crop protection. In general there is a trend to de-emphasize the use of toxicants for crop protection in the research programs at MAG.

Entomology. There are two entomologists at MAG. Both have had graduate training, one being a Ph.D. They are foreigners and are hired on short term contracts. There are two entomologists, both Ph.D.s, in the sugar industry, one with Bookers Corporation and the other with the Sugar Experiment Station. The Rice Corporation has two other trained entomologists.

The head entomologist at MAG was a rice entomologist until very recently. Now he is organizing research on insect pests of corn, coconut, and vegetable crops. The pests involved are *Spodoptera frugiperda* on corn, *Castnia*, *Brassolis* and ants on coconuts, *Oligonychus* and *Schizotetranychus* on vegetable crops. Scales on citrus become a problem where there is an abundance of ants; they are considered to be of minor importance. Tests to control these pests are being conducted using chemicals that have low mammalian toxicity, LD50 of no less than 700 mg/kg.

One of the difficulties for the small grower to implement crop protection programs is the lack of crop protection services. These growers cannot afford the equipment needed to control pests and there are no pest control operators that can render these services.

In sugar cane, the borer *Diatraea saccharalis* tends to be more of a problem in first year cane than in ratoons. Another insect that is important is *Castnia helicoides* which attack the roots and the crown. Research to control these pests as well as extension to the sugar cane estates is conducted by the entomologist at the Sugar Experiment Station.

It is our impression that the importance of the different insect pests in Guyana is not adequately known due to the short tenure of the entomologists currently active in the country.

Plant Pathology. In Guyana there are only two professionally trained plant pathologists who work for MAG. One of them received his Ph.D. degree in plant pathology from the University of Illinois, and the other has a B.S. degree from MacDonald College, Canada, where he majored in plant pathology. Both have been working for MAG for about one year at the Central Agricultural

Station. No plant pathologist is employed either at the Guyana Sugar Experiment Station or at the Rice Corporation.

Research on diseases of food crops, primarily vegetables and coconut, is the responsibility of the plant pathology staff at MAG. They have initiated a research program on vegetable crops with the facilities, funds and personnel available to them. In addition they are studying the control of diseases of tomato -- Fusarium wilt, and bacterial blight (Pseudomonas solanacearum) -- and coconut -- bud rot -- by use of chemicals and host resistance.

The plant pathology staff has published recently a very useful and informative extension pamphlet on important diseases of vegetable crops and methods for controlling these maladies. Another extension pamphlet on use of fungicides is in the process of being published by MAG.

The laboratory facilities are limited and minimal; there is also a large and well maintained screen house which is being enlarged. The reference library at the Center is small and contains a minimum of basic reference texts and journals in crop protection. The senior plant pathologist has his personal library which helps to supplement the reference material in the Center's library.

Nematology. There is no activity in nematology in this country at the present time. We were told that there was a nematologist on the staff of MAG last year, but that he left Guyana at the beginning of 1972. Neither the head of the plant pathology or entomology sections seemed informed concerning any research that might have been accomplished during his time on the staff. A young man with a B.S. in agriculture has been selected by MAG to attend a three-month course in nematology that will be offered in Venezuela beginning in January 1973.

Root-knot nematode of tomato and carrot, and red-ring disease of coconut palms were indicated as important diseases caused by nematodes.

In 1967 some initial research was started on the nematodes attacking crop plants in Guyana. It was demonstrated, under experimental conditions, that Meloidogyne incognita would attack most of the common vegetable crops grown in the country. Field surveys showed Rodoxholus similis to be present in banana and ginger, Meloidogyne arenaria in ginger and a Rotylenchulus sp. associated with papaya. There has been no follow-up on these initial investigations.

Weed Science. There are no trained weed scientists in Guyana. Weed control in sugar cane is the responsibility of an entomologist with Bookers Corporation. Gradually weed control in sugar cane fields has switched towards the use of herbicides; 2-4D is the weed killer most commonly used. Herbicide recommendations are based both on formal experiments conducted in the field (experimental and check plots) and on the experiences gained on similar situations abroad.

Specific Recommendations

Although we agree that greater effort should be devoted to establish ecologically sound pest management programs for food crops (basic grains, edible roots and tubers, fruits) the crisis stage in pest control has been

reached in cash crops, cotton mainly, so we also agree that increased efforts should be made to correct the situation in these crops. The FAO-supported program on cotton pest management in Nicaragua should be intensified, and expanded to the other countries in the region. If crop protection programs based on a multidisciplinary, crop-centered philosophy are implemented the direct benefits will be for the whole agricultural sector and not only for those crops for which the programs were developed.

On the basis of the information gathered in our visit we make the following recommendations for Central America (including El Salvador) and Panamá and for each of the countries therein. These are in addition to, or expansions of, the general recommendations submitted elsewhere in this report (pages 4-6).

For Central America and Panamá we recommend that a permanent Pest Management Advisory Team be appointed. The membership in this team should consist of, but not be limited to, one agronomist, one entomologist, one plant pathologist, one nematologist, one weed scientist, and one agricultural extension specialist. This team should coordinate all research programs towards the development of pest management programs in the region. It should work closely with MAGs and Universities and with regional international organizations such as PCCMCA, CIMMYT, OIRSA, CIAT, and IICA as well as with the different AID missions and ROCAP. The course on Pest Management at UNAN, Leon, Nicaragua, should be intensified, and made more readily available to the other countries in the region.

For Guatemala we recommend that an agronomist, an entomologist, a plant pathologist, and a nematologist be appointed to work with Guatemalan counterparts at MAG and in collaboration with the Universidad de San Carlos, in the ongoing food crop programs (bean, corn, rice, sorghum). This team should also advise and collaborate with the Consejo Nacional del Algodon to help implement a pest management for cotton and with ANACAFE on the problems that may arise as a result of changes in pest control practices to control the recently established coffee bean borer in Guatemala.

A similar team should be appointed for Honduras. The emphasis here should be in the acceleration of the bean improvement program and the concurrent development of a pest management program for this crop. Special attention should be given the control of insects of stored grains in small farms.

In Nicaragua the form of implementation of the AID Pest Management program will depend on whether the Plan Nacional de Educacion Superior, Investigacion y Extension Agricola is launched or not. If it is, a good opportunity to establish a pest management program as a part of the structure of MAG in the areas of teaching, research and extension will present itself. If it is not, a pest management team should be appointed to expand the cotton integrated control effort now being carried on by BNN, MAG, UNAN and FAO to include edible crops such as beans, corn and rice.

In Costa Rica the main objective of the AID Pest Management Program should be to coordinate the research programs currently being conducted by the Facultad de Agronomia (U. of C. R.) and MAG to make them truly interdisciplinary and crop oriented. The crops included should be beans, corn, rice cacao, plantains and oil palm. The cacao research program currently

being conducted by Dr. Jorge Soria at CTEI, IICA, could be supplemented by the addition of a plant pathologist to his staff since diseases seem to be the more important pest problems in this crop.

In Panamá the staff participating in the agricultural research program at the Facultad de Agronomia (U. of P.) should be augmented with one additional entomologist and one additional plant pathologist to accelerate pest management research in corn, rice, and vegetable crops. A greater coordination and cooperation with MAG should be sought to increase field research and extension.

In Guyana the importance of pests of vegetable crops and fruits (citrus, pineapples, coconut) has yet to be assessed. Probably the most significant contribution from AID Pest Management Program at this point would be to provide the means to train specialists in pest management and to stimulate the study of the economic significance of agricultural pests.

We must stress that these recommendations are in addition to those we make elsewhere in this report (vide supra). An efficient pest management program will not be possible unless government and/or university authorities provide for

a) economic and physical conditions conducive to permanency of research programs and personnel,

b) training of personnel so that a specialist position is filled with a properly trained individual,

c) a greater support to research on food crops,

d) the legal framework to implement and enforce pest management programs,

and realize that production unit size, and available on-farm technical knowledge and credit as they exist now impede food crop development, and decide to seek remedies to this situation.

We feel that our recommendations are in agreement with those resulting from the several sector analyses being conducted by AID in Central America and Panamá, and with the considerations and proposals of the OAS Specialized Conference on the Application of Science and Technology to Latin American Development (CACTAL), Brasilia, 12-19 May 1972.

APPENDIX I

LIST OF PERSONS INTERVIEWED BY THE UC/AID CENTRAL AMERICA TEAM

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(Persons indicated by * were with institutions in other countries. They were met at an OIRSA meeting in Guatemala.)

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APPENDIX II

Some Important Diseases of Food Crops

Diseases are often a limiting factor in the production of food crops in the countries visited. Some of the more important diseases of these crops are listed below.

Bean (*Phaseolus vulgaris*)

Several insect-transmitted virus diseases, some of unknown etiology, are serious in most of these countries, especially at lower elevations. Rust (*Uromyces phaseoli* var. *typica*), bacterial blight (*Xanthomonas phaseoli*), anthracnose (*Colletotrichum lindemuthianum*) and web blight (*Thanatephorus cucumeris*) are important diseases in some areas.

Cowpea (*Vigna sinesis*)

Cowpeas are usually cultivated in the hot lowlands where beans do not grow well. Significant crop losses result from insect-transmitted viruses and diseases caused by fungi (*Cercospora* sp.) and bacteria (*Xanthomonas vignicola*).

Corn (*Zea mays*)

Corn stunt and *Helminthosporium* leaf spots are the limiting diseases in most countries. Ear rots (*Fusarium* sp. and *Diplodia zeae*) cause large losses in storage.

Sorghum (*Sorghum vulgare*)

Helminthosporium leaf spot (*H. turcicum*) is an important disease of sorghum in these countries. In Guatemala, anthracnose (*Colletotrichum* sp.) is prevalent.

Rice (*Oryzae sativa*)

The principal disease of rice in all countries visited is blast (*Pyricularia oryzae*). With certain rice varieties, hoja blanca virus causes large crop losses.

Tomato (*Lycopersicon esculentum*)

The major disease of tomato in the lowlands was bacterial wilt (*Pseudomonas solanacearum*). Early blight (*Alternaria solani*) and late blight (*Phytophthora infestans*) are serious at times. In some countries, like Nicaragua, virus diseases limit crop production, especially at certain times of the year.

Potato (*Solanum tuberosum*)

Early blight (*Alternaria solani*), late blight (*Phytophthora infestans*), bacterial wilt (*Pseudomonas solanacearum*) and several viruses are important diseases affecting this crop in most countries of the region.

Vegetable Crops (Peppers, eggplant, onions, melons, squash, lettuce, etc.)

Numerous diseases cause serious crop losses in vegetables during the growing season and during transit and storage. In some areas viruses (most of unknown etiology) are the limiting factor in production of these crops. Foliar diseases caused by bacteria and fungi are important in many areas, especially during certain seasons of the year.

APPENDIX III

A few ubiquitous, important weeds in Central America and Panamá

Cyperus rotundus

Cyperus ferax (confused with *C. esculentus* in "Tropical Weeds")

Rottboelia exaltata (confused with *Manisuris ramosa*)

Ischaemum rugosum

Echinochloa colonum and *E. polystacha*

Paspalum virgatum

Panicum fasciculatum

Eleusine indica

Leptochloa filiformis

Cynodon dactylon

Euphorbia spp. (many)

Boerhaavia erecta

Acacia spp. (espinos)

Baltimora recta
Synedrella nodiflora
Melampodium spp.
} "flor amarilla"

APPENDIX IV

Projection on the volume of sales of agrochemicals by Astro-Agricola of Honduras through 1976* (in 1,000 U.S. dollars)

	1971	1972	% of the Honduran market	1973	1974	1975	1976
Fertilizers	400	550	60	600	600	600	600
Insecticides	50	100	70	100	175	175	175
Fungicides	50	90	80	100	112.5	125	125
Nematocides	2.5	12.5	95	12.5	12.5	12.5	12.5
Herbicides	125	212.5	80	225	250	250	250

* Data provided by Astro-Agricola

APPENDIX V

Value of insecticides imported to Nicaragua (in US$ CIF)

Year	Technical	Formulated	Total
1965	8,279,588.49	207,336.72	8,486,925.21
1966	9,866,737.22	340,619.90	10,207,357.12
1967	9,780,873.89	2,788,487.13	12,569,361.02
1968	7,396,443.52	2,624,133.58	10,020,577.10
1969	4,585,083.00	1,550,528.95	6,135,611.95
1970	4,725,303.33	1,925,526.76	6,650,829.09
1971	7,236,629.86	2,229,559.00	9,466,188.86

APPENDIX VI

FORMULATED INSECTICIDES IMPORTED TO NICARAGUA

1965

INSECTICIDES	AMOUNT	VALUE US$ CIF
Dipterex	129,974 lb.	131,895.00
Carbon bisulfide	30,000 "	4,726.50
Epicolidrin	4,770 "	1,846.58
Di-Syston 10% G	15,956 "	6,079.55
Dipterex 2.5% G	11,000 "	1,320.00
Cotton Dust 3-15	5,000 "	559.00
Cygon	200 gal.	2,194.73
Vapona 48% EC	45 "	734.21
Thimet LC 8	1,265 "	17,480.12
Thimet 10% G	875 "	1,033.73
Lebaycid 50%	962 "	10,988.00
Metasystox R	1,925 "	21,910.00
Baytex 50%	62 "	1,279.00
Baytex 60%	27 "	617.00
Guthion	112 "	152.00
Folidol M-48	206 "	1,556.00
Diazinon 60 E	200 "	2,809.00
Roxion 40%	12	156.00
TOTAL		207,336.72

September 1966

SOURCE: MAG, Managua, Nicaragua

APPENDIX VII

FORMULATED INSECTICIDES IMPORTED TO NICARAGUA

1966

INSECTICIDES	AMOUNT	VALUE US$ CIF
Azodrin	5,075 lb.	12,863.97
Baytex 5%	80 lit.	600.60
Carbon bisulfide	13,608 kg.	3,158.67
Cygon 267	1,000 gal.	10,624.00
Diazinon 60 E	2,740 lit.	10,492.77
Dipterex 80 SP	73,640 kg.	158,045.00
Dipterex 2.5 G	58,000 lb.	6,056.60
Disyston 10 G	4,000 kg.	3,400.00
Folidol M-48	300 lit.	727.00
Kival	2,000 "	6,100.00
Lebaycid 50	60 "	192.00
Metacil	6,900 kg.	19,020.00
Metasystox R	13,900 lit.	44,235.00
Mexa Gorgojicida	10,000 lb.	748.00
Ortho "B"	25,000 "	28,892.85
Perfecthion	510 lit.	1,667.00
Phosdrin 24%	30 gal.	346.50
Tergitol KD	56 drums	6,783.50
Thimet LC-8	1,225 gal.	16,612.24
Thimet 10% G	10,050 lb.	2,876.08
Vapona 48%	10 drums	682.12
Zolone	2,000 lit.	6,460.00
TOTAL		340,619.90

August 1967

SOURCE: MAG, Managua, Nicaragua

APPENDIX VIII

FORMULATED INSECTICIDES IMPORTED TO NICARAGUA

1967

INSECTICIDES	AMOUNT	VALUE US$ CIF
Tox 6	9,965 gal.	24,205.50
Agrocide 26DP	540 kg.	688.89
Azodrin 5	43,500 gal.	515,003.70
Azodrin 5	101,160 lb.	250,103.07
BHC-DDT 3-10	75,000 "	5,700.00
BHC-DDT 3-15	25,000 "	2,200.00
BHC-DDT-MP 3-15-1.5	30,000 "	3,000.00
BHC-DDT 4-10	20,000 "	1,620.00
BHC-DDT 4.5-7.5	15,000 "	1,275.00
Baytex 50%	110 lit.	366.00
Bidrin 85%	24,927 lb.	57,541.14
Bidrin 85%	150 drums	65,092.68
Carbicron 100	80 lit.	616.00
Chlordane 20%	6,000 lb.	1,252.80
Cotton Dust 3-15-0	5,000 "	594.00
Cygon 400-E	750 gal.	7,500.00
DDT 3	9,075 "	12,523.50
DDTOX-Methyl 2-4-1	32,285 "	92,657.95
DDTOX 2-4	74,085 "	160,023.60
Diazinon 60 E	1,650 lit.	5,986.04
Dimecron 50	80 "	372.00
Dimetoate 40%	1,000 "	3,500.00
Dipterex 80%	32,000 kg.	75,500.00
Dipterex 2.5%	40,000 lb.	3,481.50
Disyston 10%	44,092 "	11,785.79
Dow Fume EB-5	162 gal.	304.56
Dow Fume EB-59	120 "	612.00
Dow Fume EB-5	126 lb.	19.65
Dow Fume EB-15	264 "	48.54
Dow Fume W-85	3,000 gal.	12,701.09
Dow Fume MC-2	17,060 lb.	8,554.69
Ethyl Parathion 50	1,100 gal.	3,927.00
Endrin 1.6	3,630 "	20,073.90
Ethyl-Methyl Parathion 4-2	66,880 "	297,616.00
Endrin 2%	15,000 lb.	1,730.31
Folidol M-48	525 lit.	928.02
Guthion 20%	160 "	546.20
Kilval	8,000 "	19,200.00
Lebaycid 50%	80 "	256.00
Malathion 57%	1,900 gal.	12,166.60
Malathion 50%	9,000 lb.	46,800.00
Metacyl comb.	21,825 kg.	51,765.00
Metasystox R	60 lit.	184.00
Metasystox R	40 cans	130.00
Methyl Parathion 48%	53,900 gal.	191,884.00

APPENDIX VIII continued
FORMULATED INSECTICIDES IMPORTED TO NICARAGUA, 1967

INSECTICIDES	AMOUNT	VALUE US$ CIF
Methyl Parathion 48%	30,000 lb.	2,700.00
Methyl Parathion 40%	15,000 "	945.00
Methyl Parathion 40%	24,420 gal.	73,260.00
Mirex 450	6,050 lb.	2,270.63
Monacide	216 "	846.28
Nemagon 75%	120 gal.	983.34
Nexa Gorgojicida	10,000 lb.	784.00
Nuran 50%	60 lit.	279.00
Orthocide 50%	4,050 lb.	2,280.95
Perfecthion	2,000 lit.	5,300.00
Phostoxin	43 kg.	315.36
Roxion	5,000 lit.	12,500.00
Ruelene 25	40 units	375.00
Sevin 75%	2,000 lb.	1,340.00
Sevin 85%	60,200 "	40,334.00
Sevin 80%	964,000 "	645,880.00
Thimet LC-8	1,215 gal.	16,256.25
Zolone	4,000 lit.	9,800.00
TOTAL		2,788,487.13

October 1968

SOURCE: MAG, Managua, Nicaragua

APPENDIX IX

FORMULATED INSECTICIDES IMPORTED TO NICARAGUA

1968

INSECTICIDES	AMOUNT	VALUE US$ CIF
Agrocide 26 DP	2,006 kg.	2,110.56
Azodrín 5	68,500 gal.	835,599.15
Basudín - 10	1,000 kg.	895.35
B. H. C. 1.2	3,850 gal.	9,229.72
B. H. C. 12%	104 "	272.48
B. H. C. 12%	1,000 lb.	139.10
B. H. C. 42%	20,000 "	5,138.00
B.H.C.-D.D.T. 3-5	2,145 gal.	5,017.25
B.H.C.-D.D.T. 3-10	2,000 lb.	138.54
B.H.C.-D.D.T. 3-15	93,000 "	7,356.30
B.H.C.-D.D.T. 12-50%	8,000 "	1,484.80
B.H.C.-D.D.T. 3-15-1.5	40,500 "	3,491.40
Bidrín 85%	27,600 lit.	178,534.67
Carbicrón 100	16,180 "	89,682.00
Cidial 50	3,000 "	10,500.00
Chlordane 20%	15,000 lb.	3,099.00
Cygón 400-E	750 gal.	7,500.00
Cylán 250-E	20,800 lit.	61,558.21
D.D.T. 3	1,650 gal.	2,277.00
D.D.T. 50%	1,000 lb.	232.10
D.D.T.-Strobane 2-4	35,530 gal.	76,744.80
D.D.T.-Strobane-M.P. 2-4-1	14,830 "	42,619.50
DDTOX 2-4	22,715 "	49,064.40
DDTOX-M.P. 2-4-1	16,775 "	48,231.00
Dibrom 8	937 "	13,157.24
Dimecron 50	540 lit.	2,430.00
Dipterex 2.5%	15,000 lb.	13,002.00
Dipterex 5%	462 kg.	362.08
Dipterex 95%	95,880 "	177,076.80
Disystón 10%	10,000 lb.	2,673.00
Dowfume W-85	1,020 gal.	4,579.80
Dowfume EB-59	120 "	714.39
Dowfume MC-2	20,516 lb.	11,948.37
Endrin 1.6	550 gal.	3,007.58
Endrin 2%	60,000 lb.	6,902.90
EPN 2	3,850 gal.	22,272.25
EPN-M.P. 2.5-2.5	7,260 "	60,671.82
Ethyl-Methyl 4-2	31,900 "	145,806.35
Eusdán	5,004 lit.	13,761.00
Endrín 1.6	1,650 gal.	9,124.50
Ethyl Parathion 50	1,375 "	4,908.75
Fuertil E-8	2,750 "	18,535.00
Fuertión 70	6,600 "	39,666.00
Folidol M-48	400 lit.	720.00
Folidol M-48	600 units	186.00

APPENDIX IX continued
FORMULATED INSECTICIDES IMPORTED TO NICARAGUA, 1968

INSECTICIDES	AMOUNT	VALUE US$ CIF
Galecron 50	7,600 lit.	33,050.00
Guthion	400 "	980.00
Guthion	600 units	222.00
Guthion 3%	10,000 lb.	891.97
Kilval	10,000 lit.	24,000.00
Labaycid	200 "	640.00
Malathion 57%	90 gal.	803.91
Malathion 96%	66,000 lb.	36,785.38
Metacil Comb.	6,300 kg.	15,750.00
Metasystox R	8,500 lit.	26,850.60
Metasystox R	400 units	180.00
Methyl Parathion 2%	2,500 lb.	140.00
Methyl Parathion 3%	5,000 "	257.11
Methyl Parathion 6%	5,000 "	356.25
Methyl Parathion 40%	1,650 gal.	5,346.00
Methyl Parathion 48%	36,575 "	131,454.73
Mirex 450	18,000 lb.	6,378.63
Nemagon 75	6,076 "	3,268.05
Nexa-Gorgojicida	20,000 "	1,568.00
Nuvan 50	300 lit.	1,440.00
Ortho B	22,000 lb.	3,544.20
Orthocide 50	3,000 "	1,681.40
Perfecthion	600 lit.	1,800.00
Perthane	2,585 gal.	11,632.50
Phostoxin	157 kg.	997.00
Phostoxin	480 cans	346.99
Rothane 50	240 lb.	105.60
Roxion EC-40	1,000 gal.	13,018.00
Sevin 5%	330,000 lb.	27,930.00
Sevin 10%	3,000 "	50.00
Sevin 75%	53,200 "	26,600.00
Sevin 80%	142,480 "	71,240.00
Sevin 85%	93,000 "	52,500.00
Strobano 6	8,250 gal.	22,275.00
Strobano 8	11,340 "	30,051.00
Strobano-EPN 4-1	6,380 "	31,427.60
Thimet LC-8	1,650 "	22,687.50
Toxafeno 6	8,690 "	23,463.00
TOTAL		2,624,133.58

SOURCE: Mag, Managua, Nicaragua

APPENDIX X

FORMULATED INSECTICIDES IMPORTED TO NICARAGUA

1968

INSECTICIDES	AMOUNT	VALUE US$ CIF
Acritet 34-66	4,282 kg.	3,160.61
Azodrin 5	28,580 lb.	58,293.81
Azodrin 5	12,470 gal.	153,688.42
B H C - D.D.T. 3-10	37,000 lb.	2,783.00
B H C - D.D.T. 3-15	36,700 "	3,009.40
B H C - D.D.T. 12-50%	4,000 "	742.40
B H C - D.D.T. MP-3-15-1.5	185,800 "	16,781.78
Bidrin 85	25,063 "	47,203.00
Bliflon - Endrin - MP	30 Barriles	3,044.47
Biotrol	3,000 lb.	7,950.00
Carbon bisulfide	35,000 "	5,877.50
Methyl Bromide	400 "	1,594.59
Carbricron	500 lit.	3,125.00
Chlrorahep 5%	220 gal.	746.50
Chlorahep 5% G	20,000 lb.	2,200.00
Chlordane 10%	3,000 "	330.00
Chlordane 20%	16,000 "	3,192.00
Cylan 250-E	7,520 lit.	24,591.20
D.D.T. 75%	246,400 lb.	40,048.62
D.D.T. MP-15-2.5	15,000 "	1,140.00
Dibrom 8	1,000 gal.	17,520.00
Dimecron 100	2,160 lit.	8,640.00
Dipterex 2.5%	50,000 lb.	3,015.00
Dipterex 5% Polvo	2,540 "	464.54
Dipterex SP-95	17,270 kg.	34,744.25
Dowfume EB-59	240 gal.	1,395.23
Dowfume MC-2	43,868 lb.	24,541.04
Dowfume W-85	1,500 gal.	6,735.00
Endrin 2%	60,000 lb.	7,035.70
Endrin-Biflon Enverso	1,100 gal.	5,722.05
Ensodil	470 "	2,087.40
Eusdan	7,429 "	19,019.00
Folidol M-48	310 lb.	1,413.50
Fuerthion 70	3,850 gal.	24,747.80
Galecron	3,550 lit.	20,057.50
Gardona 24	114 kg.	185.46
Guthion 20%	100 lit.	607.50
Kelthane	152 kg.	228.48
Lannate 90%	14,098 lb.	113,022.15
Lebaycid 50%	600 lit.	1,656.00
Magnum Dynamic	28,875 gal.	89,039.09
Malathion 50%	65,600 lb.	28,806.50
Matacil	4,000 kg.	6,440.00
Matasistox "R"	1,520 lit.	6,925.00

APPENDIX X continued
FORMULATED INSECTICIDES IMPORTED TO NICARAGUA, 1968

INSECTICIDES	AMOUNT	VALUE US$ CIF
Methyl Parathion 2%	5,000 lb.	262.50
Methyl Parathion 3%	25,000 "	1,290.00
Methyl Parathion 6	31,100 "	2,516.67
Monacide 50%	216 "	850.25
MP-Thiodan-Biotrol 2-4-1.75%	55,000 "	23,100.00
MP-Thiodan-Zineb 2-4-18.75%	84,000 "	26,040.00
Nemagon 75	356 kg.	456.00
Nemagon 75	450 gal.	4,199.66
Nuvacron 60	9,483 gal.	177,366.90
Nuvacron 60	6,804 kg.	20,067.37
Ortho "B"	25,000 lb.	4,112.50
Permatox	40,000 "	10,435.22
Permatox	15 drums	446.25
Perthane	7,370 gal.	34,589.50
Phostoxin	850 kg.	8,814.48
Pysect	675 lb.	6,495.28
Sevin 5%	75,000 "	7,875.00
Sevin 75%	463,280 "	293,382.00
Sevin 80%	137,700 "	91,966.86
Sevin-MP- 7.5-3	40,000 "	5,080.00
Thimet LC-8	990 gal.	13,612.50
Thiodan	9,400 lb.	14,019.52
TOTAL		1,559,528.95

SOURCE: MAG, Managua, Nicaragua

APPENDIX XI

FORMULATED INSECTICIDES IMPORTED TO NICARAGUA

1970

FORMULATIONS	AMOUNT	VALUE US$ CIF
Acritet 34 - 66	17,517 lb.	4,872.82
Azodrin 5	116,000 "	269,231.72
Azodrin 5	31,508 gal.	366,355.77
Baygon 50%	134,045 lb.	232,090.64
BHC - DDT 12-50%	5,000 "	857.20
BHC - DDT - MP 3-15-1.5%	46,000 "	4,450.00
Bidrin 85%	8,095 "	22,750.70
Biotrol 25%	1,200 "	2,640.00
Birlane 24%	50 gal.	407.68
Methyl bromide	1,020 lb.	956.84
Carbicron 100	1,440 lit.	8,640.00
Chlorahep	275 gal.	1,072.50
Chlorahep 5%	80,000 lb.	9,257.00
Chlordane 20%	5,000 "	997.50
Chlordane 40%	1,100 "	451.00
Cylan 250 - E	10,000 lit.	31,650.00
DDT 75%	390,486 lb.	64,071.90
DDTox 2 - 4	4,125 gal.	9,817.50
DDTox ULV	1,650 "	4,448.40
Dipterex 2.5%	10,000 lb.	1,525.04
Dipterex SP - 95	101,810 "	102,643.17
Disyston 5%	80,000 "	9,775.27
Disyston 10%	5,000 "	1,215.51
Dowfume MC - 2	42,398 "	24,981.91
Estrofol WP - 50	18,810 "	15,817.50
Folidol M - 48	1,126 lit.	2,870.60
Fundal 500 E.C.	2,000 "	8,900.00
Fundal 800 P.S.	2,200 lb.	7,100.00
Furadan 3%	10,000 "	3,900.00
Furadan 5%	5,700 "	1,215.65
Galecron 50	24,500 lit.	116,995.00
Gardona 24%	1,003 lb.	726.81
Guthion M-20	8,128 lit.	9,662.40
Lannate	16,883 lb.	129,249.79
Lebaycid	600 lit.	1,580.00
Malathion 50%	31,878 lb.	1,620.00
Malathion 57%	55 gal.	397.60
Malathion L. V. 96%	55,000 lb.	25,711.80
Malathion 96%	2,750 "	1,427.84
Malathion 96%	1,072 gal.	9,004.80
Matasystox R	800 lit.	3,834.00
Methyl Parathion 2%	7,000 lb.	367.50
Mirex 450	29,810 "	11,352.68

APPENDIX XI continued
FORMULATED INSECTICIDES IMPORTED TO NICARAGUA, 1970

FORMULATIONS	AMOUNT	VALUE US$ CIF
M P Thiodan - Biotrol 2-4-1.75%	89,700 lb.	53,397.75
M P Thiodan - Zineb 2-4-18.75%	264,650 "	77,493.26
Multitox ULV	1,650 gal.	5,860.80
Nemagon 75%	780 "	6,353.61
Nexa Gorgojicida	10,000 lb.	1,116.00
Nuvacron 60	5,249 gal.	72,218.70
Ortho B	6,000 lb.	987.00
Ortho Bux 360	2,100 gal.	33,200.00
Orthocide - Dieldrin 60 - 15	1,300 lb.	1,365.00
Perthane	2,750 gal.	12,877.49
Phostoxin	1,995 lb.	7,452.26
Rothane WP - 50	192 "	151.86
Sevin 750	38,950 "	25,317.50
Supracid 40%	500 lit.	1,952,50
Tamaron 50%	3,000 "	7,950.00
Terracur P 5%	105,000 lb.	23,785.64
Terracur P 10%	10,000 "	4,635.77
Thimet L C - 8	500 gal.	6,250.00
TOX - MP 6 - 3 LV	13,475 "	55,949.20
Vapona 48%	25 "	338.38
TOTAL		1,925,526.76

SOURCE: MAG, Managua, Nicaragua

APPENDIX XII

FORMULATED INSECTICIDES IMPORTED TO NICARAGUA

1971

FORMULATIONS	AMOUNT	VALUE US$ CIF
Azodrín 5	1,250 gal.	16,116.13
Azodrín 5	246,210 lb.	563,259.14
Baygon WP-50%	241,604 "	405,759.37
B.H.C. - 6%	20,000 "	2,601.00
B.H.C. - DDT - 12-50%	3,000 "	450.60
B.H.C. - DDT - M.P. - 3-15-1.5%	50,000 "	4,700.00
Bidrin 85%	1,400 gal.	34,944.00
Methyl bromide	7,200 lb.	4,392.00
Chlorahet 5%	85,000 "	9,433.50
Chlordane 20%	7,500 "	1,496.25
Dasanit 5%	74,000 "	14,302.78
Dipterex 2.5%	60,000 "	4,563.65
Dipterex SP - 95	126.110 "	132,354.25
Disyston 10%	15,000 "	3,459.98
Dowfume MC - 2	2,400 "	1,225.20
Dowfume EB - 59	240 gal.	1,476.85
Endrin 2%	8,300 lb.	2,228.55
Etrofol WP - 50	3,850 "	3,237.50
Eusdan	135 gal.	3,348.00
Folidol M - 48	375 "	2,650.50
Folimat 800	100 "	2,426.87
Furadan 3%	252,000 lb.	97,480.00
Galecron 50 E.C.	7,500 gal.	129,137.14
Gusathion 25 E.C.	765 "	3,594.72
Jebodirex 80%	4,400 lb.	3,000.00
Lannate 90%	30,000 "	165,000.00
Lebaycid E.C. 50	180 gal.	2,045.16
Malathion 95%	12,100 lb.	5,808.00
Mesurol	3,300 "	1,610.00
Metasystox "R"	975 gal.	8,649.40
Methyl Parathion 2%	17,500 lb.	918.75
Mocap	6,000 "	2,018.19
Morestan WP - 25	550 "	1,215.00
Nemagon 75%	882 "	2,908.86
Nexa Gorgojicida	10,000 "	1,076.70
Nuvacron 60	29,638 gal.	393,571.74
Ortho B.	17,000 lb.	2,796.50
Ortho Bux 360	1,000 gal.	20,250.00
Orthocide-Dieldrin 60 - 15	2,500 lb.	2,625.00
Perthane E.C.	1,650 gal.	7,425.00
Phosdrin 24%	216 lb.	1,557.22
Phostoxin	992 "	8,816.30
Sevimol 4	70,546 gal.	117,845.00
Sevín 750	7,880 lb.	11,347.20

APPENDIX XII continued
FORMULATED INSECTICIDES IMPORTED TO NICARAGUA, 1971

FORMULATIONS	AMOUNT	VALUE US$ CIF
Sevín - M.P. - 7.5-3%	50,000 lb.	6,107.00
Thimet LC-8	1,410 gal.	18,330.00
TOTAL		2,229,559.00

SOURCE: MAG, Managua, Nicaragua

APPENDIX XIII

IMPORTATION OF TECHNICAL MATERIALS FOR THE FORMULATION OF INSECTICIDES

Nicaragua 1965

MATERIAL	AMOUNT	VALUE US$ CIF
Aldrin 96%	12,207 lb.	10,302.31
BHC 14-15%	66,000 "	6,410.00
BHC 40%	14,966 "	3,734.00
BHC 46%	20,000 "	6,940.00
Bidrin al 86%	13,020 "	25,635.00
DDT 100%	3,477,704 "	767,838.00
Dicarban	11,000 "	7,835.00
Dieldrin 100%	24,361 "	36,165.89
Endrin 2%	4,000 "	520.00
Endrin 96%	284,000 "	643,382.67
Endrin 98%	74,736 "	197,749.17
Strobane 100%	1,165,075 "	286,651.78
Ethyl parathion 98.5%	451,050 "	241,711.75
Malathion	69,094 "	50,748.50
Methyl parathion 80%	6,948,288 "	3,988,306.61
Toxaphene 100%	2,385,857 gal.	750,025.89
Toxaphene 40%	100,000 lb.	11,690.00
Telodrin 94%	413 "	1,096.40
Terbeno 90%	2,110,371 "	318,118.49
Sevin	37,550 "	26,285.00
Sevin 80%	1,028,917 "	689,374.39
Sevin 85%	309,132 "	207,118.44
Vapona 100%	660 "	1,949.20
TOTAL		8,279,588.49

SOURCE: MAG, Managua, Nicaragua

APPENDIX XIV

IMPORTATION OF TECHNICAL MATERIALS FOR THE FORMULATION OF INSECTICIDES

Nicaragua 1966

MATERIAL	AMOUNT	VALUE US$ CIF
Aldrin 94-98%	7,451 lb.	5,733.94
BHC 12%	6,750 "	908.33
BHC 14-15%	333,960 "	32,200.00
BHC 15.5%	20,000 "	2,224.00
BHC 41-42%	75,000 "	19,125.00
BHC 1.2%	8,502 kg.	3,456.00
Bidrin 85-86%	8,864 lit.	57,851.29
DDT 50%	6,750 lb.	1,071.08
DDT 75%	61,600 "	12,936.00
DDT 100%	4,591,510 "	831,193.77
Dieldrín 100%	22,349 "	33,730.00
Endrín 100%	3,000 "	8,305.50
Endrín 95-98%	360,378 "	842,027.06
Ethyl parathion 98.5%	534,050 "	285,716.75
Ethyl Nitrophenyl	106,385 "	164,237.03
Malathion 57%	180 gal.	1,638.00
Malathion	200 drums	80,887.80
Malathion LV Concentrado	11,000 gal.	80,793.00
Malathion Técnico	4,050 "	30,663.50
Methyl Parathion 80%	9,058,130 lb.	5,033,545.45
Sevin 80-85%	1,066,700 "	714,689.00
Sevin	15,250 "	10,217.50
Terbeno 100%	58,500 "	15,093.00
Terbeno	1,512 ton	206,725.82
Terbeno 90%	100 drums	15,575.96
Toxaphene 100%	3,735,200 lb.	914,164.60
Strobane 100%	1,908,275 "	462,027.84
TOTAL		9,866,737.22

SOURCE: MAG, Managua, Nicaragua

APPENDIX XV

IMPORTATION OF TECHNICAL MATERIALS

FOR THE FORMULATION OF INSECTICIDES

Nicaragua 1967

MATERIAL	AMOUNT	VALUE US$ CIF
Aldrín	4,299 lb.	3,324.18
B. H. C. 46.5%	13,514 "	3,351.47
B. H. C. 42%	269,600 "	69,026.40
B. H. C. 30%	5,100 "	1,225.92
B. H. C. 15-15.5%	110 ton	26,050.00
B. H. C. 14-15%	22,675 kg.	4,761.75
D. D. T. 100%	6,101,177 lb.	1,030,810.51
D. D. T. 75%	297,600 "	57,719.00
D. D. T. 50%	10,000 "	1,665.00
Dieldrín	31,466 "	46,858.48
E. P. N.	315,033 "	533,997.97
Ethyl Parathion 98.5%	858,890 "	506,726.92
ENDRIN	257,247 "	606,246.41
Endrín	260 drums	208,246.44
Epichlorohidrín	33,886 lb.	11,981.04
Methyl Parathion 80%	8,317,150 "	4,546,478.29
Strobane 100%	2,542,574 "	808,217.00
Strobane 90%	593,325 "	128,003.94
Terbeno	220,440 "	48,543.12
Thiodan	7,700 "	8,956.15
Toxaphene 100%	5,400,000 "	1,123,161.00
Toxaphene 40%	40,000 "	4,676.00
Vapona 100%	370 "	846.90
TOTAL		9,780,873.89

SOURCE: MAG, Managua, Nicaragua

APPENDIX XVI

IMPORTATION OF TECHNICAL MATERIALS FOR THE FORMULATION OF INSECTICIDES

Nicaragua 1968

MATERIAL	AMOUNT	VALUE US$ CIF
B.H.C.	22,000 lb.	6,600.00
B.H.C. 40%	99,979 "	28,393.93
Chlorinate camphene 90-10	131,000 "	30,457.50
D.D.T. 100%	5,310,845 "	863,478.28
D.D.T. 75%	440,000 "	86,456.30
Dieldrin	22,068 "	32,770.14
E.P.N. 100%	212,595 "	376,485.84
Endrin 95%	184,543 "	405,932.04
Endrin 96%	90,000 "	235,008.00
Endrin 97%	65,600 "	173,079.04
Ethyl Parathion 96-97%	52,250 "	28,737.50
Ethyl Parathion 97-98%	638,715 "	321,337.30
Ethyl Parathion 98.5%	573,500 "	295,825.75
Ethyl Parathion 97-99%	308,000 "	157,080.00
Kepone 80%	15,600 "	25,001.20
Kepone 50%	200 "	209.25
Methyl Parathion 80%	6,078,649 "	3,107,348.95
Merphos	1,800 "	1,800.00
Strobano 90%	222,750 "	48,024.90
Toxaphene 100%	5,603,500 "	1,156,417.60
Toxaphene 40%	160,000 "	16,000.00
TOTAL		7,396,443.52

SOURCE: MAG, Managua, Nicaragua

APPENDIX XVII

IMPORTATION OF TECHNICAL MATERIALS FOR THE FORMULATION OF INSECTICIDES

Nicaragua 1969

MATERIAL	AMOUNT	VALUE US$ CIF
Aldrin 95%	4,384 lb.	3,897.76
Azodrín	365 gal.	8,130.38
B.H.C. 40-42%	60,000 lb.	15,052.62
Cidial 94%	20,000 kg.	80,000.00
D.D.T. 100%	5,190,050 lb.	796,905.86
Dieldrin	20,062 "	29,595.09
Endrín 95%	50,000 "	113,685.27
E.P.N. 100%	86,974 "	155,683.46
Ethyl Parathion 97-98%	330,000 "	168,300.00
Ethyl Parathion 98.5%	585,750 "	261,063.00
Ethyl Parathion 97-99%	1,034,000 "	527,340.00
Phosphamidon 92%	8,640 kg.	41,868.00
Methyl Parathion 80%	4,672,812 lb.	2,336,206.55
Phosdrín	187 kg.	907.01
Sevín 99%	63,000 lb.	46,448.00
TOTAL		4,585,083.00

SOURCE: MAG, Managua, Nicaragua

APPENDIX XVIII

IMPORTATION OF TECHNICAL MATERIALS FOR THE FORMULATION OF INSECTICIDES

Nicaragua 1970

MATERIAL	AMOUNT	VALUE US$ CIF
Aldrin 94.5%	20,625 lb.	17,486.10
Azodrin	23,760 "	52,261.79
Aldrin 96.2%	1,591 "	1,352.45
B.H.C. 40-42%	40,000 "	9,934.00
Birlane	7,675 "	17,270.23
D.D.T. 100%	3,802,800 "	607,020.80
Dicrotophs	4,020 lit.	24,120.00
Dieldrin	11,464 lb.	16,993.61
Endrin 50	331 "	531.52
E.P.N. 100%	20,064 "	35,914.56
Ethyl Parathion 97-98%	592,500 "	340,250.00
Ethyl Parathion 97-99%	231,000 "	117,810.00
Ethyl Parathion 98.5%	593,300 "	304,623.00
Phosphamidon 92%	10,353 "	23,530.00
Kepone 80%	7,750 "	11,625.00
Merphos	9,900 "	10,520.76
Methyl Parathion 80%	5,150,150 "	2,616,985.04
Phosdrin	1,716 "	5,292.26
Sevin 99%	736,850 "	509,973.61
Vapona	1,764 "	1,808.60
TOTAL		4,725,303.33

SOURCE: MAG, Managua, Nicaragua

APPENDIX XIX

IMPORTATION OF TECHNICAL MATERIALS FOR THE FORMULATION OF INSECTICIDES

Nicaragua 1971

MATERIAL	AMOUNT	VALUE US$ CIF
Aldrin	4,950 lb.	4,416.68
B.H.C.- 40/42%	46,600 "	16,158.00
Carbamato 95%	13,649 "	15,946.75
Clorofenamidina 98%	25,300 "	78,95[illegible]0
DDT- 100%	4,771,350 "	830,439.25
Dieldrin	13,200 "	21,491.66
Endrín 95/96%	51,550 "	106,699.62
Ethyl Parathion 97-99%	2,044,750 "	1,007,915.00
Ethyl Parathion 98.5%	1,259,500 "	631,510.00
Methyl Parathion 80%	8,618,500 "	4,252,654.00
Phosdrin	32,890 "	66,676.39
Tamaron 100%	107,800 "	201,048.96
Vapona	2,640 "	2,723.55
TOTAL		7,236,629.56

SOURCE: MAG, Managua, Nicaragua

APPENDIX XX

Arthropod pests of rice, parasites and predators
collected in Nicaragua rice fields
by Dr. Everard Vogel, Louisiana State University
under contract with the National Bank of Nicaragua

1968 - 1972

Order	Family	Scientific Name	Common Name
Homoptera	Delphacidae	Sogatodes orizicola (Muir)	Sogata
"	"	Sogatodes cubana (Crawford)	"
"	"	Sogatodes furcifera (Howarth)	"
"	Cicadellidae	Draeculacephala clypeata Osborn	Green Leafhopper
"	"	Draeculacephala portola Ball	"
Hemiptera	Pentatomidae	Oebalus insularis (Stahl)	Stinkbug
"	"	Oebalus pugnax torridus (Sailer)	"
"	"	Proxys punctulatus P.R.	"
"	"	Euschistus sp.	"
"	"	Piezodorus guildinii Westwood	"
"	"	Andrallus spinidens	"
"	Cydnidae	Alkindus atratus Distant	Black bug
Coleoptera	Curculionidae	Sphenophorus sp.	Bill bug
"	"	Lissorhoptrus sp.	Rice water Weevil

APPENDIX XX continued

Order	Family	Scientific Name	Common Name
Lepidoptera	Pyralidae	Diatraea saccharalis (Fab)	Sugar cane Borer
"	"	Rupela albinella (Cram)	Rice stemborer
"	"	Acigonus loftini Dyar	"
"	Noctuidae	Spodoptera exigua (Hbn.)	Inchworm
"	"	Spodoptera frugiperda (J.E.Sm)	Armyworm
"	"	Mocis latipes (Guen)	"
Orthoptera	Tettigonidae	Caulopsis cuspidata (Scudd)	Long horn grasshopper
"	"	Conocephalus cinereus (Thumb)	"
"	Gryllidae	Gryllus assimilis (F)	House cricket
Diptera	Chironomidae	Coelotanypus olmecus Roback	Non-biting midge
Acarina	Tetranychidae	Schizotetranychus sp.	spider mite

Other insects that were collected on rice fields but were not observed doing damage.

Coleoptera	Curculionidae	Geraeus sp.	Weevil
"	"	Apion sp.	"
"	"	Hyperodes sp. prob. hirtella	"
"	Chrysomelidae	Physonota alutacea Boh.	

APPENDIX XX continued

Order	Family	Scientific Name	Common Name
Dermaptera	Forficulidae	Doru sp.	Earwig
Diptera	Ephydridae	Paralimna obscura Will.	
"	"	Scatella obscura Will.	
"	"	Psilopa pulchripes Loew	
"	Sarcophagidae	Sarcophaga sp.	
"	Muscidae	Limnophora sp.	
"	Otitidae	Chaetopsis debilis Loew	
"	Micropezidae	Taeniaptera lasciva (Fabricuis)	
"	Tipulidae	Limonia sp.	
"	Culicidae	Psorophora (Grabhamia) sp.	
		PREDATORS	
Hymenoptera	Vespidae	Polybia occidentalis (Olivier)	
Hemiptera	Lygaeidae	Oedancala crassimana (F.)	
"	Miridae	Tytthus parviceps (Reuter)	
Diptera	Dolichopodidae	Pelastoneurus sp.	
"	"	Chrysotus sp.	
Hymenoptera	Mymaridae	Anagrus sp.	
"	Ichneumonidae	Venturia sp.	
"	Scelionidae	Telenomus sp.	

APPENDIX XXI

Annual losses due to pests and diseases
of some important crops in Costa Rica

Crop	Area in 1,000 ha	Losses (in 1,000 ₡ or US$) due to: Pests	Diseases	Total
Corn	70.0	₡ 8,400	₡ 8,000	₡ 16,400
Rice	45.0	11,700	13,000	24,700
Beans	62.0	6,510	7,000	13,510
Bananas	20.0	56,000	56,000	112,000
Potatoes	3.0	2,640	3,200	5,840
Tobacco	1.0	1,500	1,500	3,000
Plantain	1.0	1,500	1,500	3,000
Pineapple	2.5	1,000	1,000	2,000
Coconuts	2.3	560	400	960
Coffee	75.0	10,000	30,000	40,000
Cacao	31.2	12,000	12,000	24,000
Sugar cane	26.0	1,500	1,500	3,000
Cabuya (agave)	0.6	362	250	612
Vegetables	0.7	1,000	500	1,500
TOTAL		₡ 114,522	₡ 135,850	₡ 250,522
		US$ 17,311	US$ 20,521	US$ 37,832

Prepared by Ing. Evaristo Morales, MAG, Departamento de Entomologia

SOURCES: FAO, OIRSA, Banco Central, MAG

APPENDIX XXII

Prices of Some Foodstuffs at Local Markets

Food Item	Country					
	Guatemala	Honduras	Nicaragua	Costa Rica	Panama	Colombia
Beans, black	.11[a]	.10	.15	.12	---	---
Beans, red	.13	.18	.19	.09	.19	.25
Beans, white	.14	.25	---	.15	---	---
Beans, fresh green	---	---	.18	.10	.10	.09
Rice	.13	.15	.13	.09	.14	.11
Potatoes	.05	.10	.11	.08	.10	.08
Corn, dry grains	.05	.06	.08	.06	.10	.07
Tomatoes	.05 ea	---	---	.12	.25	.22
Plantains	.05 ea	.04 ea	.05 ea	.03 ea	---	.03 ea
Bananas	---	.02 ea	.01 ea	.02 ea	.04 ea	.02 ea
Lettuce	---	.18 ea	.23 ea	.06 ea	---	.22 ea
Cabbage	---	.13 ea	.10 ea	.12 ea	.17	.18 ea
Broadbeans	.20	---	---	---	---	.05
Oranges	.50	.01 ea	---	.12	.03 ea	.11
Tangerines	.40	---	.01 ea	---	---	---
Apples, imported	.33	.25 ea	.38 ea	---	---	---
Eggs	.50 doz	.60 doz	.45 doz	.46 doz	.60 doz	---
Peas, dry	---	.40	---	---	---	.23
Sorghum	---	.08	.08	---	---	---
Yucca	---	---	.05 ea	.04 ea	---	.07
Onions	---	---	.27	.12	---	.13

[a] Unless otherwise specified prices are quoted in U.S. dollars per pound.

APPENDIX XXIII

Annual Per Capita Income and Population Growth

Country	Per Capita Income U.S.$	Population Growth %
Panama	650.-	3.3
Costa Rica	450.-	3.5
Nicaragua	370.-	3.5
Guyana	350.-	3.0
Guatemala	320.-	3.1
Colombia	303.-	3.2
El Salvador	280.-	3.7
Honduras	260.-	3.4