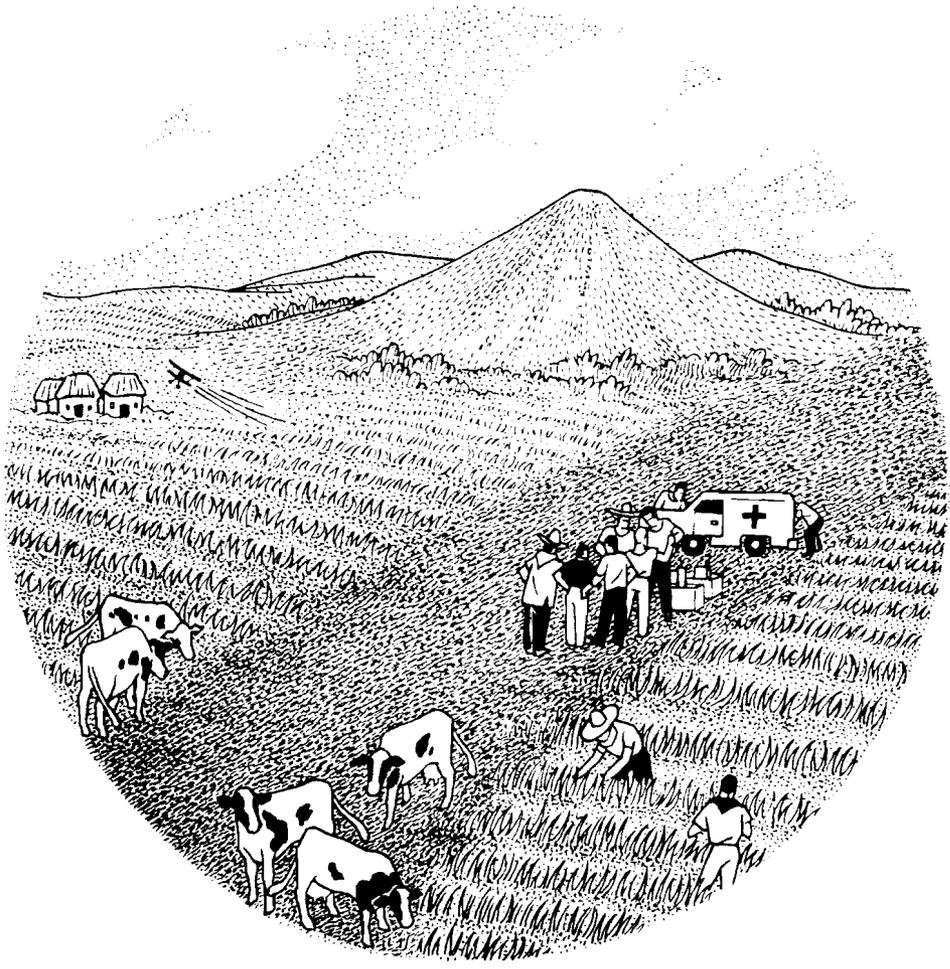


UNIVERSITY OF CALIFORNIA/
AGENCY FOR INTERNATIONAL DEVELOPMENT
Pest Management
and
Related Environmental Protection Project



Annual Report
1975

UNIVERSITY OF CALIFORNIA/AGENCY FOR INTERNATIONAL DEVELOPMENT
PEST MANAGEMENT & RELATED ENVIRONMENTAL PROTECTION PROJECT*
1974-75 ANNUAL PROGRESS REPORT

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ANNUAL REPORT

The present report provides background information and a summarized review of project activities for the first three years of its existence as well as a more detailed report of the last fiscal year's accomplishments (July 1, 1974 - June 30, 1975).

Introduction

The main purpose and short term goals of this project are to provide developing countries with assistance in devising and implementing ecologically sound and economically valid integrated pest management systems for the control of agricultural pests and diseases so that the long term, or ultimate goal, of increasing their agricultural productivity can be achieved. These goals are to be attained by developing their scientific and institutional capacity to handle diverse pest problems in the following manner: 1) through training and re-training of crop protection personnel from participating countries, 2) establishment of technical assistance and extension projects aimed at specific crop protection problems, and 3) assisting local personnel and their institutions to establish or improve programs of research, training, and extension related to crop protection.

This pest management project is complimentary to the cereal grains improvement projects financed by AID, the international agricultural research network and food crop improvement projects financed by other donors for purposes of increasing the food supply in the developing countries. The latter goal cannot be realized until the major pests and diseases attacking important food crops are identified, studied, and brought under managed control.

The trouble with much crop protection methodology is that each problem is considered in total isolation from other problems or potential problems of crop production and of environmental quality. Traditional approaches to control of agricultural pests and diseases have, for the most part, involved application of chemicals, often with little regard for the complexities of individual crops and problems or to the dangers of environmental contamination or deleterious modification of the biosphere.

Undeniably, the control of pests is often best accomplished by the use of chemicals, but the expertise for selecting and using these chemicals safely is usually in short supply in the developing countries. Much modern

pesticide usage throughout the world is ecologically unsound and often may have severe impact upon non-target organisms such as insect natural enemies, fish, wild fowl and other forms of wildlife as well as humans. Continued use of broad-spectrum materials has frequently resulted in disruption of natural controls, resurgence of pest populations, and emergence of previously innocuous species to pest status. Also, pest resistance to pesticide through genetic selection has become a critical problem, as have problems associated with pesticide residues in agricultural products and the environment.

Estimates of food losses in the developing world as a result of pest activity is variously estimated from 20% to over 80% depending on the country, crop and season. Improved pest management will permit a recovery of a significant portion of these losses. It is the aim and purpose of the UC/AID Pest Management Project to assist developing countries in adopting these improved pest management systems. Their adoption will not only increase their food production directly, it will also result in greater safety for humans and an improved general environment through the more rational use of chemical pesticides.

Objectives and General Procedures

The primary objectives of this project, to be carried out in several phases as set forth at its initiation, were to:

- 1) immediately provide an advisory system to assist AID/W in improved pesticide evaluation, procurement and use,
- 2) immediately provide a backstopping resource for USAID missions in the area of pest management,
- 3) develop and implement on a permanent basis a procedure for backstopping and providing research and technical assistance to USAID missions in the evaluation, procurement, and use of pesticides,
- 4) assist countries to develop safeguards and regulatory procedures for the importation, manufacture, formulation, distribution, and use of pesticides,
- 5) help countries to develop a national regulatory and pesticide use monitoring system,
- 6) aid countries to develop research and training procedures for the development of scientific and technical skills,
- 7) to develop country-based integrated pest management and environmental protection systems, and,
- 8) to relate these systems to an international cooperative research and technical assistance network.

Recognition of those problems having the most serious impact on food production in these developing countries was the all important first step in the implementation of this project. Each country has different problems; however, the majority of them do not have the personnel even to recognize many of their problems, much less arrive at solutions for them. To overcome this difficulty, it was proposed to make reliable appraisals of food production problems in these developing regions through the use of multidisciplinary study teams composed of scientists with considerable expertise in crop protection. Such appraisals were to be made from an interdisciplinary point of view to maximize the possibility of recognizing all of the factors involved in the cause of the problems and because many of the problems involve interrelationships between various pests.

The function of these multidisciplinary survey teams was to identify the most serious pest and disease problems (including environmental deterioration) of the most important crops in the countries which they visited. The success of these teams in recognizing and diagnosing the critical problems and evaluating them from the point of view of the needs of the area will to a large extent determine the future success of any research and training program initiated on the basis of their recommendations. For this reason, careful attention was given to the selection of these teams, primary considerations being breadth, balance of disciplines, and previous survey experience.

Each team consisted of 4-5 men representing the fields of entomology, plant pathology, nematology, and weed science. These individuals were selected from participating departments of the University of California and qualified members of other universities and the USDA.

A member of each survey team was designated as the leader and was responsible for organizing the itinerary and arranging local contacts, for collecting and distributing background material for the other members of the team, and for the completion and submission of a report of the findings of the survey team. It was planned that team members should contact disciplinary counterparts in ministries of agriculture, institutes, universities, etc., to solicit opinions on priority pest problems of major food crops and determine the status, effectiveness, and limitations of existing pest management (crop protection) programs.

Each study team report includes the following:

- 1) an analysis of the problems encountered,
- 2) recommendations for problem priorities,
- 3) recommendations for research, training and control programs based on the importance of the problems identified and the probability of successful control,
- 4) an evaluation of the technical capacity or potential of local scientists and facilities,

- 5) where possible, an identification of capable people who would fit into project training programs, or as degree students in the University,
- 6) identification of needed "institution building" and scope of the need,
- 7) an analysis of the way and extent that the UC/AID/PM Project can contribute to strengthening local capacity to manage these problems,
- 8) an evaluation of social and cultural problems that might arise as a result of problem solutions and their effects on local agriculture, marketing and economics.

A. MULTIDISCIPLINARY STUDY TEAM REPORTS

Southeast Asia: Team members were Edward H. Glass, entomologist, New York State Agricultural Experiment Station, Cornell University; Roy J. Smith, Jr., weed scientist, U. S. Department of Agriculture, Stuttgart, Arkansas; Ivan J. Thomason, nematologist, University of California, Riverside; and H. David Thurston, plant pathologist, Cornell University.

The study team spent 40 days visiting the Philippines, Thailand, Malaysia, Taiwan, Hong Kong, Singapore and Japan in order to appraise the nature and scope of pest problems affecting the food supply in these countries. They also attempted to determine whether the local environment and public health are endangered by improper use and lack of management of pesticides on food and other major crops.

The survey team found that pest management systems in tropical East Asia ranged from the highly sophisticated to the primitive, but in general, their crop protection practices were inadequate or not well conceived. The increased yields of the green revolution, based on greater energy inputs and use of a small core of germplasm, often increased the chance of serious attacks by pests and plant pathogens. The tungro virus disease epidemic on rice in the Philippines was cited as an outstanding example of the consequences of this practice.

The team also noted that the intensification of agriculture in East Asia had produced other new problems such as pesticide resistant strains of insect pests, pesticide residue problems on certain crops, and changes in the relative importance of pests on major food crops. Some general deficiencies in crop protection that were identified are:

- 1) inadequate information on losses due to pests,
- 2) lack of established economic thresholds for pests,
- 3) applied research inadequate on most food crops in most countries,
- 4) extension activities are inadequate in most countries,

- 5) pesticide regulations are out of date or inadequate,
- 6) near absence of monitoring of pesticide residues on edible crops,
- 7) post-harvest losses are seldom being studied or controlled.

The study team observed a serious lack of trained manpower for crop protection activities and recommended that the existing manpower be used by the governments with greater efficiency. Research emphasis was too often concentrated on organisms as objects of scientific curiosity in the laboratory and not on the solution of practical problems as they existed in the farmers' fields.

The insects, diseases, nematodes and weeds of major importance were given in an appendix. In most countries considerable work needed to be done on further identification of nematode and weed problems, but most major insect and disease problems had been identified. Specific suggestions were made for the improvement of library deficiencies, lack of books on tropical pest management, pesticide regulations, seed certification and regulation, study of storage pests, pest warning systems, and research priorities on problems of major importance to food crops.

To attack the highest priority pest problems, suggestions were made on how U. S. universities might make an in-depth approach to specific pest problems. The team recommended that these educational institutions accomplish these objectives through employment of scientists who could work and live overseas in "centers of excellence," such as international institutes or outstanding national universities. By providing sufficient funds these scientists could:

- 1) adequately survey the pest problem and local personnel working on the problem,
- 2) train local personnel,
- 3) break bottlenecks in research and extension,
- 4) sponsor annual workshops of regional workers, plus world authorities,
- 5) provide adequate travel funds for the project coordinator, his assistants, cooperators in other countries, and periodic visits by consultants,
- 6) support local research of the project coordinator,
- 7) hold in-country short courses,
- 8) support graduate students for overseas thesis research,
- 9) test solutions to the problems, as they arise, under farm and market conditions.

The study teams predicted that the use of pesticides, especially insecticides and herbicides, would increase. In the countries visited, with the exception of Japan, environmental problems resulting from the use of pesticides generally were of little concern in the face of overwhelming problems of health, hunger, and malnutrition. They found serious problems existed in the storage, handling, distribution, packaging, application, formulation, and use of pesticides in these countries. They stated that every effort should be made to improve this situation through short and long term training, bulletins, manuals, demonstrations, and, where necessary, legislation.

Mediterranean Basin: Team members were George E. Cavin, entomologist, U. S. Department of Agriculture, Hyattsville, Maryland; Dewey Raski, nematologist, University of California, Davis; Ray G. Grogan, plant pathologist, University of California, Davis; and Orvin C. Burnside, weed scientist, University of Nebraska, Lincoln.

The study team spent several weeks in September and October, 1972, visiting Spain, Portugal, Tunisia, Jordan and Lebanon for the purpose of evaluating the effectiveness and limitations of the crop protection programs practiced in these countries.

In their report, the team stated that insect control was the most highly developed of the crop protection disciplines practiced in this area. Knowledge of the major insect pests and their general distribution was good, although in most cases, organized surveys had not been conducted. Plant quarantines were generally in force to regulate imports and exports, but in no instance was the team made aware of the use of domestic quarantines to restrict the spread of a newly introduced pest within an invaded country. Except in Spain and Portugal, regulation of the sale and use of pesticides is still in the consideration phase. The use of pesticides had apparently been oversold, the authors noting that farmers often utilized materials providing the quickest mortality, regardless of side effects or personal safety.

The team found that no effort had been made to determine the presence of nematodes and the damage they cause. Only readily recognizable species, such as the root knot nematode, had received much attention. Research in this field is almost completely lacking. A dearth of trained nematologists in the region exists with little effort being made to alleviate the situation.

Only recently has there been much attention placed on plant diseases. Knowledge of the diseases that exist is still extremely limited in most of the countries visited. No surveys had been conducted to obtain this information. The basic tools for indexing and diagnosis of plant diseases was generally lacking in these countries. Programs to produce virus-free fruits and pathogen-free crops propagated from true seeds were nonexistent. The numbers of trained personnel for research and teaching is extremely limited; however, there seemed to be a growing awareness of the problems of plant diseases and the need for more positive corrective action.

This lack of trained personnel also applied to weed scientists. The few trained individuals in weed science were being attracted to private employment by higher salaries. The prediction that weed science activities in the Mediterranean area were going to increase rapidly because of a reduction in the labor supply and increasing food needs underscored the importance of retaining these trained personnel in the public sector.

Although the report was compiled on an individual country basis, the following general recommendations were made based on an analysis of the area's needs:

- 1) encourage and assist those countries where no agricultural college exists in the university system to develop or strengthen the curriculum with crop protection as a major component,
- 2) assist those Mediterranean Basin countries where a general lack of coordination between research, teaching and extension exists to integrate and coordinate these efforts,
- 3) provide facilities and support for more inter-regional meetings on general plant protection to overcome the general lack of communication that exists between counterparts in different countries,
- 4) establish facilities for conducting pesticide residue analyses on crops produced for export, local consumption, or feed, and on crops and animal products being imported for consumption,
- 5) institute regional projects similar to the AID/USDA Regional Insect Control Project for plant protection disciplines other than entomology to facilitate increased national interest in these disciplines,
- 6) establish a regional service for the general diagnosing and indexing of plant diseases and the identification of nematodes and weed species,
- 7) support training in plant quarantine and education of governments as to its value,
- 8) set up a regional program to produce virus-free, nematode-free citrus, stone, and pome fruits, and pathogen-free crops propagated with true seeds,
- 9) present workshops and seminars to provide instruction in the basic philosophy of pest survey and detection systems for the development of uniform survey methods and reporting systems,
- 10) institute a program of extension type training in pesticide safety, and advocate legislation to regulate the importation, sale and use of pesticides,

- 11) encourage governments to provide salaries for trained personnel commensurate with their training and experience to prevent their leaving public service for other activities
- 12) develop a directory of plant protection workers in the Mediterranean area
- 13) develop a library service with facilities for duplication and translation.

The survey team found that the countries visited were experiencing reduced availability of farm labor and higher labor costs due to migration of laborers to urban areas and to industrialized European countries. For example, Spain had 3 million citizens working overseas while Tunisia was losing 20,000 workers each year to the lure of jobs in Europe. This situation was yet another factor found to hinder the maintenance or expansion of agricultural production in these countries.

Middle East and Asia (in part): Team members were Carl S. Koehler, entomologist, University of California, Berkeley; R. D. Wilcoxson, plant pathologist, University of Minnesota, St. Paul; W. F. Mai, nematologist, Cornell University, New York; and R. L. Zimdahl, weed scientist, Colorado State University, Fort Collins.

The survey team spent 40 days visiting Turkey, Iran, Afghanistan and Pakistan charged with the same mission as noted previously. Because of the extreme diversity of agricultural and related technical developments in these four countries, the team found it impossible to prepare an integrated report on the entire region. They chose, instead, to focus on each of the countries individually, presenting their findings, analysis, and recommendations for each separately, then making general recommendations for the entire region at the end of the report. Their country analyses follow:

Turkey - The important plant protection problems have been reasonably well defined, except for those caused by viruses, soil-borne organisms, and weeds. At present, the major attention is given to chemical control of insects and fungi, with a limited amount of work on the biology of these two kinds of pests. The importance of viruses and nematodes must be evaluated, and weed studies should be broadened.

The relationship between the regional plant protection research institutes, the extension service and the universities results in only a minimal cooperative effort. A coordinated research program of crop protection should be developed with major emphasis on particular aspects of control being assumed by one institute or university. Thus, areas of pest control such as resistance, cultural practices, development of pest-free planting stocks, fumigation, dates of planting, etc., which are presently neglected, could be adequately investigated.

Iran - The team spent 6 days in Iran and were favorably impressed by the forward-looking attitudes of those close to the agriculture scene. The Iranian plant protection program has education, research and extension components. The staffs of the universities are generally well educated and the laboratories adequately equipped. Plant protection research is done at the agricultural colleges and the Plant Pests and Diseases Research Institute at Evin and is of high quality.

There is little genuine concern about environmental pollution caused by pesticides or about residue problems because pesticides are generally at a low level of use on agricultural crops. However, insecticide sales are expected to increase greatly for the next 5-10 years as a consequence of new dams being constructed and the new agricultural lands which will be irrigated from impounded water.

At present there is limited communication among professional plant protectionists at the universities and at the federal level. Technical information and concepts for making decisions relative to plant protection strategy and tactics are supplied by staff members at Evin. Procedures should be developed to allow staff of the College of Agriculture to participate in making these important decisions.

Afghanistan - The survey team found a low level of development in all aspects of plant protection in Afghanistan. On most crops it may be many years until the more basic factors limiting high yields are overcome and before operational plant protection can be viewed realistically as a priority area for attention.

The major activity of the plant protection department appeared to be problem evaluation (i.e., pest surveys). It has no real research responsibility and is involved in research only in a very limited way. There are no quarantine laws in Afghanistan and no plant protection quarantine efforts.

Very little work is in progress on the development of crop varieties resistant to pests or diseases. What work is being done is limited to wheat, potatoes, and maize, and consists of selecting out possibly resistant material from among introduced varieties and selections.

There are many plant disease problems in this country, but only a few are considered economically important although no experimental evaluation of losses has been made. Plant diseases are generally considered unimportant because the climate is dry and relatively cool during the growing season.

Visits to several agricultural areas revealed serious weed infestations in all crops, yet there is no program of weed research, and no herbicides are commercially available. Essentially nothing is known either about nematodes associated with crop plants or crop damage caused by nematodes.

Pakistan - The study team found a high degree of decentralization of activity in plant protection and other areas of agriculture in Pakistan. There are four provinces, and each functions essentially as an independent, autonomous state, although the central government also carries on plant protection activities. The team noted that the fragmentation of authority and responsibility among the provinces fostered a spirit of competition rather than cooperation and recommended that Pakistan establish a strong central plant protection agency. The existing central government plant protection department does not lead the national effort in plant protection; instead, its efforts are fragmented and directed toward just a few of the plant protection problems of the country. The survey team felt that the department should be strengthened to make it an effective voice for the plant protection needs of Pakistan and that it should redefine its goals to include all aspects of plant protection and assume such responsibilities as plant quarantine, pesticide registration, pest surveys and forecasting, training of extension workers in plant protection techniques, pesticide residue monitoring, maintenance of collections of weeds, nematodes, insects and other pest materials for reference purposes, etc.

Only the more obvious problems such as foliage diseases and insects are recognized. Control measures for these problems were being studied and often carried out. Soil-borne problems, virus diseases, and weeds were largely ignored. The recommendation was made that systematic surveys be made on the major crops to determine the most frequent pests. Loss estimates should then be made to rank the economic importance of the problems and to justify support of work.

South America: Team members were Eddie Echandi, plant pathologist, North Carolina State University, Raleigh; John K. Knoke, entomologist, U. S. Department of Agriculture, Wooster, Ohio; E. L. Nigh, Jr., nematologist, University of Arizona, Tucson; Myron Schenke, weed scientist, Oregon State University, Corvallis; and Gerald T. Weekman, pesticide specialist, North Carolina State University, Raleigh.

The study team spent six weeks in late 1972 visiting Brazil, Uruguay, Bolivia, Ecuador and the Dominican Republic in order to determine the most important problems related to plant protection in these countries. They also attempted to assess the reasons for particular problems and made recommendations for reducing or eliminating them.

The team found basic development problems in the public agricultural sector of most of the countries visited. The scarcity of qualified research scientists and the number of serious unsolved pest management problems testified to the inadequate system of organization present in those countries. However, in spite of the problem areas described in the report, many encouraging observations were made and noted.

The study team remarked that while most important fungus diseases of major economic crops have been identified, a great deal of work remains to be done. Coffee rust of recent appearance in Brazil probably constitutes the most important plant disease problem in the Western Hemisphere.

Its economic impact in Brazil is likely to be great, and its spread to other Latin American countries such as Colombia, Costa Rica, and El Salvador would bring economic ruin to their agricultural economies. To prevent this from happening, the team recommended an integrated multi-country program sponsored by AID and other national and international organizations be developed. Witches broom and Monilia pod rot of cacao are also diseases of great economic importance for which no effective control measures have been developed. Since these diseases are restricted to a few countries in South America, similar regional programs with participation of AID should be developed, not only to prevent their spread to other countries, but also to develop effective methods for their control.

Little has been done in the countries visited with respect to bacterial and virus diseases. More attention should be devoted to research in these areas and particularly to their identification.

An obvious problem for plant pathologists is to evaluate the losses caused by important diseases of the major crops. Losses are high on basic food crops, vegetables and fruits. Continuous surveys and systematic studies can provide the needed information on extent of losses from plant diseases. Such knowledge is essential to the establishment of "problem priorities."

The study team noted that in all countries visited additional research on root knot nematode problems was needed. They recommended a multi-country project be established to reduce duplication of efforts. One specific location for training and intensified research should be established in Latin America. The excellent facilities available at CEPEC in Itabuna, Brazil, were cited by the team as an ideal location for cooperative nematology research on cacao, coconut and African oil palm and for the conduct of training programs.

There are efforts by several Latin American countries to increase the export of citrus. Reports indicate that controlling the citrus nematode may be necessary to the achievement of this goal. This problem could also be pursued on a multi-country basis.

The personnel resource in the countries visited was found to be generally inadequate to cope with existing entomological problems. Entomological programs at universities and federal or state research organizations generally are underdeveloped and poorly equipped to respond to high priority needs.

Some information has been accumulated regarding the identity of insects associated with the various economic crops. In some of the countries this information appears to be current, but in others much work must be done on problem identification.

With notable exceptions, such as for cacao insects in Brazil and sugarcane and cotton insects in Bolivia, data are generally unavailable as to the relative importance of insect pests or the extent of damage

they cause. Efforts should be made to determine the economic damage attributable to pests on important crops so that the limited resources can be allocated to problems of highest priority.

Much of the current entomological research in countries visited relates largely to screening of toxicants for the control of pests. Research should be increased to provide basic information on insect biology, ecology, epidemiology, insect-pathogen-plant association, insect resistance to pesticides, and plant resistance to insects in order to permit the development of integrated pest control programs and control of pests without toxicants.

Insect control data in many cases is unavailable to the farmer through public service programs; consequently, most recommendations to farmers for insect control are made by chemical companies' personnel. Increased efforts should be made in each country to prepare and distribute information relative to insect control on specific crops.

Weed control was found to have a generally low priority on the pest management scale of the countries visited. Only Brazil and Ecuador had weed research programs with more than one full-time weed specialist. Documentation of weed-caused economic losses was available only in Ecuador and at two locations in Brazil.

Intensive short courses for personnel interested in weed control, as well as for researchers in other disciplines who should be incorporating basic weed control practices into their present programs, were recommended. A short-term training period of 8-12 months was suggested with the International Tropical Agricultural Center (CIAT) at Cali, Colombia, cited as a possible site for this training. Other training possibilities are the Ministry of Agriculture/USAID commodity research programs being developed in Brazil.

Because of a total absence of a weed research program in Bolivia, the report strongly recommended that a foreign university program be established there to help develop indigenous weed research capabilities.

The implementation of presently known cultural and mechanical weed control methods in these countries would be a significant step toward the development of "total production systems" and also reduce the frequently noted overdependence on chemical weed control methods. This increased use of chemicals for weed control was noted in all countries. This practice should be encouraged only as an aid to integrated pest management programs and where it does not have undesirable socio-economic impact.

The study team recommended that steps be taken to develop a model code of pesticide registration regulations for implementation by each country in Latin America. They further proposed that appropriate steps be taken to create regional centers for evaluating efficacy of pesticides. These centers could be established in the tropical lowlands of Itabuna (CEPEC), Brazil; in the subtropical lowlands at La Estanzuela, Uruguay;

in the Altiplano of Bolivia at Cochabamba; and in the tropical lowlands at Picilingue, Ecuador. A free interchange and acceptance of data from these or other appropriately staffed facilities could satisfy the requirements for national registration and minimize the costs of evaluating pesticides.

The study team report also urged that immediate measures be taken to create pesticide residue capability in all countries visited. Equipment must be purchased to best accommodate critical maintenance and repair problems. Although grant support from abroad for equipment and personnel are needed, each country should be required to make a firm commitment of financial support.

It seems obvious that residue capabilities are needed continent-wide, and the report recommended a coordinated program to develop such a capability. A program that provides the physical facilities, laboratory personnel and field staff simultaneously is essential to avoid the disproportionate development of one segment of the system at the expense of the remaining portions of the program. The team recommended the creation of an international center for training of laboratory and field technicians. This same center should function to develop and maintain uniform standards of operation among participating countries. Each participating country joining in the regional program effort should, in meeting the basic requirements for mutual aid, agree to implement enforcement of basic uniform standards applicable to all participants.

Tables of some of the most important plant diseases, nematodes, insect pests and weeds occurring in these countries were given in an appendix to the report.

Africa: Team members were J. N. Sasser, nematologist, North Carolina State University, Raleigh; H. T. Reynolds, entomologist, University of California, Riverside; W. F. Meggitt, weed scientist, Michigan State University, East Lansing; and T. T. Hebert, plant pathologist, North Carolina State University, Raleigh.

The eight African nations of Senegal, Niger, Mali, Ghana, Nigeria, Kenya, Tanzania and Ethiopia were visited by the study team during the period October 9 - December 1, 1972. In each country visited the team attempted to identify major pest problems (insects, plant diseases, nematodes, or weeds) through consultation with local country and mission officials, and scientists working at various universities, institutions, or ministries. Field trips were scheduled when possible for the purpose of viewing pest problems on growing crops or in storage houses.

The study team found that virtually all agricultural crops are faced with a complex of serious pest problems, and crop losses were high, certainly beyond tolerable levels. In most areas and on most crops, the complex of insects found is incompletely understood, and the potential of secondary pests needs study. However, it appears likely that most major

pest species have been identified, though in some countries visited much remains to be done.

There are several factors which favor development of pest management in the countries visited. With the possible exception of a few crops such as cocoa and coffee, the relatively small amounts of insecticide used have not resulted in massive upsets of beneficial fauna, as is the case in so many areas of the world. Also, in most areas the farms are small, diversified, and somewhat isolated, which may result in some ecosystem stability.

Very few cases of losses caused by insects have been quantified, but it is apparent that losses are beyond tolerable levels on most crops in virtually all areas visited. Losses may be total in cases of mass invasion of migratory locusts, mainly the African migratory locust and desert locust, and only constant monitoring and application of prompt control measures by various organizations prevent occasional widespread devastation from occurring. The team recommended that USAID continue to supply help in the case of migratory locusts as in the past. The entire problem of non-migratory grasshoppers, with emphasis on losses, needs to be evaluated in coordination with other international agencies.

A complex of termites are noted as pests of many crops, but the amount of damage is largely unknown. Perhaps equally or even more serious is the destruction of soil organic matter estimated to be as much as 10 tons per hectare per year in Ghana. An evaluation of this problem should be made with the activity coordinated with programs planned by other agencies.

Stored products insects were extremely serious in all areas visited. Bruchids on stored beans and peanuts cause a 50% weight loss in 8 months in Niger. In some dry areas, losses in storage at the farm level in traditional small storage conditions are considered acceptable; losses are greater in more humid areas. In commercial storage, losses are consistently high. It should be noted that cereals stored for consumption in the off-production season may be heavily infested, but because of the general food shortages, there is no differential in price between infested and non-infested stock. Thus, there is inadequate incentive to maintain clean stored products.

There is no monitoring of population levels of insects at the farmer level in determination of need for pesticide application. Only in a very few cases on major cash crops are approximate economic thresholds of pest populations necessitating treatment established. The organochlorine insecticides are normally the chemicals of choice where insecticides are applied. There are no discernible effects on the environment from use of these compounds, presumably due to the relatively small total amounts applied.

Because little insecticide is used, pesticide resistance is not a serious problem. It is suspected in a few cases but not confirmed in any reasonable way. In very few instances have pest problems changed radically or have pest complexes been altered from wide-spread and

repeated applications of insecticides.

The study team found that losses from plant diseases were heavy in all countries visited. Programs for controlling these diseases varied greatly among the countries. In the millet and sorghum areas of Senegal, Mali, Niger and the northern parts of Ghana and Nigeria, frequently a third or more of the crop is lost from diseases (principally smut and downy mildew). Production of these two crops has not been sufficient to feed the population over much of the area for the past few years. Additional support is needed to hasten the development of resistant varieties and to put into practice some of the known disease control measures over this vast area.

While there have been good surveys of fungal and bacterial diseases of plants in Africa, little has been done on identification of the plant viruses. The team recommended the possibility be explored of placing a USAID supported plant virologist in the plant virology laboratory at IITA to work primarily on identification of viruses on a regional basis and description of any new viruses found.

There were no African plant pathologists in Senegal, Niger, and Mali. While other countries had made a start in training native personnel in plant pathology, the priorities for their services had been placed on cash crops and teaching, with little effort being devoted to controlling diseases on food crops.

One disquieting note detected by the study team was the reluctance of some countries to share information on pest control of cash crops with other countries that may have been their competitors in the world market. A freer flow of information among countries would result in more efficient utilization of limited resources by reducing duplication of efforts and by more effective planning of experiments based on information obtained in more than one country.

The countries visited by the study team have serious nematode problems. For the most part, there is less knowledge concerning the role of nematodes in crop production than that which is available for insects and plant diseases. Plant-pathogenic nematodes are by nature debilitating organisms, rarely killing plants outright. Because of their subtle nature, they often go unrecognized, or the damage they cause is attributed to other causes. In several countries visited, specific nematode problems had not been identified or correlated with crop losses and consequently little attention is being given to them.

In general, the team found the needs great in most of these countries for additional scientists trained in nematology. They recommended that indigenous personnel be trained or upgraded in the basics of nematode diseases and their control. They urged that well organized workshops of short duration (2 weeks) be held on a regional basis with emphasis given on symptomatology techniques for sampling soil and plant tissue for nematodes, extraction techniques, recognition of parasitic

genera, and testing for resistance. Control methods, such as rotation and cultural practices, use of resistant varieties, clean planting stock, and chemicals would also be covered in these workshops.

The team remarked that weeds are one of the major deterrent factors in expanding agricultural production in Africa. At present there is abundant rural labor to handle most weed problems in a subsistence agriculture economy. As more industry and urbanization develops and the need for increased agricultural production by fewer people becomes necessary, weed control programs will become more important in food and feed crops. However, large scale mechanized programs and the widespread use of herbicides for weed control does not seem feasible with the availability of current rural labor and with no industry to use the labor if it is removed from agriculture. Current agricultural programs must be set up to use labor under the existing conditions in these areas.

The two major weed problems observed by the study team in the countries visited were nutsedge and witchweed. There were also many broadleaved weed species infesting the cropped area; however, these are controlled by hand. Hand labor, while reducing the population and perhaps reducing competition, has not been successful in effectively controlling nutsedge or witchweed.

The team noted that use of herbicides through equatorial Africa is very small. Its use is primarily limited to plantation type crops. There were programs at the experiment stations (IRAT, IITA) where herbicides were being evaluated. However, the study team felt that it is more important to find a place for proven chemicals in current and changing cropping systems than to evaluate new chemicals.

Toward the Savannah part of central Africa, bird depredation represents the most serious plant protection problem, the team was informed by G. E. Guyer. The Savannah includes an area of approximately 20% of Africa and the seriousness of the problem is intensified by the drought and general lack of available food. The main problem is associated with the species, Quelea quelea; however, as new crops are introduced and developed, other birds are becoming of increasing importance. Of particular seriousness is the damage to the food crops such as millet, sorghum, rice, and wheat. At present, the most serious economic loss is of millet and sorghum. Estimates of annual devastation range from complete losses in certain valleys of Senegal to millions of dollars of losses in Sudan. It is generally agreed that it will be impossible to implement many of the programs associated with the "green revolution" until bird depredation can be brought under control. The present chemical control is both costly and environmentally unacceptable and in most cases is not making a major impact on the bird populations. Multilateral programs of research and education represent the only reasonable approach to the development of an effective bird control program.

Central America: Team members were Leo E. Caltagirone, entomologist, University of California, Berkeley; Merlin W. Allen, nematologist,

University of California, Davis; Walter J. Kaiser, Jr., plant pathologist, Federal Experiment Station, Mayagüez, Puerto Rico; and Joseph R. Arsenigo, plant physiologist, University of Florida, Belle Glade.

The study team spent six weeks visiting Guatemala, Honduras, Nicaragua, Costa Rica, Panama, and Guyana in order to assess pest control programs, identify problem areas, and propose changes that could result in improved pest management practices and crop protection in these countries.

They found that a common denominator in the countries visited was the lack of minimal financial support to government and university agricultural activities in general, and to plant protection programs in particular. Only when the presumed impact of a pest had an immediate, financially disastrous effect on cash, export crops did the governments take the necessary steps to remedy the situation. The team was of the opinion that no one in decision making positions in many of these governments seemed to care about losses like those due to pests of basic grains (beans, corn, rice, sorghum) in storage, yet these losses are probably greater than those projected for any particular pest of a given cash crop.

The study team cited a lack of continuity of programs as being a common situation in pest control research. This was due to many causes. One that they readily identified is the frequency of change of personnel at top policy-making levels which usually results in a redirection in research programs. Another cause is the frequent loss of comparatively better trained and effective research personnel from the public institutions to the private sector.

Research on pest control is done mostly in the Ministries of Agriculture and in the universities. The team rarely found coordination and cooperation between these groups; too often, they found competition and duplication of efforts. Within-country support to agricultural research and extension is inadequate. This was clearly evident in most of the institutions visited by the team. There is a shortage of personnel, both of researchers and of supportive personnel (technicians); acceptably equipped laboratories and greenhouses are lacking; transportation for research personnel to conduct field work is generally limited; and libraries are small and obsolete. All these conditions, coupled with low salaries and no other type of recognition to compensate for them, were regarded by the team to be responsible for low quality, ineffective research. It is the study team's belief that if this situation is not changed, any changes made in programs will not result in improved pest management research.

Invariably, in each country visited, the team was informed that the extension service is deficient. They were told that extension people 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. 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.

In the majority of the countries visited by the team, crop protection specialists with at least some academic training in entomology could be found. In general, entomologists were paying much more attention to insect pests of cash, exportable crops (cotton, coffee, sugar cane) than to those of food crops (beans, corn). Some entomologists were engaged in basic research of apparently no immediate value to solving pest problems; others were in administrative positions with little opportunity for research.

The study team found that 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. Information on amounts and kinds of pesticides imported and on amounts actually used was seldom available. Only limited specific information on intoxication of humans with pesticides was obtained by the team, 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 of opinion among crop protection people that the importation, formulation, storage, marketing, and use of pesticides should be regulated.

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.

The team noted that 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 in these countries. This lack of knowledge is particularly true of the virus diseases which infect many of these crops. The team cited the need for disease surveys in these countries to determine the occurrence, distribution, and importance of diseases of food crops.

The study team learned of some successful cooperative research programs between plant pathologists in government agencies of the countries visited and international research centers like CIMMYT, and CIAT, and regional programs of PCCMCA 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. The team urged that more cooperative programs of this nature be established among the countries of the region.

The survey team found that, aside from the research activities in nematology supported by 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 time of the study, there were no persons with technical training at the level required to successfully plan and carry out meaningful research in nematology. There have been surveys in some countries directed toward determining the presence of parasitic nematodes on food crops. However, they appeared to the team to have been poorly planned and in the majority of instances no use had been made of the scanty information obtained in the surveys.

The team was 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 the individuals working in this field to techniques in applied nematology seemed to have induced the attitude that meaningful applied research cannot be accomplished in the absence of sophisticated equipment. The team suggested that they give more attention to the simple alternatives that can be successfully employed when expensive and complicated equipment is not available.

In those few instances where there was any attempt to control nematode pests, the team observed that there was a definite tendency to select those nematocidal materials that can be applied in granular dry forms. The team report stated that 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.

Most of the personnel engaged in weed science research have additional research responsibilities, the report indicated, and have a less than total and professional grasp of weed science and its role in overall food crop production. The team felt that this is probably related to a high personnel turnover rate in the public agencies, which is also responsible for a marked discontinuity in applied weed research programs.

Personnel now active in weed science in Central America have been trained pragmatically through experience, the report noted; their capabilities and qualifications are neither uniform, nor adequate, for strong weed science programs. The applied weed research conducted in public agencies is oriented toward specific crops. Weed control experiments

have been conducted in many food crops: dry bean, corn, peanut, potato, rice, sesame, sorghum, soybean, wheat, yuca (=cassava), carrot, crucifers, cucumber, onion, and tomato. The report stated that much applied research has been sporadic and inadequate to provide widely applicable data or recommendations.

Programs appear national, no international programs were observed except for the IPPC Oregon State University AID contract in support of and coordinating national programs. This program has provided chemicals, equipment, and some practical training. Basic weed science research programs were neither observed nor reported.

South and Central America: A preliminary study of the pest management programs and conditions of pesticide use in selected Central and South American countries was made by a two-man team consisting of J. Lawrence Apple, plant pathologist, North Carolina State University, Raleigh, and Ray F. Smith, entomologist, University of California, Berkeley, during Feb.-Mar., 1972. The purpose of the trip was to: 1) ascertain relative importance of pest problems to development goals through contacts with USAID mission and country personnel, 2) discuss the purposes and rationale of the UC/AID/PM Project with appropriate personnel, 3) obtain information on the use of pesticides, and 4) explore the feasibility of developing regional projects for combatting high priority pest problems.

The two men visited the following countries on this trip - Brazil, Uruguay, Bolivia, Peru, Ecuador, Columbia, Panama, and Guatemala. Through a brief stay in each country, they ascertained the general level of crop protection program activities and gained an appreciation for major pest problems in the individual countries. However, because of the short duration of their trip they were not able to make many of the contacts and visit many of the institutions and agencies involved with crop protection programs that would have been necessary to acquire a more comprehensive understanding of the principal problems. For this reason, they recommended that follow-up teams be organized to return to Latin America later in the year for a more in-depth study.

This recommendation was discussed with USAID mission and host country personnel and the decision was made to organize two teams to conduct these follow-up visits. A summary of the team evaluations and analyses of the important plant protection problems in these countries has already been presented in the preceding pages. The broad overview of the general situation in Central and South America as provided by Apple and Smith was corroborated and further amplified by the two follow-up reports.

Since much of the material presented in the Apple and Smith report appears in greater detail in the Echandi et al. and Caltagirone et al. reports reviewed earlier, any further summary would be redundant. However, it would be worthwhile and appropriate to quote from these authors' philosophical analysis of the prevailing situation in Latin America:

"There are many critical resource needs in some countries that will deter crop protection program progress. These needs include trained scientists, research facilities, and adequate program support funds. In some situations political and national economic crises so overshadow the technical problems of the agricultural sector that progress is not possible in the latter without alleviation of the former. In many situations, professional salaries are so low or working conditions are otherwise so unattractive that trained scientists are not retained in public service programs. There are also internal organizational problems such as between ministry and university and/or institute groups so that little or no cooperation and collaboration takes place with resulting duplicated effort, lack of coordinated planning, or appropriate priority problem identification. Some of these problems have a political base and can only be solved through the political process. All of these factors are deterrents to the development of effective programs and represent some of the most difficult problems to solve over the long term. They can be solved only by public-spirited individuals who, as advocates of the common good, are bold enough to rise above institutional or geographic interests."

The comprehensive appraisal of the important pest management problems confronting the 32 countries visited by the six study teams and the recommendations contained in their reports are under consideration and review at the present time by the projects' advisory group. Two of the problems identified in the reports have already been selected as candidate subjects for the development of regional research programs (bacterial wilt and root knot nematode).

B. PESTICIDE MANAGEMENT

Programs for the regulation and proper use of pesticidal materials are grossly inadequate in nearly all developing countries. Most countries have pesticide registration requirements, but the registration process is either routine or one based on very little toxicological, analytical, and performance data. The requirements in some countries consist of a sample that is submitted by the company and analyzed for its "active ingredient." If it meets the analytical claims of the manufacturer or distributor, it is registered for distribution and sale. This results in the use of many pesticide formulations in these countries that are based on their clearance in the U. S. or other countries which have quite dissimilar pests and environmental conditions.

Since pest control efficacy data generally are not required for registration, pesticide use recommendations are at the distributor's discretion. The misuse of many pesticides is the consequence, e.g., they are used on the wrong crops for the wrong pests or improper amounts are

used. The result of this practice is often high-level toxic residues on food crops. The capacity for monitoring food crops for pesticide residues is very limited in developing countries. In fact, the residue problem has received only minimal attention, especially on food crops for domestic consumption. Pesticide residues on agricultural commodities for export are now receiving additional attention because of the restrictions imposed by international commerce. However, these countries will need to mobilize a much greater effort before adequate programs for the regulation of pesticide use are developed.

A very serious and major problem arising from the existing inadequate pesticide regulations is the occurrence of literally hundreds of cases annually of human pesticide poisonings in many of these countries. Most poison cases occur among workers directly involved with the application of pesticides and result from the use of improper application equipment, failure to use proper protective clothing, or from mishandling of toxic materials in mixing and filling application equipment. Poisonings also commonly occur from the frequent sale of used pesticide containers in local markets and subsequent use in the home as a mixing or storage container for food or water. Since the use of pesticides is increasing in nearly all of these countries, the problem of toxic residues on food crops and cases of human poisonings is sure to increase also unless the capability of these nations to regulate the use of these pesticides is markedly improved. To assist them in developing this capability, the UC/AID/PM Project organized and presented a series of Pesticide Management Seminar/Workshops and will present additional ones in the future.

El Salvador: The first workshop was held in San Salvador, El Salvador from Dec. 3-7, 1973. It was organized at the request, through the AID mission, of high officials in the government of El Salvador. Prior to the presentation of the workshop, two fact-finding visits were made to make a preliminary review of the total problems in the country.

First trip (April 6-15, 1973) - A two-man team consisting of John E. Davies, medical toxicologist, University of Miami, and Virgil H. Freed, pesticide chemist, Oregon State University, Corvallis, visited El Salvador on the dates given. The purpose of their trip was: 1) to make an assessment of the disciplinary sources for training, 2) ascertain available facilities for support of the pesticide management training team, 3) develop contacts with appropriate ministries and individuals in those ministries, and 4) develop an understanding of the pesticide problems of the country.

The team reported that very substantial quantities of pesticides are being imported into El Salvador and used for both agricultural production and public health programs. It was estimated that 8 million pounds of pesticide are imported annually. Probably upwards of 60% of the total imported is ethyl and methyl parathion. The principle use of the pesticide appears to be in cotton production.

Considerable time was spent by the team in investigating the amount of pesticide used in cotton, and the practices that are followed

in the different crops. Approximately 80% of the insecticide applied to cotton is methyl and ethyl parathion. However, several other organophosphates in minor quantities and a limited amount of organochlorine compounds are also used. Corn is another crop on which quantities of pesticides are used with the principle one being aldrin. The aldrin apparently is used as a preplant treatment for establishment of the crop and then, after emergence, subsequent applications of aldrin are made. A variety, but more limited amount, of pesticides is used in establishment and maintenance of pasture, coffee production, fruit production, and sugar cane production.

Pesticide use for public health is predominantly for malaria control, the team stated. One of the chief insecticides used here is propoxur, employed for spraying dwellings. Limited quantities of DDT are also apparently used in certain regions.

From this investigation of pesticide uses in El Salvador, the team concluded that the principal problems derived from the cotton, corn, and cattle culture. The problems were categorized as poisoning, persistence, and resistance.

As noted earlier, a considerable amount of insecticides is applied to cotton. With dwelling quarters adjacent to the cotton fields, and considerable amount of foot traffic along roads bordering cotton fields, inadvertent human exposure is understandably frequent. Additionally, there are workers that enter the fields regularly for insect counts and cultivation purposes. With the frequency of pesticide applications (18-22 times a season) that regularly occur, a substantial number of poisoning cases from the organophosphates occur annually.

Residues in meat are another important problem in El Salvador. These residues, the report stated, accumulate from the practice of using chlorinated hydrocarbons in the corn and cotton and then using these plants for cattle feed. Since the corn is also used as feed in the lot, an opportunity for the residue level to drop does not exist. An uncontaminated source of feed is badly needed to resolve this problem.

The third problem cited by the authors is the resistance of the mosquito vector of malaria, Anopheles albimanus, to organophosphates and the possibility that it will become resistant to carbamate insecticides and DDT. The area of high incidence of malaria in El Salvador is along the coastal plain where cotton is also produced. Unless special precautions are taken in the types of pesticides used for malaria control and cotton production, the report warned, resistance could quickly develop in the mosquito.

The basic problem, however, in the team's opinion, was not pesticide use per se, but the misuse that arises from a lack of a sufficiently broad base of trained personnel. There are just too few people well trained in all aspects of use of pesticides in El Salvador to permit the coordination and control that is essential for protection of human health,

and avoidance of unwanted residues. Plans for the seminar/workshop in pesticide management were then initiated to provide this training.

At the conclusion of their report, the team made these recommendations:

- 1) A training program to develop interdisciplinary pesticide management teams in El Salvador should be given high priority.
- 2) The Agro-Medical approach, involving consideration of both agricultural production and public health, should be emphasized in this training.
- 3) A continuing effort to insure the flow of technical information to El Salvador to enable them to improve their practices should be made.
- 4) The expansion of the analytical laboratory capabilities of the Ministry of Agriculture should be encouraged so that it could handle both regulatory monitoring problems as well as research problems.

Second trip (June 30 - July 6, 1973) - Shortly after the return of Davies and Freed to the U. S., the UC/AID/PM Project received an airgram from AID Mission Salvador requesting additional consultation on technical problems and discussion on the training program. In response, the project again sent these two men to El Salvador during the period indicated. The purposes of this trip were to: 1) provide consultation on the analytical laboratory operation and performance to improve capabilities in residue and monitoring programs, 2) review the organization of the laboratory and offer suggestions on development of proposed new facilities, 3) discuss the further development of plans for the training program, 4) consult on pesticide formulations and practices, and 5) confer with appropriate officials and industrial representatives regarding the problem of residues in livestock.

The team, upon arrival, held discussions with Dr. Damon Boynton and Mr. Jack Morris of AID Mission Salvador to review the purposes of the trip. Immediate attention was given to the problem of the analytical program to meet the current needs of the country. After further study and conferences with the director of the laboratory, the team suggested that a reorganization and expansion of the present facilities was needed. Specific suggestions were developed for the addition of a temporary building for storage of solvent and chemicals and a scheme of staff organization and specialization.

The government of El Salvador was also planning to make a substantial investment for construction of new chemical laboratories. After reviewing the preliminary plans, the team suggested that modification of these laboratories to meet both current and future needs for residue and monitoring work was desirable. They recommended that the laboratories dealing with pesticides be organized into four sections and that the staff be organized into specialized groups with an appropriate supervisor for each.

The upcoming training program was discussed at a lengthy meeting with the Sub-Secretary of Agriculture of El Salvador. It was learned that a great deal of preliminary arrangements for development of this program had already been made. Consultation with other ministries had been held, and physicians, chemists and biologists had been identified that might attend this training program. The program was envisioned as being about five days in length with some general sessions and also specialized sessions to meet particular disciplinary needs.

During and following the team's first trip to El Salvador, there had been some exchange of information regarding formulations of pesticides that might help reduce both the amount of the pesticide used and the residue levels. It had been suggested, for example, that microencapsulated insecticides combined with a sticker, might provide sufficiently long residual control to permit reduction of the excessive number of treatments made annually in cotton.

Suggestions were made by the team for development of pasture and feed sources removed from areas where contamination with pesticides could occur to assist in abating the residue problem in livestock. It was also suggested that carbon be incorporated into the feed to help reduce the residue levels and that an analytical program be instituted, including monitoring of carcasses, to ensure that the feed was free of residues. These suggestions were well received and certain of them were to be implemented, according to officials of the government.

As a result of these visits, it was readily apparent that El Salvador had a severe human pesticide poisoning problem, as well as a residue problem as manifested by contamination found in the meat and also a vector resistance problem where in certain areas of the country an Anopheles albimanus population had developed which had become resistant to propoxur. The existence and severity of these problems led officials of the Ministries of Health and Agriculture to request USAID to set up a training program in pesticide management in their country.

Pesticide Management Seminar/Workshop (Dec. 3-7, 1973) - Upon receipt of the request for the training program, the AID project at the University of California was given initial responsibility to begin development of the program. Very early in this process the Pan American Health Organization (PAHO) and the AID Mission in El Salvador, and a number of officials of the government of El Salvador became involved in the planning and arranging of the program. The theme of the seminar was "Pesticide Management in El Salvador," with emphasis on the problems of persistence, resistance, and pesticide poisonings. The need for a multi-disciplinary agro-medical approach was to be emphasized and pesticide management recognized as a preliminary step to the ultimate goal of integrated pest control.

The objectives of this seminar/workshop were to be:

- 1) to develop with the participants a knowledge and understanding of the interrelationship of health, agriculture, and the environment to the economy and welfare of the country.
- 2) to share a common knowledge base with all the participants of pesticides, their properties, use, and toxicology and the problems of persistence, resistance, and poisoning in relation to the pest management problem.
- 3) to provide a background for development of:
 - a) pesticide management teams within the country,
 - b) a central clearinghouse function dealing with problems of persistence, resistance and poisoning, and
 - c) an appropriate organizational system to support the pesticide management team and clearinghouse activities.
- 4) to provide an informational background to assist in further development of the problem solving capabilities of the pesticide management team.
- 5) initiate a program of information exchange and develop a system to increase availability to current literature.

The seminar was held in San Salvador the first week in December under the direction of Ray F. Smith, UC/AID/PM Project Director. It was opened on December 3 with introductory statements by the Minister of Agriculture and the Minister of Health who indicated the commitment of their government to the program and outlined the needs for the seminar and set forth its objectives. The rest of the first day was devoted largely to introductory material and orientation topics and the formation of interdisciplinary working groups that would function in problem solving situations throughout the week. For the next three and one half days, the format of the meeting was one of technical presentations and discussions. For example, Tuesday was given to the problem of residues or persistence and Wednesday to the problem of resistance of insects and other pests to chemicals. The topics covered in these sessions ranged over a wide spectrum of issues: from the chemistry, toxicology, and chemodynamics of pesticides, and development of resistance, to a consideration of integrated pest control methods.

The final day of the program consisted of technical sessions recapitulating and augmenting the information and training provided in the previous sessions. This was followed by a plenary session in which the interdisciplinary teams addressed the problem of developing the system and organization for establishment of pesticide management teams, clearinghouse activity, monitoring and residues analyses, and presented their recommendations. These latter resolutions were condensed and forwarded to the Ministers of El Salvador for their consideration and possible implementation.

The seminar was only the first part of the training program. It was followed by special intensive training of in-country chemists. This was conducted by Stephen Poznanski, analytical chemist, University of Miami, in the laboratory at Santa Tecla the week following the seminar. Time was spent in the laboratory working with the chemists, reviewing the existing instrumentation, and introducing new analytical methods for residue analysis on a micro-scale. Additional training was planned for this group in 1974 at which time an in-house quality control program to update the efficiency of the personnel was to be introduced. Additional equipment instruction was also planned on a gas chromatograph and the infra-red spectrophotometer.

In addition to the chemists' training program, provisions were made for the intensive specific training of the other members of the pesticide team. The Pan American Health Organization agreed to support training for a medical doctor in Miami. The candidate would be supported through the mechanism of a PAHO scholarship in Miami at the Department of Epidemiology and Public Health under the direction of Dr. John E. Davies. Future training was also planned for ingenieros agronomos at the University of California under the direction of Dr. Ray F. Smith and for chemists at Oregon State University under Dr. Virgil Freed.

Indonesia, Initial Visits (February 1-5, 1974; April 3-14, 1974): The USAID Mission in Jakarta received a request from the government of Indonesia in late 1973 to have the UC/AID/PM Project present a Pesticide Management Seminar/Workshop in their country. In response to this request, Ray F. Smith, Project Director, visited Indonesia in February, 1974, to discuss the proposed training with Jarrett Clinton, William H. Johnson, and Paul Stangel of USAID Mission and personnel in the Ministry of Health, Ministry of Agriculture, and Ministry of Manpower, Transmigration, and Cooperatives. A general outline of the seminar/workshop was developed as a result of these discussions. The three Ministries agreed to form a committee to further develop the details of the program and to invite participants.

In April, Stephen Poznanski, project coordinator, also visited Indonesia to discuss additional details of the program with the standing committees. He and the committee met several times and discussed the topics that were to be included in the seminar and which were acceptable to all the Ministries. A list of topics was prepared and incorporated into the proposed schedule and then reviewed in a meeting with representatives of the Ministries of Manpower and Agriculture. The program was designed for a 4-day lecture series, followed by a 2-day workshop, and a 2-3 week course of specialized training in residue analysis.

Pesticide Management Seminar/Workshop (July 8-13, 1974) - The plans and arrangements for this seminar were finalized by the Indonesian committee after Poznanski's visit. The seminar was held in the Rumah Sakit Auditorium, Jakarta, Indonesia the second week in July with nearly 300 participants from the Departments of Health, Agriculture and Manpower in attendance. The emphasis of the seminar/workshop was on a multi-disciplinary agro-medical team approach to enhance the safe and effective use of pesticides in Indonesia.

The meeting was opened with introductory statements by the Minister of Agriculture, Minister of Health, the UC/AID/PM Project Director, and other officials who defined the problems that existed in the country because of unsafe use of pesticides. These were:

- 1) increases in human pesticide poisonings,
- 2) growing problems of pest and disease vector resistance, and
- 3) pesticide residue problems of food and humans.

The principal objectives of the seminar/workshop were to increase the participants' knowledge and understanding of pesticides, their properties, use, and toxicology and the problems of persistence, resistance and poisoning in relation to pest management. This was accomplished through technical presentations on the chemistry, toxicology, chemodynamics, toxicity, and hazards of pesticides and also by lectures on epidemiology and medical aspects of pesticide poisoning.

The workshop, following the seminar, was held on July 12 and 13. The objective of the workshops was to develop plans for implementation of pesticide management programs in Indonesia. Six Working Groups of 10-15 people each, representing the three sponsoring Ministries and the pesticide industry, were organized. Following an explanatory plenary session, the Working Groups met in separate meetings to discuss their assigned topics. The following aspects of pesticide management were considered:

- 1) importation, distribution, storage, and transportation of pesticides,
- 2) safe use of pesticides,
- 3) pesticide industry,
- 4) education,
- 5) regulation and registration of pesticides,
- 6) research.

In a final plenary session, the recommendations and plans of the several Working Groups were reviewed and ratified. These resolutions were presented to the Ministers of the Indonesian government for their possible implementation.

Following the Seminar/Workshop sessions in Pesticide Management in Jakarta, a three week specialized training session in residue analysis was provided for in-country chemists. This course was conducted by instructors Stephen Poznanski and Ian Tinsley from the UC/AID/PM Project, with assistance from Drs. Koesmijati Widodo, Itawati Pranata, and Janahar Murad of the Ministry of Health.

Twenty-two people from the Provincial Health Laboratories, Research Institutes, and laboratories under the Ministry of Health, Ministry of Agriculture and other ministries participated in this intensive training course. They were divided into four groups of about six people each. Each group was given two weeks training in thin layer chromatography and one week on gas chromatography.

The emphasis of the course was on laboratory work, with background information given in several lectures. The first week's training exercises were in screening methods of pesticides, preliminary analysis and analysis of the functional groups in unknown samples of pesticides, and extraction clean-up methods in samples such as blood, fat tissues, rice, flour, oil, water, etc. In the second week, two groups were trained in thin layer chromatography procedures in analyzing pesticide residues, especially the interpretation of results. The remaining two groups were trained in the operation of a gas chromatograph. This consisted of an evaluation of the instrument, setting up the instrument, determining optimum operating conditions, and evaluation of the sample. The groups exchanged training assignments during the third week of the course.

The laboratory section ended on August 3 with a formal ceremony. In the afternoon, a Varian gas chromatograph 440-20 purchased by the UC/AID/PM Project for this training course and donated to the Indonesian government was moved to the Ministry of Health laboratories and installed.

As a follow-up to this training program, the UC/AID/PM Project was to continue to maintain contact in person and by correspondence with the pesticide management programs in Indonesia and assist in their continued expansion and improvement. It was proposed that Stephen Poznanski revisit Indonesia early in 1975 for a review of laboratory residue analysis problems and to provide specialized training as needed. In addition, it has been suggested that project personnel provide specific technical guidance in the development of a number of small applied research projects needed to further improve pesticide management. Furthermore, technical assistance was to be provided in the development of surveillance and monitoring systems for pesticides and otherwise implementing the recommendations that were made in the workshop.

The Philippines, Initial Visit (July 15-20, 1974): Following the Jakarta Pesticide Management Seminar/Workshop, Virgil Freed, John Davies, and Ray F. Smith visited Manila from July 15-20, 1974 to discuss presenting a similar workshop there with Philippine officials. Upon arrival, the team first met with Dr. Frank W. Sheppard, AID Mission Manila, to inform him of the purpose of their visit.

Later, the UC/AID team met with Reeshon Feuer and Hipolito Custudio of the Bureau of Plant Industry. With Custudio's help, they were able to contact a number of people and organize a Steering Committee to plan the seminar/workshop. That afternoon, Freed and Davies visited a processing plant where lumber was being treated with a copper arsenite compound. They

do not use pentachlorophenol (PCP), as do the Indonesians, and did not seem to be having any intoxication problems.

The following day all three men, along with Reeshon Feuer, went to the University of the Philippines campus at Los Baños. They met with Fernando Sanchez, Rueben Aspiras, and Edwin Magallona at the College of Agriculture to discuss the composition of the Steering Committee as well as the content of the various training sessions and the seminar program. After the meeting, the team briefly toured the laboratory facilities in IRRI and the pesticide residue laboratories in the college. Afterwards, the group went to the Cyanamid Agricultural Research Foundation laboratory and met briefly with industry representatives. The pesticide management workshop was discussed and received the support of the Pest Control Council of the Philippines. This council consists of pest control operators, entomologists, plant pathologists, weed scientists, and insecticide dealers.

The next day, Ray F. Smith, Reeshon Feuer, and John Stivers looked at facilities to evaluate possible places for the seminar/workshop. The site which appeared to them to be the most suitable was the Magsaysay Center in Manila.

Pesticide Management Seminar/Workshop (February 10-15, 1975) - Final arrangements for this seminar were made by the Philippine Steering Committee subsequent to the UC/AID team's visit in July. The seminar was formally opened on February 10 in the Ramon Magsaysay Center, Manila, Philippines, with over 300 people in attendance, representing more than 50 agencies involved with the use of pesticides in the Philippines. Introductory remarks were made by the Director of the Bureau of Plant Industry, the Acting Secretary of the Department of Health, the UC/AID/PM Project Director, the Acting Director of USAID/Manila, and other officials identifying the problems and benefits derived from the use of pesticides. The need for the multidisciplinary agro-medical team approach emphasized by the seminar/workshop was recognized by everyone concerned as the best means to achieve a safe pesticide use program.

The objective of the seminar/workshop was to provide the participants with a greater knowledge and understanding of pesticides and the latter's relation to pest management. This goal was attained by the presentation of technical talks on such topics as: pesticide chemistry and metabolism, biochemical and physiological effects of pesticides, medical aspects of pesticide poisoning, pesticide formulation and application, agro-medical approaches to pesticide management, etc. The discussion following all of these talks were lively and prolonged, reflecting the high degree of interest of the participants in pesticide management problems in the Philippines.

At the conclusion of the seminar sessions, Ray F. Smith, UC/AID/PM Project Director, presented a plan for the organization of the workshop groups and explained the topics assigned to each group. In order to formalize and express the accomplishments of this seminar, he proposed

that four interdisciplinary work groups be appointed to deal with broad problem areas. The function of these work groups was to examine the problems within their area of responsibility and develop recommendations. They were also to make suggestions for implementation of their recommendations.

A Chairman was appointed for each group. He in turn appointed two rapporteurs to record the deliberations of the group and to assist him in the preparation of the final report. The problem areas considered by the four work groups, and some examples of topics discussed, are given below:

- 1) Pesticide Industry
 - a) formulations of pesticides for specific crops and conditions of the Philippines
 - b) toxicology of pesticides in relation to use
- 2) Safe Use of Pesticides
 - a) field practices to reduce contamination
 - b) protective clothing for occupationally exposed workers
 - c) monitoring of human poisonings
- 3) Regulation and Registration of Pesticides
 - a) requirements for importation, distribution, and sale of pesticides
 - b) regulations for disposal of chemicals and containers
 - c) data needed for registration
- 4) Education and Research
 - a) education for the professional expert and commercial applicator
 - b) role of extension in pesticide management
 - c) residue analyses research

The workshop groups met independently on Thursday evening and Friday and developed a series of recommendations. These recommendations were then presented in a plenary session on Saturday morning, February 15.

That afternoon, formal closing ceremonies were held. Several speakers talked on the importance of pesticide management in food production and

improved health. The Director of the Bureau of Plant Industry called for the establishment of an ad hoc committee of several agencies to continue the cooperative work that had been established during the seminar. It was subsequently agreed that this committee would be organized.

C. SEMINAR/WORKSHOP FOLLOW-UP REPORTS

Follow-up in Indonesia: Project Director, Ray F. Smith and three other members of the UC/AID/PM Project, John Davies, Virgil Freed, and Stephen Poznanski, visited Jakarta from February 4-7, 1975 to hold important discussions with Indonesian health and agriculture officials as part of follow-up activity to the July, 1974, UC/AID Pesticide Management Seminar/Workshop.

Lengthy meetings and interviews were held with country representatives from the Departments of Health, Manpower, and Chemical Industry, the Institute of Occupational Health, the University of Indonesia, and other institutions to discuss the progress they had made in implementing the recommendations that were made at the conclusion of last year's workshop.

An official of the Department of Health reviewed the activities of the health program in relation to pesticide use for the UC/AID team and stated that the desired coordination between the Ministries of Agriculture, Health, and Manpower had not yet been achieved, although each department in its own way had made significant progress in the field of pesticide management. Progress had also been made in the licensing and registration of pesticides while the design of legislation for the licensing of pesticide control operators was now being carefully studied.

Indonesian officials also related that attempts were being made to classify pesticide chemicals on the basis of their toxicity and hazard, with the availability of the more toxic chemicals being limited to licensed or skilled applicators. Application of the more toxic substances used on rice and other crops was made by commercial applicators rather than individual farmers.

With regard to the development of pesticide protection teams in the provinces, an Indonesian Pesticide Committee spokesman indicated that active participation by agriculture on the agro-medical teams had not yet been obtained, but soon would be. The Madan area in North Sumatra was selected for this future participation because there have been complaints about pesticide poisonings in this area. The function of these agro-medical teams would include monitoring and surveillance of pesticide use, as well as education.

The UC/AID representatives were informed that pesticide poisonings were reported only sporadically; the last annual total was in 1972. A manual was being prepared on how to investigate these occurrences. It is to be disseminated in the Indonesian language to all the pesticide

protection teams this year. The major pesticides causing problems are Endrin and pentachlorophenol (PCP). Parathion was still apparently being used on cotton and rice, but it is not on the list of legally permitted imported pesticides.

Government officials also disclosed that resistance of the malaria vector was a great problem in central Java. This resistance is believed due to the earlier use of Endrin. In the coastal region where the vector, Anopheles sundaicus is a problem, resistance to both DDT and Dieldrin occurs. Dieldrin was withdrawn from use not only because of resistance, but because it was suspected of killing cattle. DDT spraying in central Java is partially effective, and it is still possible to interrupt transmission of the disease. In anticipation of a growing problem with resistance, a series of newer insecticides are under trial in central Java.

Apparently, there was some confusion by local chemists on how to run PCP's on the gas chromatograph. They were assisted in this problem by Stephen Poznanski and Virgil Freed. The larger problem of the analytical capability of the Indonesian laboratories was discussed by Poznanski with the local officials. The participation of these laboratories in a quality control program was strongly urged. This program would organize the laboratories so that they would use the same methods and standards. Acceptance of this program would lead to greater accuracy and reproducibility of results.

The UC/AID Pest Management personnel also discussed future cooperative activities with Indonesian scientists and made presentations of several research projects that might be developed by that Asian nation. The proposed research projects were:

- 1) protective clothing and barrier cream,
- 2) formulations of pesticides,
- 3) epidemiology,
- 4) pollution control,
- 5) disposal of chemicals.

The pentachlorophenol problem and protective clothing and barrier cream were used as an illustration of how a research project might be approached.

Follow-up in El Salvador: Project coordinator, Stephen Poznanski, visited El Salvador from February 18 - March 2, 1974, to provide further assistance on technical problems. The first week of his stay developed into a repair session, since many of the instruments at the Santa Tecla laboratory were not in operational condition. While repairing these instruments, he also trained one of the local people to do this work in the future. The instruments repaired were a Perken-Elmer 900 Gas Chromatograph, an Atomic absorption Perken-Elmer unit, and a Perken-Elmer 337 Infra-red Spectrophotometer.

While doing this repair work, Poznanski was made aware of a new problem facing the laboratory. Apparently one of the beef slaughter houses was recovering the blood and drying it. The blood was then mixed into the cattle feed and used for its high protein content. A problem exists with this practice because no one was checking the blood for its pesticide content. During the week a method for analyzing this blood was developed and some samples were analyzed satisfactorily. The laboratory is now using this method routinely and will continue to analyze samples of blood used for feeding cattle.

During the second week of his visit, Poznanski met with the Director General of CENTA at Santa Tecla. The items discussed were the progress of the laboratory, new plans initiated by Dr. Virgil Freed, and the future planning for the new laboratory. Poznanski recommended that they acquire three or more gas chromatographs for the laboratory and these were included in the budget. While observing their procedures, he discovered that the laboratory was only getting 70% recovery from the control sample. He found that the Florosil used in the laboratory was too old and recommended a new batch be obtained that would meet specifications, thus permitting 95% recovery of a pesticide. Poznanski also met with Jack Morris at the American Embassy. He was informed that the company, Quality Meat, had had a shipment of meat to the U.S. refused by the FDA some time after the UC/AID seminar/workshop in December. It turned out, however, that the company had not submitted any samples to the laboratory in El Salvador, but had gone to Guatemala for their analysis.

At the conclusion of his visit, Poznanski made the following recommendations:

- 1) Additional training be provided in El Salvador. This would include the introduction and demonstration of new micro-methods and training in cholinesterase analysis.
- 2) A quality control system be established with supervision by the University of Miami.
- 3) Out of country training be provided for some laboratory personnel.
- 4) Presentation of a more advanced Pesticide Management Seminar/Workshop in November or December, 1974, with more cooperation with the other countries of Central America.

Freed-Davies Trip (June 9-13, 1974) - Following Poznanski's visit, the team of Virgil H. Freed and John E. Davies also travelled to El Salvador for the purpose of following up the December 1973 seminar/workshop and to provide further technical consultation and assistance. The following specific objectives were to be achieved by meeting with the appropriate people and agencies in El Salvador:

- 1) review the progress of implementation of the recommendations developed at the December seminar/workshop,
- 2) provide technical consultation and assistance for development of the pesticide management teams,
- 3) review developments and progress in the residue laboratory at Santa Tecla and afford technical consultation,
- 4) consult with the directors of the hospitals at Usulután and San Miguel regarding progress and abatement in cases of human poisoning,
- 5) ascertain the progress made in reducing the problem of pesticide residue in beef and other agricultural exports,
- 6) provide technical consultation on formulation, application and use of pesticides to foster safety and effectiveness of use and to encourage further progress in interfacing as part of an integrated pest control program.

With these objectives in mind, the team visited a number of people from the AID Mission in El Salvador, the Ministry of Agriculture, the Ministry of Health, and other officials of the government of El Salvador, and with representatives of industry. From these conversations, the team learned that the amount of chlorinated hydrocarbons (DDT - dieldrin) residue in the cattle of El Salvador had been reduced. Evidently, the recommendations on carefully avoiding contaminated feed and proper management of the livestock (see page 25) were adopted. The team's earlier suggestion to add charcoal to the feed to reduce the residue levels had also been employed, at least for a time, in the feed lots.

At the time of their visit, the Ministry of Agriculture was considering the implementation of new regulations. Among these regulations was a requirement for (1) drainage of run-off to a sump area from treated fields. This would be particularly true of fields that drain into a stream or body of water. Another proposed regulation was (2) the prohibition of spraying within at least 100 meters of human habitations or buildings, and within 200 meters of live streams. A requirement of prohibiting the planting of cotton within 100 yards of a stream, plus a 100 yard buffer strip, was also being contemplated.

The Agricultural Attache at the U.S. Embassy credited the UC/AID Project with focusing attention on the malaria problem and producing a response from the USDA to do something about malaria. The USDA-ARS now has underway a two year program of release of sterile male Anopheles albimanus mosquitoes in an attempt to suppress the population of the malaria vectors. The project is being coordinated through the University of Florida. However, the incidence of malaria in El Salvador had shown a significant increase from the previous year. When the first four months of 1974 were compared with the similar period in 1973, a three-fold increase

in positive malaria isolations and a thousand times increase in the percentage prevalence of transmutive falciparum was noted. It was predicted that the number of malaria cases would reach 80,000 in 1974, compared with 42,000 in 1973.

The UC/AID team was again informed that the incidence of Anopheles albimanus resistance was very high along the coast, particularly in the tourist areas bordering the Pacific. The control strategy for malaria was the use of DDT in the north and Baygon in the west, east, and south areas of the country. In the areas around Usulután where the mosquito vector is 100% resistant drug therapy is employed. The drugs used are Chloroquin and Primaquin. It was indicated to the team that the mosquito in this area had become resistant because of the simultaneous use of Sevin and Parathion for rice and cotton in these areas.

Freed and Davies also had discussions with officials of CENTA concerning plans for the construction of a new environmental laboratory at San Andrés. They suggested as a precaution that there be a modification of the plans to have the quality control laboratory more or less isolated from the rest of the laboratories. Thus, in the event of a spill or an accident involving an organophosphate, contamination of the other laboratories would be avoided. They also suggested that when the director of the laboratory had been selected that he come to the United States for a short period of training in environmental chemistry.

The two men were very encouraged to learn during their trip of the substantial progress that had been made in pesticide management in El Salvador since the December seminar/workshop. This progress was evidenced by a reduction in the number of cases of human poisonings from pesticides and the substantial drop in residues in agricultural exports. They believe it is reasonable to credit the UC/AID/PM Project in part with assisting to achieve some of this progress.

Poznanski Visit (October 16-30, 1974) - The UC/AID Project coordinator, Stephen Poznanski, again visited El Salvador in October for the purpose of providing technicians and chemists from several major hospitals with training on the use of the Michel method for determining blood cholinesterase level. This method will be used to determine cholinesterase levels in insecticide poisoning cases in El Salvador and will aid in the development of an adequate monitoring system in that country.

The day following his arrival, Poznanski met with Jack Morris of AID Mission Salvador to discuss this training program. Morris advised him that the primary responsibility for this program would rest with officials in the Ministry of Population and Health and therefore Poznanski should meet with them to discuss the proposed program. Accordingly, a meeting was arranged at which the instruction program for the hospital technicians was discussed. Because of the distances between the hospitals, it was decided that the program should be condensed and that all the technicians should be brought together at the Zacatecoluca Hospital for the training session. The equipment at the hospitals was also discussed and

it was found that the pH meters were of a German make with instructions in German and thus no one was able to use the instruments.

Poznanski also met with Dr. José Alberto Galiano, Director of the Zacatecoluca Hospital, who endorsed the program and permitted the use of the hospital's laboratory for the demonstration and training sessions. However, the laboratory's pH meter, balance and centrifuge were not working and had to be repaired. A new micro-electrode for the pH meter had to be purchased so Poznanski called Miami and had one sent to him.

After the equipment, solutions, glassware, etc. had been checked and found operational, the demonstration was given on Friday, October 25. There were eight technicians and seven medical doctors from six major hospitals present at this demonstration. Steve Poznanski went through the entire test procedure for them, using several blood samples from actual poisoned cases. Although considerable time was taken in the demonstration and discussion of the method, the results obtained were only fair. The technicians informed Poznanski that they did not have a working pH meter in any of the hospitals, so he gave them instructions on its maintenance.

The following Tuesday, the same group met at the CENTA laboratory in Santa Tecla. They reviewed the method, obtained blood from several of the workers, and then ran the cholinesterase tests again with excellent results. Two of the chemists at CENTA also learned the method and plan to start a program of monitoring the workers at Santa Tecla in the future.

D. PROJECT REPRESENTATION AT INTERNATIONAL MEETINGS AND CONFERENCES

Since its inception, the UC/AID Project has promoted and encouraged attendance at various important international meetings and conferences by members of the project and consultants as a necessary and vital activity. One of the primary benefits of this activity is the opportunity it affords for liaison and contacts to develop between project members and officials of various international organizations such as FAO, UNDP, WHO, etc. who are responsible for planning and implementing programs in the pest management area. A list of these meetings and conferences attended since initiation of the project is attached as Appendix 3. A review of some of the more important meetings attended in the last fiscal year, 1974-75, follows.

EPPO Conference on Integrated Control in Horticultural Crops, Kiev, USSR (August 27-31, 1974) - The UC/AID/PM Project sponsored Ray F. Smith, Project Director, and Edward H. Glass, New York State Agricultural Experiment Station, to attend this conference. This meeting provided the two men with an opportunity to meet with leading crop protectionists from the Soviet Union and other Eastern Block countries as well as those from several western European and Mediterranean countries. It also provided them with a limited opportunity to hear about progress in integrated control in these countries. The program also enabled them

to visit the Ukrainian Research Institute for Plant Protection in Kiev, the Dmitrovka Experiment Station, Ukrainian Institute of Horticulture and the Tarasovsky State Farm, which is also located near Kiev.

Nearly all of the technical papers of the conference presented information on research and development activities concerned with integrated pest control on horticultural crops. There was a general awareness of the validity and need for integrated pest management among the delegates and the several governments represented seemed to be making considerable effort to utilize this approach. For the most part, however, Smith and Glass found it difficult to assess the amount of research effort already or now being made and the degree of actual implementation in the field. In their judgment, some considerable progress had been made in some countries and little, or none, in others.

Several Soviet scientists described massive rearings and releases of such parasites as Trichogramma species and the golden-eye fly predator of the Colorado potato beetle. Rather exhaustive studies of the biology of the codling moth had been made and were reported. There were, however, no reports of "ecological races" of this pest based on latitude of origin. The sex pheromone of this moth that had been elucidated in New York had been found to be very attractive to this pest throughout its range in the USSR.

The tour portion of the program proved to be disappointing. The two men stated that their tour of the Ukrainian Plant Protection Institute was all too brief to obtain a comprehensive overview of the program. Due to lack of time, only four of its laboratories were visited. In general, they found the tour of the Dmitrovka Experiment Station and the Tarasovsky State Farm to be also disappointing because they were not provided with detailed information or data on crop protection practices in actual use. Furthermore, the people responsible for these practices were not present to answer questions.

IOBC General Assembly, Madrid, Spain (October 7-11, 1974) - Project Director, Ray F. Smith, attended the meetings of this General Assembly held in Madrid. The sessions were given at the Instituto Nacional de Investigaciones Agrarias and consisted largely of reports reviewing the various programs of the West Palearctic Regional Section of the IOBC. As a very large number of the programs involved integrated pest control, the discussions were very informative and provided a general overview of integrated pest control developments in western Europe. Dr. Smith reported that IOBC is developing a new identification program with new centers then being established. Most of these would be located in West Germany.

As in many other parts of the world, considerable concern was expressed about getting clearance protocols for various pathogens, particularly viruses which would be most useful in integrated pest control. Dr. Smith also stated that a number of IOBC projects have become involved in genetic control; perhaps the most advanced of these is the genetic

control of the onion maggot in the Netherlands. An interesting report cited by Dr. Smith involved the microbiological control of the Gypsy moth. Apparently there are many different strains of the virus from the different geographic regions and these have different reactions with the various strains of the Gypsy moth. The reports which were distributed at the meeting were deposited by Dr. Smith on file in the International Plant Protection Library in Berkeley.

Meeting of FAO Panel of Experts on Integrated Pest Control and FAO Working Party on Resistance of Pests to Pesticides, Rome, Italy (October 15-26, 1974) - The UC/AID/PM Project was represented at these meetings by Ray F. Smith, Project Director; Perry L. Adkisson, entomologist, Texas A & M University; H. David Thurston, plant pathologist, Cornell University; and Louis A. Falcon, insect pathologist, University of California. The Panel meeting was divided into two sessions: one, an ad hoc session to develop a global strategy for the development of integrated pest control; and second, the regular fifth session of the Panel. The latter was opened by William R. Furtick, Director of the Plant Protection Division, FAO, who welcomed the Panel and discussed how the serious nature of the shortages and high prices of fertilizer and pesticides was affecting world food and fiber production.

Ray F. Smith was then elected Chairman of the Panel and proceeded to outline the agenda and the matters to be considered during the meeting. An ad hoc Panel of Experts on Integrated Pest Control was also formed to discuss and assist FAO in the development of a Global Cooperative Project on Integrated Pest Control for consideration for funding by UNEP. Working papers and country reports then were distributed for study by the Panel. Several committees were formed to review and develop various aspects of the Panel report and the UNEP proposal.

The next several days were spent in committee meetings, working sessions and Panel discussions concerning the UNEP proposal, present status of integrated pest control, methodology and tactics of integrated control, and preparation of outlines for two sets of Guidelines on Integrated Pest Control: one on rice and the other on maize pests. Considerable discussion also was given to the present status of the development and use of invertebrate virus for pest control.

After the Panel's session was formally concluded on Friday evening, October 25, a small drafting committee stayed over through October 26 to complete the first draft of the Panel report. The latter will include several recommendations to FAO on how integrated control may assist in alleviating the pesticide shortage by minimizing use of these chemicals, and on implementation of training and research programs.

CENTO Seminar on "Toxicology of Pesticides with Special Reference to Environmental Hazards, Tehran, Iran (October 20-24, 1974) - This seminar was attended by Edward H. Glass, entomologist, New York State Agricultural Experiment Station, as an official delegate of USAID. It was held at the Plant Pests and Diseases Research Institute, Evin, Tehran with 19 delegates

and 21 observers from five countries in attendance. An official report on the Seminar was submitted to CENTO by the organizer of the meeting.

The main concern of the seminar was the toxicology and hazards of pesticides and their use. Speakers from the United Kingdom stressed the hazards of pesticides prior to and during application rather than problems of residues and contamination of the environment. One speaker criticized certain restrictive residue tolerances established by some governments. Dr. Glass stated that many developing countries are just now becoming actively concerned with residues, primarily in response to the need to meet tolerances for products being shipped to countries with established pesticide residue tolerances. In Iran, however, there is a recently established government unit that is pursuing food residues and environmental hazards of pesticide use with a zeal equal to that of the EPA in the United States.

An United Kingdom scientist from the Ministry of Agriculture, Fisheries and Food described the work of a colleague on a new type of protective clothing thought to be suitable for use under tropical conditions. He mentioned the need for conducting research in a suitable location. Dr. Glass remarked in his report on the relevance of this research to Virgil Freed's (UC/AID Project advisor) project on protective clothing. He suggested that a cooperative research project between these two men might be very productive.

Armyworm Workshop, Nairobi, Kenya (January 6-9, 1975) - This workshop was attended by Alton N. Sparks, entomologist, USDA, Tifton, Georgia and Everett R. Mitchell, insect ecologist, USDA, Gainesville, Florida, consultants to the UC/AID/PM Project. The meeting co-sponsors were the International Center of Pest Control and the East African Agriculture and Forestry Organization. Thirty-six scientists, representing 10 countries were invited to present data and discuss all facets of control of armyworms of several species throughout the world. The primary discussion centered on the African armyworm, Spodoptera exempta. However, research related to S. frugiperda, S. exigua, S. littoralis, S. dolichos, S. laticfascia, and pertinent research related to Heliothis zea, H. virescens, and H. armigera was also discussed.

The two men reported that it was apparent from the discussions that the African armyworm is not as consistent a pest in the East African countries as H. armigera. When outbreaks of the armyworm do occur, however, they stated that the results can be devastating. The proclaimed forecasting service, in their view, was somewhat less than satisfactory at the present time. It was evident that much information is still lacking concerning the basic biology, ecology, and behavior of this species. In their opinion, the proposed areas of research listed in the recommendations adopted by the workshop relating to a more basic understanding of the biology and habits of the African armyworm should receive the highest consideration. However, they felt that the recommendations relating to the use of radar for early detection of this pest should be viewed with the realization that the technique is in its formative stage of development and cannot be utilized fully until more basic

information is available. The most valuable contribution of the workshop, they concluded, was the establishment of lines of communications with scientists working in fields of common interest, thus allowing for the exchange of information and materials.

Ad Hoc Government Consultation on Pesticides in Agriculture and Public Health, Rome, Italy (April 7-11, 1975) - The meeting was held at FAO Headquarters in Rome with 150 delegates, representing 50 countries, 30 organizations and the chemical industry, in attendance. Channing J. Fredrickson, TAB, AID/W, and two UC/AID/PM Project consultants, Perry L. Adkisson, entomologist, Texas A & M University, and Harold T. Reynolds, entomologist, University of California, participated at this meeting as a delegate and observers, respectively.

The Consultation, because of the large number of diverse aspects to be considered, was divided into 12 sub-committees, each of which was assigned a particular topic. The sub-committees comprised delegations particularly interested in a given topic, meeting in sessions held concurrently. The Consultation, in its several sub-committees, dealt primarily with supply, cost, registration, safety, and other factors associated with use of pesticides in developing countries.

At the meetings of the sub-committees attended by P. L. Adkisson and H. T. Reynolds, considerable discussion was given to the need for training research extension workers, pest control officials, and farmers on pesticide safety, methods of application, dilutions, and non-chemical alternative methods of pest control. The need for various types of pesticides was noted with added emphasis on the necessity for development of a sound pesticide application technology. It was recommended that a panel of experts be convened to develop application techniques, standardize evaluation of equipment, suggest uniform methods to assess pesticide spray deposition, promote training in application, and research on efficacy of pesticide application.

Adkisson chaired the sub-committee on Host Plant Resistance where the proposed FAO program on Horizontal Resistance to Crop Pests and Diseases was considered. This program will be established on approximately 20 crops in various cooperating countries.

Hal Reynolds was chairman of the session on the proposed UNEP/FAO Cooperative Global Program for the Development and Application of Integrated Pest Control in Agriculture. The sub-committee strongly supported a proposal for regional programs on cotton, rice, maize, millets, sorghum, fruits, and olives within the Global Program. An informal session was later held to discuss the possibilities of application of part of the FAO/UNDP Cotton Pest Control Project within the framework of the proposed Global Program. Iran and Turkey expressed strong interest in the proposal, and Iran indicated the possibility that some funds to support work in their country might be made available. Pakistan has already prepared a scheme on the introduction of integrated techniques in cotton and rice, but implementation has been delayed due to lack of expertise.

T. Buyckx reported that UNDP is preparing a large project on cotton production and use that will include a pest control component. UNDP is also interested in supporting the Global Program on integrated control.

In the general plenary session, W. Furtick indicated a restructuring of FAO will occur with the establishment of an international coordinating secretariat and several regional programs. Increased emphasis will be placed on host plant resistance and crop loss appraisal. There will also be some restructuring of various Panels and Working Parties to provide more flexibility. A proposed FAO Committee of Experts on Pest Control will review and provide guidance on FAO policies and programs in the area of pest control, including the activities of other panels.

R. Gonzalez (FAO) reported that plans were underway for basic training programs in integrated control in Chile, Peru, Brazil and Colombia scheduled to be held in 1976 and 1977.

In summary, the meeting served well to advance member government support for needed budgetary increases in the area of plant protection activities. The recommendations for initiation of the Global Cooperative Program for Integrated Control were received warmly, as was the proposal for an FAO program on Horizontal Resistance to Crop Pests and Diseases. Industry, especially, contributed strongly throughout the meeting, adding substantially to its success.

E. PROJECT LIAISON ACTIVITIES

CIMMYT, Mexico City, Mexico (August 1-3, 1974) - Project advisors, Edward H. Glass, New York State Agricultural Experiment Station, and H. David Thurston, Cornell University, visited Mexico for the purpose of discussing with CIMMYT personnel the proposed research project, "Strengthening Crop Protection in Asia," (developed by the Advisory Group of the UC/AID Pest Management Project) in terms of coordination and cooperation with CIMMYT's programs and activities.

Their discussion with the scientific personnel confirmed their belief that the crop protection program of this institute as it relates to maize is excellent and is being pursued effectively. Their primary emphasis, except for local situations, in crop protection on maize is placed on the development of host resistance to pests.

Glass and Thurston felt that, considering CIMMYT's constraints of personnel and budget, this approach is correct even though it is very limited and leaves serious gaps in efforts to develop the crop protection systems required to prevent serious losses due to pests. They emphasized that the magnitude and diversity of crop protection problems throughout the maize growing regions of the developing countries is much too great to be handled by a few scientists working in and out from a single institute. It was well, therefore, that CIMMYT scientists concentrate on breeding for resistance, an operation which they stated could be done most effectively at a center with help from cooperators in key regions.

On the other hand, they reported, such crop protection activities as determining seasonal occurrence of pest organisms, principal periods of infection, etiology of plant diseases, biology and population dynamics of insects, etc. must be conducted locally and can best be accomplished by resident scientists.

The two men concluded, therefore, that the proposed UC/AID Project for strengthening crop protection in Asia cannot be readily done by CIMMYT, even with additional funding. Such a project, however, in their view would complement and strengthen CIMMYT's program and be of direct assistance in terms of evaluating their maize populations in Asia and adapting them to local pest complexes.

Pakistan (August 8-22, 1974) - Carl S. Koehler travelled to Pakistan for the primary purpose of serving as an advisor, representing the UC/AID Pest Management Project, to a USDA/ARS team reviewing a newly funded project on pest management research on rice, maize, sugar cane and cotton in Pakistan. Because the three ARS cooperating scientists had never before visited Pakistan, visits to various research and other institutions were considered necessary in order to achieve a grasp of research facilities and capabilities prior to the preparation of a plan of work. In this regard, the 1972 UC/AID multidisciplinary study team report "Plant Protection in Turkey, Iran, Afghanistan, and Pakistan" was considered a valuable background document.

The pest management project is to be administered by the Agricultural Research Council of the government of Pakistan. Up to this time, this central government agency had had no research capability of its own, merely administering funding of research projects. Koehler stated that a definite movement was underway to conduct various research efforts on an all-Pakistan basis. This is a departure from the recent past, when each of the four provinces seemed in pursuit of its own research activities, with little regard for coordination with other provinces (refer to study team report, cited above).

The three ARS cooperating scientists prepared a comprehensive report on the results of their trip. Koehler's evaluation of the project was that it is a large undertaking necessitating proper coordination and discipline integration. In his opinion, the success or failure of the project will depend heavily on whether a competent U.S. plant protection advisor can be headquartered in Pakistan to work closely with the project coordinator, particularly during the initial two years of the project. He considered that USAID would be one of the more likely agencies to provide such an advisor, perhaps by means of the Agricultural Research Development Loan recently awarded Pakistan.

Munich, Federal Republic of Germany (September 3-6, 1974) - Project Director, Ray F. Smith, travelled to Munich for the purpose of participating in the meetings of the governing board and International Committee of ICIPE. Dr. Smith stated in his report that ICIPE was at a turning point in its development and was seeking new funds and a new base of funding. However, at that time they had great constraints in funding

and both the International Committee and the governing board made certain decisions which limited the scope of ICIPE in the immediate future or until additional funds were found. The International Committee recommended that ICIPE should not involve itself directly in integrated pest control, but should contribute by keeping in close touch with institutes that do integrated control research and by strengthening ecological aspects of ICIPE's research program. This was later confirmed by the governing board. It was also recommended that there be no expansion of staff of ICIPE until adequate funding could be found for their current operation.

Rome, Italy (September 7-11, 1974) - After the ICIPE meetings, Ray Smith continued to Rome for the purpose of discussing liaison between the Food and Agriculture Organization of the United Nations and the University of California/AID Pest Management Project. Most of the discussion involved personnel of the Plant Protection Division. Among the topics discussed was the proposed membership of the FAO Panel of Experts on Integrated Pest Control for the next four years. A list of the persons to be invited to the Panel meeting to be held in October 1974 was also discussed. Important to the discussion was the relationship between FAO and UNEP with respect to the institution of a global plan for the development of integrated pest control in developing countries. The government of Iran had been quite active in this area, but in fact had only a very limited number of people with experience in this field.

Considerable time was also spent on developing the agenda for the FAO Panel Meeting on Integrated Pest Control. Smith also discussed the plans for the FAO/Industry Seminar on the Safe and Effective Use of Pesticides to be held in Nairobi in November 1974. The UC/AID Pest Management Project agreed to participate in that seminar and to encourage participation from the African countries.

Another topic discussed was the terms of reference and operational rules and procedures for the governing board for the new Southeast Asia Crop Protection Program. Apparently a separate governing board needed to be devised for the operation of the UNDP section of the regional program. Although this will be very closely coordinated with the other parts of the regional program, legal requirements made a separate autonomous governing board essential.

F. SPECIAL STUDY TEAMS FOR USAID MISSIONS

Analysis of Pesticide Use in Pakistan: Team members were W.E. Yates, agricultural engineer, University of California, Davis; R.C. Maxwell, pesticide specialist, Washington State University; and J.E. Davies, medical examiner and pathologist, University of Miami, Florida.

This study of pesticide use in Pakistan was initiated as a result of a request from the Central Department of Plant Protection to USAID, Islamabad through the Economic Affairs Division of the Government of Pakistan. This Department is responsible for all aerial spraying and for general administration of federal regulations on pesticide registration, handling and use. Their request to USAID was for technical assistance on the safe use of agricultural pesticides. This request was transmitted to

AID/Washington and approved. The UC/AID Pest Management project was then asked to organize a study team to carry out the request.

Accordingly, the three people mentioned above were contacted, hired as consultants and sent to Pakistan for six weeks during July and August 1974. Specifically, they were asked to:

- 1) Evaluate present use of pesticides under local conditions.
- 2) Make recommendations for adopting necessary precautions and safety measures appropriate for large scale use of pesticides in Pakistan.
- 3) Provide technical advice on symptoms caused by pesticide poisoning and recommend para-medical treatment, including antidotes.
- 4) Evaluate possible pesticide pollution problems and make recommendations for evaluating and minimizing hazards.

The study team visited the major cities of Karachi, Hyderabad, Multan, Lyallpur, Lahore, Islamabad and Peshawar during their trip in order to meet with directors and scientists at various research institutes and universities. Trips were arranged from these cities to visit provincial, district, and local village areas where pesticides and application equipment were stored. Many trips were made to see field conditions and field applications of pesticides by progressive farmers and some small farmer application activities. Discussions were held with many of the Agricultural Extension staff, including Agricultural Assistants, Field Assistants and farm laborers at the places visited.

The study team reported that the procurement and administration of pesticides in Pakistan continues to be a serious problem which interferes with the effective use of pesticides and the development and use of safety procedures. Until the 1973 crop season, all pesticides were procured and distributed by the Central and Provincial Governments. However, this system proved to be inadequate to meet the country's needs and millions of dollars worth of pesticides were reported to have deteriorated in government storage. Just prior to the 1973 crop season, 11 private distributors were allowed to participate in the distribution and sale of pesticides in the Punjab province.

A major disadvantage of this procurement program, the report noted, was the uncertainty of an adequate supply of the right pesticide at the right time each year, no matter if it involved public or private distribution. The team was informed that pesticides may not be received at all; they may be received in smaller quantities than anticipated; or they may arrive too late to be used effectively that season. In the latter case, the pesticide must be stored until the next season or perhaps even longer. These stored materials present a hazard, particularly under conditions existing in Pakistan, and they are subject to rapid deterioration because of high temperatures. Other problems created by the uncertain supply of pesticides, the study team indicated, include the following:

- 1) Growers purchased pesticides long before they needed them in order to be assured of an adequate supply. If the pest problem did not develop, the pesticide may have been used for pests or crops not covered by the directions.
- 2) Lack of suitable pesticides encouraged use of more readily available pesticides which may have been less effective or not labelled for the intended use.
- 3) Mixtures of several pesticides were sometimes used simply to extend the use of a preferred pesticide which was in short supply. Such mixtures are often not tested and could increase risk to spraymen and crops and reduce effectiveness of pest control.

The survey team visited 4 pesticide formulation plants, one of which also manufactured BHC and DDT. They noted a wide range of conditions, from very good to poor, in these plants relative to worker safety and protective clothing utilized by the workers. The most unsatisfactory conditions were generally found in granular or dust formulating facilities. One of the areas that appeared very hazardous was a bagging operation of BHC and DDT wettable powder. The work area of this plant was not sufficiently ventilated, and the workers did not have adequate protective clothing.

The team remarked that there was a great deal of variability in the strength of containers used for pesticides in Pakistan. Some 45-gallon drums contained extra heavy rims and heavy gauge steel that survived rough handling without leaking. On the other hand, they found leaking 5.5-gallon metal containers containing Guthion in several storage areas. In one such area, they reported that about 200 of these metal containers were completely empty. Their contents, about 1000 gallons of Guthion, had leaked out during transport on railway cars. The team expressed the concern that "spills" of this kind might not be properly cared for and would result in contamination of commodities, including food, which might be transported in the same railway cars at a later time.

Pesticide storage areas of the Department of Agriculture, Extension, were visited by the study team and found to be extremely poor. In many instances, drums were stored in the open where they were subjected to rain and temperatures above 100 °F. Many of these were so badly corroded that they were leaking and identifying marks were completely gone. An accumulation of spilled pesticides - liquids, dusts, and granules - was evident in most of the storage areas visited by team members. Some covered storage was generally available and used primarily for bags of pesticides and spray equipment.

The UC/AID team regularly asked and observed the safety equipment and procedures used during spraying operations. They were pleased to find that all government officials were very much aware of the hazards and necessary precautions that spray applicators should follow. They were given several brochures and leaflets that were published on this subject. However, they noted that the man doing the application was often not adequately trained and did not fully recognize the hazards.

Mixing and loading operations are very hazardous since the operator may be exposed to the concentrated material. Members of the team repeatedly saw mixing operations where the loader, with bare hands, bare feet, and cotton clothing, poured concentrated materials such as Endrin, Guthion, Meta-Systox, Zolone or DDT, into small measuring vessels and then into an open mixing tank. However, the most serious safety problem noted by the study team was related to the basic design of the application equipment. The hand sprayers required the operators to walk through the sprayed area, resulting in their becoming wetted by the applied material. Lack of proper maintenance of this equipment could also directly expose the operator because of leaky gaskets, hose, etc. Because of these factors, many persons related to the team that it was very common for the workers to develop nausea, headaches, etc. As a result, some large farmers found it difficult to hire operators for their spray equipment.

In order to improve the present situation regarding pesticide use in Pakistan, the study team report made specific suggestions on pesticide regulations related to registration, establishment of toxicity categories, and a special "restricted" use category for certain dangerous compounds. Suggestions were also given on methods to increase the involvement of the private sector in the sales and distribution of pesticides with the Agricultural Extension Service providing an increased effort in demonstration, advisement, and education on the use of pesticides. The report stated that rigid standards for quality control on granular formulations of highly toxic pesticides were of utmost importance.

Several factors related to reducing losses and hazards during distribution were mentioned in the report. This included distribution in consumer-sized containers, attachment of label with ingredients, precautions and directions for use on each container. Also mentioned were minimum standards for strength of containers and storage conditions to minimize loss during transport or due to severe climatic conditions.

The team also recommended that a professional agricultural engineering research station be established to design and develop suitable pesticide application equipment for conditions in Pakistan. This unit could effectively assist in training Agricultural Extension staff on application techniques to improve efficacy and minimize hazards. The report emphasized that toxic compounds placed in a "restricted" use category should only be applied by qualified applicators utilizing specified protective clothing.

The report urged that federal support of health oriented agencies be given to establish centers to assist in the diagnosis and treatment of pesticide poisoning cases. The establishment of a central registry to document all pesticide poisoning of humans, fish, wildlife and livestock was also recommended. In addition, the provision of federal funds to support field research studies on human health problems of pesticides and educational programs on pesticide safety was suggested.

Analysis of Pesticide Handling and Use in South Vietnam: This study was initiated in response to a request from the South Vietnamese government to the USAID Mission in Saigon. It was performed by Boysie E. Day, plant pathologist, University of California, Berkeley, during the period February - March, 1974, under the sponsorship of the UC/AID project.

Dr. Day arrived in South Vietnam on February 18 and proceeded to visit the agricultural areas in the vicinity of Tuy Hoa and Nha Trang in the central coastal area and near Can Tho in the Mekong Delta during the course of his stay in that country. The purpose of his trip was to consult on problems relating to pest management policies and procedures with particular regard to the safe and efficient employment of pesticides in plant protection. He carried out his assignment by obtaining information and opinions from both field observations and direct contact with personnel in public and private agencies, such as the University of Saigon, Pasteur Institute, Thanh Son Co., and Shell Company Formulation Plant. He also held many discussions and conferences with agricultural officials in the Ministry of Agriculture, the Agricultural Research Institute and the Plant Protection Service to gain a comprehensive understanding of the prevailing crop protection situation in South Vietnam.

Dr. Day's report stated that the regulation of the importation, formulation, distribution and use of pesticides in South Vietnam is largely vested in the Plant Protection Service. This agency also has such other functions as pest and disease detection, survey and assessment of losses, plant quarantine, experimental work on pest control technology and the mounting of governmental pest abatement campaigns when appropriate. Its responsibilities are numerous, ranging from the direct delivery of pest management services to the exercise of governmental policy powers in matters relating to pesticides and plant protection. In the latter capacity, it is the principal agency involved in the administration of the government decree of May 9, 1966.

This decree defines insecticides, herbicides, fungicides, etc., as plant protection chemicals subject to regulation. It is specified that only designated persons may manufacture or formulate these materials and import the necessary technical grade materials to do so. It also provides that a license to manufacture pesticides may be granted to firms by the Commissioner of the Economy upon certification by the Ministry of Agriculture that the applicant is properly qualified and that there is a need for the product. The products to be manufactured must be registered with the Plant Protection Service which issues a "certificate of verification" authorizing manufacture and sale.

Official requirements for labelling the pesticide container are also specified in the decree. The label must state the nature and content of active ingredients and explain how to use the material. Conditions requiring display of the skull and crossbones are prescribed, and a system of colored bands is specified to appear on labels. The most toxic materials are indicated by orange color bands, while bands of yellow and green on the labels indicate successively lower mammalian toxicity.

Regarding the routine handling of pesticides in formulation plants, the report stated that manufacturers were sensitive to the hazards inherent in such operations. For example, Dr. Day observed materials being transferred from shipping containers to mixing vats by pumping or other methods that reduced the exposure of personnel. He found that sanitation procedures in formulation plants ranged from fair to excellent for routine mixing and packaging. However, the need to mount bottling machinery over waste recovery sinks was not recognized nor was packing line machinery designed or arranged for easy decontamination in the event of "spills." In one plant visited by Dr. Day, persons exposed to an organophosphate pesticide on the packaging line were rotated periodically to other kinds of work. Cholinesterase levels were routinely monitored in these workers through an arrangement with the Pasteur Institute in Saigon, but he did not determine to what extent and under what arrangements this diagnostic capability was being utilized.

The report cited a notable deficiency among formulators in quality control analysis. The formulation plants were not commonly equipped and staffed to perform precise analyses of the technical grade pesticides received from manufacturers. This uncertain quality control by formulators was matched by an uncertain surveillance of product quality by the Plant Protection Service. This latter agency did not have the facilities for pesticide quality surveillance and the detection of error and fraud.

As a result of this ineffective quality control and supervision, there was a widespread suspicion that pesticides in South Vietnam were often being fraudulently or erroneously labelled. Suspicion fell upon basic formulators and all others in the supply chain, but particularly upon retailers who repackaged the pesticides for small lot sale.

Dr. Day reported that faulty packaging was also a serious deficiency in the formulation of pesticides. Liquid formulations were commonly packaged in glass bottles with labels attached with rice paste. Under the prevailing high humidity, labels frequently became detached from bottles. This was so commonplace in retail outlets that Dr. Day found that perhaps one bottle in 10 or 20 might have a loose or misplaced label.

Observations of retail store outlets by Dr. Day demonstrated that storekeepers often opened pesticide containers and dispensed the contents in amounts appropriate to the need of the customer. This was particularly true of granular materials, such as Basudin, a 10% Diazinon mixture formulated on sand. This insecticide was often weighed into polyethylene bags and marketed without labels. Fortunately, however, the material has a distinctive appearance and appeared to be readily identified in agricultural channels.

The practice of repackaging pesticides frequently resulted in spilling, the report noted. This was visibly evident on the floors and counter tops of retail stores visited by Dr. Day. The label admonition to "Keep out of Reach of Children" was universally ignored and barefoot children were seen to track through pesticide spills and to play near low boxes and shelves stocked with pesticides. Despite this situation, merchants were well aware that certain materials required special handling precautions.

The application of these agricultural pesticides was usually done by the farmer himself or by a member of his family. Liquid pesticides in rice and row crops were essentially universally applied by hand-carried or backpack sprayers, and granular materials were thrown by hand. Sprayers were equipped with adjustable cone nozzles, and the operator set these to spray a pattern judged by him to be most effective. He then slowly waded through the crop swinging the spray nozzle in an arc ahead of himself. Spray operators were seen to spray in both directions relative to the wind and rarely took the trouble to walk to the windward side of the field to work downwind and avoid spray drift to themselves. The report also stated that applicators were known to mix different kinds of pesticides or mix them with fertilizers without recognizing that chemical reaction or alteration of physical properties of these materials could result.

The report cited the great need for improved and enlightened pest management in South Vietnam. Dr. Day felt that this need could be met by measures directed toward a better information and educational base and a stronger technological and managerial basis for pest abatement activities in both the private and governmental sectors. He presented a list of 14 recommendations by which this base might be achieved and evaluated them in terms of upgrading personnel, improvement in materials and methods, acquisition of information, occupational and public health, environmental protection, regulatory activities and improved communication.

Dr. Day considered the first priority for improvement of plant protection to be a general upgrading of the technical competence of pest management personnel in South Vietnam at all levels - from the farmer and field worker to the administrator and industrialist. Better and safer pest management in South Vietnam, he felt, could be achieved by having better trained people at all levels of operations, by strengthening and diversifying available methods and materials, and by the realistic, conscientious and humane administration of suitable laws and regulations.

Appendix 1.

Financial Summary

Expenditures for the period July 1, 1971 to December 31, 1974, on Project AID/csd 3296, Pest Management and Related Environmental Protection, appear on the following table:

Salaries and Wages	\$ 133,187
Consultants	127,592
Employee Benefits	12,851
Overhead	69,376
Travel, Transportation and Allowances	186,659
Other Direct Costs	89,387
Equipment	13,595
Subcontracts	117,928
North Carolina State University	
Cornell University	
University of Miami	
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	\$ 750,575

Upon termination of the first contract, a new three-year contract has been approved with total expenditures projected at \$903,000 for the period.

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Summary of Overseas Activities of Consultants and Project
Personnel of the University of California/USAID Pest
Management and Related Environmental Protection Project
1971-1975

1. Drs. Edward Glass, H. David Thurston, Ivan Thomason, Roy Smith -
October 16 - November 24, 1971 to Philippines, Thailand, Malaysia,
Taiwan, Hong Kong, Singapore and Japan to evaluate the plant pro-
tection situations of the various countries and to formulate
recommendations. Report submitted June 1972.
2. Drs. Ray Smith and J. Lawrence Apple - February 12 - March 25, 1972
to Brazil, Uruguay, Bolivia, Peru, Ecuador, Colombia, Panama and
Guatemala to evaluate plant protection and formulate recommendations.
Report submitted September 1972.
3. Drs. George Cavin, Ray Grogan, Orvin Burnside and Dewey Raski -
September 5 - October 12, 1972 to Morocco, Tunisia, Libya, Jordan
and Lebanon to evaluate plant protection and formulate recommendations.
4. Drs. Carl Koehler, William Mai, Robert Zimdahl and Roy Wilcoxson -
September 5 - October 15, 1972 to Turkey, Iran, Afghanistan and
Pakistan to evaluate plant protection and formulate recommendations.
5. Drs. Eddie Echandi, Myron Schenke, John Knoke, E.L. Nigh and Gerald
Weekman - October 1 - November 15, 1972 to Venezuela, Brazil,
Uruguay, Paraguay, Ecuador and Bolivia to evaluate plant protection
and formulate recommendations.
6. Drs. Joseph Sasser, Harold Reynolds, William Meggitt and Teddy Hebert -
October 14 - November 20, 1972 to Ethiopia, Kenya, Nigeria, Ghana,
Lesotho, Mali and Niger to evaluate plant protection and make recom-
mendations.
7. Drs. Leo Caltagirone, J.R. Orsenigo, Walter Kaiser and Merlin Allen -
October 15 - November 27, 1972 to Guatemala, Panama, El Salvador,
Costa Rica, Nicaragua, Colombia, Dominican Republic to evaluate plant
protection and make recommendations.

8. Dr. Ray Smith - January 30 - February 3, 1973, to Rome, Italy, to present paper of Technical Advisory Committee of Consultative Group on International Agricultural Research.
9. Dr. Leo Caltagirone - February 25 - March 2, 1973, to attend a seminar on "Potentials of Field Beans and Other Food Legumes in Latin America" in Cali, Colombia. Report submitted March 20, 1974.
10. Dr. J. Lawrence Apple - March 24 - April 2, 1973, to Turrialba, Costa Rica, to Tropical Ecology Workshop (TEW). (NSF paid part of it.) Report submitted May 8, 1973.
11. Drs. Virgil Freed and John E. Davies - April 6-15, 1973 to Central and South America, to discuss pesticide management problems with USAID Missions and local people. Report submitted August 30, 1973.
12. Dr. Richard P. Norgaard - May 8-16, 1973, to: a) International Symposium on Crop Protection, Rijksuniversiteit-Ghent, Belgium; b) Conference on Plant Protection Economy, European and Mediterranean Plant Protection Organization, Brussels, Belgium. Report submitted August 20, 1973.
13. George Cavin, Robert Rhode, J.D. Shaw and David Kirpatrick - May 12-20, 1973, to participate in Mediterranean Fruit Fly Workshop in Panama, Costa Rica, Nicaragua, Guatemala and Mexico.
14. Dr. Albert Grigarick - May 21-29, 1973, to: a) Seminar on Plant Protection by West Africa Rice Development Association in Monrovia, Liberia; b) B.U.D./Senegal to observe pest problems of vegetable crops, Dakar, Senegal. Report submitted August 27, 1973.
15. Dr. David Thurston - June 6-8, 1973, to attend Workshop on "Downy Mildews of Sorghum and Corn" in Corpus Christi, Texas. Report submitted July 19, 1974.

16. Dr. Ray Smith - June 9 - July 14, 1973, to: a) EPP0, Switzerland to meet with Dr. Gus Mathys, Director-General; b) Joint EPP0/IOBC/WPRS Conference on Integrated Approaches in Plant Protection, Vienna; c) FAO Working Party of Experts on Pest Resistance to Pesticides (9th session) Rome; d) Met with Doug Waterhouse, CSIRO and Peter Haskell of COPR in London; e) Ad Hoc Consultation on International Plant Protection, FAO, Rome. Report submitted August 27, 1973.
17. Dr. Eddie Echandi - June 18-22, 1973, to Guayaquil, Ecuador to attend the 5th International Cacao Research Conference. Report submitted July 27, 1973.
18. Dr. Dave Schlegel - June 26-30, 1973, to AAAS Meeting on "Science and Man in the Americas" sponsored jointly with Consejo Nacional de Ciencias y Tecnologia of Mexico. Report submitted February 13, 1974.
19. Dr. Virgil Freed - June 30 - July 6, 1973, as a follow-up to visit by Freed and Davies to set up training activity for pesticide management in El Salvador. Report submitted August 30, 1974.
20. Dr. David Schlegel - August 21-24, 1973, to Quebec, Canada to attend 2nd International Conference on Comparative Virology. Report submitted February 13, 1974.
21. Dr. Ray Smith - September 10-18, 1973, to Kiev and Rome to attend Conference on Integrated Pest Management.
22. Mr. George Cavin - November 12-16, 1973, to attend IOBC/SORP Working Group for Control of Rhagoletis and Ceratitis Capita and Meeting of Joint Division of FAO/IAEA Use of Sterile Male Technique for Fruit Fly Control, in Vienna, Austria. Report submitted April 12, 1974.
23. Dr. Kenneth Trammel - November 19-22, 1973, 3rd International Symposium on Chemical and Toxicological Aspects of Environmental Quality in Tokyo. Report submitted March 21, 1974.

24. Dr. David Thurston - December 2-9, 1973, to attend 3rd International Symposium on Tropical Root Crops at IITA in Ibadan, Nigeria. Report submitted March 22, 1974.
25. John Davies, Steve Poznanski, Virgil Freed, Perry Adkisson, Ray Smith and Lou Falcon - Workshop on Pesticide Management in El Salvador. December 3-7, 1973.
26. Dr. Allyn Cook - December 9-14, 1973, to attend 13th Meeting of Caribbean Division of American Phytopathological Society in San Jose, Costa Rica. Report submitted March 21, 1974.
27. Dr. Ray Smith - December 31, 1973 - February 7, 1974: a) member of U.S. delegation to Pugwash Meeting in India; b) discuss plant protection problems with USAID Missions and local governments in Dacca, Karachi, Islamabad, Ludhiana, Kuching, Kuala Lumpur, Jakarta and Manila. Report submitted June 19, 1974.
28. Dr. Boysie Day - February 8 - March 2, 1974. Pest Management and the Efficient Use and Safe Handling of Pesticides in Viet Nam. Report submitted July 10, 1974.
29. Dr. David Thurston - February 11-21, 1974, to West Lafayette, Indiana, to attend a workshop on corn diseases at Purdue University. Report submitted January 10, 1975.
30. Mr. Stephen Poznanski - February 18 - March 2, 1974, follow-up to Pesticide Management Seminar held in El Salvador. Report submitted April 11, 1974.
31. Dr. Leo Caltagirone - March 10-16, 1974, to attend IXth Meeting of Latin-American Association of Plant Technologists in Panama. Report submitted July 18, 1974.

32. Mr. Stephen Poznanski - April 3-14, 1974, to finalize plans for Pesticide Management Workshop in Jakarta, Indonesia. Report submitted June 12, 1974.
33. Dr. William Snyder - April 7-25, 1974, to Tunisia to evaluate disease situation in datepalm plantings in the South. Report submitted October 22, 1974.
34. Dr. David Thurston - April 8-11, 1974, to attend Symposium on Protection of Horticultural Crops from Pests, Diseases and Weeds in Trinidad. Report submitted June 11, 1974.
35. Dr. Lou Falcon - April 22-26, 1974, to attend 3rd FAO/IAEA Research Meeting on Ecology and Behavior of Heliothis Complex as Related to Sterile Male Technique, Monterrey, Mexico. Report submitted July 19, 1974.
36. Dr. Ray Smith - April 22 - May 1, 1974, Conference on "Insecticides for the Future: Needs and Prospects" at Bellagio, Italy and FAO/Rome to discuss coordination for FAO and UC/AID Project. Report submitted July 3, 1974.
37. Mr. George Cavin - May 13-17, 1974 to Mali, Cameroon and Chad; and June 3-9, 1974 to Ethiopia and the Sudan, to discuss locust problems in Africa and annual Council Meeting of Desert Locust Control Organization. Report submitted October 2, 1974.
38. Dr. James Smith - June 3-8, 1974, Insect Problems of Annual and Perennial Forages on North Andros Island, Bahamas. Report submitted July 19, 1974.
39. Drs. John E. Davies and Virgil Freed - June 9-13, 1974, Follow-up to Pesticide Management Workshop in El Salvador. Report submitted September 30, 1974.
40. Dr. David E. Schlegel - June 10-12, 1974, to attend Workshop on "Professional Doctorate in Pest Management" in Hawaii. Report submitted July 5, 1974.

41. Steve Poznanski, Ray Smith, Virgil Freed, Ian Tinsley, John Davies, B. Dwight Culver, Wesley Yates, June 26 - August 9, 1974, present pest management workshop in Indonesia. Report submitted November 7, 1974.
42. Drs. Theo Watson and Winfield Sterling - July 2-17, 1974, to make an appraisal of cotton insect pest problems in Egypt. Report submitted August 13, 1974.
43. Joseph Davis, Wesley Yates and Richard Maxwell - July 15, 1974, to Pakistan to evaluate needs for and development of pesticide management and safe use of pesticides in Pakistan. Report submitted February 13, 1975.
44. Drs. Ray Smith, Virgil Freed and John Davies - July 15-17, 1974, to consult with USAID Mission and officials for Pesticide Management Workshop to be held in Manila in 1975. Report submitted November 27, 1974.
45. Dr. James Smith - July 29 - August 1, 1974, Appraisal of Insect Pest Problems of Annual and Perennial Forages on North Andros Island, Bahamas. Report submitted November 5, 1974.
46. Dr. Edward Glass - July 31 - August 3, 1974, Mexico, to attend meetings with CIMMYT personnel. Report submitted November 27, 1974.
47. Dr. Carl Koehler - August 8-22, 1974, to Pakistan as advisor to USDA/ARS team reviewing newly funded project on pest management research on rice, maize, sugarcane and cotton. Report submitted October 1, 1974.
48. Drs. Ray Smith and Ed Glass - August 27 - September 1, 1974, to present papers at EPP0 Conference on Integrated Control in Horticultural Crops, Kiev, USSR. Report submitted January 31, 1975.
49. Drs. Lou Falcon, Perry Lee Adkisson and David Thurston - October 15-25, 1974, to attend FAO Panel of Experts on Integrated Pest Control, 5th Session, Rome. Report submitted February 5, 1975.

50. Mr. Stephen Poznanski - October 16-30, 1974, El Salvador, follow-up of pest management workshop and checking quality control in pesticide residue laboratory, etc. Report submitted January 13, 1975.
51. Dr. Edward Glass - October 18-26, 1974, to attend CENTO Seminar and to present paper on integrated pest control, held in Tehran, Iran. Report submitted January 10, 1975.
52. Dr. Ray Smith - October 30 - November 10, 1974, from Rome to Nairobi to Rome, to attend FAO Industry Seminar on "Safe and Effective Use of Pesticides in Africa." Report submitted February 4, 1975.
53. Mr. Stephen Poznanski - November 20 - December 11, 1974, as follow-up to pest management workshop held in El Salvador.
54. Dr. Alton Sparks and Dr. Everett Mitchell - January 6-9, 1975, to Nairobi, Kenya, to attend ICIPE Workshop on Spodoptera.
55. John E. Davies, Virgil Freed, Steve Poznanski and Ray Smith - January 30 - February 13, 1975, to Jakarta, Indonesia, as a follow-up to the Pest Management Seminar/Workshop held in Jakarta. Report submitted June 4, 1975.
56. Virgil Freed, John E. Davies, Ray Smith and Wesley Yates - February 10-15, 1975, to Manila, Philippines to conduct a seminar/workshop on pest management. Report submitted June 13, 1975.
57. Dr. Ray Smith - February 18-25, 1975, from Bangkok to Rome, to meet with FAO for consultation on crop protection matters.
58. Dr. Ray Smith - March 22 - May 15, 1975, to Australia and the Pacific Region to attend Australian Applied Entomological Research Conference and to consult with various crop protection specialists.

59. Drs. Perry Adkisson and Harold Reynolds - April 7-11, 1975, to Rome to attend FAO Ad Hoc Government Consultation on Pesticides in Agriculture and Public Health. Report submitted May 29, 1975.
60. Mr. Stephen Poznanski - April 29 - May 1, 1975, to Beltsville, Maryland, to attend a seminar of the Federal Working Group on Pest Management.
61. Mr. Stephen Poznanski - June 1-6, 1975, to El Salvador, as a follow-up to the pest management workshop.
62. Ray F. Smith - May 29-30 and June 14-18, 1974, Rome, for consultation with FAO Plant Protection Service.

Appendix 4.

UC/AID Pest Management and
Related Environmental Protection Project Publications

- Anonymous, 1974. Management of Pesticides and Protection of the Environment. A Report on a Seminar held at San Salvador, El Salvador, December 3-7, 1973. Sponsored jointly by UC/AID/PM; Ministries of Agriculture and Livestock; Public Health and Social Welfare; USAID Mission; and the Pan American Health Organization.
- Anonymous, 1974. A Report on a Seminar, Workshop and Training in Pesticide Management. Proceedings of these activities held at Jakarta, Indonesia, July 8 - August 3, 1974. Sponsored jointly by UC/AID/PM; Departments of Health, Agriculture and Manpower, Indonesia; FAO; WHO and the local pesticide industry.
- Anonymous, 1975. A Report on Seminar and Workshop in Pesticide Management held in Manila, Philippines, February 10-15, 1975. Sponsored jointly by UC/AID/PM; USAID/Manila; the Bureau of Plant Industry, Philippines; and the local pesticide industry.
- Apple, J. Lawrence and Ray F. Smith, 1972. A Preliminary Study of Crop Protection Problems in Selected Latin American Countries. UC/AID/PM Preliminary Report.
- Barr, Barbara A., Carlton S. Koehler and Ray F. Smith, 1975. **Crop Losses - Rice: Field Losses to Insects, Diseases, Weeds, and Other Pests.** UC/AID/PM Special Report.
- Caltagirone, L.E., et al., 1972. The Crop Protection Situation in Guatemala, Honduras, Nicaragua, Costa Rica, Panama and Guyana. UC/AID/PM Multidisciplinary Study Team Report.
- Cavin, George, E., et al., 1972. Crop Protection in the Mediterranean Basin. UC/AID/PM Multidisciplinary Study Team Report.
- Davies, John et al, 1972. International Survey on Pesticide Use. UC/AID/PM Panel on Pesticides.
- Day, Boysie E., 1974. Pest Management and the Efficient Use and Safe Handling of Pesticides in South Vietnam. UC/AID/PM Special Report.
- Echandi, Eddie et al., 1972. Crop Protection in Brazil, Uruguay, Bolivia, Ecuador and Dominican Republic. UC/AID/PM Multidisciplinary Study Team Report.
- Glass, Edward H., et al, 1971. Plant Protection Problems in Southeast Asia. UC/AID/PM Multidisciplinary Study Team Report.

Koehler, C.S., et al, 1972. Plant Protection in Turkey, Iran, Afghanistan and Pakistan. UC/AID/PM Multidisciplinary Study Team Report.

Sasser, J.N., et al, 1972. Crop Protection in Senegal, Niger, Mali, Ghana, Nigeria, Kenya, Tanzania and Ethiopia. UC/AID/PM Multidisciplinary Study Team Report.

Smith, Ray F. ed., 1974. Report of the Sahel Crop Pest Management Conference. Proceedings of an AID-sponsored conference held in Washington, D.C. December 11-12, 1974.

Yates, W.E., et al., 1974. Analysis of Pesticide Use in Pakistan. UC/AID/PM Multidisciplinary Study Team Report.

Zimdahl, R.L., ed., 1973. Weed Science in the Developing Countries of the World. UC/AID/PM Summary Report.