A PRELIMINARY STUDY OF CROP PROTECTION PROBLEMS IN SELECTED LATIN AMERICAN COUNTRIES

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Special Note: Some sections of this document may appear to the reader more academic than appropriate for a trip report, but the authors have used this report as a mechanism for subjecting to wide review certain ideas and concepts applicable to the final report required under Contract No. AID/csd-3296.

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1.0 SUMMARY:

The trip on which this report is based was made during February-March, 1972 under Contract AID/csd-3296 with the University of California. The report gives the rationale basic to our concern for pest management problems in developing nations and recommends several actions that might be taken to abate them. It outlines the increasing crop protection problems resulting from the great agricultural changes already achieved and anticipated. This general thesis is supported by a number of observations in the countries visited.

General observations of crop protection programs and problems are summarized in Section 4. Among topics discussed are plant quarantine, pesticide management, biological control, crop losses due to pests and crop protection capabilities.

Country-specific observations in Section 5 highlight the situation and important pest problems in the countries visited. This is not intended to be an exhaustive treatment of such problems, firstly, because the Team represented only two crop protection disciplines, and secondly, because time in each country was not sufficient to make many of the contacts and visit many of the institutions and agencies involved with crop protection programs.

Weed and nematode problems do not receive adequate treatment in the report because we did not possess the expertise required to pursue intelligently these problems or properly evaluate them.

The insights gained during this trip convince us that crop losses due to pests in many Latin American countries exceeds all reasonable limits of tolerance. We also found evidence of intensified pest problems in conjunction with the introduction of new agronomic practices, including varieties. Examples are corn in Brazil and wheat in Bolivia. Some old pest problems have moved from minor or a reasonably well controlled status to serious, e.g., pinworm of tomato in the Cauca Valley of Colombia, witches broom and Monilia fruit rot of cacao in Ecuador, Colombia and other areas. Pests have also breached international boundaries, e.g., coffee rust in Brazil (which threatens all other coffee-producing areas in Latin America) and golden nematode on potatoes in Colombia. Indications of insect resistance to pesticides were found on cotton in Santa Cruz, Bolivia, and pinworm of tomato in Colombia. Pesticide management problems are critical in some countries with many cases of pesticide poisonings reported annually (and probably many more not reported) Some of these result in death of the victims. Pesticide residues constitute a major problem on export crops in many developing countries and have been responsible for trade restrictions. Also very important are residue problems on food products produced for domestic consumption in developing countries but to date this area has received very little attentior

The present crop protection programs in most Latin American countries do not have sufficient response capability to cope with their economic

pest problems on principal crops. In this connection, a distinction must be made between solving an important high priority pest problem in a developing nation and developing a crop protection response capability. The former has been used all too often in the past and is still advocated in some quarters today. This overlooks the fact that pest problems do not stay solved. Pest problems involve dynamic pest populations which are continually shifting. Pest problems can only be managed over time and the process requires a continual surveillance and an action response capability.

The development of regional research projects, wherein the participating countries play a dominant role in planning and carrying out the work, can serve as an effective vehicle for strenghtening crop protection programs in general Toward that end, we must have a better understanding of the high priority national problems. This will require follow-up teams of broader disciplinary representation which can explore these issues in greater depth They must not only identify high priority, economically important problems but identify institutions that could and desire to participate in regional activities and those of their staff who would be involved

Pest problems are of vital importance to the achievement of food production goals of USAIDs in Latin America. The losses due to pests have already reached levels of intolerance in most of the countries visited. We have reason to predict that losses will escalate as additional new agricultural technology is introduced and adopted. Few of the areas visited have adequate program capability to mount the pest management programs required to protect the principle food and fiber crops against destructive pest attacks Pest management programs, which includes the proper management and use of pesticides, must receive more attention in the future than in the past if the potential gains of the "green revolution" are to be realized and insured. The only means of coping with the pesticide management problems of the developing nations is to develop more adequate pest management (crop protection) programs within which the use of pesticides can be regulated and placed in proper perspective as one of several means of "managing" pest populations below the economic threshold.

2.0 INTRODUCTION:

The Technical Assistance Bureau of AID/W entered into Contract No. AID/csd-3296 with the Regents of the University of California on 29 June 1971 to provide for technical assistance in the areas of pesticides and pest management in an effort to minimize food production losses due to pests in developing countries through the use of methods consistent with a quality environment. Subsequently, the Contractor entered into Sub-Contracts with North Carolina State University at Raleigh and Cornell University

This project entitled "Pest Management and Related Environmental Protection" was developed in recognition of: (1) the increasing importance of pest problems as deterrents to increased crop production in developing nations and (2) the mounting seriousness of the problems of overdependence upon and misuse of pesticides in developing countries. The Plan of Work called for the establishment of a panel of experts on pesticides to study the pesticide procurement and use problems with the object of developing program guidelines for the consideration of AID/W and for the organization of multidisciplinary pest management study teams to visit selected countries in the major AID regions with the aim of identifying major pest problems, establishing a set of pest problem priorities, and recommending a role for the U. S. in assisting with the resolution of those problems.

The multidisciplinary study teams were planned as four- or five-man teams consisting of an entomologist, plant pathologist, nematologist, weed scientist and pesticide specialist (where applicable). To the extent possible, teams were to be staffed with individuals with previous experience in the region to be visited and thus already somewhat familiar with the problems and customs. 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.

On the recommendation of the Office of Development Resources, Bureau for Latin America, AID/W, a two-man team was selected to make a preliminary study of the situation in Latin America. This team consisted of the authors who visited selected Central and South American countries to: (1) ascertain relative importance of pest problems to development goals through contacts with USAID mission and country personnel (to extent possible within time limitations); (2) discuss the purposes and rationale of the "Pest Management and Related Environmental Protection" with appropriate personnel; (3) obtain information on the use of pesticides; and (4) explore the feasibility of developing regional projects for combating high priority pest problems. The country visits were initiated on 24 February 1972 and terminated on 25 March 1972. Eight countries were visited. A detailed itinerary appears as Appendix I.

Many technical names and terms are used in the report (rather than non-technical language) to facilitate communication with professional

colleagues in the countries visited. Common names for most pests vary from locale to locale and thus have little or no communications value out of that region. Many common names are used in the report, but in most cases they are clarified by the technical name of the biological entity involved.

It is the conclusion of the authors that a more in-depth follow-up study is necessary because of the limited time and disciplinary scope of their study; consequently, this must be considered as a preliminary report of the situation in Latin America. The matter of follow-up teams was discussed with USAID mission and host country personnel. All agreed (without exception) that follow-up teams were necessary to provide for broader disciplinary coverage and a more comprehensive study.

3.0 RATIONALE FOR IMPROVED PEST MANAGEMENT PROGRAMS IN DEVELOPING NATIONS:[1/]

Only a few years ago many noted agriculturists and demographers were predicting world famine within this decade because they were convinced that the race between food production and population was being lost.[2,3/] The world has witnessed an amazing turnabout! Tremendous food production gains have occurred in some developing nations within the past few years. This widely publicized phenomenon has been termed the "green revolution". It has resulted from a combination of many factors, and chief among them are: (1) new high-yielding crop varieties, (2) availability of purchased production inputs, (3) new crop management technology (especially double cropping), (4) improved irrigation capability, (5) favorable weather, and (6) the long-term cumulative effect of development efforts by national governments, international agencies and foundations.

Briefly described, the system of traditional agriculture characteristic of many areas in developing nations is giving way to modern agricultural technology. Traditional agriculture is generally considered to be a production system operating at a low energy level and approaching a state of biological equilibrium. It is labor intensive with low capital inputs and low productivity. The fields are generally small and sparsely planted with seeds of mixed genetic types. Such a "mixed cultural system" is not as readily exploitable by endemic plant pests as modern "monoculture" systems, and it also provides some protection against climatic adversity and attack by new pests because of its inherent heterogeneity. The tillage system of traditional agriculture is generally so poor that the plants are not as susceptible to some pests as types grown under more favorable conditions.

Although traditional agriculture has some inherent pest management advantages, it is still beset with a wide range of pest problems. In reference to traditional Mexican Agriculture, Harrar[4/] pointed out that pests ".... have been tolerated rather than controlled, although on occasion they have exceeded any reasonable limit of tolerance." The potential for pest damage is greater in most of the developing nations than in the developed countries because the former are mainly tropical or subtropical.

1/ As used in this report, "pest" refers to all forms of biotic and abiotic agents which cause plant disease; insects that damage crop plants; and weeds that compete with cultivated crops. Although the term "pest management" and "crop protection" are sometimes used interchangeably, the pest management concept implies an integration of population management techniques to maintain pest populations below the economic injury threshold. Crop protection is a widely used term which does not necessarily imply (but does not exclude) an integrated approach.

2/ Paddock, William C. 1970. How Green is the Green Revolution? Bioscience 20: 897-902.

3/ Revelle, Roger. 1968. Projected World Population and Food Production Potentials. In: The Land-Grant University and World Food Needs. University of Illinois, College of Agriculture, Special Publication No. 13. pp. 1-12.

4/ Harrar, J. George. 1967. Strategy Toward the Conquest of Hunger. The Rockefeller Foundation, New York. 315 p. (p. 42)

Pest species occur in greater numbers in the tropics, and their populations are not inhibited by the vicissitudes of climate as in the temperate zones. Wellman[5/] documented this for plant diseases by comparing the number reported on the same crop species in the tropical and temperate zones; e.g., Lycopersicon esculentum, 278 vs. 32; Ipomea batatas, 187 vs. 15; Phaseolus vulgaris, 253 vs. 52; and Zea mays, 125 vs. 85 for tropical and temperate zones, respectively.

As contrasted to traditional agriculture, modern agriculture is a more intensified system that integrates capital inputs with management technology to maximize production per unit of area at minimum cost per unit of production. Many of the practices developed to achieve these goals contribute to increased plant pest problems.[6,7/] Some of the most important are:

3.1 Plant Introduction: The development of modern agriculture has seen the exchange of genetic materials between continents to achieve desired varietal characteristics such as higher yields and resistance to pests. On the negative side, plant introductions transport pests to new areas where they may become more destructive than in their original habitat, or the newly-introduced plant types may be more susceptible to previously innocuous endemic pests than local varieties. The mobility of man and his transport capability has seen the movement of vast numbers of crop and ornamental species between continents and across international boundaries. Some very serious pests have also been carried along. This will be a problem of increasing severity in the future.

3.2 Monoculture: Modern agriculture, as exemplified by that of the U. S. and other developed nations, is often dependent upon a monoculture system. Crop varieties are highly selected for yield and other desired traits so that genetic variability between individuals is minimized. Such varieties are then planted on vast acreages within the same general region which provides a very favorable environment for the build-up of insects and diseases. This has led to a situation where several major crop plants of modern agriculture exist on a very narrow genetic base which enhances their vulnerability to devastation by pests. As an example, an estimated 90% of the U. S. corn acreage in 1970 was planted to varieties having a common source of cytoplasm. In that year an outbreak of Southern Corn Leaf Blight (caused by Helminthosporium maydis) reduced significantly corn yields in the United States.

3.3 Plant Breeding and Selection: In most plant breeding programs, major emphasis is given to the selection of high-yielding genotypes. At

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5/ Wellman, F. L. 1969. More Diseases on Crops in the Tropics than in the Temperate Zone. Ceiba 14(1): 1-12.

6/ Adams, M. W., A. H. Ellingboe, and E. C. Rossman. 1971. Biological Uniformity and Disease Epidemics. Bioscience 21: 1067-1070.

7/ Yarwood, C. E. 1970. Man-Made Diseases. Science 168: 218-220.

times segregating populations are also selected for pest resistance; however, it is not possible to expose the new selections to all possible pests (or all strains of any one pest) before it is distributed as a new variety. History records many examples of new varieties that were highly susceptible to previously innocuous pests or to new strains of major pests.

3.4 Vegetative Propagation: Many important food crops are propagated vegetatively to preserve highly desirable genotypes. The method has the disadvantage of disseminating pathogens which are carried in plant parts, e.g., the viruses of *Solanum tuberosum*.

3.5 Management Practices: Many management practices of modern agriculture enhance susceptibility to disease or attack by insects such as: (a) fertilization which produces larger and more succulent plants that are often more susceptible to disease or insect damage than plants grown at lower nutritional levels; (b) irrigation which favors many disease and insect pests as contrasted to the flunctuating soil moisture levels under natural rainfall condition; (c) tillage which Yarwood[8/] found to be an important factor in increasing the incidence of disease as compared to no-tillage culture; (d) multiple cropping which promotes rapid build-up of pest populations; and (e) more dense plant populations with resulting micro-environment changes that favor the development of some pests.

The "green revolution" has introduced the above "modern" agricultural practices into the developing nations at a very rapid rate, and the pace of the process promises to quicken in the future. Motivated by increased production under the new technology, many developing countries and international organizations have placed greater emphasis on the development and introduction of new agricultural technology applicable to the developing world. We do not take issue with the validity of these developments -- there is no other alternative -- but we are concerned that these modernizing practices, which also enhance the potential for destructive pest attacks, are being introduced without giving proper attention to crop protection as a component of agricultural development programs. The fact that the changed ecology coincident with the introduction of new methodologies will result in shifts in and probably an intensification of pest problems is not properly reflected in most of the development programs with which we are familiar around the world. There is mounting evidence indicating that pest problems in the developing countries are becoming more severe as modern practices are introduced. Unless bold measures are taken to protect these crops against the ravages of pests, production gains realized could vanish and hope for the future could be lost. Welsch and

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8/ Yarwood, C. E. 1968. Tillage and Plant Diseases. Bioscience 18: 27-30.

Sprague[9/] have expressed a similar concern: "We begin by recording our belief that the 'green revolution' in Southeast Asia has not been a technological revolution because it has failed to lay the basis for a self-sustaining process of technological change, not only in grain production but in agriculture in general." With regard to the threat of plant diseases, the 1968-1969 CIMMYT Report[10/] states the following: "The importance of plant pathology cannot be over-emphasized. Without surveillance the 'green revolution'could become a 'black counter-revolution'. The discipline is in urgent need of strengthening both in numbers of personnel and facilities. Some steps are being taken to improve the situation, but in the meantime every effort must be made to monitor the disease situation. Those few individuals available to work on wheat pathology form a thin line."

In ecological terms, the agro-ecosystem represented by modern agriculture is more simple biologically than that represented by traditional agriculture. The latter has greater genetic diversity and greater natural adaptation to the environment than the former. In general, the potential for pest exploitation of an agro-ecosystem is inversely proportional to diversity. The pest response to changes in the agro-ecosystem follows the pattern of the "domino theory"; viz., the introduction of a new (or substituted) factor into the system will prompt a series of readjustment changes. This does not dictate against the introduction of new factors of production (modern practices) but does stress the need for an enhanced crop protection response capability in most developing nations.

In the absence of adequate crop protection programs in many developing nations, there is an over-reliance on the use of pesticides for pest control. There are numerous well-documented examples of the inadequacy of this approach in both developed and developing countries. Unless pest management or integrated control type programs are initiated, additional "pesticide abuse" situationswill arise. Complete dependence on pesticides over a period of time not only fails to control the pests in question but may actually aggravate pest problems and endanger human health and environmental quality by the heavy pesticide burden on or in food products and in the general environment. Pesticide misuse also imposes an additional cost on production.

9/ Welsch, D. E. and E. W. Sprague. 1970. Technical and Economic Constraints on Grain Production in Southeast Asia. p. 13-28. In: Agricultural Revolution in Southeast Asia. Vol. I. Impact on Grain Production and Trade. Report of a SEADAG Rural Development Seminar Meeting, Honolulu, June 19-21, 1969.

10/ Anonymous. 1969. CIMMYT Annual Report for 1968-69. Wheat-India. p.68.

4.0 GENERAL OBSERVATIONS:

These observations are applicable to the majority of the countries visited. The brief nature of the study on which these observations are based, however, did not permit the development of voluminous documentation to support many of these general statements. Country-specific observations and problems are cited in the Section 5.0 which follows.

4.1 Plant Quarantine Situation: The general increase in the ground and air transport within these countries is bringing new pressures on their already inadequate quarantine facilities. New roads are being constructed which are opening new areas to mass transport of people and materials within individual countries. This will probably result in the spread of existing pests into new areas at an accelerated rate. International travel and trade is bringing increased movement of agricultural products with the always present danger of introducing new pests.

Most of the plant quarantine programs are ineffective because they lack personnel, legal authority, organization and facilities. Plant introduction stations are totally lacking where newly introduced plant materials can be grown under quarantine conditions to ascertain the presence of unwanted pests before their release into the country. There are situations in which selected growers are authorized to produce such material under quasi-quarantine conditions before release for general use. Inspections for pests at ports of entry in most countries is either inadequate or lacking. In many cases, the quarantine statutes need updating before effective programs can be developed.

Plant quarantine under the best of conditions cannot be 100 per cent effective in preventing the introduction of unwanted pests; however, its effectiveness has been demonstrated repeatedly in the U. S. where dangerous pests have been discovered many times on incoming shipments by quarantine officials. The Latin American countries need to strengthen this aspect of their crop protection programs.

It is possible that the Cartagena Pact of the Andean Group will provide a mechanism for improving this situation for some countries, but it could further confound the problem if trade agreements are developed without proper consideration to pest problems.

4.2 Pesticide Management: Programs for the regulation and proper use of pesticidal materials are grossly inadequate in nearly all Latin American 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 being submitted by the company that is analyzed for "active ingredient". If it meets the analytical claims of the manufacturer or distributor, it is registered for distribution and sale. This results in the registration and use of many pesticide formulations in developing countries that are based on their clearance in the U. S. or other countries with quite dissimilar pests and environmental conditions.

Since pest control efficacy data generally are not required for registration, pesticide use r commendations are at the discretion of the distributors. This situation undoubtedly results in the misuse of many pesticides, i.e., use on the wrong crops for the wrong pests and in improper amounts. This results in high-level toxic residues on food crops. The capacity for monitoring food crops for pesticide residues is very limited throughout Latin America and is not adequate anywhere. This problem area 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, but even in this area much remains to be done before the developing nations will have adequate programs to regulate the use of pesticides.

Pesticide poisoning is responsible for the sickness or death of scores of individuals annually in most Latin American countries. Most of this poisoning is due to accidents with pesticides or pesticide containers or to inadequate precautions in applying pesticides under field conditions. It is difficult to get accurate data on the extent of pesticide poisonings in these countries, but the following data from World Health Organization on the numbers of hospital patients treated for pesticide poisoning in Guatemala over a four-year period demonstrates the magnitude of the problem.

1968 - 1,374
1969 - 736
1970 - 659
1971 - 1,100

There is no way to estimate the number of unreported and undiagnosed accidental pesticide poisonings which result in serious illness or death. Most poison cases occur among workers directly involved with the application of pesticides. This results 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. Another common mechanism for poisoning is from the pesticide container. It is frequently sold in the local markets or brought home from the fields by the worker for use as a mixing or storage container for food or water.

The use of pesticides is increasing in all countries in Latin America except where importations are restricted by government controls. But these importation restrictions are based on the need to control balance-of-payments problems rather than the pesticide-use problem. This trend indicates that these nations are becoming more and more dependent on the use of pesticides as the principal weapon for pest control This trend undoubtedly will result in many more pesticide resistance and pest resurgence problems as already experienced in some Latin American countries, the U. S. and other areas.

4.3 Lack of Biological Control Capability: As a principal method of managing insect populations, biological control is not receiving adequate attention in Latin America. This stems from the fact that there are very few in these countries formally trained in biological control. Some areas have already experienced pesticide resistance and pest population resurgence problems because of the overdependence on chemical control which has eliminated natural predators and parasites. The experiences with

cotton in both Peru and Nicaragua are good examples. Resistance was built up in the pest populations to the point of ineffective chemical control even with morethan 30 applications each growing season With this high cost of achieving what amounted to poor pest control, cotton production became economically unfeasible In several coastal valleys of Peru a tremendous reversal was achieved by the application of ecological and biological control principles. A similar trend is evident in Nicaragua.

Although the use of pesticides is increasing, the usage level has not reached that of the developed countries. Consequently, there remains much natural biological control in Latin America that should be utilized to develop and maintain economically and ecologically sound pest management programs The cotton situations in both Peru and Nicaragua (as well as other countries) signals the hazard of ignoring biological control and demonstrates the benefits derived from its promotion. This aspect of pest management should be strengthened in Latin America

4.4 Importance of Pests Now and Projections for the Future: It has been difficult to collect accurate data on crop losses due to pests anywhere in the world and this is especially true in the developing nations. As was pointed out in Section 3 0 of this report, there is a propensity for more severe pest problems in the tropical and subtropical zones than in the temperate zones. Since nearly all of Latin America lies within the former zones, crop plants are stressed by an array of insect, disease and weed pests Based on what many specialists consider to be conservative estimates, annual agricultural production in the world is reduced by 25% due to pests It definitely is much higher in the tropical zone (developing nations) than in the temperate zone (principally developed nations) by a factor of at least two. Recently compiled statistics for Peru illustrate the high loss of potential crop production attributable to pests. The value of crop production in Peru during 1970 was estimated at $487 million. It was estimated by the Sub-Direccion de Defensa Fitosanitaria of the Peruvian Ministry of Agriculture that production was reduced by 38 2% of its potential by pests or by a monetary value of $187 million, assuming stable market prices. These losses by type of pest are as follows:

Type of Pest	Crop Loss (per cent)	Crop Loss (U.S.$-Millions)
Diseases	10.8	53.0
Insects	15.8	77.3
Nematodes	6.0	29.3
Weeds	5.6	27.4
TOTALS	38.2	187.0

Crop loss estimates due to pests would probably be similar for other Latin American countries. Some may consider these estimates excessively high but experimental data supports losses of this magnitude and even higher for pests, especially weeds.

This is a tragic price to pay in total food production by food deficit countries. And this magnitude of loss occurs under production conditions which utilize predominately "traditional" rather than "modern" production technology.

Given the present crop protection capabilities of most Latin American countries, crop production losses due to pests will increase as modern production technology is utilized more widely. Potentially, the stage could be set for pandemics (outbreaks of disease that affect wide geographic areas) and damaging insect pest attacks unless measures are taken to strengthen crop protection programs.

4.5 Crop Protection Programs - Personnel, Facilities, Support: The crop protection program capabilities vary widely between the countries visited. Although great improvements have been made in most countries over the past 20 years, additional progress and broader approaches are needed. In some countries there is evidence of deteriorating response capability in view of present pest problems and new country goals. There are well-trained crop protection specialists in some countries but in all cases their numbers are inadequate to the task. Almost without exception the well-trained individuals are "under-employed"; i.e., critical elements of a vital, problem-oriented program are lacking so that they are not performing at full potential as measured by program accomplishment. In most cases, the time of crop protection specialists is divided between too many problem areas. General program support is inadequate. The result is a "holding-action-type" program absorbed by yesterday's problems and without sensitivity to contemporary problems or to opportunities for developing long-term pest management strategies. This is the situation because of the diversity and multiplicity of the crops and their pests in the tropics and too few people and resources to work on them.

Crop protection as a general problem area has received inadequate attention throughout Latin America. Most of the agricultural production programs have emphasized agronomic factors without due consideration of production limitations imposed by pests. Our discussions with research program officials in Latin America revealed an increasing awareness of the current production losses due to pests and their potential for inflicting even heavier losses under conditions of intensive culture. Most administrators expressed the desire to improve their research and education (extension) programs in the pest management area.

4.6 Important Problems That Should Yield to Solution: There are many important pest problems in Latin America for which solutions are highly feasible. The institutions and ministries in many countries are developing systems for priority-ordering problems so that existing resources may be concentrated on the high priority problems. Many of the decisions which must be made to effect impact programs are within the administrative prerogatives of present program directors and would not require significant new resources. In many instances such activities could profit greatly from the inputs of highly qualified short-term consultants. Such individuals could assist with the priority ordering of problems and the organization of impact programs, including the research and demonstrational (extension) approaches that should be most productive.

4.7 Tough Problems to Solve: 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.

5.0 COUNTRY-SPECIFIC OBSERVATIONS:

Discussed below are some of the most important aspects of problems recognized in each country visited. This is not intended to be an exhaustive treatment, but one highlighting impressions and important problems. It is our intention to be at all times constructive, so if statements identify deficiencies, they are made in the spirit of identifying deterrents to the solution of important food production problems. They are not intended to fault any individual, organization, or agency.

5.1 Brazil: A continuing and difficult problem in Brazil is the lack of administrative or program linkages between the programs of the Federal Ministry of Agriculture, the universities and the state institutes. But progress is being made with this problem as evidenced by the plan to establish joint research/educational programs between Federal institutes and Federal universities under the agricultural sector development loan. If these inter-institutional problems can be overcome, planning and implementing national programs would be greatly facilitated.

Another serious deterrent to the Ministry programs is the inequity of salaries between Ministry personnel and faculty of the Federal and State universities. According to Dr. Meirelles, Director of Research in the Federal Ministry, the system of merit salary supplementation carried out through the Consejo Nacional do Pesquisas (CNPq) is critical to the continuation of Ministry programs. Some 300-400 Ministry employees receive salary supplements from that source.

As might be expected, much of the crop protection talent is concentrated in universities and in the special institutes that deal with export crops (e.g., cacao, sugar and coffee). This is partly the result of the differential salary structure discussed above but also these institutions receive financial support that is proportionately higher than that available to commodity programs of the Federal and State institutes. Some shifting of support or allocation of new resources for basic food crops (e.g., cassava, rice, vegetables) or other export crops (e.g., maize, soybeans) would appear to be appropriate.

A large proportion of the trained professionals in entomology and plant pathology have kept themselves aloof from the practical problems of production agriculture. Where they have engaged in research, it has generally involved only "basic" studies. Recently, there has been a refreshing change in this attitude, particularly among younger professionals, and there is renewed interest in practical problems. This trend should be encouraged through research grants, salary supplements and other incentives.

Some of the important pest and pesticide problems that need attention in Brazil are as follows:

(a) Coffee - Without question coffee rust is the problem of principal concern to the agricultural economy of Brazil. Some Brazilian agriculturists hold the view that the disease will

not be as serious as some have predicted whereas others (and perhaps the majority) predict that it will challenge seriously their principal crop. They also predict, however, that the industry will survive by developing and implementing chemical control programs as soon as possible and converting to resistant stocks as soon as practical.

A survey for root knot nematodes on coffee is now being conducted by the Instituto Biologico which indicates that Meloidogyne exigua and M. cofficola are very widespread in coffee plantations and inflicting heavy damage. The coffee berry borer also continues to be an important problem.

(b) Citrus - Citrus canker (Xanthomonas citri), gummosis (Phytophthora), and several virus diseases (including a new one for which the causal agent is unknown) pose a threat to the citrus industry of the country. Several scale insects (including a native Icerya) and several cerambycid borers are continual problems.

(c) Pesticide registration and control - Appropriate regulations and personnel to carry out effective programs are lacking. The current regulations were issued in 1934.

(d) Quarantine regulations - Brazil has a very weak quarantine program with no quarantine station facilities for propagating imported materials prior to their distribution in the country. The importance of quarantine to Brazil is emphasized by the fact that they reportedly have no important virus diseases of peanuts, maize, or rice. Furthermore, the cotton boll weevil and rice stem borers do not occur in Brazil.

(e) Phytophthora fruit rot of cacao - This is an important disease in Brazil but witches broom and Monilia fruit rot are not important problems as in Ecuador.

(f) Brown rot of potato - The brown rot disease (Pseudomonas solanacearum) is more important on potatoes in Brazil than diseases caused by viruses. It occurs in all potato producing areas of the country. Late blight (Phytophthora infestans) is also severe in areas.

(g) Heliothis and related Lepidoptera on maize - These insects constitute a very important problem, not only on corn but on tomatoes, sorghum, and cotton. The problem threatens to become more severe because of reports of developing resistance to pesticides

(h) Fruit flies - These insects greatly curtail the export of fruit. This is especially true for the specialty tropical fruits as well as melons, citrus, etc.

(i) Spittle bugs on pasture grasses - This complex problem affects many grasses over a wide area which threatens the welfare of

the livestock industry in Bahia and elsewhere. Resistant grasses and biological control are possible solutions. This problem is different from that of spittle bugs on sugar cane.

(j) Stored product insects - A variety of insect pests attack beans, maize and other products in storage. There exists a great need for improved storage, particularly at the farm level.

(k) Cassava - This is an important food crop in Brazil but remarkably little study has been made of its insects and diseases An important bacterial disease of this crop is discussed in Section 5.6 under the CIAT program. The sphingid moth larvae, Erinnyis ello, is an important defoliator. Several weevils and cerambycids mine the stems which sometimes result in the death of the plant. A small fly, Autodiplosis brasiliensis, causes leaf galls and a trypetid fly attacks the growing point.

(l) Sugarcane - The common sugarcane borers, Diatraea spp., have good biological control but "Broca Giganti" does not. The spittle bug is an increasing problem. When BHC or other pesticides are used to control spittle bug, biological control of the borers is disrupted. Some progress has been made with microbial control within integrated control programs to manage the principal pests on this important export crop.

(m) Leaf cutting ants - "Saúvas" continue to be important problems in both pasture and crop land. Much research has been done on these pests. This needs to be tested more thoroughly at the practical level and control practices disseminated through improved extension.

(n) Cedar - This is an important forest product grown in plantation sytle. A phycitid moth is an important pest in many areas. Biological control offers considerable promise.

(o) Vegetables - A number of aphid-borne virus diseases are limiting the production of cruciferous and solanaceous crops in some areas. A pyraustid moth larva "broca de pequena tomate" (Neuleucinodes eleganpulus) is a serious pest and difficult to control.

The above represent some of the more important pest problems on a national scale, but there are scores of other pest problems which are of critical regional or local significance. Some of these problems are receiving some attention at various state and federal research institutions, but in almost every case these problems merit expanded activity and support.

Since Brazil is such a vast country with a wide range of climates and crop cultures, it likewise experiences a great diversity of pest problems. Many of these important problems are not receiving adequate attention because of lack of trained personnel, facilities and other resources. There

is also need for a national research program with improved coordination through which multiple efforts could be focused on a single research problem area such as through a formal regional research project as in the U. S. Evidence indicates that pest problems are becoming more serious as agricultural practices are intensified and as new varieties are introduced or developed. As an example, the new corn hybrids which have been introduced have many more serious pest problems than the previously produced open-pollinated varieties. The same situation has been observed with rice, cereals and other crops.

Brazil has several major projects for developing new agricultural areas or for modifying the structure of old agriculture. These include the establishment of entirely new agriculture in the Amazon basin, the development of new vegetable and fruit culture in the central region, and the diversification of agriculture in the cacao producing areas. These new and modified agricultural production systems will have new crops and hence new crop protection problems. Furthermore, these areas will also feel the impact of the movement of people, supplies, and pest along the trans-amazonian highway.

A much more intensive study of the situation in Brazil with a balanced input of the several crop protection disciplines must be carried out to gain an overview of the principal problems and a better understanding of institutional capabilities. Such a study is requisite to the development of long-term strategies for crop protection in the country.

5.2 Uruguay: The crop protection programs of Uruguay are hampered by one of the most serious funding limitations of any country visited. Funds are not available for the bare essentials of a field-oriented research program. As a result most of the research staff of the Ministry of Agriculture must confine their research activities to the Center at Sayago in Montevideo (Centro de Investigaciones en Sanidad Vegetal). These facilities are also inadequate and obviously suffer from lack of maintenance funds.

Of the some 16 million arable acres in Uruguay, approximately 14 million are in pasture, but emphasis is now being placed on increased vegetable, fruit, and field crop production. Under this expanding program of crop culture, many pest problems are emerging which threaten production.

(a) Nematodes - There is one nematologist in the country who was trained through the N. C. State University conducted short course held in Peru. She is now conducting surveys to determine the species involved and obtaining assistance on identification from experts in other Latin American countries and the U. S. Indications are that nematode problems are important on several crops.

(b) Citrus - This is an undiagnosed decline disease suspected to be caused by a virus. It is possibly the same as the undiagnosed disease on citrus found in Brazil and other neighboring countries. New trees planted into infested areas generally do not show symptoms until after 10 years.

Mediterranean fruit flies and other fruit flies hamper the export of citrus and other fruits.

(c) Weeds in pastures - This constitutes a serious economic problem. Much 2-4 D is now used and problems with drift cause considerable damage on other crops, especially grapes.

(d) Viruses of vegetable crops - Based on observations on two farms and an experiment station in the Montevideo area, the mosaic viruses are very widespread and serious on solanaceous crops.

(e) Pesticide management - There is a strong desire to improve the management of pesticides in Uruguay but almost complete lack of necessary legislation, regulations, laboratory facilities, and enforcement personnel. About 60% of the pesticides used are applied to fruit orchards. No residue data exist on these important food and export crops. Pesticide intoxication is common and is rarely diagnosed or treated properly. A typical pesticide container disposal problem also exists. The pesticide laboratory has the facilities and capabilities for making only routine analyses.

(f) Clover - Several insect pests attack these important forages. Of special importance is a gelechid moth (*Anacampsis humilis*).

Although present program activities are suppressed by lack of funds, the crop protection group at the Center is energetic and capable. Also, USAID/Uruguay is now placing greater emphasis on training additional individuals at the graduate level. This provides a good base on which to build a quality crop protection program in Uruguay with an input of a modest amount of additional resources.

5.3 Bolivia: We visited only Santa Cruz (two days) and La Paz (one day) in Bolivia. These observations indicate that the Government program in crop protection has only a limited response capability. Apparently the Government and university programs are not very attractive to individuals trained at the graduate level since we were told that of 27 trainees sponsored by the Rockefeller Foundation, only three remain in Bolivia. All of the others have found employment outside of the country!

Cotton is the principal crop in the expanding agriculture of the Departmento de Santa Cruz and the principal user of pesticides. Although precise statistics are not available, it would appear that about 90% of the greatly increased importation of pesticides is being used in Santa Cruz and most of that goes on cotton. The cotton situation in the area is probably reaching the crisis stage in its overdependence on pesticides. In the 1970-1971 growing season, many growers used 10-12 applications of pesticides. At least some of the cotton producers have been dissuaded from this course of pest control by the extension efforts of the Facultad de Agricultura Tropical. This group has stressed the importance of naturally occurring parasites and predators. The British Mission in Tropical Agriculture has also been of assistance in importing parasites of insect pests.

Cotton is a rapidly expanding export crop. Integrated control programs must be developed to save this industry from excessively high production costs.

Other important problems in Bolivia are:

(a) Nematodes - Although little work has been done on the problems, nematodes constitute an important pest on vegetables and other crops.

(b) Rice blast - This disease is important on local varieties. Bolivia cooperates in the varietal testing program of Dr. Ou from IRRI.

(c) Citrus pests - Gummosis and tristeza limit production of citrus. Many of the trees in old plantings have been killed. A large number of scale insects are serious pests in Bolivia. Fruit flies prevent expansion of export market.

(d) Fusarium wilt of cotton - This most serious disease on cotton in the area is possibly part of a disease complex involving root-knot nematodes, although this relationship is not verified locally

(e) Sugarcane pests - The worst insect pests are three species of Diatraea. Yields may be reduced as much as 30% by these pests. Some introductions of parasites have been made by the Commonwealth Institute of Biological Control to improve natural control. Virus diseases are also important.

(f) Fruit flies - Several species of Anastrepha and the Mediterranean fruit fly are serious pests of fruits wherever grown. Apricots and peaches are commonly 100% infected. Figs, pears, almonds and citrus are seriously attacked. The small export market in citrus is greatly hampered by these pests. Whole consignments of fruit have been rejected because of fruit fly infestation. Expansion of fruit exports cannot be seriously contemplated until the fruit fly situation is resolved.

(g) Maize pests - As in many Latin American countries, maize is the most important grain crop. Corn stunt caused by a mycoplasm appears to be increasing in importance. Insects attack the plants at all stages of growth. Heliothis, Diatraea, and Spodoptera are responsible for great losses.

(h) Leaf cutting ants - These species are widely distributed and are most destructive in the low lands.

(i) Potato pests - This is a staple food of most of the population. Potatoes are attacked by several serious insect pests. The most important is a group of agromyzids of the genus Liriomiza. The potato leaf skeletonizer, the potato stem weevil and several leaf eating beetles are also important.

We learned that winter wheat is being promoted as a cash crop in the Santa Cruz area. Some varietal testing is being done under the Utah Contract. We met two technicians there from the Utah Team who indicated that they were already having serious pest problems on introduced wheat varieties in their test plots. As agronomists they were not able to diagnose these problems or get anyone else in the country to do so. If the promotional campaign is successful and a substantial acreage of wheat is planted in the area, it is probable that the industry will not persist more than three-four years because of damaging pest attacks. This is a good example of where a multidisciplinary crop protection team (involving all disciplines) could be very helpful in identifying the hazards in this development and suggesting a pest management program to assist in its success.

Currently a large UNDP study is underway in the more arid region south of Santa Cruz (Proyecto Abapo-Izozog, FAO-Bolivia 16). This is a feasibility study to determine the suitability of this area for agriculture. If this region is developed, new pest problems will be encountered. For example, the South American locust, Schistocerca pananensis, could be far more destructive if this area were irrigated.

At present the Ministry of Agriculture is unable to exert significant control over the import, sale and use of pesticides in Bolivia; consequently, misuse of pesticides is all too common. New pesticide laws are being proposed but these will be ineffective without realistic enforcement. In the Departmento de Santa Cruz, the area of greatest pesticide use, pesticide intoxication of plane loaders, flag men and individuals who use back-pack sprayers is commonly encountered. Two deaths due to insecticides were reported in that area in 1971.

5.4 Peru: The programs in agriculture in Peru including crop protection are seriously hampered by budget constraints. In the Ministry programs as well as the Universidad Agraria (U/A), low salaries (actually salary reduction at U/A) and inadequate program support have had a serious effect on staff morale. Peru has one of the best personnel resources trained in crop protection to be found in Latin America but unfortunately they are not able to function at a level approaching full potential. As a result many highly qualified individuals (some trained at the Ph.D. level) are seeking and finding better employment opportunities outside of public service programs and in some cases outside the country. This is a tragic situation because this resource has been developed over a long period at great monetary cost and program sacrifice by sending faculty and staff abroad for long-term degree training. New physical facilities have also been provided for the U/A and for the National Research Center of the Ministry. Once dissipated, restructuring a group of crop protection specialists with the capability of that which now exists will be a long and arduous task.

As pointed out above, Peru has a very valuable resource of well-trained crop protection specialists in the U/A and Ministry. Graduate programs in both plant pathology and entomology are under way at the U/A. Further, Peru has some very good examples of integrated control of cotton insect pests and the U/A has outstanding new classroom and laboratory facilities. These resources could be used to advantage of other Latin American countries in training crop protection specialists.

The Commodity In-Depth Programs carried out jointly by the Ministry of Agriculture and USAID through the N. C. State University Contract have had a significant effect on some of the commodities involved. For example, significant program progress as reflected in national production was achieved in the potato and rice programs. The bean program is also making progress All of these programs had crop protection components which addressed the most critical pest problems of these crops Significant progress in the potato program has been the establishment of a "clean seed" production program which has involved a tuber-indexing approach to eliminate "seed" transmitted viruses which have been serious for years in Peru. Research has also been initiated on other serious insect and disease pests, including brown rot caused by Pseudomonas solanacearum. The latter is a problem of increasing importance in the potato production areas on the Peruvian coast New potato varieties have also been developed with improved horticultural and pest resistance characteristics. It was noted that USAID/Peru support of these projects through the N C State University Contract is being phased out

As pointed out in Section 4.4 of this report, crop protection specialists in the Ministry estimate that pests reduce the potential crop production in Peru by 38.2% annually Even if one assumes that these estimates are biased upward by a large percentage, losses due to pests remain a critical problem impeding food production in Peru. For example, it is estimated that pests reduce potential production of potatoes by 25% which amounts to $25 million in value annually. Losses of this magnitude surely justify greater emphasis on crop protection programs Similar losses are also sustained in other crops.

Peruvian agriculture is a blending of both traditional and modern approaches Modern pest management principles are being used to great advantage with cotton in the valleys along the coast after having the experience of complete collapse of pest control programs based on the exclusive use of pesticides But primitive agricultural methods are still commonplace in the sierra and selva of Peru. This is characteristically subsistence agriculture utilizing very few purchased inputs or improved methods.

Some of the most serious pest problems in Peru which should receive additional or continuing attention are as follows:

(a) Bacterial wilt caused by Pseudomonas solanacearum - This pathogen now occurs on several crops of economic importance in Peru and is spreading rapidly into new areas. Important crops involved are potatoes where a unique situation has been encountered The bacterium may survive in the high elevations in potato seed production fields but does not produce disease symptoms in the tubers (brown rot disease), but when these same "symptomless" tubers are used for planting stock on the coast, some fields are 100% infested with the disease. Furthermore, this disease is also spreading very rapidly in the selva on native plantains along the Amazon and is destroying the principal staple food of the natives in the region It is inevitable that it will soon reach the commercial banana production areas in the Huallaga

and Tulumayo valleys which could have a very severe economic impact on the agriculture of those regions. The same bacterium also attacks essentially all of the solanaceous crops. A comprehensive project is needed on this pest to work across all economic crops which serve as host plants.

(b) Other potato pests - There are many other important insect and disease pests of potato in Peru. These include many viruses, golden nematode, and several insects. It is anticipated that the programs of the new International Potato Center will have a significant impact on these problems.

(c) Pesticide use and pesticide residues - Ministry personnel are very conscious of these problems not only as they affect human health but impose limitations on the export trade of the Nation. The Peruvian representative to the meeting of Governmental Experts on Quarantine, Sanitary and Health Regulations in Washington, D. C. (February 29 - March 3, 1972) raised many questions relating to pesticide residue problems and their influence on international trade.

The new law involving importation, registration, and sale of pesticides was published on March 14, 1972. This will not correct the pesticide management situation because it does not deal with the major problems of pesticide usage. A serious residue problem exists on food consumed domestically. The Ministry does not have facilities for residue analysis; there is no enforcement of proper waiting periods, etc.

(d) Alfalfa - This important forage is attacked by a number of destructive insect pests. A lepidopterous larva, *Epinotia aporema*, is normally under good natural control. Unwise use of pesticides can unleash it in devastating numbers. It also attacks beans, soybeans, and other legumes. The larvae of the noctuids (*Spodoptera sp.*) are also important on alfalfa and aphids appear to be increasing in importance.

(e) Maize - This very important food crop is seriously attacked by *Heliothis*, *Diatrea*, *Elasmopalpus*, *Spodoptera* and thrips. The beginnings of an integrated control program for these insect pests is being developed.

5.5 Ecuador: The Instituto Nacional de Investigaciones Agropecuarias (INIAP) impressed us as one of the better organized, equipped, and managed national research organizations of the countries visited. The *esprit de corps* is impressive. Our limited observations of the Boliche, Pichilingue, and Santa Catalina Experiment Stations reveal well-planned and utilized laboratory facilities and well-managed field research activities. There is obvious evidence of attempts to establish problem priorities and to allocate INIAP resources accordingly.

The three principal crops in Ecuador are banana, coffee, and cacao. Although cacao is third in national importance, perhaps the most serious diseases occur on this crop. The most important pests in both the tropical and sierra zones are as follows:

(a) Witches broom of cacao - This disease, caused by Marasmius perniciosus, is now a limiting factor to the production of this crop in Ecuador. Many years ago a source of resistance to witches broom was discovered in the Amazon and was incorporated into varieties planted in Ecuador. In recent years, however, this source of resistance has failed to provide economic control of the disease. The effect of this pest is so severe in some areas that the trees are being killed.

(b) Watery pod rot of cacao - This disease, caused by the fungus Monilia roreri, has also become very serious and widespread. As many as 30-80% of the pods on a given tree may become infected. The disease is also very difficult to control with chemical sprays because infections are most prevalent during the early rainy season Since the trees are also flowering profusely at that time, there is evidence that sprays also reduce fruit set.

(c) Cacao insects - Insects are less important than the diseases. Stenoma cecropiae can sometimes be a serious defoliator. Bark beetles and the mirid bugs are also sometimes important.

(d) Diseases of vegetable crops - There are many important diseases of vegetable crops which cause serious damage. These include bacterial wilt of tomato (Pseudomonas solanacearum), viruses and Phytophthora wilt (P. capsici) of pepper, leaf blight of corn (Helminthosporium turcicum), and late blight (Phytophthora infestans) and viruses of potatoes.

(e) Pesticide residues in food products - INIAP has recognized the importance of this problem and is now establishing a pesticide residue research and analytical laboratory at the Santa Catalina Experiment Station. INIAP is receiving assistance on this project from the Swiss Government in the form of equipment for the laboratory and two laboratory technicians. The laboratory facility is under construction and the necessary equipment is already in the country.

(f) Diseases of cereals - Important among these are stem rust, stripe rust (Puccinia glumarum), take-all disease (Ophiobolus graminis), and yellow dwarf in barley.

(g) Maize insects - The major insect pest of maize is Heliothis zeae. Usually in the Sierra, 60% or more of the ears are attacked. Spodoptera frugiperda and the otitid fly (Euxesta eluta) are also important pests.

(h) Potato insects - The Andean potato weevil is important in the higher ranges but seems to be handled satisfactorily with

insecticides. Flea beetles, cut worms, leaf miners, and caterpillars (Copitarsia) are occasionally important.

The administrators in INIAP place high priority on the cacao diseases and would like very much to receive assistance in this area. They are also anxious to initiate cooperative research with neighboring countries which also have some of the same disease problems on cacao such as Brazil, Colombia, and Venezuela. Preliminary discussions have already taken place between Ecuadorian officials and representatives from Venezuela, Costa Rica and Brazil about this possibility. Ecuador has some technical assistance monies in the USAID Agricultural Development and Diversification loan program ($7.2 million) which has just been signed. This could possibly be used to initiate a technical assistance relationship with a North American university, perhaps as a part of the University of California Contract.

There is much concern in Ecuador about the continued availability of DDT for malaria control. As presently conceived, DDT is essential to their malaria control program. Articles in the U. S. press has created fear that the U. S. will no longer manufacture or export DDT. Fortunately, recent announcements by the Environmental Protection Agency should correct this situation

5.6 Colombia: The Instituto Colombiano Agropecuario (ICA) now has national responsibility for all research, extension, quarantine, pesticide regulation, and graduate education in the agricultural sciences. Great emphasis has been placed on graduate education in Colombia, and about 75 individuals in the employ of ICA now have the Ph.D. degree. ICA has initiated its own graduate education program in the agricultural sciences but train only to the M. S. level with no plans for initiating Ph.D. programs. This activity is carried out jointly with the Universidad Nacional de Colombia but the program is administered and funded through ICA. The ICA Graduate School now has 127 students enrolled with the greater number of these majoring in agronomy which includes programs in soils, genetics, plant breeding, plant production, and plant pathology. There is a curriculum in entomology but the program is suspended at the moment because of lack of trained personnel to teach the courses.

Although Colombia has trained a large number of professionals to the Ph.D. level, many of them are no longer available to research and training programs because they have moved into administrative positions within ICA and other government posts in Colombia. On the one hand it is gratifying to observe many capable individuals in administrative roles but their loss to the action programs is great. As a result, many of the research programs in crop protection are understaffed. As was mentioned above, no entomologists trained at the Ph.D. level are available to teach graduate courses in Bogota or Tibaitatá. Likewise the field ranks of the plant pathology program are thin on well-trained scientists. Hopefully, this situation will correct itself over time as additional persons receive training abroad or complete graduate programs through ICA. The UC/AID project undoubtedly could assist in this situation through training programs and consultants.

There are many serious pest problems which are exacting heavy crop losses in Colombia. Principal among these are:

(a) Bacterial wilt caused by Pseudomonas solanacearum - This pathogen causes important diseases on bananas, potatoes, tobacco, plantains, and other solanaceous crops.

(b) Cacao diseases - Watery Pod Rot (Monilia), witches broom, and other diseases reduce yields by an estimated 50%. Colombia has gone from an exporter of cacao within the past few years to importing two-thirds of the national consumption. Increasing cacao production is a high national priority. They would like very much to enter into a cooperative regional project with neighboring countries to facilitate the solution of some of these serious problems.

(c) Tomato pinworm - This insect pest of tomato is definitely at the crisis stage in the Cauca Valley. It is the number one pest of tomato in the area because it has developed resistance to chlorinated hydrocarbons, phosphates and carbamates. Many small growers can no longer produce tomatoes that are marketable. Since this was their chief "cash crop", it has produced a serious economic impact on growers. Prices of tomatoes have soared in the Valley.

(d) Red ring of coconut (Rhadinaphelenchus cocophilus) - This nematode-caused disease is important to coconut plantations throughout the American tropics.

(e) Rice blast (Pyricularia oryzae) - This is the most important disease on rice. ICA has a collaborative program with CIAT through which they are searching for horizontal type resistance. Dr. Barriga estimated a reduction of 30-40% of potential rice yields due to diseases.

(f) Pseudomonas disease of cassava - This disease is a major limiting factor to the production of this crop in Colombia. As indicated below, this disease is receiving major attention in the research program at CIAT.

(g) Beans - Severe disease and insect problems limit the production of beans in the lowland tropics. Cowpeas are a possible substitute, but local acceptance of this legume is not good.

(h) Rice - Hoja Blanca is of diminishing importance in Colombia because of the widespread use of the new varieties. Rice blast is now the most serious problem. CIAT is working with that disease along several lines and also on sheath blight.

(i) Maize - Diatraea and Spodoptera frugiperda are important pests on maize in Colombia.

There are many other pests of all classes that are of considerable economic importance either locally or regionally in Colombia. Pests on vegetable crops, for example, as well as those on corn, tobacco, potatoes

(the golden nematode was discovered in Colombia in 1971), bananas, and citrus are not receiving adequate research or extension attention.

The Extension Service under ICA is aimed primarily at the subsistence farmer with the programs of Sanidad Vegetal being geared more to the needs of the large producers. The programs of the latter division (also under ICA) have aspects of both extension and promotion. They are pursuing many programs aimed at either the eradication or control of important pest problems. Examples of such programs are: eradication of the moko disease of banana (Pseudomonas solanacearum), control of sigatoka of banana (Cercospora musae), and control of the fruit fly.

The possibility of entering into cooperative regional research projects on important pest problems was discussed with Dr. Climaco Cassalett, Director of Research for ICA. Dr. Cassalett agreed that it would be possible and advantageous to pursue some of their important problems on this basis. He cited the diseases of cacao, wheat, banana and cotton as candidate problem areas.

We also visited the new location for CIAT near Palmira and held discussions with Dr. Colin McClung, Deputy Director; Drs. Guillermo Galvez and Carlos Lozano, plant pathologists; and Dr. Peter Jennings, plant pathologist and rice breeder.

A major project is underway at CIAT on cassava with principal focus on resistant and high yielding clones. An international collection of cassava varieties and clones numbering over 2,700 accessions has been assembled. Since almost no work on the pests of cassava is being done in Latin America except at CIAT and since it is such an important basic food crop throughout the area, the cassava project has become a major activity (with funding from the Canadian Government). The principal disease is bacteriosis caused by Pseudomonas. The cassava collection is being screened for resistance to bacteriosis, and 21 resistant types have been discovered. An extensive literature review on the pest problems of cassava is being carried out at McGill University which is cooperating on other aspects of the cassava work.

Major emphasis in the rice project at CIAT is on the blast disease (Pyricularia oryzae). They are screening an international collection of 1,000 cultivars for "horizontal" resistance to the races prevalent in Colombia. Selections are made at the 20-35 day stage (the neck rot phase of the disease) and at the panicle stage of growth. Seedling resistance is correlated with mature plant resistance, but some cultivars are resistant in the seedling stage and susceptible as mature plants and vice versa.

Varieties of rice with resistance to the hoja blanca virus are being developed in the program of Dr. Peter Jennings. Lines are available which are resistant to either the virus or the leaf hopper vector (Sogatodes oryzicola) or to both virus and leaf hopper. Severe outbreaks of the hoja blanca disease occur in cycles of several years in a given area probably because the virus affects adversely the reproductive potential of viruliferous females so that the potential vectors in wild populations drop below the effective transmission threshold.

Dr. Jennings urged the development of regional projects which have a field- and problem-solving orientation carried out by multidisciplinary teams. He emphasized that crop protection specialists must work in association with plant breeders to maximize the opportunities of controlling pests through host resistance and to anticipate genetic weaknesses to pest attack by minor or new pests in new materials under development. He holds the view that basic breeding work for major crops can be centralized in a single location. He emphasized that regional projects must be flexible to compensate for local conditions and that funds must be available through the regional mechanism for the many miscellaneous items that are necessary to get the job done. Rice blast, in his view, should be pursued through a regional project in Latin America. Dr. Jennings also stressed the view that crop protection is receiving too little attention in Latin America.

5.7 Panama: The crop protection capabilities of Panama are limited since there are only two plant pathologists and one entomologist with graduate level training working in their professions in Panama. All of these are at the Universidad de Panamá. Consequently, ingeniero agronomos without post-graduate training are carrying out the crop protection work in the Ministry of Agriculture. In discussions with Ing. Irma Arjona de Polanco, Sub-Director de Division de Investigaciones, she pointed to the need to strengthen crop protection programs in relation to new projects being developed in the area of edible legumes and cereals. One gains the impression that the programs in the Ministry of Agriculture are not adequately funded. The programs in the Universidad de Panama, Facultad de Agronomia, appear to be well-organized and focused on specific, economically important problems. Within the Facultad there is a Centro de Investigaciones Agropecuarias (CIA) which is funded partially through the Universidad but receives ca. $200,000 annually directly from the Planificacion de la Presidencia. Faculty of the Facultad de Agronomia constitute the staff for CIA. This group would be very anxious to collaborate in regional projects with neighboring countries and would also like to obtain technical assistance backstopping through a U. S. university.

Listed below by hosts or agents are some of the more important pest problems recognized in Panamá.

(a) Beans (*Phaseolus vulgaris*) - Disease and insect problems limit the production of this crop in Panamá and Central America. Principal among them are virus diseases which are seed borne. Since the varieties produced do not have resistance and since they do not have a virus-free seed source, the problem is propagated from one crop to the next in the planting stock. Bean rust (*Uromyces phaseoli*) is also serious. Important insects are *Spodoptera frugiperda*, *Diabratica balteata*, and *Empossea fabae*.

(b) Rice - The principal disease is blast (*Pyricularia*) and a principal insect is the stem borer, *Rupela albienella*.

(c) Banana - The moko disease (*Pseudomonas solanacearum*) for which no effective control has been developed, is most important on this export crop.

(d) Avocado - An important disease on this crop in Panamá and many other Latin American countries is root rot caused by Phytophthora cinnamomi. It is generally spread from location to location on infested planting stock.

(e) Sweet orange - Gummosis (Phytophthora sp.) is an important factor in reducing yields.

(f) Tomato - Bacterial wilt (Pseudomonas solanacearum) reduces yield of this crop by an estimated 50%.

(g) Nematodes - Many nematode species cause significant crop production loss in Panamá. Little research has been done in this area.

(h) Maize - Virus diseases and the insects Spodoptera, Heliothis and Diatreae are most important pests on this crop.

Although the resources are limited, the prospects for collaborative research on crop protection problems are good in Panamá. The important problems are generally known and some good work is under way.

5.8 Guatemala Crop protection capability is essentially lacking in the public service programs of Guatemala. According to Ing. Anibal Palencia, Sub-Director de Investigaciones, Ministry of Agriculture, there are no professionally trained entomologists or plant pathologists in the Ministry at the present time.

We were informed that a new semi-autonomous research organization will probably be formed this year under the name of Instituto de Ciencas y Technologia Agricola (ICTA). It is to be patterned after INIAP in Ecuador. ICTA would coordinate all agricultural research in the country. It is planned to establish national commodity programs for beans, rice, corn, wheat and sorghum. We suggested that enhanced crop protection capabilities must be incorporated into these new national programs.

Since we were unable to visit with either plant pathologists or entomologists knowledgeably about the overall pest problems of Guatemala, we actually obtained limited information on specific problems of priority significance. Dr. Al Plant, agronomist working under the Mississippi State University Contract, indicated that diseases were very serious on sorghum, a crop with which he is working. Among these are anthracnose (Colletotrichum sp.), Helminthosporium leaf blight (H. turcicum), bacterial blights (probably both bacterial stripe caused by Pseudomonas andropogoni and bacterial streak caused by Xanthomonas holcicola), and rust (Puccinia). Several insect pests also cause damage. Also, Dr. James Walker, working under the N. C. State University Contract on soil fertility problems, indicated that there were several potentially serious pest problems on corn including viruses and leaf rust.

If the new organization (ICTA) is formed in Guatemala as planned, there will probably be real opportunities for strengthening crop protection programs.

6.0 RECOMMENDATIONS:

The authors of this report recommend, without equivocation, that measures should be taken to strengthen crop protection programs in the Latin American countries visited. As pointed out above, these countries vary widely in crop protection capability, but none of them have developed crop protection programs commensurate with their needs. It is probable that funds expended by improving crop protection programs would result in greater crop production gains per unit of investment than in any other aspect of crop production technology. This is true because in some cases potential crop yields are reduced by 25% or more because of uncontrolled pest problems, and there is a risk of economic disaster with new varieties and crops. In our view modernization of the agricultural production systems in these developing nations cannot be achieved on a stable basis over the long term without an improved capability for "insuring this production". Some more specific recommendations follow.

6.1 Follow-Up Study Teams: Through a brief scheduled visit in each country on the itinerary, we ascertained the general level of crop protection program activities and gained an appreciation for major pest problems. We were not able to observe many areas in these countries that should be visited to acquire a more comprehensive understanding of principal problems. Since we represent only two crop protection disciplines (plant pathology and entomology), this report gives a restricted and undoubtedly biased view of the overall situation. We recommend that follow-up teams be organized which will include not only a plant pathologist and an entomologist but a weed specialist and a nematologist. It is further recommended that one team be organized principally for Central American countries and Panamá and another for South America. Since the pesticide use and residue problems are becoming critical in some of the South American countries, it is recommended that the South American Study Team include also a pesticide specialist. Each of these teams should devote more time than we did to each country and visit additional institutions. Of specific concern to the study teams should be the acquisition of such information as: principal pest problems by regions, principal pest problems on a national basis; inventory of crop protection personnel by institutions and agencies; inventory of current crop protection programs; crop protection program deficiences by country (personnel, facilities, general program support, library facilities, etc.), identification of research problem areas as candidates for regional projects; identification of potential collaborators (institutions and personnel) in regional projects; and the development of preliminary objectives for some specific project proposals. Recommendations on the composition of these follow-up teams and suggested countries to be visited are found in Section 7.0 (APPENDIX II.)

6.2 The Regional Research Project[11/] Approach to Strengthening Programs and Solving Critical Crop Protection Problems: Based on our discussions, there appear good possibilities for developing cooperative regional research projects as the mechanism for solving crop protection problems of major importance among several countries. It is recommended that this concept be explored thoroughly as a "second generation" approach to development assistance programs. Since it is, in our view, an important mechanism for establishing effective programs in developing nations, the basic elements of regional, multi-country, research projects will be discussed

The International Agricultural Research Consultative Group is giving great attention to the development of international research centers as a basic element in a worldwide research network. It is recognized, however, that these international centers must form vital linkages with programs in both developed and developing countries if they are to reach their full potential for contributing to improved agricultural technology. Regional projects based on the concept described below could serve as the fiber to form and maintain a functional international research network. The international centers have and will continue to produce new technology applicable to the problems of the developing nations, but that is not enough There must be a mechanism to join the efforts of developing nations with those of the centers and other applicable institutions such as agricultural universities and institutions in developed countries and certain international organizations. The pursuit of common crop protection problems through regional projects could form a set of linkages for an international research network.

These linkages must go beyond the "program collaborator concept" of the international centers and institutes. Under the "outreach" program of the International Rice Research Institute, for example, genetic

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11/ "Regional research project" is used to denote the type of collaborative research effort that is carried out under the regional research program in the United States. Under that program, two or more states agree to pool their resources in researching a common problem which requires a regional perspective and which cannot be handled by a single institution. They develop a project outline which defines the problem, outlines the specific research objectives and approaches and indicates the areas of research responsibility by individual institutions. Partial funding comes from Federal sources and the remainder from the participating institutions This is quite a different concept as compared to the regional projects of AID/TAB. Under the latter, several countries may be involved but the project activity does not include a direct collaborative effort between indigenous institutions and personnel.

The regional research project concept expounded here is a multi-country project which integrates the efforts of an institution in developing countries with that of selected assisting institutions.

materials are made available through a system of collaborators in many parts of the world. The collaborating countries or institutions have and can benefit from this participation by screening these genetic materials for adaptability to local conditions. But that system does not go far in assisting with the development of more viable local programs. The "regional project concept" would establish a much more intimate relationship with collaborating institutions by involving their personnel in the processes of problem identification, project planning, project implementation, and project review. This should enable them to use more effectively the new technology flowing from the international centers.

At the present time there is very little collaboration between developing countries with common problems. Most of them have very limited resources. The cooperative regional project would be a means of maximizing the utilization, on a collective basis, of these scarce program resources, of minimizing duplication of program efforts, of improving the system for priority problem identification, and of maximizing research results applicable to the problems of each participating country.

Two elements would be critical to the success of international regional projects: (1) a source of "international" funding to defray the truly "international costs" of the project such as the cost of meetings for planning and reviewing research and perhaps project initiation and modest operational costs of in-country project components; and (2) a management institution which would provide leadership in developing, implementing, and carrying out the project activity as well as managing the financing for the project. This management instituion could be one of the international centers, other international organization, or AID through a contract with a U. S. agricultural university.

Other important characteristics of regional projects on crop protection problems would be as follows:

6.21 Based on a collaborative research relationship between two or more research and/or educational institutions in developing countries and one or more "common interest" international institutions or agricultural universities from a developed country. It must be assumed that each developing-country collaborating institution has sufficient crop protection expertise to carry out cooperative research with technical backstopping from the developed country institution(s).

6.22 Developed around "common crop protection problems" which are subject to a regional approach and which will benefit from the broader perspective than can be gained by confining research efforts to a single country.

6.23 Financed by the collaborating institutions (including both developing and developed country institutions) to the extent of local funding availability and by other "international" sources to defray those costs directly assignable to the international aspects of the project

and perhaps "seed money" to encourage project development and implementation.

6.24 Focused on high-priority crop protection problems in each collaborating country

6.25 Developed and directed by a technical committee of the active researchers from each collaborating institution. This committee would have responsibility for developing the project outline which would ascribe the research role to each collaborating institution This approach would avoid unnecessary duplication of effort, expedite research progress through pooled resources and enhance communication between scientists of common interest in different countries so that each can benefit from the results and experiences of his international peer group. The committee would meet annually for developing program plans for the coming year and reviewing results of the past year

6.26 Aimed at strengthening crop protection programs in the developing countries commensurate with their long-term needs to insure against catastrophic crop losses from pests. This is considered a critical need in the face of the expanding "green revolution" which will bring shifts and intensifications of pests problems.

In many respects such international regional projects would share common characteristics with the regional research program carried out jointly by the U. S. Department of Agriculture and the land-grant institutions within the states

An important justification for "internationalizing" crop protection research is the fact that many of the most serious pest problems are worldwide in distribution and importance. These problems must be studied and understood on an international scale to permit development of ecologically and economically sound, long-term control strategies. On the other hand, many pest problems are location-specific in that certain varieties perform differently between areas due to differences in strains or races of the pests or due to different environmental factors. We must know and understand the common elements of different locations which account for problem similarities but just as importantly we must know the factors which produce problem dissimilarities between locations because these may provide the basis for control procedures at other locations.

In summary the regional project approach enables a group to accomplish collectively objectives that neither can realize working independently with limited resources

6.3 Crop Protection Libraries: We observed a number of crop protection specialists working at experiment stations and in some cases at small universities without benefit of minimal library facilities. Those reference works and textbooks available generally were much out of date and inadequate. These individuals have little opportunity of keeping abreast of the developments in their disciplines under these circumstances.

It is our recommendation that "Crop Protection Libraries" be developed for each of the major disciplines represented. These would include listings of the standard reference works within plant pathology, entomology, weed science, nematology and pesticides. These works could be purchased in volume lots at discount prices and distributed to needy experiment station, university or research center libraries either under a grant through AID/W or with funds provided through the appropriate regional bureaus. Distributions would be based on the recommendations of each study team consistent with their observations of "needy institutions". The cost is not yet determined for a complete set of the "Crop Protection Library" but we estimate in the range of $3,000 - $3,500, including packing and shipping costs.

6.4 Pesticide Management Committees: The pesticide use problem in developing countries is a major concern under the U/California Contract. As we observed this problem in the countries visited, there emerged clearly the need for improved pesticide management programs. There is need to improve procedures for registration, handling, sampling for residues, etc. It is our recommendation that a pesticide management committee be established in each country as a means of focusing the best expertise available on this important problem area. This panel should function on a continuing basis as a source of recommendations on pesticide usage in the country and as a body to consider special situations on a case by case basis that involve control efficacy, residue tolerances, environmental quality and human safety. The UC/AID Contract Panel on Pesticides has developed a short-term training program proposal for members of local pesticide management committees. The reader's attention is directed to that proposal for additional details about the role of these committees, their membership composition, and proposed training experiences to prepare them to carry out this role (available through TAB/AID/W).

6.5 Short Course on Integrated Control: Few crop protection specialists in Latin America have had formal training in the principles of integrated control or pest management. If a shift in crop protection philosophy (from reliance on pesticides to a balanced ecological approach) is to be made, instruction at many levels must be accomplished. In view of this need we recommend that an eight-week training course entitled "Ecological Methodology for Integrated Pest Control" be developed and offered in Latin America. Preliminary planning for this course has been done with the Ministerio de Agricultura, Ministerio de Educación, and the Universidad Nacional Agraria in Perú and with FAO, Rome. The Universidad Nacional Agraria in Perú is willing to host the training course and supply some of the faculty. They have excellent facilities for this purpose and faculty highly qualified to participate as instructors. The course is proposed for March-April, 1973 and would be limited to 35 participants from Latin American countries. In order to qualify, a participant should be an ingeneiro agronomo or a "perito" with five programs.

Perú is especially well qualified to host this training course. It is in a central geographic position and has a wide variety of crops and climates. The application of ecological principles to plant pest control dates back over a quarter of a century in Perú. The crop protection specialists have a strong orientation toward the pragmatic aspects of pest control. These specialists have had success with integrated control

and continue to improve on that success. They have considerable experience in the use of regulatory programs in pest management. Their crop protection people are well trained, at home and abroad.

The course will provide training in ecological methods as a basis for the development of integrated control principles. It will be conducted by means of lectures, discussions, laboratory and field demonstrations. It will demonstrate how integrated control, in the context of the agroecosystem and the population dynamics of the pest species, utilizes all suitable control techniques and methods in the most compatible manner to maintain pest populations below the economic injury level. The course would be concerned only with entomological pests.

The budget requirements for this short course are estimated at $50,000 which includes salary for five instructors (three local, two external); travel and subsistence for participants; travel and subsistence for external instructors; and other necessary costs The successful completion of this course should do much to disseminate the principles of pest management or integrated control at the working level to many countries with a very modest investment

6 6 Short-Term Consultants: In the course of discussions with crop protection specialists and program administrators, many problem situations were described that could be assisted substantially by highly qualified short-term consultants (up to one month under the UC/AID contract; longer with mission support). In some situations, the short-term specialists may be able to make positive identification on previously unidentified problems or to outline procedures whereby such identifications might be achieved Some of the citrus decline problems of Brazil, Uruguay and other countries fall into this category. A number of individuals stressed the need for assistance with pesticide residue laboratories, pesticide residue tolerance guidelines, etc. These needs could be met through appropriate short-term consultants. There were many examples of this type of need pointed out to us. Therefore, we recommend that funds to meet such short-term consultant needs be made available through AID/W over the next three-year period and that the availability of this backstopping capability be made known to the USAIDs through appropriate channels.

6.7 Training Needs in Crop Protection: Most developing countries have far too few crop protection specialists trained at the professional level to staff adequate domestic programs. The regional project concept proposed in Section 6.2 above provides outstanding opportunities for training indigenous personnel at the graduate level and doing so in a manner consistent with the needs of the developing country in question. As an example, a regional project on rice blast in Latin America might have as collaborating institution(s) one or two U. S. universities with expertise in this problem area. If Colombia, as a participating country in this regional project, found it desirable to train additional personnel at the Ph.D. level in plant pathology, the person(s) selected for this training could pursue his thesis research as a part of the regional project while in Colombia He would then do his formal course work at the participating U. S. university campus and perhaps also continue with aspects of his thesis research but with an orientation toward the field problems of his home country.

If the regional project concept is implemented, we strongly recommend that funds for "in-service" graduate education be included in project budgets to permit graduate level training in a manner appropriate to needs of their countries. The support for this training must be flexible to allow the trainee travel between his home country and the U. S. university perhaps two or three times to facilitate his problem-oriented research activity. Funds should also be available, in modest amounts, to provide some program support for these individuals after they receive their degrees so they can utilize more fully their professional talents than many of the participants who have returned to their home institutions in years past.

7.0 APPENDIX I. ITINERARY INCLUDING INDIVIDUALS CONTACTED FOR THE PERIOD FEBRUARY 12 - MARCH 24, 1972

February 12: R. Smith in transit, San Francisco - Mexico City.

February 13-16: R. Smith attended sessions of the Congresso de Entomologia held in the Unidad de Congresos Centro Medico IMSS.

February 17: R. Smith - Mexico City to Caracas, Venezuela.

February 18: R. Smith spent day with Jan Bechyné of the Facultad de Agronomia, Universidad Central de Venezuela, Maracay.

February 19: Caracas to Itabuna, Brasil
R. Smith had discussions with Pedrito Silva, Chefe da Divisão de Entomologia, Centro de Pesquisas do Cacau.

February 21-26: R. Smith attended sessions of the Reunião de Entomologia Agrícola, Urucuca.

February 27: R. Smith - Itabuna to Brasilia, Brasil.

February 23: J. L. Apple in transit, Raleigh - Guayaquil.

February 24-25: J. L. Apple held discussions with Dr. Enrique Ampuero, Sub-Director of INIAP and made visits to experiment stations at Pichilingue and Boliche.

February 26: J. L. Apple in transit, Guayaquil - Brasilia.

February 28: Brasilia
- J. L. Apple and R. F. Smith met with E. B. Bowen, USAID/Brasilia.
- Discussions with Mr. Vicente Picorelli Netto, Director Substituto of Division of Sanidad Vegetal. Also present was Dr. José Caramare Dianese, plant pathologist, Universidade do Brasilia.
- Discussions with Roberto Meirelles de Miranda, Director General de Escitório de Pesquisas e Experimentação.
- Visit with John Murdoch.

February 29: Brasilia
- Visit with Vicente Picorelli.
- Visit to Universidade do Brasilia. Discussions with Dr. José Dianese and Armando Takatsu.

March 1: Rio de Janeiro
- Brief visit in Ministry of Agriculture with Dr. Audir Gomes, Director Estadual do M.A.da Guanabara.
- With Clovis Deruiz Beduin, entomologist, to Sao Bento. Met with Dr. Americo J. Lobo Goncalves and Dr. Mario Amaral, Chefe da Estação Fitosanitaria.
- Brief tour of Universidad Rural at Km 47.

- Met with Dr. Guida, Director IPEACS. Discussions with Shinobu Sudo, plant pathologist in charge of entomology, Octavio A. Drummond, plant pathologist, and other staff.

March 2: São Paulo
- Spent day in discussions with Dr. Nobriega, Director of the Instituto Biológico, and his staff.

March 3: Piracicaba, São Paulo
- Discussions with Dr. Trevor G. Arscott, Chief of Party, OSU/AID Project.
- Visit and general discussion with Professor Ferdinando Galli, Director of Escola Superior de Agricultura "Luis de Queiroz", Universidade de São Paulo.
- Discussions with staff in entomology and plant pathology.

March 4: Campinas, Instituto Agronomico
- General discussion with Oswaldo Paradela Filho, Department of Plant Pathology.
- Visit with A. Carvalho, Secão de Genetica.
- Discussion with Dr. Claudio Costa, Virology Laboratory.
- Discussion with Carlos Jorge Rossetto, entomologist.

March 5: Campinas, Brasil to Montevideo, Uruguay.

March 6: Montevideo
- Field trip scheduled for Monday morning cancelled because of high winds and rain.
- Visit to Centro de Investigaciones en Sanidad Vegetal with Chester Hitz, International Development Service Morning and afternoon sessions with Ing. Agr. Lucia Koch de Brotas, Directora del Centro; Ing. Agr. Mario Bouroukhovitch, entomologist; Ing. Quimico German Ott, Director of the Direccion Laboratorias de Analeses; and other staff from Centro. Afternoon session included Ing. Arg. Eduardo Darré, Chief of the Seccion Ventas, Shell Uruguay Ltd. and Ing. Agr. Enrique Llanes, Jefe of the Seccion Desarrollo Técnico, Shell Uruguay, Ltd. Also, Ing. Agr. Enrique Casella and Ing. Agr. Carlos S. Morey from the Facultad de Agronomia, University of Uruguay; and from Centro de Investigaciones en Fruicultura, Horticultura y Viticultura were the Director, Ing. Agr. Cayo Mario Terella, Ing. Agr. Joaquim Carbonel Bruhan and Ing. Agr. Carlos Crisei Pisano.
- Discussions with Tom Stephens, Rural Development Officer, USAID/ Montevideo.

March 7:
- Discussions at Universidad de La Republica, Facultad de Agronomia with Carlos S. Morey Tremoleras, Enrique M. Casella and Mario Bouroukhovitch
- Visits to Estacion Experimental "Las Brujas" and large fruit growing and vegetable growing operations north of Montevideo.

March 8: Montevideo, Uruguay to Santa Cruz, Bolivia.

March 9: Santa Cruz

- With Dr. José Daniel Candia Z., Decano of Facultad de Agricultura Tropical, Universidad Gabriel René Moreno, and Oscar Tapia, of the Estacion Experimental de Saavedra to farm operation of ALBOSA (Algodoniera Boliviana, S.A.)
- Visit to Estacion Experimental de Saavedra of the Division de Investigaciones of the Ministry of Agriculture. Visited the Laboratories of Entomology and Plant Pathology.
- Made talks at meeting with Asociacion de Productores de Algodon in the Cámara de Comercio e Industria.

March 10: Santa Cruz and La Paz, Bolivia

- Brief discussion British Mission in Santa Cruz with Fred Bennett and Frank Squires.
- Brief visit to Santa Cruz Headquarters of FAP/UNDP Project "Bolivia 16" and discussion with Ake Burchardt, the project manager.
- Visit to Facultad de Agronomia Tropical of the Universidad Gabriel René Moreno.
- Discussions with Remberto Herbas, Division de Sanidad Vegetal, Ministerio de Asuntos Campesinos y Agricultura.
- Visited the laboratory of the Division de Sanidad Vegetal.
- Brief visit with the Director-General Abel Coronel Carvalho.
- Discussions with Segundo Alandia, Head of the Division de Investigaciones.
- Discussions with Jack R. Morris, Earl E. Smith and William F. Farnsworth, USAID/La Paz.

March 11: La Paz, Bolivia to Lima, Peru.

March 12: Lima

- Discussions with North Carolina/AID project personnel.

March 13: Lima

- Discussion with Ernesto Velarde Santa Maria, Head of Direccion General de Promocion Agropecuaria.
- Discussions with Curry Brookshier, USAID/Lima.
- Discussion with faculty of Universidad Nacional Agraria at La Molina, Departamento de Sanidad Vegetal.
- Discussions with Oscar Beingolea, Head of Sub-Dirección de Defensa Fitosanitaria. Also present: José Salazar, head of entomology and Rafael Sattler, in charge of CICLU (biological control lab).

March 14: Lima

- Discussion with Mariano Segura, Director General, Centro Investigaciones Agropecuarias.
- R. Smith had discussions with staff of Department of Entomology, Centro Investigaciones Agropecuarias.
- J. L. Apple visited with staff of Department of Plant Pathology and Nematology.
- Discussion Carlos Valverde, Deputy Director, Direccion General de Investigaciones Agropecuarias.
- Brief discussion with Dr. Voysest, Menestras project.
- Brief visit with Miguel de las Casas, Direccion Internacional Cooperation and Development.
- Discussion Ing. Agr. Ivar A. Murat A., in charge of pesticide regulation.

- Short visit with Peter T. Knight, an advisor on economics and agriculture with Ford Foundation in Peru.
- Discussions with Dr. Alexander Grobman, director for investigation and development in Latin America of Northrup, King and Company.

March 15: Lima
- Discussions with entomologists and plant pathologists in the Universidad Nacional Agraria at La Molina.
- Visit to the new International Potato Center.
- Discussions with Jim Bryan, Frank Doggett and others on North Carolina project.
- Luncheon meeting with the Comité de Importadores, Representantes y Formuladores de Pesticidas. Eleven companies were represented in discussions.
- Discussions with Curry Brookshier, Rural Development Officer, USAID/Lima.

March 16 Lima, Peru to Quito, Ecuador
- Discussions with Neil C. Fine, Assistant Rural Development Officer, and Pancho Lopez, USAID, Quito.
- Discussion with Ing. Agr. Fabian Portilla R., Director General, Instituto Nacional de Investigaciones Agropecuarias (INIAP).
- Discussion with Ing. Cesar A. Wandemberg S., Jefe de Sanidad Vegetal, Ministerio de Produccion.

March 17:
- Visited with Dean Coba. Then Jose G. Donoso L., entomologist, and Victor Proaño, plant pathologist, Facultad de Agronomia, Universidad Central del Ecuador.
- Tour of the Santa Catalina Experiment Station, INIAP, with Juan Gerardo Vega V., head of plant pathology and Gualberto Merino, head of entomology.
- General discussion with Galo E. Romero R., Director of the Station.
- R. F. Smith discussion with Gualberto Merino and Victor Vazguez, entomologists
- J. L. Apple discussion with plant pathologists and nematologist (Mario Difaz, Juan Vega, Julio Cascante).
- Discussion with Rogelio Ferreyra Gueneros, Director, UNDP Project Ecuador 22.
- Discussions with Neil C. Fine, Harold Haight, chief of the Family Health Services Division, USAID, Quito, and Dr. Donald J. Pletch, consultant to AID/W Technical Assistance Bureau for Health.

March 18: In transit, Quito, Ecuador to Cali, Colombia
- Discussion with Colin McClung, Deputy Director of CIAT, and other staff of CIAT.

March 19: Cali

March 20: Cali to Bogota, Colombia
- Extensive discussions with Colin McClung, Deputy Director, CIAT.
- Discussion with Guillermo Gálvez and Carlos Lozano, plant pathologists.
- Discussion with Peter Jennings, rice breeder with CIAT.

- Instituto Colombiano Agropecuario, Palmira, discussions with entomologists and plant pathologists. Present were: Alfredo Saldarriaga, Director of the Nacional Programa Entomologia; Caesar Cardona; Reinaldo Cardenas; Fulvia Garcia; Ing. Agr. Adolfo Trochez, Jefe Regional Sanidad Vegetal of ICA and Gustavo A. Granada Ch., plant pathologist with ICA.

March 21: Bogota
- Discussions with Howard H. Harper, Rural Development Officer, Roger D. Sandage, Assistant Rural Development Officer; Agapito Olea M., agricultural advisor; and Dick Morris, economist, USAID/Bogota.
- Discussion with Rodolfo Barriga, Director of the Programa de Fitopatologia, ICA, Tibaitatá.
- Discussion with Carlos Garces Orejuela, Director of the Programa de Graduados in ICA. Also present were Cesar Escobar, Director of Sanidad Vegetal in ICA and Dr. Henry E. Martin, FAO consultant in Sanidad Vegetal.
- Tour of experimental area, ICA, Tibaitatá.

March 22: Bogota to Panama
- Discussion with Alejandro Hugo Manzano, Director of the Departamento de Agronomia, Climaco Cassalett, Director of Division Investigaciones and Carlos Garces.
- Meeting with Howard H. Harper, Rural Development Officer, USAID/Bogota.

March 23: Panama
- Discussions with Jessee Robert Moffett, Rural Development Officer, and Ervin T. Bullard, USAID/Panama.
- Ministerio de Agricultura, Comercio e Industrias, Direccion General de Investigaciones y Extension Agropecuaria. Met with Sub Director, Ing. Irma Arjona de Polanco, Rolando Lasso Guevara, plant breeder with INA, and Heleodaro Miranda of the Guatemala office of IICA.
- Universidad de Panama, Facultad de Agronomia. Discussions with Dr. Gilberto Ocaña, plant pathologist, and Esequiel Espinoza, agronomist.

March 24: Guatemala City
- Discussions with Mr. Alphonse C. Chable, Rural Development Officer, and Joseph S. Courand, Assistant RDO, USAID/Guatemala.
- Met with Anibal Palencia, Sub Director, Ministry de Investigaciones; Al Plant, soil scientist with Mississippi State, joined the conversation.
- Conversation with Ben Waite, plant pathologist from Costa Rica on USAID consulting assignment in Guatemala.
- Discussion with Benjamin Gallegos J., assistant to Wayne Sharp, agricultural attache.
- ROCAP met with Lester S. Anderson
- Discussion with Ing. Miguel A. Elvir Rubio, techrical assistant in the regional office of the Instituto Interamericano de Ciencias Agricolas (IICA) of the Organization of American States.

8.0 APPENDIX II - RECOMMENDATIONS FOR LATIN AMERICAN STUDY TEAMS

8.1 Composition of Teams and Suggested Countries to be Visited:

Central American Study Team	Suggested Countries
Leo E. Caltagirone, Entomologist (Team Leader) University of California at Berkeley	Guatemala Panama El Salvador Costa Rica
J. R. Orsenigo, Weed Scientist Everglades Expt. Station, Florida	Colombia Nicaragua Dominican Republic
Walter J. Kaiser, Jr., Plant Pathologist U. S. Dept. of Agriculture Mayaguez, Puerto Rico	Jamaica ? Guayana ? Surinam ? CIMMYT (Mexico)
Merlin Allen, Nematologist University of California at Davis	

South American Study Team	Suggested Countries
Eddie Echandi, Plant Pathologist (Team Leader) N. C. State University, Raleigh	Venezuela Brazil Uruguay Paraguay
Myron Shenk, Weed Scientist Oregon State University, Corvallis	Ecuador Bolivia
E. L. Nigh, Jr., Nematologist University of Arizona, Tucson	
G. T. Weekman, Pesticide Specialist N. C. State University, Raleigh	
J. K. Knoke, Entomologist U. S. Dept. of Agriculture Wooster, Ohio	

8.2 Briefing Meeting for Study Teams: A briefing meeting is recommended for the above team members to acquaint them with the results of the preliminary trip by the authors, review the background and objectives of the overall project, procedures for operation of study teams while abroad, and to develop listings of individuals and institutions that should be contacted. Other logistic problems will be discussed and resolved during such a briefing meeting.