CROP PROTECTION IN BRAZIL, URUGUAY, BOLIVIA, ECUADOR AND DOMINICAN REPUBLIC

A MULTI-DISCIPLINARY STUDY TEAM REPORT

by

EDDIE ECHANDI
Plant Pathologist and Study Team Leader
North Carolina State University
Raleigh

JOHN K. KNOKE
Entomologist, U.S.D.A. - A.R.S.
Ohio Agricultural Research and Development Center
Wooster

E. L. NIGH, JR.
Nematologist
University of Arizona
Tucson

MYRON SHENK
Weed Scientist
Oregon State University
Corvallis

GERALD T. WEEKMAN
Pesticide Specialist
North Carolina State University
Raleigh

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FOREWORD

The purpose of this study team was to visit various countries in South America and, through personal interviews and inspections, determine the most important problems related to plant protection. An attempt was also made to access the reasons for particular problems and to make recommendations that will reduce or eliminate them. Consequently since this is a problem assessment report, it will by necessity reflect program limitations but there is no intention to be negative. We hope it is an objective assessment which offers constructive alternatives for improvement

In spite of the problem areas described, there were many encouraging observations that surfaced during the visit. Therefore it should not be construed that "bright spots" do not exist in Latin American countries. On the contrary, they were frequently encountered and it is regretable that time and space do not permit our recognizing each of them. We would like to express our thanks to the personnel of the Agency for International Development in Washington, D. C and in the countries visited. Their help and courtesy was of great value to gain insight concerning the status of crop protection in the countries visited

To all the hundreds of persons who devoted their time and efforts in making information available, their frankness and honesty is to be commended. To the many individuals who attempted in so many ways to make our tour as comfortable and problem-free as possible, we wish to express our special thanks. To people like Renato Ruschel, Ministry of Agriculture, Brazil, Earl Smith and Max Long of the AID Office and mission in Bolivia; Paulo Alvim, CEPEC, Itabuna, Brazil; and Manuel de Js. Vinas C., Manager Antilles Chemical Co., Santo Domingo, D. R. we are especially indebted for all the help above and beyond the call of duty.

All study team members have had overseas experience in their respective disciplines with the exception of the pesticide specialist; four team members had previously spent time in South America. The team study trip began in Brazil on October 22 and ended in the Dominican Republic on December 2, 1972 with intervening stops in Uruguay, Bolivia and Ecuador. A detailed itinerary of the trip and persons contacted appears in the appendix.

INTRODUCTION

Following a visit to South America by Drs. Ray F. Smith and J. L. Apple in early 1972, they recommended that an interdisciplinary study team should return to South America and evaluate, in more detail, problems related to pest management.[1] They recommended a team composed of a plant pathologist, an entomologist, a nematologist, a weed control specialist and a pesticide specialist. This team was to obtain information regarding principal pest management problems and program deficiencies. Members of the team were:

Dr. Eddie Echandi, Plant Pathologist and Team Leader
North Carolina State University
Raleigh

Dr. John K. Knoke, Entomologist
U.S.D.A. - A.R.S.
Ohio Agricultural Research and Development Center
Wooster

Dr. E. L. Nigh, Jr., Nematologist
University of Arizona
Tucson

Mr. Myron Shenk, Weed Control Specialist
Oregon State University
Corvallis

Dr. Gerald T. Weekman, Pesticide Specialist
North Carolina State University
Raleigh

[1] Apple, J. L. and R. F. Smith. 1972. A preliminary study of the crop protection problems in selected Latin American Countries. Univ. California, Berkeley. Contract No. AID/csd-3296, Berkeley, California.

SUMMARY AND RECOMMENDATIONS

There are basic development problems in the public agricultural sector of most of the countries visited that must be resolved before the detailed recommendations contained in this report can be implemented successfully. The scarcity of qualified research scientists and the number of serious unsolved pest management problems is mute evidence that the present system of organization is inadequate to meet the needs of these countries. Agricultural programs must receive due recognition. Budgets for research must be increased. Young scientists must be better educated within their own countries, and through an objective screening those individuals with superior ability should be sent to institutions capable of providing appropriate postgraduate training in crop protection. Upon completion of their training, they must return to their countries. Young trained scientists should not be indiscriminately given administrative positions, but they should use their knowledge to assist in developing and executing long-range plans. Adequate salaries, facilities, equipment and well defined and planned objectives must be available to retain these scientists. When these problems are given due recognition by those in authority, there will be opportunity for the following recommendations to be affective and have meaning.

1. Training.

In order to provide qualified scientists for the countries visited, some consideration should be given for a means of conducting courses in the areas of pest management. These courses should be of sufficient duration and intensity to train individuals who could and would be involved in research and extension upon completion of their training. Financial remuneration should be sufficient to attract the most qualified teachers with Spanish and Portuguese speaking proficiency and with previous experience in Latin America. Participating countries should share instructional costs through financial support for the trainees. Three possible training locations are: (1) IICA, Turrialba, Costa Rica, (2) Universidade Federal de Vicosa, Brazil, and (3) Escola Superior de Agricultura Luiz de Queiroz, Piracicaba, Brazil. Objectives should include pest identification, research techniques and methods, crop loss estimates and methods of control. Students should be selected on the basis of qualification, desire to participate and assurance that they will be assigned responsibilities in pest management upon completion of their training.

The need for advanced training leading to the M.S. or Ph.D. degree in specialized areas of plant protection is clearly evident in all countries visited. Arrangements should be made with such sponsoring agencies as AID, Rockefeller, Ford and FAO to provide leadership and coordination of training grants that will allow qualified scientists to pursue such training in the United States or other countries. Care should be taken to select only those institutions

that will actively support such programs. They must be willing to provide training in or applicable to pest management. Research should be restricted to the needs of the particular country, and when practical it is strongly urged that research should be conducted in the student's country or on problems pertinent to the needs of his country. Coordination between participating countries, institutions and granting agencies is therefore essential to insure that the required training needs are fulfilled.

Retraining programs are also needed for indigenous personnel who received graduate training ten or more years ago. Provisions should be made to support such programs through the development agencies now in these countries.

2. Salaries

In every country visited the value of agriculture as a source of international exchange was emphasized, however, salaries of professionals and technicians were low and hardly competitive with comparably trained personnel working in the private agricultural sector. Symptomatic of this problem is the age of existing staff and the scarcity of young persons dedicated to careers in agriculture. We recommend that professional pay scales be examined and adjusted to a competitive level and that an adequate incentive program be developed to attract and maintain productive professionals.

3. Physical Facilities and Equipment

Poor physical facilities and lack of equipment essential for crop protection research are chronic problems in many institutions. Physical facilities were found adequate at most Brazilian institutions; at La Estanzuela, Uruguay; and at Boliche and Santa Catalina, Ecuador. Equipment needs are so critical in Bolivian and Dominican Republic institutions that simple tasks cannot be performed. The study team strongly recommends more government support for alleviation of these problems.

4. Communications and Publications

Communications are poor and publications few in all countries visited. Library facilities, serial journals and textbooks of national and international origin were very limited in most countries. A central information dissemination service similar to the East African Scientific and Technical Literature Service located at EAAFRO, Nairobi, Kenya, would be of significant benefit to Latin American scientists involved in pest management. The Interamerican Institute of Agricultural Science at Turrialba, Costa Rica, could coordinate such a service.

The development of "Crop Protection Libraries", as outlined by Apple and Smith[1], at key university and research centers is highly desirable.

Attendance at national and international professional meetings and workshops should be promoted to help scientists keep abreast of developments in their fields of interest. Frequently, travel to such meetings is impossible because of financial difficulties. USAID could assist in this matter.

5. Extension

Some form of extension service exists in the countries visited. However, its effectiveness varies drastically from country to country and even within countries. Lack of adequate financial support is a major factor contributing to weak extension programs

There is a immediate need to upgrade personnel by providing salaries commensurate with professional training. Leadership must be provided when possible by U. S. extensionists to establish concepts and programs in extension. Programs must be established not only to train new personnel but to re-train many of those individuals who are now in extension.

It is strongly recommended that efforts be made to assist these countries in establishing sound extension programs. Regional programs should include extension personnel that would help disseminate applied research information. Development agencies such as AID should strive to stimulate greater interest in and support for extension programs in pest management

6. Regional (Multi-Country) Crop Protection Programs.

Interdisciplinary crop protection programs should be developed to counter high priority, common interest problems utilizing the concepts put forward by Apple and Smith. These programs should focus on problems of major crops and could serve as model programs in Latin American countries. Centers of operation should be those institutions with adequate facilities such as CEPEC in Itabuna, Brazil; INIAP in Ecuador; and Universidade Federal de Vicosa, Brazil. Examples of problems that could be pursued on a regional or multi-country basis through the stimulation and support of AID are: coffee rust, witches broom, monilia pod rot, phytophthora pod rot, thrips, and mirids of cacao, and diseases, insects and weeds of dry beans (*Phaseolus vulgaris*).

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[1]Apple, J. L. and R. F. Smith. 1972. A preliminary study of the crop protection problems in selected Latin American countries. Univ. California, Berkeley. Contract No. AID/csd 3296, Berkeley, California.

7. Coordination of International Organizations:

International organizations with interest in crop protection should coordinate efforts to implement some of the recommendations put forward in this report. Some coordination is evident between AID, IICA and FAO, but should include programs of other international agencies and bilateral programs such as the British mission in Santa Cruz, Bolivia, the Swiss mission in Quito, Ecuador, and the Taiwanese mission in San Cristobal, Dominican Republic.

8. Plant Quarantine

The organization and training of a professionally competent crop protection service is necessary in all countries visited. Every port of entry must be staffed and equipped to prevent the free movement of infested plant material across national borders and most importantly across the remaining geographic barriers. Parallel to the development of an inspection service should be an international certification system to control movement of plant materials. It is recognized that full international cooperation may be difficult to obtain since many of the countries compete in world markets.

The potential danger of using quarantine measures to gain economic advantage is present everywhere and if allowed to become a political issue could well prevent effective implementation. An international agreement in plant inspection and quarantine could pave the way for joint training of technicians and for establishment of a highly professional and efficient inspection system to accommodate trade in raw agricultural products.

Subject Matter Recommendations

A. Plant Pathology.

The need for qualified personnel in plant pathology is less acute in Brazil than in Uruguay, Bolivia, Ecuador and Dominican Republic. Brazil has M.S. and Ph.D. programs in plant pathology at the "Escola Superior de Agricultural Luiz de Queiroz" in Piracicaba and a M.S. program at the Universidade Federal de Vicosa. These programs should continue to receive foreign assistance. The lack of qualified personnel in plant pathology in Uruguay, Bolivia, Ecuador and Dominican Republic is a serious problem. These countries do not have a graduate program in plant pathology and at times their undergraduate program has been discontinued for as much as 3 to 4 years (Uruguay) due to student unrest. This problem requires immediate solution.

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

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

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

An obvious problem for plant pathologists is to evaluate the losses caused by important diseases of the major crops Continuous surveys and systematic studies can provide this information Such knowledge is essential to the establishment of "problem priorities".

Losses are high on basic food crops, vegetables and fruits Disease control on these crops is requisite to increased productivity.

B. Nematology

All countries visited need additional research on root knot nematode problems. A multi-country project should be established to reduce duplication of efforts. One specific location for training and intensified research should be established in Latin America. Organizational and review meetings would be essential for exchange of information and research project planning

The excellent facilities available at CEPEC in Itabuna, Brazil, make this an ideal location for cooperative nematology research on cacao, coconut and African oil palm and for the conduct of training programs.

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

C. Entomology:

The personnel resource in the countries visited is generally inadequate to cope with existing entomological problems, and with few exceptions existing personnel need additional training. Entomological programs at universities and federal or state research organizations generally are underdeveloped and poorly equipped to respond to high priority needs.

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

With notable exceptions such as for cacao insects in Brazil and sugar cane and cotton insects in Bolivia, data are generally unavailable as to the relative importance of insect pests or the extent of damage they cause. Efforts should be made to determine the economic damage attributable to pests on important crops so that the limited resources can be allocated to problems of highest priority.

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

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

Recommended projects and coordinating organizations include: (1) biology studies, chemical control and dissemination of information on leaf cutter ants at University Rural do Rio de Janeiro, Km 47, Brazil, Instituto Biologico, Sao Paulo, Brazil and CEPEC, Itabuna, Brazil; (2) control of fruit flies and residue determinations at IICA, Turrialba, Costa Rica, Escola Superior de Agricultura, Luiz de Quiroz, Piracicaba, Brazil and Instituto Biologico, Sao Paulo, Brazil; (3) chemical and biological control of spittle bugs on pastures at CEPEC, Itabuna, Brazil; (4) chemical and biological control of sugar cane insects at Gabriel Rene Moreno University. Santa Cruz, Bolivia; and (5) control of stored product insects at Instituto Biologico in Sao Paulo, Brazil and INIAP, Ecuador.

D. Weed Control:

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

More weed control specialists must be trained at the M.S. and Ph.D. levels. While specialists are being trained, stop gap

measures should be taken, such as intensive short courses for personnel interested in weed control, as well as for researchers in other disciplines who should be incorporating basic weed control practices into their present programs. This would promulgate the concept of "total production systems" as all phases of pest management agronomic inputs are integrated.

Short-term training of 8-12 months at the International Tropical Agricultural Center (CIAT), Cali, Colombia, is strongly recommended for weed control specialists from the countries visited.

Other training possibilities are the Ministry of Agricultural/ USAID commodity research programs being developed in Brazil. A number of U. S. universities will be bringing in teams of pest management specialists and should be able to establish a significant training program. Weed research programs should also be established with national universities wherever possible Only six universities with weed control curricula were encountered in the countries visited.

Because of a total absence of a Weed Research Program in Bolivia it is strongly recommended that a foreign university program be established here to help develop indigenous weed research capabilities.

The implementation of presently known cultural and mechanical weed control methods in these countries would be a significant step toward the development of total production systems and also reduce the frequently noted overdependence on chemical weed control methods.

Increased use of chemicals for weed control was noted in all countries. This practice should be encouraged <u>only</u> as an aid to integrated pest management programs and where it does not have undesirable socio-economic impact.

E. <u>Pesticides</u>

1. Pesticide regulations

Recognizing the severe financial limitations in the countries visited and assuming they are similar in the remaining Latin American countries, steps should be taken to develop a model code of registration regulations for implementation by each country. This international code of registration should contain uniform standards for labeling, misbranding and adulteration. We further propose that appropriate steps be taken to create regional centers for evaluating efficacy of pesticides. Centers could be established in the tropical lowlands of Itabuna (CEPEC), Brazil (pastures, cacao, sugar cane); in the subtropical lowlands at La Estanzuela, Uruguay (pasture, small grains, livestock); in

the Altiplano at Cochabamba, Bolivia; and in the tropical lowlands at Pichilingue, Ecuador (bananas, cacao, coffee). A free interchange and acceptance of data from these or other appropriately staffed facilities could satisfy the requirements for national registration and minimize the costs of evaluating pesticides. The policy of imposing only token registration fees on registrants should be modified to a point where the private and the public sector share more equitably in the incurred development costs.

We further recommend that appropriate international discussions be initiated to establish minimum standards of competency among persons applying pesticides by aircraft. Regulations similar to those recently enacted by the U. S. Congress (FEPCA) are out of the question at the present time in the countries visited and quite likely for many years to come. The EPA (formerly USDA) compendium of "Registered Pesticides Uses" serves as an extremely valuable guide for South American regulatory authorities. The copies we saw were well worn through use and unfortunately several years out of date. For some reason the transfer of responsibility from USDA to EPA had terminated the distribution of this series in the countries visited. Making this publication available to the countries would seem to be a highly desirable and reasonable first step toward better communications in pesticide regulation.

2. Pesticide residues

Immediate measures must be taken to create pesticide residue capability in all countries visited. Equipment must be purchased to best accommodate critical maintenance and repair problems. Although grant support from abroad for equipment and personnel are needed, each country should be required to make a firm commitment of financial support. The opinion in the local country may be just the opposite since they will say that the U.S. and Europe have established unreasonable standards on crops that only the tropics can produce and hence the buyers of these crops should be willing to bear the burden of assuring that tolerances are observed.

Planned regional residue laboratories appear at first to be a progressive first step toward establishment of an effective enforcement program. But the lack of an organized and trained field force will severely limit the effectiveness of the sophisticated laboratories.

It seems obvious that residue capabilities are needed continent-wide and we recommend a coordinated program to develop such capability. A program that provides the physical facilities, laboratory personnel and field staff simultaneously is essential to avoid the disproportionate development of our segment of system at the expense of the remaining portions of the program. We recommend the creation of an international center for training of laboratory

and field technicians. This same center should function to develop and maintain uniform standards of operation among participating countries. Each participating country joining in the regional program effort should in meeting the basic requirements for mutual aid agree to implement enforcement of basic uniform standards applicable to all participants.

COUNTRY - SPECIFIC OBSERVATIONS

Below we will discuss the most important problems recognized in each country. This discussion is not necessarily an in-depth analysis of the problems pertaining to pest management, but one highlighting impressions of important problems as detected by interviews with local technical personnel. Our intention is to be constructive. If our statements identify deficiencies, they are made in the spirit of identifying deterrents to solutions of important pest management problems.

BRAZIL

Brazilian Institutions and Research: Each important agricultural state in Brazil supports a university and, in some cases, additional state or federally supported institutions. Research stations are located near universities and supplement the limited research activities of university personnel. Teaching is the principal responsibility of the university staff. Insufficient personnel to properly conduct needed research and, at the same time, teach the large numbers of students attending these institutions were encountered. Academic training of the teaching faculty is generally limited to the Master of Sciences (MS) level. No more than 10% of the instructors have training beyond the MS degree. Of these approximately 50% have received training outside of Brazil. There is at present a significant effort by universities to upgrade the technical competence of their staff. In the institutions visited, personnel are usually working in their specific areas of training.

Salaries, research support and compensation for additional academic training are frequently insufficient to attract and/or to retain scientific personnel in the state institutions. Salaries at federally supported universities are usually higher than at state supported institutions which produces a constant shifting of young scientists to better paying positions and in some cases leads to termination of essential research projects.

Inadequate facilities for research are the rule, especially for field, greenhouse and controlled climate research. In general, laboratories and classrooms are adequate, frequently new and spacious.

Generally, the areas of strongest emphasis are plant pathology and entomology, with less in nematology and weed control. Chemical control is the primary approach to pest control. Little interest is exhibited in natural control methods, although there is some research activity in the area of host plant resistance and biological control.

High priority research programs are being established by the Ministry of Agriculture with AID loan funds. Five commodity groups are included: rice, beans, corn and sorghum, soybeans, and cattle and pastures. These five commodity programs will emphasize research, training, extension and planning on a national basis. They are

expected to bring together technical personnel from AID contracts with Brazilian counterparts to work in the various agronomic and plant protection phases of production.

State, industrial, and to a limited extent, the federal government through the universities, are developing research capabilities in crops other than the five commodity groups. Examples are cacao, which is heavily subsidized by the cacao industry, citrus to include a citrus certification program, and rubber, which is intended to make Brazil self-sufficient in natural rubber and improve the economic well-being in western, central and northern Brazil. Oil palm and coffee are also receiving government support

Total research is limited because of inadequate personnel, funds, and frequently inadequate support by specific commodity interests. The "Centro de Pesquisas do Cacau" (CEPEC) in Itabuna is an example of what can be accomplished by industrial support. Areas of research in CEPEC include pest control, and production and marketing of cacao. Research is underway at this center to include other commodities therefore broadening the economic base in the cacao producing area. These include oil palm, rubber, coconut, bananas, and cattle.

Plant Pathology: Coffee rust is the number one plant disease in Brazil. Other diseases of importance are: Black pod rot of cocoa incited by *Phytophthora palmivora* (causes losses of 20-25% of the crop); leaf blight of rubber incited by *Dothidela ulei*; sigatoka of bananas (produce 50% losses when not controlled); bacterial and virus diseases of dry beans; septoria leaf blotch, and rust of wheat; rice blast; virus diseases of potato; bacterial canker of tomato; bacterial diseases of cassava; citrus canker; sugar cane smut and others (Table 1).

Most of the important plant diseases have been identified in Brazil, but epidemiological studies are needed and economic losses are generally unknown.

A number of trained plant pathologists are working in federal and state institutions but teaching responsibilities and lack of research facilities limit productive research. Attention and support must be directed towards field oriented programs and better utilization of existing experiment stations and personnel.

There is a noticeable lack of communication among researchers in Brazil. Attendance and participation in scientific meetings and workshops would tend to reduce the existing communications problem. Federal and state governments should be encouraged to send their personnel to scientific meetings such as those sponsored by the Brazilian Phytopathological Society and other phytopathological societies.

Communication between researchers and extension personnel could be encouraged through cooperation in demonstration projects to improve the flow of available research information to growers. Brazilian plant pathologists should be encouraged to communicate with scientific organizations throughout the world to provide for a broader exchange of publications, technical information, germplasm, and personnel

Nematology: Throughout Brazil there are essentially no trained research personnel in nematology. Nematode diseases encountered appear to be of major economic importance in such crops as vegetables, coffee, cacao and soybeans

With two exceptions, Brazil's nematode program is nonexistant. Problem identification is limited and almost entirely restricted to observations by plant pathologists who recognize roots infected with species in the genus Meloidogyne. This situation is incongruous when one considers that Brazil has one of the world's earlier workers in plant nematology. Dr Lordello, located at Piracicaba, one of the superior universities in Brazil, has heavy teaching and other responsibilities that preclude his involvement in research. While Dr. Lordello has identified many of the nematode problems throughout the country he has, with few exceptions, not been able to establish their pathogenic and economic importance.

There appears to be interest in nematode problems and many individuals considered nematodes as important pathogens. However, no plans are evident to obtain or train scientists to pursue these problems in the near future.

Every effort should be exerted to obtain trained personnel in this area of plant protection and encourage research activities that will provide information that can reduce serious economic losses. This is without question one of the most sadly neglected areas of pest management and one that demands immediate attention and improvement.

Entomology: Most entomological research on applied agricultural problems in Brazil is conducted by individuals with little formal training beyond the B.S. degree level. Those entomologists with advanced training are usually located at universities and have heavy teaching or administrative responsibilities. With few exceptions, investigators are underpaid, have inadequate financial support for their projects, poor laboratory, insectary, and greenhouse facilities, and no technical assistants. Studies are generally of an elementary nature frequently related to taxonomy, distribution or behavior of specific pests, or screening of toxicants for the control of specific pests. Some basic studies are financed by grants from special crop interest groups.

Major entomological problems in Brazil include leaf cutter ants, spittle bugs on pastures in the south and on sugar cane in the north, and stored product insects both in large warehouses and at local on-farm facilities. The cotton insect complex of bollworms, leafworms, stem borers, plant bugs and aphids, receives about 70% of the insecticides used in Brazil. Large amounts of BHC are applied on coffee to control the coffee berry borer and on cacao for control of thrips, leaf beetles, ants and mirids.

Limitations in funds, facilities and trained personnel have caused entomological research to proceed at a slow pace and in an uncoordinated manner. Research related to taxonomy, biology, and control of the leaf cutter ant complex has been under study for many years, and suitable control methods and chemicals are available. Still, current losses are estimated to be as high as 25% of the total agricultural production in Brazil. Losses to three Atta species in the state of Sao Paulo on pastures, forest land and in sugar cane may exceed $130 million per year. In pastures, leaf cutting ants in 10 nests consume as much forage as one cow. Damage assessments to the sugar cane borer in sugar cane are as high as $50 million per year in the state of Sao Paulo.

Some research has been done in biological control of insects using insect and fungus parasites. Work is also being done with the use of resistant plant varieties. Very little research is underway on insect vectors of plant diseases.

Most crops in Brazil have the normal compliment of insect pests. Those pests most frequently mentioned by the entomologists contacted are included in Table 3. These and other Brazilian pests, their host plants and natural enemies and a Brazilian entomological bibliography are well documented[2], but data on economic losses due to most insects is lacking. In many of the low yielding subsistance crops it is difficult to assess potential pest problems. As yields and acreages are increased, changes in the severity of insect damage and diversity of species involved may require an ever increasing effort in insect pest management. Most institutions involved in entomological teaching and research in Brazil are poorly equipped and inadequately staffed and will be unable to train adequately the personnel needed in the next few years. A new agriculturally oriented Entomological Society has recently been formed in Brazil. This may improve communications and promote the more efficient use of the entomological resources in Brazil.

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[2] Silva, Aristoteles Godofredo d'Araujo e, et al. 1968. Quarto catalogo dos insetos que vivem nas plantas do Brasil. Parts I and II, books 1 and 2. Ministerio da Agricultura. Rio de Janeiro, GB, Brasil.

Weed Control: Weed control is the most recently developed facet of plant protection in Brazil. Less than 40 people are engaged in weed control research and teaching in Federal and State institutions and less than 10 of these are full time. In fact, the number of personnel involved with weed control has declined during the past 15 years.

Meanwhile, the use of herbicides is rapidly increasing, due mainly to the efforts of the chemical industry. All companies which actively market herbicides in Brazil have "on farm" product testing programs conducted by salesmen or special agents. Several companies maintain their own research farms for the specific purpose of testing herbicides and other pesticides.

A National Herbicide and Weed Control Society exists with approximately 250 members, the majority representing industry. However, the Society suffers from lack of funds.

Within the various Federal and State supported institutions conducting weed control research, most efforts are directed at elementary field testing of commercial products to obtain data for making recommendations for usage (rates and time of application). With the exception of the Instituto Agronomico, Campinas, most experimentation is limited in scope and provides a minimum of what must be considered essential information. Economic analyses were lacking in all research data reviewed. Very little basic research is being conducted, and it is doubtful that Brazil needs such at this time

A National Herbicide and Weed Commission has been established to coordinate and standardize weed control research among all State and Federal institutions. National priorities are established each year and uniform field experiments are conducted at all locations Researchers are also encouraged to work on local and regional problems not included in the national priorities.

The limited number of technical personnel active in weed control stems largely from a general lack of awareness of the importance of this field plus low salaries at the state institutions as compared with those of universities and industry. Prior to 1969, weed control courses were not offered in Brazil. A one-term course is presently scheduled as an elective for undergraduates in four universities. A fifth university has included an undergraduate course in weed control in its 1973 curriculum and plans a graduate level course in 1975 coincident with the return of a professor currently studying for a Ph.D. degree in the United States. A basic weed control textbook has also been published by the University of Sao Paulo at Piracicaba. Among Brazilian weed researchers, few have studied outside of Brazil and none have obtained more than an M.S. degree.

Several weed control workers suggested that, before they can teach effectively at the university level, an intensive three month training seminar should be conducted for them using highly qualified professionals from outside the country.

Dissemination of information generated by various institutions is seriously deficient. The results of weed control experiments at nearly every institution have been published in well prepared bulletins. However, very few of these bulletins are found at other experiment stations of the same institutions or at other institutions. In many cases bulletins are published after a single experiment. The lack of information dissemination has been further heightened by the fact that the National Commission on Herbicides and Weeds has lacked sufficient funds to publish their research data for the past three years.

Among factors mentioned as contributing towards the general low level of interest in weed control were the high cost of herbicides and the abundance of hand labor for traditional manual weeding. However, labor scarcity is becoming increasingly acute in states with large urban centers such as Guanabara (Rio de Janeiro), Sao Paulo, Parana, and Rio Grande do Sul. These four states account for most of the agronomic crop production of the nation and producers in these areas are clamoring for herbicides.

In certain other areas - especially northeastern Brazil and the state of Bahia - hand labor is abundant, with localized exceptions, and the introduction of herbicides is not socially acceptable at this time.

Most applied weed control research in Brazil is being conducted at the Instituto Agronomico, Campinas. Apart from herbicides, considerable emphasis is being given to mechanical and cultural control and combinations of these with chemical control.

The weed control group at the Instituto Biologico, Campinas, is deeply involved in testing herbicides which have been submitted to the Ministry of Agriculture for registration; little time is left for pertinent problem-solving research. However, some work in competition studies, pastures, aquatic weeds, horticultural crops and the cash crops common to this region (cereals, soybeans, coffee, cotton, grapes and bananas) is underway. All field trials are conducted on off-station sites due to a lack of land at this Institute. Transportation, greenhouse, field facilities, and research personnel who can assume leadership roles were also mentioned as being serious deficiencies here.

Three Ministry of Agriculture experiment stations were visited: Brasilia; IPEACO (Sete Lagoas) and IPEACS-Km 47 (Guanabara). No weed control program exists at the station near Brasilia despite extensive range areas which are infested with many woody species. Also, as the range is being cultivated (a practice which will

undoubtedly increase to meet the growing demand for edible products in Brasilia), a number of species have become serious invaders including Acanthospermum spp., Sida spp., Cenchrus spp. and Axonopus sp

A Botanist at IPEACO is dedicating full time to weed control in rice, corn, soybeans, cotton and horticultural crops. The primary weed problems in this region are Cyperus rotundus, Digitaria spp. and Acanthospermum sp. Inadequate transportation and lack of a trained weed control specialist were mentioned as limiting factors in the weed control program here.

At IPEACS, an agronomist is devoting full time to weed control in irrigated rice, sugarcane, citrus, bananas, pineapple, corn, pastures and horticultural crops No data have been obtained to document weed losses in these crops although losses in rice, horticultural crops and pastures are known to be serious. Carrots and bananas are receiving wide use of herbicides with good economic advantage in this area.

Two or three unrelated thesis projects in pastures and horticultural crops are in progress at the University of Vicosa. In addition, an ambitious program with horticultural crops is being conducted by a Ph.D. student from Purdue University who is presently residing in Vicosa. This project, in addition to chemical control, includes considerable research on cultural and manual control, as well as detailed competition studies.

Weed control activity at the University of Sao Paulo at Piracicaba, is limited to an undergraduate course. Teaching duties, coupled with lack of funds, greenhouse, and field space, preclude applied research there.

The National Cacao Research Institute (CEPEC) in Itabuna, Bahia, has an agronomist working nearly full time in weed control. He has successfully developed the practice of thinning shade trees in old cacao plantations by injecting picolinic acid and phenoxy herbicides into the unwanted shade trees, thereby realizing a considerable savings over the traditional "girdling" method. Economic advantages are apparent in the chemical control of an agressive grass weed in cacao, Setaria sulcata through a split application of dalapon.

Following is an estimation of weed losses for the major crops as given by the research groups at the Instituto Agronomico and Instituto Biologico in Campinas. These figures are based on losses experienced using traditional weed control methods and are subject to local and regional variations.

	Crop	% Loss
	Coffee	light
	Citrus	light
*	Cotton	10 - 15
*	Sugarcane	10
	Soybeans - beans	15
	Peanuts	20
	Corn	30
**	Rice	30
	Bananas	10 - 20
	Pastures	40 - 90

* A high percentage of cotton and sugarcane acreage is presently being treated with herbicides.

** Weeds tend to be most serious in dryland rice. Large areas of rice lands can no longer be planted to rice due to the serious infestation of red rice.

Pesticides and Plant Quarantine: Concern for pesticide residues in crops and livestock center on the export commodities such as meat (beef), tobacco, cacao, and soybeans, and to a lesser extent, cotton seed cake and oil. Established tolerances for pesticides parallel those set in the U. S. and Western Europe. The point of enforcement of tolerances is at the ports of disembarkation, and as far as we could determine no attempt is being made to enforce tolerances at points of production or on crops grown exclusively for domestic consumption.

Facilities to test pesticide efficacy exist at the Biological Institute in Sao Paulo and are used almost exclusively for statutory product evaluation prior to registration by the Ministry of Agriculture. Laboratories for residue determination exist at Sao Paulo and Piracicaba, but as with efficacy testing, these facilities are used almost exclusively for regulatory (registration) functions.

Product adulteration and misbranding is not an area of concern at the present time. However, only a small number of samples are drawn once a product is licensed for import and registered for sale. Private users of pesticides apparently recognize the problem in maintaining uniformity in composition and stability of formulations, since some secure private analyses to confirm quality and concentration.

Uniquely, Brazilian regulations do not require a universal ingredient statement, and there is no requirement that batch numbers appear on products offered for sale. In spite of these rather obvious weaknesses, the general attitude appears to be that the pesticides available, (approximately 5200 brands on October 1, 1972), are of acceptable quality as determined by performance.

Products can be removed from the market by decree. An example is the action by the Ministry of Agriculture to prohibit the use of organo-chlorine insecticides on tobacco in March 1972 and a earlier action against the use of BHC on pastures in 1971. There is no evidence that local enforcement of these decrees is possible except indirectly through marketing channels. Both actions were carried out at the request of interested producer-exporter groups who were faced with strict tolerance enforcement at foreign ports.

Brazil has a joint Health-Agriculture committee to establish pesticide tolerances in all crops. As mentioned earlier, the tolerances established parallel those established by foreign interests. The enforcement of tolerances is an area of crisis for the country's export crops, and the government is making an effort to establish a positive mechanism. The Ministry of Agriculture has requested funds from international sources to establish eight regional laboratories in the immediate future. The Biological Institute of Sao Paulo has asked for an extension of its FAO grant to continue the activities of the Sao Paulo facility. The residue laboratory facilities of Brazil must be expanded quickly just to cope with present needs for residue analysis in foods grown for export consumption. There is interest in developing a research capability in residue chemistry but we argue that further development of research capabilities should be delayed until a workable regulatory system is in operation to meet export and domestic needs. Projects on metabolism of pesticides should be low priority in a country that cannot as yet enforce its own residue tolerances in products destined for local consumption.

Regulations exist for plant and animal sanitation but have only limited implementation due to insufficient personnel, equipment and facilities. Quarantine regulations are not considered of importance by many government officials principally because of difficulties in enforcement.

URUGUAY

Uruguayan Institutions and Research: Uruguay is a country approximately the size of the state of Missouri with a population of slightly more than 3 million over half of which live in the city of Montevideo. Its economy is traditionally based on agriculture with beef and wool the dominant exports. Only one-tenth of its arable land is devoted to horticultural or field crops; the rest is devoted to livestock production. The instability of the national economy has produced serious problems in agriculture research and production.

Research facilities sponsored by the federal government are located at Las Brujas, La Estanzuala, Sayago, and other smaller experiment stations. Personnel, facilities and equipment are

inadequate for the problems facing the nation. The lack of communications among government agencies and personnel is a perpetual problem in Uruguay. The research data available do not usually reach the grower, since publication facilities are inadequate and an extension service does not exist in the country.

The country supports but one university with a college of agriculture. Academic training appears to be restricted to the Ingeniero Agronomo level although some individuals have had additional post-graduate training. Research in most cases is restricted to problem identification, although long range research projects in entomology have been submitted that would provide needed data to identify economic losses.

There is interest in expanding the crop export base to include citrus, peaches, apples and cereals. Losses due to pests reportedly limit this expansion. Only with government support to expand research activities is there any hope of increasing large agricultural exports in these commodities.

Pesticide residues are not as yet limiting factors in exports. Government regulations in tick control on livestock and the limitations on available pesticide have tended to minimize residue problems.

Plant Pathology: Lack of funds and trained personnel seriously limit plant pathological research in Uruguay. Although the most important plant diseases have been identified, a great deal of work remains to be done in this area. Sudden wilt of citrus, is perhaps the most serious disease in Uruguay, a similar disease is also present in Argentina. Other important citrus diseases are those caused by viruses such as psorosis and exocortis. Potato seed viruses, wheat rust, septoria leaf blotch of wheat, and sunflower rust and rust and wilt of flax are also very important. A list of some of the most important diseases is given in Table 1. Due to student unrest and other problems, plant pathology has not been taught at the University for the past 3 to 4 years. There are apparently only three trained plant pathologists in Uruguay and only one at the M.S. level. Practically no research in plant pathology is evident at this time, except for limited variety trials of cereal and oil seed crops at La Estanzuela. With the exception of La Estanzuela, physical facilities, equipment, supplies and transportation are inadequate to perform even the elementary work now underway.

There is little communication among technical personnel and even less between technical personnel and the farmer. The lack of an extension service seems to be the primary cause of the latter. Publications at the technical, intermediate, and farmer levels are non-existent in Uruguay.

Nematology: Officials in the Ministry of Agriculture have not recognized the need for a nematologist in Uruguay in spite of preliminary soil surveys showing these plant parasites to be distributed throughout the country and attacking a wide variety of crops. To date, all sampling has been conducted by one entomologist whose training has been limited to a short course in nematology.

With increased emphasis being placed on the export of citrus, peaches and other fruits, every effort should be exerted to determine the nematode species involved with these crops and their economic losses.

Some of the most important nematode species observed in Uruguayan crops have been Meloidogyne spp., particularly M. incognita and M. arenaria on peaches, sugar beets, radishes, clover, and tobacco. There is some interest in the root-knot nematode on clover as it is a most important plant in the permanent pasture complex which is used in the production of meat.

Other potential problems exist with Heterodera schachtii in sugar beets, Xiphinema and Longidorus spp. in vineyards, and Tylenchulus semipenetrans attacking citrus. Effort should be made to regulate the movement of all nursery material, including vegetable transplants that have not been certified to be free of pathogenic nematodes.

Entomology: Entomological research in Uruguay is severely limited by lack of advanced training of personnel and lack of financial support for adequate salaries, laboratories, insectaries, greenhouses, supplies, equipment, scientific literature, transportation and technical help. Most of the resources appropriated for agriculture are directed towards livestock and range management. Entomological problems on range animals are apparently handled by veterinary specialists, but no information was available from them on losses caused by arthropod pests.

Much entomological effort in Uruguay is devoted to taking inventory of specific pests in fruits, vegetables, cereals, and pastures and stored products. The recognized entomological pests are listed in Table 3. The determination of economic thresholds is essentially in the proposal stage and estimates of losses are unavailable.

Major faunistic agricultural pests in the country include locusts and the larvae of several species of lepidoptera on pastures. Birds, mainly parakeets and pigeons, may cause a 20% loss in cereals, maize, sorghum, sunflower and fruits. Some 15 insect species are recognized as pests of stored grains and may cause a 15-20% loss annually. Leaf cutter ants attack all crops with Acromyrmex sp.

distributed over the entire country and Atta sp. limited to the northern part of the country. The med fly causes 10-20% losses in citrus and peaches in some years.

Weed Control: Weed control has been greatly neglected in Uruguay. Only two persons are actively engaged in weed control research in the Ministry of Agriculture. A third person is related to the program but other duties and lack of funds preclude active research on his part. (Private sugar cane companies have done considerable work in this field but their results and recommendations are generally unavailable to the public.)

The limited weed control research in Uruguay stems from a general unawareness of the seriousness of the problem. At the national university weed control research and teaching have been virtually nonexistant. Crop losses due to weeds, while probably extensive in most crops, have not been documented. The high prices of herbicides and their limited availability also suppress interest in, and the development of, adequate programs.

The return of a student from Oregon State University in 1971 (with a M.S. degree) has given great impetus to the weed control program at the "La Estanzuela" Experiment Station. Field experiments are presently underway in wheat, corn, sorghum, flax, peanuts, soybeans, sunflowers, minimum tillage, cultural control and competitions studies. Formal weed control research in pastures and rangeland will soon be initiated.

Training of additional personnel, and funds for on-going field research are the most urgent needs of the weed control program in the Ministry of Agriculture. Availability of replacement parts for equipment is becoming increasingly serious. The need for weed control courses in the University is also acute, though contingent upon the availability of qualified personnel.

Pesticides and Plant Quarantine: Uruguay has existing legislation which requires all manufacturers or importers of pesticides to be registered prior to offering for sale any products. This authorization to sell is obtained by submitting samples of the product for analysis along with the labeling which will be affixed to the product. Although the procedures established appear to parallel those in force in North America and Western Europe, limitations in local capability to enforce the intent of the regulations limit its effectiveness to a simple analysis of content (does the product in fact contain what the manufacturers say it does), and in some cases a biological evaluation of the effectiveness of the product when used as directed in the accompanying label. Uruguay does not possess a manufacturing capability for pesticides with the exception of wettable sulfur, and hence must import nearly

all of the products needed. The favorable pricing of organo-chlorine pesticides has led to their wide spread use throughout the country on both export and domestically consumed crops and livestock. Enforcement of residue tolerances in Western Europe and the United States have forced Uruguay to ban by decree the use of some organo-chlorine products in livestock production (Uruguay's principle source of foreign exchange), a decree unfortunately that can be effectively enforced only by banning importation of the products. Like Brazil, Uruguay does not have the analytical capability to protect its exports or its domestically consumed products from excessive residues. Two gas liquid chromatography instruments are available in Montevideo, one under the control of the central government in the Ministry of Livestock which is not available for routine analysis of pesticides or of their residues in crops. The second GLC is in the Federal University of Montevideo, controlled by the Faculty of Chemistry. This second instrument we were told is for educational use only and is not available for use in regulatory programs. Since these two instruments are in operation we must assume that there is at least a basic technical capacity to operate them. But we could not determine whether these instruments could be used to train additional technicians. The prevailing attitude among Ministry officials leads us to believe that neither laboratory could function to serve the country's regulatory needs. Assistance in equipping laboratories and training technicians is the most common request but unlike Brazil the local officials did not indicate willingness to commit local resources to this purpose.

Further complicating the pesticide problems in Uruguay are strict price and import controls on pesticides. The import quotas in existence limit volume to no more than $U.S. 2.8 million annually, a figure that has remained nearly constant over the last several years. Both public and private sources stated that present quotas are grossly inadequate to supply present needs, even though the national goal is to rapidly expand the production of meat, grain, and horticultural crops for export. Just how government planners expect to maintain quality in fruits and vegetables (fruits and vegetables we saw in the central market were of poor quality due to pest damage), grains and meat without liberalizing import quotas appears to be without rational. In addition we were told that although production loans for seed, land preparation, fertilizer and harvest were generally available to the producer, loans were not available to purchase pesticides. In order to protect themselves from losses due to rampant inflation, chemical companies have had to adopt a cash policy and abandon 180 days credit for their customers. There is little incentive for industry to initiate development and marketing programs when the market cannot be expanded without elaborate negotiations at high government levels. Uruguayan agriculture, the backbone of the national economy, has potential for expansion in many areas particularly in meat and grain with a minimum of pesticide use, but presently the country does not possess the capability to implement available pest management technology known to be effective in other agricultural areas of the world.

Perhaps significant is the attitude among technicians in relation to the problem of enforcement of residue tolerances. They said repeatedly that the established residue tolerances in Western Europe and the U.S. are used to willfully discriminate against the less developed producers of raw agricultural products. Although this argument seems to us to be without foundation, it is not easy to explain U.S. tolerances to people who are struggling to feed their own population while trying to maintain a competitive position in the world markets.

Uruguay must develop analytic capability to police its production of export crops. It must have the capability to establish appropriate intervals to harvest and it must develop regulatory capability to manage its domestic pesticide problems.

Uruguay does not have an effective quarantine system to prevent import of exotic pest species. Enforcement of regulations with the extensive geographic borders with Argentina and Brazil makes this a formidable problem. For example, an estimated 2,000,000 head of livestock are moved illegally into Brazil each year for slaughter. Obviously Uruguay must adopt effective measures of internal control and seek international cooperation to resolve this problem.

BOLIVIA

Bolivian Institutions and Research: Interest in agriculture has been greatly overshadowed by the mining industry of Bolivia. This results in minimal financial support to the Ministry of Agriculture. As a consequence agricultural research activities have been essentially non-existant. Only 2% of the annual budget is devoted to agriculture. This combined with an unstable government, an annual population increase in excess of 2.4%, and a large Indian population that practices subsistance-type farming contributes to a weak agricultural sector replete with technical and resource problems.

Two very different geographic areas exist in Bolivian agriculture; the "altiplano", that produces mainly meat and wool and limited cultivated crops; and the eastern sub-tropical area where almost 100,000 acres have been put into cultivation in the past 10 years.

Bolivia's agricultural future would appear dependent upon continued expansion and development of these eastern areas. Food imports could be drastically reduced if the proper incentives were provided to attract investors

The lack of technically trained scientists must be overcome by stronger university programs There is a great need to upgrade the faculties through advanced training outside of the country. Facilities and equipment must also be upgraded to provide the capability for high quality undergraduate education.

One bright light in Bolivia is the land-grant concept being incorporated into a newly formed University and College of Agriculture in Santa Cruz, located in the tropical area. Dr. Daniel Candia, Dean of the College of Agriculture is a highly competent administrator and educator. Everything possible to encourage his support is recommended. Certainly through the cooperative efforts of the College of Agriculture and the Saavedra Experiment Station at Montero, an outstanding research and educational organization could be developed. With adequate financial support this could become a reality.

Plant Pathology: Plant diseases in Bolivia are as serious as in any of the other countries visited but very limited research is being conducted. Limiting factors are; low salaries, lack of personnel with adequate training and poor facilities. Laboratories, equipment, scientific literature, transportation and technical help are totally inadequate. There are five plant pathologists in the country, four of them with M.S.degrees. Nevertheless, only two are working full time in plant pathology and are mostly engaged in diagnostic work; the other three spend

75-100% of their time in administrative duties. Some of the important plant diseases have not been identified and information regarding losses due to plant diseases is non-existant. Some of the most important diseases in Bolivia are; Helminthosporium leaf blights of corn, late blight of potatoes, virus diseases of sugar cane, rice blast, septoria leaf spot of wheat, gummosis and virus diseases of citrus. A preliminary list of the principal diseases of some of the most important crops is given in Table 1.

Student unrest has resulted in the closure of the University for 1 1/2 years with opportunities lost to utilize available funds to train young graduates in plant pathology. In Bolivia there is little or no communication among technical personnel and even less between technical personnel and the extension service and the farmer. Publications at the technical, intermediate and farmer level are fewer than in any country visited.

Nematology: To date, plant parasitic nematodes have received little attention in Bolivia. Three persons working in plant pathology expressed some interest in nematology. One of the three is Ing. Martha Bustos, plant pathologist with the Division of Sanidad Vegetal, Ministry of Agriculture, located in La Paz. She attended the nematology short course in Lima, Peru in 1971 conducted by Drs. Mai and Sasser. Lack of facilities and other responsibilities have prevented her from becoming active in nematology. A new laboratory is under construction and they hope to have sufficient equipment to extract and identify nematodes. Upon completion of the laboratory, Ing. Bustos will solicit plant and soil samples from the agricultural experiment stations and extension workers throughout Bolivia, extract the nematodes and initially send them to various institutions in the U.S. for identification.

Ing. Oscar Tapia located at the Saavedra Experiment Station in the Departamento (State) of Santa Cruz also displayed interest in nematode problems. He has made limited surveys but because of inadequate training and literature, his activities are basically restricted to observations of galled roots caused by nematodes in the genus Meloidogyne. He has been extracting nematodes and will send specimens obtained from the agricultural area of Santa Cruz to the Department of Plant Pathology, University of Arizona for identification. Ing. Tapia, who also serves as Director of the Experiment Station, will begin conducting classes in Plant Pathology at the University of Santa Cruz in the near future. His already overburdened work load and responsibility will be further diluted by this new activity.

Conflicting testimony exists concerning the importance of root-knot nematodes in cotton. Ing. Tapia indicated that horticultural crops were severely attacked in many fields.

However, when cotton followed these crops, no root galling was found. This would indicate that Meloidogyne javanica is the probable species involved. Instructions were given to use a bioassay method to differentiate the species.

In discussions with several farmers and with Dr. Daniel Candia, damage from root-knot nematodes in cotton was mentioned. Arrangements have been made with Mr. Max Long of the Utah State University USAID Contract to assist in the selection of varieties resistant to root-knot nematodes

Ing. Favian Crespo is located at the Experiment Station in Cochabamba where major research activities involve deciduous fruits and grapes. Unfortunately, Ing. Crespo has had no training in nematology. He has received a M.S. degree in Plant Pathology from Utah State University and received additional training in virus transmission studies at the University of Minnesota.

This area is also the major dairy center of Bolivia with pasture and alfalfa being of major importance. Nematode problems indicated in the Cochabamba area included nematodes attacking vineyards and alfalfa. In both cases these observations were of galls produced by species of the genus Meloidogyne. Ing. Crespo stated that damage in the winter-dormant varieties of alfalfa was severe in many fields. Alfalfa seed of the non-winter dormant type will be sent to the station for evaluation. These selections have excellent nematode resistance and should be of greater value in their cultural program than those varieties now being planted. No information was available concerning nematodes attacking the deciduous fruit trees. Ing. Crespo has agreed to send nematode specimens to the University of Arizona for identification purposes.

All three Bolivian plant pathologists were aware of the workshop that is to be conducted in Venezuela in January 1973 by the Dutch government. Apparently, none has received formal invitations or made application to attend the three-month session.

Because of the limited resources for research in nematology, it would appear from this visit that the most effective and expedient method of obtaining research capabilities in nematology in Bolivia would be to send a U.S. nematologist to the country for a short period to work directly with the three pathologists and perhaps entomologists who may be able to devote some of their time to nematological investigations. Specific time could be devoted to teaching research techniques especially those involving methods of evaluating losses caused by nematodes. During this same period, these individuals could develop interest in the importance of nematodes in disease complexes with other plant pathogens. This could also serve as a follow-up on the intended survey for nematodes which is to be conducted in cooperation with other institutions.

Entomology: Approximately two-thirds of the people in Bolivia live on farms but the agricultural industry produces only about 23% of the gross national product. Bolivia has the lowest gross national product per inhabitant in South America.

Major agricultural crops in Bolivia include sugar cane, potatoes, corn, bananas, other fruits and fresh vegetables. The production of cotton is rapidly increasing in the eastern lowlands. Major export crops include cotton, coffee, sugar cane, rice and tropical fruits while Bolivia is self-sufficient in corn, potatoes and wheat.

Plant protection in Bolivia has a very low priority with the federal government. Although small experiment stations are located in several areas of the country, they are understaffed, poorly equipped, and function with little federal support. Two entomologists with "Ingeniero Agronomo" degrees are employed by the Ministry of Agriculture, one in La Paz and the other near Cochabamba. Neither has adequate facilities, although a small laboratory is under construction in La Paz. Research objectives of these entomologists are: 1) incidence and economic losses due to insects; 2) control of insects with special emphasis on the use of insecticides; and 3) study the spread and reproduction of insects in relation to ecology. These objectives are generally not accomplished (due to lack of qualified personnel and financial support).

Two other entomologists, formerly with the Ministry of Agriculture, are now located in the lowlands at Santa Cruz and are employed by the Gabriel Rene Moreno University and/or by cotton and sugar cane interest groups. They have advanced degrees in entomology from U.S. universities and have active programs in identification and control of cotton and sugar cane pests, despite the lack of suitable laboratories and supporting facilities. Both individuals are actively engaged in teaching or on the job training programs of university students in the area.

The control of cotton insects in Bolivia consumes most of the insecticides used in this country. An effort is being made in the Santa Cruz area to reduce the amount of toxicant used in aerial applications of specific toxicants based on detailed scouting reports of pests in individual fields. Most of these efforts are undertaken through farmer cooperatives and should reduce production costs and accidental poisonings in the area. Control of sugar cane pests is, on the other hand, being attempted by introducing parasites into the Santa Cruz area from outside Bolivia.

The great diversity of crops and climate in Bolivia permits a wide range of insect pests. These pests are detailed by Squire[3]

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[3]Squire, F. A. 1972. Entomological problems in Bolivia. Pans 18(3):249-268.

and summarized in Table 3. The most serious pests include leaf cutter ants, fruit flies on citrus and deciduous fruits, and aphids on numerous crops. Important pests of major agricultural crops follow. Two sugarcane borers, Diatraea rufescens and D. saccharalis cause up to 30% loss annually. Small agromizid stem borers, Liriomyza spp., seriously damage potatoes, a staple food of most of the population. Cutworms, earworms, stem borers, and armyworms normally cause a 30% loss in corn. Twenty percent of the rice crop may be lost to armyworms, stem borers and spittle bugs. The most important pests of cotton are a leafworm, two species of Heliothis, an armyworm, the pink bollworm and three Dysdercus species.

Serious losses also occur in potatoes, corn, wheat, and sugarcane where aphids or leafhoppers are vectors of viruses or mycoplasma pathogens. Details of damage or vector - pathogen - host plant associations are unavailable due to the lack of trained personnel and equipment for transmission studies.

Weed Control: There is no organized weed control program within government supported institutions in Bolivia. Approximately ten weed control experiments have been conducted within various production programs of the Ministry of Agriculture during the last five years, resulting in very preliminary data. Trained weed control specialists and resources for a research program are seriously lacking within the Ministry of Agriculture and universities.

Although documenting data are not available, weed-caused crop losses are considered serious in the sub-tropical and high valley areas. When herbicides were used in a recent wheat experiment at the San Benito Experiment Station, Cochabamba, production increased nearly 30%.

An entomologist with a M.S. degree from the University of California is working in weed control for the Sugar Cane Growers Association (CNECA) in Santa Cruz. His research shows that losses due to weeds are high in both sugar cane and cotton. Furthermore, due to the large expansion of cotton (from 8,000 to 70,000 hectares since 1969), hand labor is becoming scarce and more expensive in the area.

An additional factor limiting the efficacy of hand weeding is the fact that many crops are planted with the initiation of the rainy season. Frequently, fields are too wet to enter for manual weed control practices for several weeks. It is precisely during these first 20-40 days that weed competition is most critical in the majority of crops.

Large areas are being cleared for crop production in the sub-tropics. After two or three years of cultivation a dramatic change is noted in the weed complex of these areas; grassy species

gain predominance over broadleaf species. The resulting infestation of these aggressive grassy species obligates most small farmers to abandon these fields and move to new lands. However, rapid settlement of this zone is restricting the alternative of moving to new land. Herbicides and advanced weed control methods are becoming a necessity if economical production is to continue in these areas.

There is a pressing need to initiate a program to catalog and study the biological and ecological aspects of the above cited changing species complex. This effort will become increasingly important as a more intensive agriculture develops. Several very serious grassy weeds (Rottboellia exaltata, Sorghum halepense, Imperata sp., and Trichachne sp.) are becoming established in localized areas. An in-depth biological-ecological study would aid in establishing a program to prevent the spread of these weeds throughout the entire area.

Pesticides and Plant Quarantine: On May 30, 1972 a decree reorganizing the "Servicio de Sanidad Vegetal" was signed setting forth an elaborate series of regulations to protect Bolivian agriculture from foreign and domestic plant pests and to govern the import and manufacture of pesticide chemicals. In Bolivia specific insects and plant diseases are identified for special control measures and restrictions on movement of host materials. Under the decree all pesticides are to be registered with the Ministry of Agriculture prior to sale in the country. Interestingly, this same decree prohibits the use of organo-chlorine chemicals on forage crops, oil crops and fruit, and states that residue tolerances shall be established on milk, meat, corn, beans, potatoes and rice, and sets forth minimum standards of safety in the application of highly hazardous pesticides. Unfortunately, little progress has been made in implementing the decree during the 6 months of existence. We were told that, of the four Administrative Divisions created by the decree, only the Division "Diagnostico y Campana Fitosanitaria" exists. The remaining divisions, "Pesticidas y Fertilizantes", "Importacion y Exportacion de Productos Vegetales", and "Agencia de Sanidad Vegetal" exist only on paper.

Although Bolivia's isolation in the west and the remoteness of the agricultural areas of the eastern lowland have placed the country in an enviable position to prevent the introduction of foreign plant and animal pests, present air communications and the developing highway network will quickly eliminate the existing natural barriers particularly in the sub-tropical eastern lowland.

Practical pesticide regulation does not appear to exist. Persons desiring to import pesticides can place orders with local salesmen and obtain delivery at reasonable prices in approximately 6 months without government interference or inspection. Except for the heavy use of pesticides in the production of cotton in the east, amounts used in Bolivian agriculture are low.

In the light of the situation we must recommend the immediate implementation of the existing plant quarantine and pesticide regulations. Although the Bolivians did not acknowledge the existance of residue problems, it is obvious that the threat of residue problems has stimulated the new bans against the organic chlorine chemicals. Residue tolerance enforcement simply does not exist in Bolivia, a situation that must be corrected to protect the country's limited export of agricultural products. No data exist on residue problems in domestically consumed foods, a situation similar to the other countries in South America.

ECUADOR

Ecuadorian Institutions and Research: Problems in pest management facing Ecuador are almost identical to those of Bolivia. The altiplano and the coastal tropics can be considered the major cultivated areas. Crops grown in the high mountain valleys are therefore quite different than those which are planted in the hot tropical lowlands In the latter, bananas are the most important crop as it constitutes one of the country's major agricultural exports. Cacao, coffee, sugarcane, and coconuts are grown extensively Oil crops such as soybeans, sesame, peanuts, castor beans and cotton are also planted in the lowlands. Potatoes, small grains and pastures for livestock grazing, are the principle crops of the higher elevations. In spite of its resource potential, Ecuador still finds that it must import various agricultural products to feed its rapidly expanding population.

There appears to be a growing awareness within government agencies that these imports can be reduced by increased agricultural production, which can result only from increased scientific knowledge. While financial support has been minimal in the past, there is now evidence of budget increases for agriculture. New physical facilities are completed or under construction for the Instituto Nacional de Investigaciones Agropecuarias (INIAP). This organization has dynamic progressive leaders who recognize the agricultural needs of the country and have developed well-founded long range plans for research to address these needs.

At present, professional scientists at the research stations are not only limited in number but also suffer from insufficient technical training required to fully execute their assigned responsibilities In most cases this is a direct reflection of the educational capability of the various Ecuadorian universities training these scientists Many of the institutions have remained closed for extended periods of time, have poorly trained and motivated faculty and there is little opportunity for application of classroom theory to agricultural production. Attractive salaries, enlightened administration, and adequate research facilities will assist in upgrading the universities.

What appears to be a totally ineffective extension service exists, and it simply serves to drain the already inadequate budget Research data that are developed all too frequently remain unavailable to the farmer.

Certainly the advances being made by INIAP must be emphasized. The basis for sound agricultural research is available through this organization in Ecuador.

Plant Pathology: In Ecuador most of the important plant diseases have been identified, with the exception of those caused by viruses, bacteria and nematodes. However, epidemiology, economic losses

Some of the important diseases that need attention in Ecuador are: Witches broom, monilia pod rot and black pod rot of cacao, sigatoka and Panama disease of bananas, Helminthosporium on corn, bacterial wilt and late blight of tomato, koleroga on coffee, broad bean rust and wheat rusts. A list of some of the most important diseases of the principal crops is given on Table 1.

Ecuador has a number of well trained plant pathologists, but few are working in their field of training and only about seven are engaged full time in research. The universities have few full-time professors of plant pathology and those interviewed are not involved in research. Often teachers have more than one job, and consequently teaching for them may be secondary in importance. Because of student unrest, teaching of plant pathology at the university level has suffered seriously in the last few years.

Agricultural research in Ecuador is conducted at the Instituto Nacional de Investigaciones Agropecuarias (INIAP), and, to a lesser degree, at the Ministerio de la Produccion and by the commercial pesticide companies. INIAP is one of the better organized, equipped, and managed research institutions in the countries visited. Santa Catalina and Boliche experiment stations have several well trained personnel, adequate physical facilities, equipment, and supplies. INIAP has enjoyed an amazing stability, strong leadership, and at least reasonable government support; this has assured project continuity and reasonable stability among its staff. However, low salaries are a complaint of INIAP technical personnel. The Ministerio de la Produccion, through the Department of "Sanidad Vegetal", performs some research as previously mentioned. However, their main responsibility is to provide service to farmers. The extension service seems to be extremely poor in Ecuador: consequently INIAP and the commercial pesticide companies do their own extension in plant diseases. Publications in plant disease control at the farmers level are prepared and distributed by INIAP.

Nematology. One person with nematological training was encountered in Ecuador. An Ingeniero Agronomo employed by the "Ministerio de la Produccion" had received training for approximately 12 months in Holland. This organization, Ministerio de la Produccion, has the responsibility of extension and regulatory functions with limited resources for research. Two entomologists, at INIAP branch stations at Boliche and Pichilingue, both in tropical areas, expressed interest in nematology and have conducted research in beans, sesame and soybeans that concerned nematodes. In the branch station at Santa Catalina, one of the two plant pathologists was also interested in nematodes and had investigated the possible complex between root-knot nematodes and a Fusarium disease attacking clover in permanent pastures.

In the coastal tropical areas two nematode problems were considered to be of major importance. In bananas, the burrowing nematode was quite common, broadly distributed and stated to be a limiting factor in production. Costs of chemical control were considered to be in excess of anticipated economic return. Several of the systemic insecticides had been tested by technical personnel of the National Banana Institute. These materials were ineffective and uneconomical. Unfortunately, there was no information available on nematodes attacking cacao and coffee, two of the major crops grown in the coastal area. Both coconuts and African oil palm are attacked by the nematode causing red ring disease. In the northern coastal area coconut trees are severely infected, resulting in the death of many trees.

Nematode surveys are in progress especially in the altiplano by the nematologist of the Ministerio de la Produccion. Of the total nematodes identified, those of interest and importance are the alfalfa stem nematode attacking alfalfa and two species of Heterodera which have been identified as H. rostochensis and H avenae in wheat Meloidogyne spp. are of significant importance in vegetables especially tomatoes. Of interest is the fact that Ditylenchus dipsaci is reported on alfalfa, onions and garlic. In alfalfa, it is found in the principal alfalfa seed producing area and thought to be distributed to non-infected areas by contaminated seed

Entomology: The large number of crops grown support a wide range of entomological pests. Losses to insects vary with the season area and the efficiency of control practices. Typical estimates of losses to insects include; a 30-40% reduction in Cavendish bananas due to attack by the banana borer, a 70% reduction in pod set on cacao due to feeding by mirids, a 60% infestation of potato tubers by a weevil in fields that are repeatedly planted to potatoes, and a 85% loss in green and dry corn to larvae of lepidoptera and diptera that attack the loose husked, long silking-period corn used in Ecuador. These and other important pests of major crops are included in Table 3.

The two crops receiving most of the insecticides used in Ecuador are bananas and cotton Bananas are normally sprayed by aircraft with a mixture of toxaphene and oil to control the defoliating caterpiller Ceramidia viridis and sigatoka disease. In cotton, 10 to 12 chemical applications (35% of the cost of production) are made per season to control the worm weevil-aphid complex. On most of the small farms in the highlands, insecticides are applied with hand sprayers or dusters.

In general, insecticides are applied to crops with little information on their exact need or efficacy. Bulletins containing specific recommendations prepared by trained entomologists are generally not available. Most farmers obtain and use insecticides upon the direct recommendation of the insecticide suppliers. There is considerable concern among entomologists about the promiscuous use of insecticides in Ecuador, particularly with some of the highly toxic systemic materials.

The greatest deficiency in entomology in Ecuador is the lack of trained entomologists. Of the 8-10 working in entomology in the country, perhaps half have received training towards the M.S. degree outside of Ecuador. Most of these individuals are involved, at least part time, in research on practical field problems with INIAP, while the remainder are limited to teaching one or two courses in entomology at universities. Essentially no collaboration exists between entomologists in these different institutions.

Support for individuals working in entomological research in Ecuador is generally poor. Serious deficiencies exist in laboratories, insectaries, insect rearing facilities, basic supplies and equipment, reference material, transportation, and supporting personnel. It would appear that, with further normal development, the INIAP organization will be able to alleviate at least some of the above deficiencies, provide further graduate training for their entomologists, recruit additional qualified personnel with entomological interests, and serve as a viable nucleus for entomological research and information in Ecuador.

Weed Control: An active weed control research program has been developing within INIAP since 1969. A core of enthusiastic young scientists has been formed, consisting of six men with at least an Ingeniero Agronomo degree.

Four of these men have received additional training of 8-12 months under the Oregon State University/Instituto Colombiano Agropecuario weed control program in Colombia. One has recently obtained an M.S. degree in Mexico and another will soon finish academic requirements for an M.S. degree at Oregon State University and will carry out his thesis research at the International Tropical Agriculture Center (CIAT), Cali, Colombia. In addition, two university graduates are presently conducting thesis projects under the INIAP weed control program.

Losses due to weed competition have been documented in most annual crops, averaging from 15 to 20% with traditional control methods. *Panicum maximum* and *Cyperus rotundus* are two of the most serious weeds encountered in the lowlands. Water weeds, especially *Eichhornia crassipes*, have the potential of becoming a serious problem in many rivers and canals of the lowlands.

As a more intensive agriculture develops, residues from herbicides used in corn are becoming increasingly serious in corn-soybeans or corn-rice rotations. Also, continued use of atrazine in corn has resulted in a serious predominance of Panicum maximum in some areas. The INIAP weed control team is working on these problems and has been instrumental in making an alternative herbicide for corn available in Ecuador which when applied alone or in combination with atrazine or 2,4-D, controls Panicum maximum without leaving toxic residues for crops in this rotation. They are also educating farmers to the problems of herbicides in other rotations.

Weed control recommendations in corn, rice, soybeans, the small cereals and potatoes should be forthcoming in 1973. Within another year recommendations will also be made for cotton, bananas, peanuts, sesame, and possibly cacao.

In 1969 it was noted that an insect, Bactra sp., was causing the death of Cyperus rotundus. This insect was subsequently studied in cooperation with the entomology department at the Pichilingue Experiment Station for a possible biological control of this serious world wide weed. It does not appear practical at this point. Cultural control is also receiving considerable attention in the INIAP weed control program.

Despite high prices and a limited choice of products, the use of herbicides is increasing rapidly in Ecuador and will continue to do so as farmers gain confidence in the INIAP program. This was demonstrated by the enthusiastic response of more than 700 [illegible] visitors at a recent weed control field day at the Boliche Experiment Station.

Approximately [illegible] percent of the 100,000 hectares of rice in Ecuador were treated with herbicides in 1971. Other crops have a much lower herbicide usage.

Additional trained staff are needed to man fully other INIAP Experiment Stations and supply the manpower demands of commercial firms. New equipment, and maintenance of existing equipment, will also be needed for these stations. Greenhouse facilities at the Boliche Station would also aid in special studies of the biological relationships between crops-weeds and plants-herbicides, and soil residue studies. One of the strong points of the INIAP weed control program is the high degree of cooperation, planning and exchange of personnel between the various research centers.

Weed control activities in the universities have been limited to the University of Guayaquil where the leader of the Boliche weed control program is giving two night classes. University facilities are very inadequate for teaching and research.

Considerable research has also been conducted by two sugar cane companies and by commercial companies selling herbicides. However, these data tend to be of limited use to the small farmer.

Pesticides and Plant Quarantine: Pesticide and plant quarantine regulation although developing, is still in a primitive stage. Ecuador lacks pesticide manufacturing and formulation capability, and has directed its regulations at imported products. Although the usual requirements to prevent adulteration and misbranding exist on paper, the Ministry of Agriculture does not have even rudimentary analytical capability and hence does not enforce its regulations beyond the simple requirement that all products be registered prior to importation. Although the lack of enforcement would appear to be a severe handicap to the country's agriculture, and a source of constant problems, no one we talked with during our visit could site specific instances in which deficient or adulterated products had been used in agriculture. Perhaps this lack of specific problems can be explained in part by the limited use of pesticides at the present time, and in part by the control the local banana association, which includes both producers and exporters, place on the use of chemicals on that crop and their concern to protect this critical export in foreign markets. We were told that no pesticide would be used on bananas prior to approval by the U.S.F.D.A. On the surface this procedure would appear satisfactory but it is difficult to believe such voluntary control can be or remain entirely satisfactory on bananas, let alone the many crops grown for domestic consumption.

Plant quarantine and inspection regulations do exist and all imports are subject to search to detect exotic plant and animal pests. Unfortunately this system of plant protection does not function efficiently. (We entered Ecuador via Guayaquil and upon entry observed several fellow passengers carrying living plant material which was allowed entry). The problem here appears to be a lack of a professional plant inspection service and the adequately trained personnel to make a quarantine program effective.

Ecuador is in the process of developing plant pest regulations, the main provision of which is a requirement for farmers to take appropriate control action against as yet to be named pests. The intent of this proposed regulation is not necessarily against foreign pests, but rather, endemic pest species and it gives us the impression of being a lever against the farmer to force adoption of advanced pest control technology, primarily pesticides, although well intended, such a policy could lead to inumerable problems.

The pesticide residue situation beyond bananas is unknown. One interesting and critical problem of indirect contamination has

dwellings in which cacao is fermented, dried and stored. The dilemma in this case is do you change a traditional cottage industry or do you abandon DDT for malaria control? Neither choice is an easy one to implement. The only laboratory equipped to determine pesticide residues is located near Quito at the INIAP experiment station "Santa Catalina". This laboratory financed in part by the Swiss Government, has begun operations in pasture and grain quality analysis but as yet has not begun its planned survey of pesticide residue problems in the major crops grown in Ecuador. Although this laboratory appears fully equipped and, we were told, supplies and operating funds were no problem, the staff at the laboratory does not include a pesticide residue specialist and it is doubtful that the personnel there can effectively operate the kind of program that is needed.

Ecuador only recently removed all duties on pesticidal products to stimulate their use in expanding agricultural production. At the same time the government announced a plan to control prices of pesticide imports, a plan that chemical industry personnel fear may severely limit their ability to effectively introduce new products to the Ecuadorian farmer since it has been a frequent comment that the commercial salesman are the most effective delivery system of new chemical technology in insect, weed and plant disease control.

DOMINICAN REPUBLIC

Dominican Institutions and Research: Changes in government and subsequent policies regarding agriculture have adversely influenced research and crop production in the Dominican Republic. At present, there would appear to be insufficient long-range planning that would have an immediate influence on pest management problems. Several hundred (possibly as many as 300) students have been sent to agricultural colleges outside of the country and these have begun to return. Unfortunately, many cannot locate positions for which they are trained. This, coupled with inadequate programs, facilities, and salary incentives cause constant shifts of personnel with the most qualified leaving for better positions.

Plant protection problems are not identified with the exception of few crops. Sugar cane and rice both would appear to be in the progress of some long-range planning and investigation. The decision to divert the productive rice lands into the agrarian reform is unfortunate since production will no doubt be reduced and the increased production of rice that has resulted from the country's research will then need to be augmented by costly imports.

Deficiencies in academic training as well as total personnel in all areas of pest management were evident in most agricultural commodity areas. Increased export demand for both tobacco and meats has put the country in a advantageous position. Principally, through the effort of the Tobacco Institute and Texas A & M/USAID Mission, some of the principle production problems have been eliminated or avoided. Increased interest in production of bananas, coffee and cacao will undoubtedly suffer due to several serious plant protection problems that can influence their production. Certainly available water, and the climatic advantages put agriculture in a favorable position in the Dominican Republic. However, only through research efforts will the country overcome some of the serious deficiencies now facing its agricultural production.

Plant Pathology: Very little work has been done in the field of plant pathology in the Dominican Republic. Lack of trained personnel seems to be the limiting factor. Through the years very few Dominicans have received training in plant pathology and little help has been received in this field from international organizations operating in this country. However, some of the more important plant diseases have already been identified, with a great deal more effort needed (Table 1). Important diseases in the Dominican Republic are: Helminthosporium blight and virus diseases of corn; blast and Helminthosporium blight of rice; sigatoka and Panama disease of bananas; bacterial diseases and anthracnose of dry beans and lethal yellows of coconuts. Plant Pathology is being taught at the Central University and at the Universidad Nacional Pedro Henriques Urena (UNPHU). We only visited UNPHU, consequently, we are not in a position to comment on the national university. UNPHU is a relatively new university, being in operation for about 6 years. Although its physical facilities, equipment, and library are poor, the administration has a strong desire for improvement.

The Centro Nacional de Investigaciones Agropecuarias has poor facilities and is considerably understaffed. At this center the government provides information to the Extension Service, and farmers, and conducts some fungicide screening tests.

Research in plant pathology is also conducted by autonomous and private organizations, such as the Rice Institute, the Tobacco Institute, and La Central Romana (Division of Gulf and Western Americas Corporation), whose interest is sugar cane.

As in other countries visited, the Extension Service in the Dominican Republic is poor. Publications at the technical, intermediate and farmers level are practically non-existent.

Nematology: Nematodes are important economic pests of the major agricultural exports of the Dominican Republic. In spite of their importance, the country's scientific capability in this area

of pest management is essentially non-existent. One "Agronomo" without formal training in nematology is responsible for nematological identifications and investigations. While distance is not a major issue, his being located in San Cristobal does leave him at a disadvantage since this is not the principle agricultural area with nematode problems.

Perhaps of number one importance to agriculture production in coffee is the attack of a root-knot nematode, Meloidogyne exigua. This problem is compounded by serious infestations of Pratylenchus coffeae and Xiphinema americanum. These identifications were made by Dr. Eugenio Schrieber, consultant for IICA, who described the attack of nematodes to be one of the most serious pest management problems facing coffee growers in the Dominican Republic.

While major exports of bananas have been non-existent since United Fruit Company suspended its operations almost five years ago, there is renewed interest in this industry with efforts now in progress to replant old banana growing areas. The burrowing nematode, Radopholus similis, constitutes a major obstacle in this planned expansion since the pest seriously affects those plants now in production and was a serious problem to former banana producers.

There has been no serious attempt to evaluate nematological problems involved in cacao production. However, various species of nematodes have been recorded, including a Meloidogyne sp., that are said to cause severe galling of the cacao roots. With increased acreage of cacao being anticipated, and the production problems that now exist, there should be immediate nematode investigations involving this crop

Both Meloidogyne spp. and Heterodera spp. attack tobacco, one of the Dominican Republic's principle export crops. Capable scientists of the Tobacco Institute are cognizant of the problem and have indicated that investigations will be carried out in the near future to access the economic value of nematicide treatments. The Director of the Institute indicated that while Phytophthora root-rot was not a major problem, it is increased when the nematodes are present, thereby increasing the importance of nematode control.

While not of major economic significance it is interesting to note that garlic, used extensively in the country, is attacked by Ditylenchus dipsaci. This is a high value cash crop on the domestic market and up to $1,000 per acre can be realized from good production. Seed reportedly imported from Mexico was infested with the nematode and production has been seriously reduced in those areas where it was planted. Sanitation practices to reduce the incidence of infection were suggested.

Entomology: Of the seven individuals working in entomology in the Dominican Republic, perhaps 2 conduct research of an applied nature (mainly screening of insecticides), one works in insect taxonomy, and the remainder teach the one or two basic entomological courses offered by the various universities. Many have additional administrative responsibilities that dilute their efforts as entomologists. At least four individuals have received entomological training at the M.S. level or equivalent, outside of the Dominican Republic, but none has training to the Ph.D. level.

Entomology in the Dominican Republic is largely undeveloped. Little of the information obtained from applied research in the country reaches the farmer. Recommendations for insect control are made largely by companies selling pesticides, resulting in a probable overdependence on, and over use of, insecticides. No information was available on losses to specific pests although major pests of crops have apparently been identified[4] (Table 3). No entomologists were located at three research centers devoted to the improvement of rice, sugar cane, or tobacco, although insects are apparently responsible for significant losses in these crops.

Individuals working in entomology in the Dominican Republic are no less dedicated to their tasks than individuals working in other fields. At least some are aware of the desirability of integrated pest control programs and the reduction of insecticide usage to limit residues in domestic and export crops. Comments were made by entomologists and other individuals working at crop related research centers that insect transmitted pathogens cause "significant losses" in such crops as tobacco, corn, rice, and sugarcane. However, with the lack of sufficient numbers of well trained entomologists, little is being done to implement integrated control programs or identify and reduce losses to insect-vectored pathogens.

Weed Control: Considerable advances in weed control have been realized in the sugar cane and rice industries of the Dominican Republic. Weed control research has virtually been ignored in other crops.

Herbicides represent the majority of all pesticides used in the Dominican Republic. Some 70-75 percent of all sugar cane acreage is treated with herbicides. The recent development of a foliar applied herbicide has been a great aid in controlling grassy weeds which were becoming serious due to their resistance

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[4]Santoro, Rolando. 1960. Notas de Entomologia Agricola Dominicana. Secretaria de Estado de Agricultura y Comercio. Republica Dominicana. 474 pp.

to triazine and substituted urea herbicides Approximately 25-30% of the sugarcane acreage is cultivated by small "traditional" farmers (colonos), who rely mainly on hand weeding along with a very low level of other technical inputs. (Production per unit area by the "colonos" is about 50% of that obtained on the large plantations).

Rice is direct seeded in the Dominican Republic, thus rendering manual and mechanical weed control impractical. Water control and cultural practices are generally very deficient, resulting in an overdependence on herbicides for weed control. Approximately 90% of all rice acreage is treated with herbicides.

Weed control research, teaching, and extension are generally very inadequate within the Ministry of Agriculture and the various universities Frequently Ministry personnel are working out of their field of training in several areas, resulting in a dilution of their efforts.

A weed control research project has been established at the Ministry of Agriculture Experiment Station in San Cristobal, in collaboration with a West German technical assistance program. This program strongly emphasizes the biology and ecology of weeds, with an integrated control approach (cultural, mechanical, and chemical). An extensive collection of weeds found in most crops, with identification and life cycle data, is nearing completion.

Chemical companies have the most active "extension programs" in the country and are making "demonstration-type" experiments to convince traditional farmers to use herbicides (and other pesticides).

Misuse of herbicides (dosage and time of application) and improper applications are very frequent. In fact, improper applications have been so extensive that the government recently passed a law requiring that all aerial herbicide applicators have a special license and that aerial applications be made only in the presence of two "government inspectors". Training of personnel in government institutions is needed and short course training programs in pesticide use and safety are needed at all levels of the pesticide industry.

Additional research is needed in cultural control methods (land preparation, water control, etc.) to supplement and reduce the dependence on herbicides. More weed control research is also needed in pastures, horticultural and other traditional crops. The high cost of hand labor demands that the efficacy of present weed control methods be increased in the Dominican Republic.

Pesticides and Plant Quarantine: The Dominican Republic issued a decree in 1948 which established a reasonably complete set of regulations governing the manufacture, importation and sale of pesticides In this decree, authority to regulate pesticide products and residues is given to the Secretary of Agriculture. In its fundamental purpose the decree compared with the usual registration laws intended to protect pesticide consumers. With the exception of the limited output of a small formulation facility operated by Shell Chemical, all pesticides are imported in ready-to-use form. Beginning as late as January 1972, the Secretary of Agriculture began to require all importers to submit samples of product as well as labeling prior to granting a certificate of registration. In addition to the submission of labels and samples of products, the companies are required to provide standard toxicological, physical, and efficacy data in support of their requests for registration. In response to a growing problem the Secretary of Agriculture now requires that all products be sold only in the manufacturers original labeled containers.

Although the above regulations are complete, the ability of the Secretary to adequately exercise its authority is limited. Analytical facilities to enforce adulteration and misbranding provisions do not exist.

With the exception of organo-chlorine residues in tobacco produced for export, no residue problems were cited as being of critical concern among other crops. The only residue facility in the Dominican Republic is in operation at San Cristobol and at the time of our visit, it was processing meat samples for pesticide residues. As in the South American countries visited, concern centers on crops grown for export and although the technicians recognize the potential for residue problems in domestic foods, the general attitude is to give local problems low priority for the immediate future. We were told that the "Instituto del Tabaco" plans to construct, equip and operate a residue facility to protect a lucrative source of foreign exchange.

Pesticide use regulations do not exist at the present time but several recent incidents in which herbicides drifted into adjacent crops during application to sugar cane has led to a proposal to require registration and we presume some competancy among aerial applicators using herbicides. Dominican agriculture is becoming increasingly dependent on pesticides to increase production None of the technicians interviewed expressed concern for the hazards of increased pesticide use nor toward alternate means of pest control.

Although an island nation has the most to gain from an effective inspection and quarantine program against agricultural pests we did not see nor find evidence that such an effort was

in operation. Bulk shipments of agricultural products, such as tobacco, soybeans, cereals, etc., are inspected at points of entry and fumigated as necessary. However, small lots, and especially tourist traffic, even though rigorously searched for contraband, can enter carrying live plant material. One entomologist in Federal Service indicated that customs officials did send him suspicious insect specimens for identification but we could not determine if this identification of specimens limited movement of the host material or simply was done for purposes of information. We did not find any indication of a training program for customs inspectors in pest identification.

Appendix I. Itinerary and Individuals Contacted for the Period October 22 - December 2, 1972.

October 22-23: Miami to Brazilia, Brazil

October 23: Brazilia

USAID

Mr. L. Abel - Project Manager

Ing. Targino Siqueira - Agricultural Specialist, A.I.D.O.

Ministry of Agriculture

Dr. Roberto Meirelles - Director General

Ing. Helio Teixeira - Head, Division of Plant & Animal Protection

Dr. Renato Ruschel - Plant Breeder

Dr. Targino Siqueira - Agric. Spec., A.I.D.O.

Dr. John Murdock - Senior Advisor to Director, Univ. of Wisconsin

Dr. Jose Carmin Dianese - Head, Biological Sciences Institute, University of Brazilia

October 24: Brazilia

USAID

Mr. William Rogers - RDO

University of Brazilia

Dr. Jose Carmin Dianese-Plant Pathologist

Ing. Armando Takatsu - Plant Pathologist

Ministry of Agriculture

Ing. Durual Herriques da Silva - Division of Plant & Animal Protection

Dr. John Murdock - Senior Advisor to Director, Univ. of Wisconsin

October 25: Brazilia to Rio de Janeiro

IPEACO Experiment Station - Brazilia

Ing. Wilson Soares - Head

DENEPEA Office - Rio de Janeiro

Ing. Salomao Aaronovich - DENEPEA Representative in Rio

Dr. Ady Raul da Silva - Wheat Geneticist, IPEAS

October 26: Rio de Janeiro

Universidade Rural do Rio de Janeiro - Km 47

Ing. Akiba Fugio - Plant Pathologist

Ing. Kimura Osamu - Plant Pathologist

Dr. Cincinnato Goncalves - Entomologist

Ing. Jose Hercio Carneiro Ribeiro - Entomologist

IPEACS Experiment Station

Dr. Octavio Drummond - Head, Plant Path. Sec.

Ing. Jose U. A. Barbosa - Agronomist

October 28: Rio to Illeus to Itabuna

CEPEC - Cacao Research Center, Itabuna

Dr. Paulo de T Alvim - Director
Ing Hermino Rocha - Plant Pathologist
Dr R D Sharma - Nematologist
Ing. Pedrito Silva - Entomologist
Dr. Saulo Soria - Entomologist
Ing Biswa Nath Ghosh - Plant Pathologist
Ing. Asha Ram - Plant Pathologist
Ing. Chhatthoo Ram - Plant Pathologist
Ing Joao Manuel de Abreu - Entomologist
Ing. Roberto Carvalho Bereira - Weed Control Specialist

October 29: Itabuna to Illeus to Rio de Janeiro

October 30: Rio de Janeiro to Belo Horizonte

IPEACO Research Station - Belo Horizonte

Ing E S Emrich - Director
Ing Jario Silva - Director, Regional Corn Program
Ing. Margareta Carvalho - Animal Nutritionist
Ing. Julio Pascoal Coelho - Botanist
Ing Jose Guido Gomez - Plant Pathologist

October 30-31: Belo Horizonte to Vicosa

Universidade Federal de Vicosa

Dr. Geraldo Martins Chaves - Plant Pathologist
Dr. Mauro Silva Reis - Plant Pathologist
Ing. Joao da Cruz - Plant Pathologist
Ing. Murilo G. Carvolho - Plant Pathologist
Dr. Silamar Farraz - Plant Pathologist
Ing. Jose Alberto Haueisen Freire - Entomologist
Ing. Jose Mario Braga - Entomologist
Mr. Raymond D William - Weed Control Specialist, Purdue Univ Project
Dr Robert Pickett - Chief of Party, Purdue Univ. Project
Dr Otto Andersen - Plant Pathologist, Purdue Univ. Project

October 31: Vicosa to Belo Horizonte to Sao Paulo

November 1: Sao Paulo

Instituto Biologico

Dr Oswoldo Gionnotti - Dir. Chem Section
Dr. Karl Silverschmidt - Plant Virologist
Ing. Mario B. Figueiredo - Plant Pathologist
Ing. Regina Mello Amaral - Plant Pathologist
Dr. Takao Namekata - Plant Pathologist
Ing. Celia Campos Lasca - Plant Pathologist

Ing. Elpidio Amante - Head, Entomology Section
Ing. E. A. Bitran - Entomologist
Dr. A. Lima G. Pereira - Bacteriologist

November 2: Sao Paulo to Piracicaba
Escola Superior de Agricultura Luiz de Quiroz
Dr. Hasino Tokeshi - Plant Pathologist
Dr. Luiz Gonzaga E. Lordello - Nematologist
Ing. Ailton Rocha Monteiro - Nematologist
Dr. Clyde C. Allison - Plant Pathologist
Dr. Carlos H. W. Flechtman - Acarologist
Dr. Gilberto Casadei de Batista - Entomologist
Dr. Paulo Nogueira de Camargo - Botanist
Dr. Roger Williams - Entomologist - Ohio State Project

November 3: Sao Paulo to Campinas to Sao Paulo to Porto Alegre
Instituto Biologico - Campinas
Ing. Wilson Brandao Toffano - Director
Ing. Sergeio Curi - Nematologist
Ing. Euardo Issa - Agronomist
Ing. Walter O. Heinrich - Entomologist
Ing. Nabor Dias Netto - Entomologist
Ing. Leao Leiderman - Agronomist
Ing. Luciano S. Paes Cruz - Agronomist
Ing. Nelson Grassi - Agronomist
Ing. Carlos Alberto Lobato los Santos - Agronomist
Dr. Helio Garcia Blanco - Agronomist
Ing. Raynaldo Forster - Agronomist

November 4: Porto Alegre
Universidad Federal de Rio Grande de Sul, Facultad de Agronomia
Dr. Jesse M. Scholl - Agronomist, Wisconsin Project
Dr. George Freitag - Agronomist, Wisconsin Project
Dr. Paul Lehman - Plant Pathologist, Wisconsin Project
Prof. J. P. da Costa Neto - Plant Pathologist
Ing. Nilton Rodrigues Paim - Agronomist

November 6: Porto Alegre to Montevideo, Uruguay
Ministry of Agriculture Rio Grande de Sul - Porto Alegre
Ing. Jamil Feres - Plant Breeder
Ing. Jamina C. Gomes - Plant Pathologist
Ing. Carlos Caio Machado - Plant Pathologist
Dr. Paul Lehman - Plant Pathologist, Wisconsin Project

November 7: Montevideo

USAID

Thomas O. Stephens - RDO

Ing. Juan C. Crespi - Assist. to RDO

Ministerio de Ganaderia y Agricultura, Centro de Investigacion - Fruticulture-Horticulture-Viticulture

Ing. Juan Curotto - Director of Center

Ing. Carlos Crisci - Entomologist

Ing. Joaquin Carbonel - Entomologist

Ministerio de Ganaderia y Agricultura, Centro de Investigacion en Sanidad Vegetal

Ing. Lucia Koch de Brotos - Director of Center

Ing. Lis Mesa - Plant Pathologist (Nematology)

Ing. Celia Boazzo - Plant Pathologist

Ing. Carlos Gandolfo - Plant Pathologist

Ing. Carlos Umpierre - Plant Pathologist

Ing. Agustin Ruffinelli - Entomologist

Ing. Mario Boroukhovitch - Entomologist

Ing. Germain Ott - Chemist

Ing. Juan V. Cappeletti - Weed Specialist

November 8: Montevideo

Experiment Station Las Brujas

Ing. Carlos Crisci - Entomologist

Ing. Joaquin Carbonel - Entomologist

Montevideo

Ing. Hugo Pablo Estaville - Shell Chem. Co. Representative

Ing. Jorge Fusario - Agroquimica Basso Representative

Ministerio de Ganaderia y Agricultura, Centro de Investigacion en Sanidad Vegetal

Ing. Mario Boroukhovitch - Entomologist

Ing. Germain Ott - Chemist

November 9: Montevideo to La Estanzuela to Montevideo

La Estanzuela Experiment Station

Ing. C. M. Tavella - Director

Ing. Carlos Rava - Plant Pathologist

Ing. Eduardo Locatelli - Weed Control Specialist

Ing. Alfredo Costells - Plant Breeder

Ing. Joaquin Carbonel - Entomologist

November 10: Montevideo to Buenos Aires, Argentina

Ministerio de Ganaderia y Agricultura, Centro de Investigacion - Fruticulture-Horticultura-Viticultura - Montevideo

Ing. Juan Curotto - Director of Center

Ing. Carlos Crisci - Entomologist

Ing. Joaquin Carbonel - Entomologist

Ing. Lucia Koch de Brotos - Plant Pathologist

Ing. Mario Boroukhovitch - Entomologist
Ing. Germain Ott - Chemist
Ing Juan C Crespi - Asst to RDO

November 12: Buenos Aires to La Paz, Bolivia

November 13: La Paz

USAID

Mr. Earl Smith - Acting RDO
Mr. Max G. Long - Agronomist, Utah Project
Ing Segundo Alandia B - Head Research Div., Ministry of Agriculture
Ing. Maria L. Hinojosa de Fernandez - Entomologist, Min. of Agr.

Ministry of Agriculture

Ing. Martha Bustos - Plant Pathologist
Ing. Maria L. Hinojosa de Fernandez - Entomologist

November 14: La Paz to Santa Cruz, Bolivia

Santa Cruz

Dr. Daniel Candia - Entomologist, Dean Agronomy Faculty, Univ. Gabriel Rene Moreno, Santa Cruz
Ing. Oscar Tapia - Plant Pathologist, Director, Experiment Station, Saavedra, Montero
Ing. Oscar Teran - Entomologist

November 15: Santa Cruz to Montero to Santa Cruz

Saavedra Experiment Station - Montero

Ing. Oscar Tapia - Plant Pathologist
Dr. Daniel Candia - Entomologist
Ing. Oscar Teran - Entomologist
Ing. Jose Luis Acebey - Agronomist
Ing. Angel Cordero - Agronomist
Ing. Hebert Zurita - Agronomist
Ing. Jorge Velasco - Agronomist, Nat. Inst. of Wheat, Ministry of Agriculture

Universidad Gabriel Rene Moreno - Santa Cruz

Dr. Prudencio Aramayo - Veterinarian
Dr. Daniel Candia - Entomologist

November 16: Santa Cruz to Cochabamba to La Paz

San Benito Experiment Station - Cochabamba

Ing. Juan C. Rodriguez - Agronomist, Director of Station
Ing. Jaime Salamanca - Agronomist
Ing. Alberto Cordova - Agronomist
Ing. Raul C Hinojosa - Entomologist
Ing. Favian Crespo - Plant Pathologist

November 17: La Paz to Lima

Ministry of Agriculture - La Paz

Ing. Abel Coronel - Director General of Agriculture

Ing. Maria L. Hinojosa de Fernandez - Entomologist

Mr. Max G. Long - [illegible]

Mr. Earl Smith - [illegible]

November 19: Lima to Guayaquil, Ecuador

November 20: Guayaquil

Boliche Experiment Station - INIAP

Ing. Francisco Valverde - Director of Experiment Station

Ing. Eduardo Calero - Agronomist

Ing. Jose E. Villacis - Entomologist

Ing. Eloy Salazar - Agronomist

Ing. Gilberto Munoz - Cotton Breeder

Guayaquil

Dr. Enrique Ampuero - Subdirector INIAP

Juan H. Kruger Company

Mr. Joaquin Tamariz - Sales Manager

Ing. Byron Sotomayor - Entomologist

National Banana Program

Ing. Gonzalo Gambarrotti - Director

Ing. Alfredo Jacome - Agronomist

Ing. Alejandro Barques- Agronomist

November 21: Guayaquil to Pichilingue

Universidad Central de Guayaquil

Ing. Victor Villao - Plant Pathologist

Ing. Byron Sotomayor - Entomologist

Ing. Jenny Escobar - Entomologist

Ing. Gardenia V. de Manging - Entomologist

Pichilingue Experiment Station - INIAP

Ing. Jorge Matamoros - Director

Ing. Marat Rodriguez - Plant Pathologist

Ing. Adolfo Cevallos - Entomologist

Ing. Daniel Navia - Weed Control Specialist

November 22: Pichilingue to Quito

USAID

Dr. K. C. Fine - RDO

November 23: Quito

Ministry of Production

Ing. Cesar A. Wandemberg - Head, Plant Pathologist

Ing. Hugo Vallejo - Plant Pathologist

Ing. Ramiro Eguiguren - Nematologist

Ing. Gabriel Andrade - Entomologist

INIAP
Ing. Fabian Portilla - Director General
Santa Catalina Experiment Station - INIAP
Ing. Juan Vega - Plant Pathologist
Ing. Julio Cascante - Agronomist
Ing. Herman Gonzales - Agronomist
Ing. Gilberto Merino - Entomologist
Mr. Nicholas Roulet - Chemist
Ing. Anthoney Rihs - Chemist

November 24: Quito to Caracas, Venezuela
Universidad Central, Facultad de Agronomia - Quito
Ing. Victor Proano - Plant Pathologist
Ing. Jose G. Donoso - Entomologist

November 26: Caracas to Santo Domingo

November 27: Santo Domingo
USAID
Mr. James Stone - Acting RDO
Mr. James Murphrey - Ag. Economist, Texas A & M Project
Universidad Nacional Pedro Henriquez Ureña (UNPHU)
Dr. Juan Tomas Mejia Feliu - President
Dr. Vinas - Head, Dept. of Biology
Santo Domingo
Ing. Manuel de Js. Viñas - General Manager, Antilles Chemical Co.
Agr. Sergio Almanzar - Pesticide Distributor
Mr. G. H. Crombie - Pesticide Distributor
Ing. Ramon Madera - Pesticide Distributor
Ing. Fernando Gonzalez - Pesticide Distributor

November 28: Santo Domingo to San Cristobal to Juma to Santiago to Santo Domingo; Santo Domingo to La Romana to Santo Domingo
Laboratorio de Sanidad Vegetal CNIA - San Cristobal
Agr. Eligio Hichez - Plant Pathologist, Head
Agr. Manuel Leonardo - Entomologist
Agr. Manuel Peralta - Entomologist
Dr. G. A. Jurgens - Weed Control Specialist
Ing. Raymundo Hansen del Orbe - Botanist
Rice Research Station - Juma
Agr. Jose M. Cordero - Head
Yin-Tieh Hsieh - Rice Breeder, Chinese Tech. Mission
Wen Li Hung - Plant Pathologist, Chinese Tech. Mission
Chan-Hsiung Wang - Hydraulic Engineer, Chinese Tech. Mission

Instituto del Tabaco - Santiago
Ing. Francisco Diaz - Director
Chi-An Wu - Agronomist
Romain P de Cock - Dir. FAO Program
La Romana
Dr. Raul E. Perdomo - Director, Agric. Research
Ing. Ricardo A. Santana - Entomologist

November 29: Santo Domingo
UNPHU
Dr. Hector Luis Rodriguez - Dean
Agr. Eligio Hichez - Plant Pathologist
Agr. Jose M. Cordero - Agronomist
Ing. Luis Guillermo Flores - Entomologist

December 2: Santo Domingo to Miami

Appendix II. Tables of important diseases, nematodes, insect pests and weeds in Brazil, Uruguay, Bolivia, Ecuador and Dominican Republic

Table 1. Important diseases in Brazil, Uruguay, Bolivia, Ecuador and Dominican Republic

Crop	Disease and Causal Organism	Country
Cotton	Angular leaf spot (*Xanthomonas malvacearum*)	Ec, Br, Bol
	Ball rot (*Physalospora rhodina*)	Ec
	Fusarium wilt (*Fusarium oxysporum* f. *vasinfectum*)	Br, Bol
	Cercospora leaf spot (*Cercospora gossypina* and *C. althaeina*)	Ec
	Fiber rot (*Cladosporium herbarum*)	Ec
Oats	Rusts (*Puccinia graminis*)	Ec, Uru, Bol
	(*P. coronata*)	Ec, Uru, Bol
	Fusariosis (*Fusarium* sp.)	Ec
	Stunt (Virus disease)	Ec
Rice	Blast (*Piricularia oryzae*)	Br, Uru, Bol, Ec, Dom Rep
	Blight (*Helminthosporium oryzae*)	Br, Uru, Dom Rep
	Straighthead (Non parasitic)	Uru
Avocado	Decline disease (*Phytophthora cinnamomi*)	Ec, Br
	Scab (*Elsinoe persea*)	Br
	Anthracnose (*Colletotrichum* sp.)	Br
	Dieback (*Phomopsis* sp.)	Ec
	Alga leafspot (*Cephaleuros virescens*)	Ec
Alfalfa	Wilt (*Fusarium oxysporum* f. *medicaginis*)	Ec
	Damping-off (*Pythium* sp.)	Ec
	Peca (*Pseudopeziza medicaginis*)	Ec, Uru
	Anthracnose (*Colletotrichum trifolii*)	Uru
Bananas	Panama disease (*Fusarium oxysporum* f. *cubense*)	Ec, Br, Bol, Dom Rep
	Sigatoka (*Mycosphaerella musicola*)	Br, Bol, Ec, Dom Rep
Coffee	Rust (*Hemileia vastatrix*)	Br
	Ojo de gallo (*Mycena citricolor*)	Bol, Ec
	Koleroga (*Pellicularia koleroga*)	Bol, Ec

Cacao	Witches broom (Marasmius perniciosus)	Br, Bol, Ec
	Monilia pod rot (Monilia roreri)	Ec
	Black pod rot (Phytophthora palmivora)	Br, Bol, Ec, Dom Rep
	Mal del machete (Ceratocystis fimbriata)	Br, Ec
	Pink disease (Corticium salmonicolor)	Br
	Morte subita (cause unknown)	Br
Sugarcane	Leaf scald (Xanthomonas albilineans)	Br, Bol
	Red Rot (Physalospora tucumanensis)	Bol, Ec
	Smut (Ustilago scita)	Br
	Rattoon stunt (Virus)	Br, Bol
	Witches broom (Virus)	Ec
	Mosaic (Virus)	Br
Rubber	South American leaf spot (Dothidella ulei)	Br, Ec
Barley	Rusts (Puccinia graminis)	Uru, Bol, Ec
	(P. hordei)	Uru
	Smut (Ustilago hordei)	Ec
	Net blotch (Pyrenophora teres)	Uru, Bol
	Mildew (Erysiphe graminis)	Uru
	Stunt (Virus)	Ec
Citrus	Tristeza, Psorosis and Exocortis (Virus)	Br, Uru, Ec, Bol
	Canker (Xanthomonas citri)	Br
	Gummosis (Phytophthora sp.)	Br, Uru, Bol, Ec, Dom Rep
	Sodden wilt (cause unknown)	Uru
	Scab (Elsinoe australis)	Uru
	Melanose (Diaporthe citri)	Uru
Coconuts	Bud rot or leaf drop (Phytophthora palmivora)	Br
	Lethal yellows (Mycoplasma)	Dom Rep
Beans	Rust (Uromyces phaseoli)	Br, Ec, Dom Rep
	Bacterial diseases (Several species of bacteria)	Br, Ec, Dom Rep
	Mosaic (Virus)	Br, Ec, Dom Rep
	Anthracnose (Colletotrichum lindemuthianum)	Br, Ec, Dom Rep
	Angular leaf spot (Isariopsis griseola)	Br, Ec
Broad beans	Leaf spot (Mycosphaerella sp.)	Bol, Ec
	Rust (Uromyces fabae)	Bol, Ec
Corn	Leaf blight (Helminthosporium sp.)	Br, Bol, Ec, Dom Rep
	Mosaics (Virus)	Br, Bol, Ec, Dom Rep
	Smut (Ustilago maydis)	Uru, Bol, Ec, Dom Rep
	Ear Rot (Diplodia zeae)	Br, Ec
	Palmorado (Virus)	Bol

Peanuts	Brown spot (*Cercospora personata*)	Br, Ec, Uru, Bol, Dom Rep
	Southern blight (*Sclerotium rolfsii*)	Br, Bol, Ec, Dom Rep
	Rust (*Puccinia arachidis*)	Bol
	Root and stem rot (*Fusarium* sp.)	Ec
Apples	Scab (*Ventura inaequalis*)	Uru, Bol, Ec
	Powdery mildew (*Podosphaera leucotricha*)	Uru, Ec
	Black rot (*Physalospora obtusa*)	Uru
Potatoes	Late blight (*Phytophthora infestans*)	Br, Uru, Bol, Ec
	Virus diseases	Br, Uru, Bol, Ec
	Bacterial wilt (*Pseudomonas solanacearum*)	Br
	Rust (*Puccinia pittieriana*)	Ec
	Storage rot (*Fusarium* sp.)	Br
	Scab (*Streptomyces scabis*)	Uru
Tobacco	Wilt (*Pseudomonas solanacearum*)	Br, Ec
	Virus diseases	Br, Ec, Dom Rep
Wheat	Rust (*Puccinia recondita*)	Uru, Bol
	(*P. glumarum*)	Uru, Ec
	(*P. graminis*)	Br, Uru, Bol, Ec
	(*P. rubigo-vera*)	Ec
	Blotch (*Septoria nodorum*)	Br, Uru, Bol
	(*Septoria tritici*)	Br, Uru, Bol
	Aluminum toxicity	Br
Tomatoes	Late blight (*Phytophthora infestans*)	Br, Uru, Bol, Ec, Dom Rep
	Bacterial canker (*Corynebacterium michiganense*)	Br, Ec
	Bacterial wilt (*Pseudomonas solanacearum*)	Br, Ec
	Virus diseases	Br, Uru, Bol, Ec, Dom Rep
	Early blight (*Alternaria solani*)	Ec
Grapes	Gray mold (*Botrytis cinerea*)	Ec
	Downy mildew (*Plasmopora viticola*)	Uru, Bol, Ec
	Powdery mildew (*Uncinula necator*)	Uru, Bol, Ec
	Anthracnose (*Elsinoe ampelina*)	Uru, Ec
Peaches	Witches broom (*Taphrina pruni*)	Uru, Bol
	Brown rot (*Monilia laxa*)	Uru, Bol
	Crown gall (*Agrobacterium tumefaciens*)	Uru, Bol
Sunflower	Rust (*Puccinia helianthi*)	Uru
	Black rot (cause not determined)	Uru

Flax	Rust (*Malampsora lini*)	Uru
	Wilt (*Fusarium oxysporum* f. *lini*)	Uru
Beets	Damping-off (*Pythium*, *Rhizoctonia* and others)	Uru
	Southern blight (*Sclerotium rolfsii*)	Uru
Soybeans	Bacterial diseases	Br, Bol
	Virus diseases	Br, Bol
Cassava	Bacterial blight (*Xanthomonas manihotis*)	Br
	Virus diseases, mosaic	Br
	Leaf spot (*Cercospora caribeae*)	Dom Rep
Cabbage	Soft rot (*Erwinia carotovora*)	Br
	Black rot (*Xanthomonas campestris*)	Br
Eggplant	Bacterial wilt (*Pseudomonas solanacearum*)	Br
	Wilt (*Verticillium* sp.)	Br
Mango	Anthracnose (*Colletotrichum gloeosporioides*)	Br
Onions and Garlic	Purple blotch (*Alternaria* sp.)	Br
	White rot (*Sclerotium cepivorum*)	Br
Papaya	Anthracnose (*Colletotrichum* sp.)	Br
	Virus diseases	Br, Bol, Ec
Pineapple	Brown rot (*Fusarium moniliforme*)	Br
Sorghum	Rust (*Puccinia purpurea*)	Dom Rep

Table 2. Important nematodes in Brazil, Uruguay, Bolivia, Ecuador and Dominican Republic

Crop	Nematode	Country
Alfalfa	*Meloidogyne* spp.	Dom Rep, Br, Uru, Bol, Ec
	Ditylenchus dipsaci	Ec
	Pratylenchus spp.	Br, Uru, Bol, Ec
	Trichodorus sp.	Ec
Avocado	*Xiphinema* spp.	Br
	Pratylenchus spp.	Br
Bananas	*Radopholus similis*	Dom Rep, Br, Bol, Ec
	Meloidogyne spp.	Br, Bol, Ec
	Helicotylenchus sp.	Br, Ec
	Scutellonema spp.	Ec
	Pratylenchus spp.	Ec
Cacao	*Meloidogyne* spp.	Dom Rep, Br, Bol, Ec
	Dolichodorus sp.	Br
	Trichodorus sp.	Br
	Xiphinema spp.	Br
	Hemicycliophora sp.	Br
	Criconemoides spp.	Br
Coconut	*Rhadinaphelenchoides cocophilus*	Br, Bol, Ec
	Meloidogyne spp.	Br, Bol, Ec
Coffee	*Meloidogyne coffeae*	Br, Ec
	Meloidogyne exigua	Br
	Pratylenchus coffeae	Br, Bol, Ec
Cotton	*Meloidogyne incognita*	Dom Rep
	Rotylenchus reniformis	
Citrus	*Tylenchulus semipenetrans*	Dom Rep, Br, Uru, Bol, Ec
	Xiphinema americanum	Dom Rep, Br, Ec
Corn	*Helicotylenchus* sp.	Uru, Ec
	Tylenchorhynchus spp.	Br, Bol, Ec
Garlic	*Ditylenchus dipsaci*	Dom Rep, Ec
Grapes	*Xiphinema* spp.	Br, Uru, Ec
	Meloidogyne spp.	Br, Uru, Ec
	Pratylenchus spp.	Br, Uru, Ec

Oil Palm	Rhadinaphelenchoides cocophilus	Br, Ec
Peanuts	Meloidogyne spp.	Br, Ec
	Pratylenchus spp.	Br, Ec
Pineapple	Meloidogyne sp.	Br, Bol, Ec
	Helicotylenchus sp.	Bol, Ec
Potato	Heterodera rostochiensis	Ec
	Meloidogyne sp.	Dom Rep, Br, Uru, Bol, Ec
Rice	Pratylenchus brachyurus	Br
	Aphelenchoides besseyi	Dom Rep, Br
Rubber	Pratylenchus sp.	Br
	Xiphinema sp.	Br
	Hemicycliophora sp.	Br
	Trichodorus sp.	Br
Soybeans	Meloidogyne sp.	Br, Ec
Sugar Cane	Meloidogyne spp.	Br, Uru, Ec
	Helicotylenchus spp.	Br, Uru, Ec
Tobacco	Meloidogyne sp.	Dom Rep, Br, Uru, Ec
Tomatoes	Meloidogyne spp.	Dom Rep, Br, Uru, Bol, Ec
Wheat	Heterodera avenae	Ec

Table 3. Important insect pests in Brazil, Uruguay. Bolivia, Ecuador and Dominican Republic

Crop	Insect	Country
Apples	*Carpocapsa ponomella*	Uru
	Argyrotaenia sphaleropa	Uru
	Quadraspidiotus perniciosus	Uru
	Bryobia rubrioculus	Uru
Bananas	*Cosmopolites sordidus*	Br, Ec, Dom Rep
	Ceramidia viridis	Ec
	Scirtothrips sp.	Dom Rep
	Tetranychus sp.	Dom Rep
Beans	*Hedylepta indicata*	Dom Rep
	Ceratoma ruficornis	Dom Rep
	Anticarsia gemmatalis	Dom Rep
Cacao	*Selenothrips rubrocinctus*	Br, Ec, Dom Rep
	Atta cephalotes	Br
	Acromyrmex sp.	Br
	Monalonion bondari	Br
	Monalonion dissimulatum	Ec
	Xyleborus ferrugineus	Ec
	Toxoptera aurantiae	Dom Rep
	Xyleborus spp.	Dom Rep
	Bocchoropsis pharaxalis	Dom Rep
Citrus	*Orthezia praelonga*	Br
	Ceratitis capitata	Br, Uru
	Anastrepha fratercula	Br, Ec
	Frankliniella insularis	Uru
	Heliothrips haemorrhoidalis	Uru
	Aonidiella aurantii	Uru
	Unaspis citri	Uru, Ec
	Saissetia coffeae	Ec
	Saissetia oelae	Ec
Coconut	*Rhynchophorus palmarum*	Ec
Coffee	*Hypothenemus hampei*	Br
	Leucoptera coffeella	Br, Ec, Dom Rep
	Coccus viridis	Ec, Dom Rep
	Solenopsis germinata	Dom Rep
	Wasmannia auropunctata	Dom Rep

Corn	Heliothis zea	Br, Uru, Bol, Ec, Dom Rep
	Diatraea saccharalis	Br, Uru, Ec
	Spodoptera frugiperda	Uru, Bol, Ec, Dom Rep
	Agrotis ipsilon	Uru, Bol
	Mocis latipes	Bol
	Diabrotica sp.	Ec
	Heliothis virescens	Ec
	Euxesta obliquestriata	Ec
	Peregrinus maidis	Dom Rep
Cotton	Heliothis zea	Br, Bol
	Pectinophora gossypiella	Br, Bol
	Alabama argillacea	Br, Bol, Ec
	Dysdercus spp.	Bol
	Spodoptera frugiperda	Bol, Ec
	Heliothis virescens	Bol
	Anthonomus vestitus	Ec
	Bucculatrix thurberiella	Ec
	Dysdercus collaris	Ec
Flax	Plusia nu	Uru
	Helicoverpa gelotopoeon	Uru
	Peridroma saucia	Uru
Papaya	Empoasca papayae	Dom Rep
	Toxotrypana curvicauda	Dom Rep
	Cryptoblades aliana	Dom Rep
Pastures	Tomaspis entreriana	Br
	Pseudaletia adultera	Uru
	Peridroma margaritosa	Uru
	Spodoptera frugiperda	Uru
	Scyllinops sp.	Uru
	Dichroplus sp.	Uru
Peaches and Plums	Grapholita molesta	Uru
	Pseudaulacaspis pentagona	Uru
	Ceratitis capitata	Uru
Potatoes	Myzus persicae	Uru, Ec
	Macrosiphus euphorbiae	Uru
	Epitrix hortipennis	Uru
	Liriomyza quadrata	Bol
	Liriomyza brasiliensis	Bol
	Trichobaris trinotata	Bol
	Acordulecera sp.	Bol
	Empoasca spp.	Bol, Ec
	Premnotrypes vorax	Ec
	Epitrix sp.	Ec

Rice	Spodoptera frugiperda	Uru, Bol, Ec, Dom Rep
	Nymphula depunctalis	Uru
	Diatraea saccharalis	Uru, Bol
	Elasmopalpus lignosellus	Uru, Bol
	Mocis latipes	Bol
	Aeneolamia spectabilis	Bol
	Rupella albinella	Ec
	Oebalus ornatus	Ec, Dom Rep
	Lissorhoptrus oryzophilus	Dom Rep
Sorghum	Spodoptera frugiperda	Dom Rep
	Aphis maidis	Dom Rep
	Contarinia sorghicola	Dom Rep
	Diatraea saccharalis	Dom Rep
Soybeans	Nezara viridula	Br
	Elasmopalpus lignosellus	Br
	Trichoplusia ni	Br
Sugar Beets	Agalliana ensigera	Uru
	Myzus persicae	Uru
	Aphis fabae	Uru
Sugarcane	Leucocastnia licus	Br
	Delasser rubicundus indentatus	Br
	Mahanarva indicata	Br
	Sphenorhina liturata ruforivulata	Br
	Diatraea rufescens	Bol
	Diatraea saccharalis	Bol, Ec
	Metamasius bilobus	Bol
	Metamasius hemipterus	Ec
	Calisto pulchella	Dom Rep
	Elasmopalpus lignosellus	Dom Rep
	Diaprepes abbreviatus	Dom Rep
Sunflower	Plusia nu	Uru
	Homoesoma heinrichi	Uru
Tobacco	Myzus persicae	Dom Rep
	Phlegethontius sextus	Dom Rep
	Agrotis subterranea	Dom Rep
Wheat, Barley, Rye, Oats	Pseudaletia adultera	Uru
	Schizaphis graminum	Uru
Stored Products	Sitotroga cerealella	Br, Uru, Bol, Ec
	Sitophilus oryzae	Uru, Bol, Ec
	Sitophilus granarius	Uru
	Tribolium confusum	Bol, Ec

General Pests	*Schistocerca americana*	Bol
	Atta cephalotes	Br, Bol, Ec
	Atta colombica	Bol
	Atta vollenweideri	Bol, Uru
	Atta laevigata	Bol, Br
	Atta sexdens piriventris	Uru, Br
	Acromyrmex sp.	Br, Uru
Birds	*Myositta monacha monacha*	Uru
	Zenaidura auriculata chrysauchenia	Uru

Table 4. Important weeds in Brazil, Uruguay, Bolivia, Ecuador and Dominican Republic

Crop	Weeds	Country
Most crops	*Cyperus rotundus*	All countries visited
Rice, corn, oil seed crops, cotton, vegetables, plantation crops	*Echinochloa colonum*	Br, Bol, Dom Rep, Ec
Corn, vegetables, cereals	*Echinochloa crus-galli*	Uru
Rice, corn, oil seed crops, cotton, cereals, vegetables, plantation crops	*Digitaria* spp.	All countries visited
Rice, corn, oil seed crops	*Leptochloa* spp.	All countries visited
Corn, cotton, vegetables, oil seed crops, cereals	*Amaranthus* spp.	All countries visited
Rice	*Oryza sativa* "Wild rice"	Br
Rice	*Eleocharis* spp.	Dom Rep, Ec
Rice	*Ischaemum rugosum*	Br, Ec, Dom Rep
Rice, sugar cane, cotton, pastures	*Rottboellia exaltata*	Br, Bol, Dom Rep
Sugar cane, cotton, pastures, bananas	*Imperata brasilensis*	Br, Bol
Pastures	*Sporobolus indicus*	Br, Bol, Dom Rep
Pastures	*Sida* spp.	All countries visited
Pastures	*Eupatorium* sp.	All countries visited
Pastures	*Cynara cardunculus*	Uru
Pastures, cotton, sugar cane	*Sorghum halpense*	Bol, Br

Pastures, sugar cane	*Sorghum sudanense*	Dom Rep
Most crops	*Ipomea* spp.	All countries visited
Pastures	*Paspalum virgatum*	Dom Rep
Corn, cotton, pastures, plantation crops	*Paspalum* sp.	All countries visited
Corn, cotton, soybeans, peanuts, vegetables, orchards, vineyards	*Cynodon dactylon*	All countries visited
Cacao	*Setaria sulcata*	Br
Corn, cotton, oil seed crops, plantation crops, orchards, cereals	*Setaria* spp.	Br, Bol, Dom Rep, Uru
Rice	*Monochoria* sp.	Br, Dom Rep
Rice, corn, soybeans	*Jussiaea* spp.	Br, Bol, Dom Rep, Ec
Pastures, oil palm, cacao	*Axonopus* spp.	Br, Ec, Dom Rep
Corn, oil seed crops, plantation crops	*Euphorbia* spp.	All countries visited
Cereals, pastures	*Xanthium spinosum*	Uruguay
Corn, cotton, vegetables, orchards	*Portulaca* spp.	All countries visited
Vegetables, corn, bananas, citrus	*Oxalis martiana*	Br, Dom Rep, Uru
Corn, cereals, oil seed crops, cotton, plantation crops, vegetables	*Convolvulus* spp.	All countries visited
Corn, cotton, plantation crops	*Panicum maximum*	Br, Bol, Dom Rep, Uru
Most crops	*Bidens* spp.	All countries visited

Pastures	*Acanthospermum* spp.	Br
Pastures	Numerous "woody species"	All countries visited
Cereals	*Raphanus* spp.	Br, Uru, Bol, Ec
Cereals	*Brassica* spp.	Br, Uru, Bol, Ec
Cereals, vegetables, rice	*Alternanthera* spp.	All countries visited
Pastures	*Stipa* sp.	Br, Uru
Pastures	*Andropogon* sp.	Br, Uru, Dom Rep
Most crops and pastures	*Eleusine indica*	All countries visited