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ADMINISTRATIVE REPORT No. 004/80
INFORME ADMINISTRATIVO No.

END OF TOUR REPORT

Name: William M. Brown Jr.*

Date of Appointment: September 13, 1977

End of Tour: July 1st, 1980

Job Title: Plant Pathologist

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July, 1980

LA PAZ, BOLIVIA

ABOUT THE AUTHOR

Dr. William M. Brown, Jr. was born in Hastings, Nebraska, in 1935. He attended school in Livermore, California, a small agricultural community in the San Francisco area. He completed his B.Sc. in Plant Pathology at the University of California, Davis, in 1957, and his Ph.D. in Plant Pathology and Biochemistry at Oregon State University in 1965. Upon completing his Ph.D., he accepted a foreign assignment with the USAID/Colorado State University Project in Eastern Nigeria until 1967, then in Thailand with a USAID/University of Kentucky Project from 1968 to 1973. He then joined a UNDP/FAO Plant Protection Project in South Korea, where he worked as an Integrated Pest Management specialist. He returned to the Colorado State University Faculty again in July 1977 and was assigned to the CID Bolivia Project in September 1977.

During his career he has worked in most phases of plant disease detection, control, research and extension. He has also taught botany, plant taxonomy and plant pathology in different countries, vocational schools and in different universities. He is a member of several professional societies both American and foreign.

Dr. Brown, with his 15 years in foreign agriculture, is best known for his extension and foreign agricultural development interests. At the end of his tour in Bolivia (1977-1980), he is returning to the Colorado State University as Extension Plant Pathology and Colorado State Coordinator for Integrated Pest Management programs.

SUMMARY OF RECOMMENDATIONS

1. The CID Plant Pathologist should be replaced by a plant pathologist that has expertise in soil borne diseases.

2. The CID Plant Pathologist should be replaced only if IBTA hires a minimum of two new staff for Toralapa. One for plant pathology and one for entomology.

3. The new CID Plant Pathologist should concentrate on potato research at Toralapa (80%) and should assist the plant diagnostic clinic at San Benito (20%). Under no circumstances should CID staff continue to be involved in fruit research and development.

4. COTESU should be requested to staff a plant pathologist at San Benito.

5. Administration and manpower at the Toralapa Station should be changed to allow Ing. Gonzalo Claure more time as the Station Director.

6. The IBTA extension needs more subject matter expertise and specific commodity and technical support. Diagnostic and training programs should be expanded.

7. The University of San Simon needs to have a long-range USAID/Title 12 University Program that would eventually lead to doing away with the Ingeniero Agrónomo thesis degree program.

8. CIP and USAID/Bolivia must reorder their relationship and means of operating. More funding for commodities and specific funding for CIP selected and programmed participants is needed.

INTRODUCTION

The title "End-of-Tour Report" implies that the work is all done and it is the end of an individual's endeavor. This phrase is misleading in developmental agricultural programs such as the CID/Bolivia program. In truth, the work of CID in Bolivia and hopefully my own involvement in Bolivia are really just beginning.

In the three years I have spent in Bolivia I have come to know many of the problems confronting Bolivian agricultural development, IBTA, MACA, the universities and the donor agencies. In this report, I have attempted to give the background (results) of my endeavors in cooperation with my three very outstanding counterparts, Ing. Mery H. de Quitón, Mr. Vidal Velasco and Mr. Gerardo Caero. Their friendship, patience and help has made this a very enjoyable tour and the work reported here would not have been possible without them.

Also, I especially wish to express my appreciation to Ing. Mario Pérez who has given me considerable support and Ing. Jaime Salamanca, an outstanding research leader and experiment station administrator, who although not always in agreement, generously supported work towards our common goals.

The real content of this report though represents my own thoughts, attitudes and the culmination of many experiences while attempting to establish a viable plant pathology program in Bolivia. Thus my recommendations may cause some dissatisfaction in some of my colleagues both Bolivian and expatriate. My recommendations are made with considerable thought and in the best interest of a country, of a community and of friends that I value very much and carry a great concern for. I hope that some of what I have done will be of service.

JOB DESCRIPTION

The job description under which the CID plant pathologist was recruited is as follows:

> "Cereals Agronomist will be assigned as counterpart to the leader of the National Wheat Program at San Benito Research Station. His principal task will be to research, critical problems and develop related extension program as related primarily to wheat. Also, he will advise in the development and management of a project-wide improved, cereals seed multiplication and distribution program. He also will collaborate with University staff in research, teaching and student advisement."

In the CID 1977-78 Technical Plan of Work (007/77), it was stated:

"The Plan of Work reflects an attempt to move beyond the job classifications in terms of commodity specialities, i.e., cereals, oilseeds, etc., as set forth in the Contract and related documents. In addition to research on specific crops, the work program and training of Bolivian counterparts will extend to agronomic specialities such as pest management, plant pathology, irrigation, soil fertility, etc., and the research programs will reflect his focus."

In response to the need for a more specific job description for the plant pathologist, updated terms of reference were proposed in February 1978 that, retaining a commodity orientation, emphasized his speciality area. It is this latter job description that the present CID plant pathologist has been following:

"A plant pathologist will be assigned to Cochabamba. His principal task will be to advise and participate in potato research and seed improvement in support of the National Potato Program. In addition to this, he will participate in:

1. developing appropriate research in support of the national cereal improvement program;

2. participate in a general ongoing national disease survey and extension support activities; and

3. advise in plant pathological research and development in other programs where time allows and is appropriate within the definition of the IBTA/CID contract and the overall CID plan of work.

Collaboration with Bolivian University staff in strengthening research and teaching as well as advising students on thesis problems will be encouraged but will in no instance account for more than 10 percent of the technician's official time."

All elements of this latter job description have been addressed and most successfully carried out during the tenure of this technician. Specific accomplishments in the fulfillment of this job description are cited in subsequent sections of this report.

Toralapa Experiment Station

The Toralapa Experiment Station is the national center for potato research. The center is located at 71 Km on the Cochabamba-Santa Cruz road at an altitude of 3,500 m. The climate and soil are very representative of high sierra potato producing areas throughout Bolivia.

Potato Disease Research

Prior to the arrival of the present CID plant pathologist, there was very little plant disease research in progress. Dr. Ken Ellis, the former CID technician, in cooperation with Mr. Gerardo Caero had started investigations relevant to nematodes attacking potatoes. Upon arrival, the present CID plant pathologist sought to establish priorities for potato plant disease research. This was done in cooperation with Mr. Caero and the growing seasons of 1978-79 and 1979-80 saw the establishment of a very successful late blight (*Phytophthora infestans*) and early blight (*Alternaria solani*) control program. At the same time, definition of other potato disease problems was initiated. The following summaries define the results of the CID/IBTA cooperative potato research program. All work reported here was in cooperation with Mr. G. Caero unless otherwise specified.

Fungicide Control of Late Blight

Justification: Late blight, caused by *Phytophthora infestans*, is one of the main limiting factors in high yield production of potatoes in the more humid high areas of Bolivia. Appropriate chemical control is well known in many potato producing areas of the world, but had not been successfully established in Bolivia.

Objective: To increase potato yields through control of late blight disease with fungicides.

Results: Field trials were carried out in growers' fields in 1978-1979 and 1979-1980. Traditional fungicides as well as newer systemic *Phytophthora* specific fungicides (i.e., Ridomil and Curzate) were tested. Yield increases of

number one grade of potatoes (i.e., Sani Imilla and Imilla Blanca) were more than doubled with systemic fungicides.

Papers and Publications: Caero, Gerardo and William M. Brown, Jr. 1980. Control de la Enfermedad del Tizón Tardío (*Phytophthora infestans*) en Papa en Bolivia. Seminario Nacional de Investigación Agropecuaria y Forestal, Santa Cruz, March 14-16, 1980 .

C.I.D. 1979. Semiannual Report. CID Administrative Report 001/79 for period of January 1 - June 30, 1979. pp. 19-22.

Recommendations: (a) Chemical control of late blight is economically feasible for the Bolivian small farmer. Screening of new fungicides and fungicide combinations should continue with consideration of the development of more exact dosages, frequency and time of application. This work should be carried out only in the Escalante area where travel from Toralapa is feasible. For other areas, a package demonstration program should be prepared by Toralapa research personnel and operated by local extension agents. Possible use of five different treatments or treatment combinations and an unsprayed check would be sufficient. Each location should be carefully selected for uniformity and accessibility to growers. Each location could subsequently be utilized as a replication and supportive analysis could evaluate the success of the recommended practices. This type of demonstration could be worked into a regional trial program.

(b) Continued emphasis on deployment of suitable disease resistant material should receive high priority. Chemical control should be considered as a temporary approach only, or at most as part of an overall integrated management program.

Evaluation of Losses in Growers' Fields due to Erwinia caused diseases

Justification: Potato seed piece survival is quite poor in many growers' fields. One of the most common diseases causing decreased plant population is caused by *Erwinia* species attacking potatoes were present in Bolivia and the extent of their damage.

Objective: To determine the presence and distribution of *Erwinia* caused potato diseases in Bolivia.

Results: This study was initiated as a thesis program with Tito Revollo and the collaboration of Dr. Monty Harrison of Colorado State University. In 1979, a comprehensive survey was initiated that showed for the first time that *Erwinia* bacteria were widespread in Bolivian potato fields. The *Erwinia* species had not been found to be associated with potatoes in Bolivia prior to this time. Several conclusions are made from this study that have considerable significance. (a) Both *E. carotovora* var. *carotovora* and *E. carotovora* var. *atroseptica* were found to be associated with both healthy appearing and blackleg affected plants. (b) No isolations of *E. chrysanthemi* were found. (c) Although no yield or stand data were collected, the impact of this disease elsewhere is well known. Therefore, an evaluation of the *Erwinia* species impact on potato stands is essential.

Papers and Publications: Harrison, Monty, G. Carvajal, G. Caero, T. Revollo and W. M. Brown. 1979. *Erwinia* spp. Pathogenic to Potatoes Described from Bolivia. IX International Congress of Plant Protection and 71st Annual Meeting of the American Phytopathological Society, Wash., D.C., August 5-11, 1979.

Revollo, Tito, G. Caero, G. Carvajal, M. Harrison, and W. M. Brown. 1980. III Seminario Nacional de Investigaciones Agropecuarias y Forestales. Santa Cruz, Bolivia, March 14-16, 1980.

Harrison, Monty. 1979. Tour Report on the IBTA/CID Potato Pathology Program and *Erwinia* Survey in Bolivia. CID Working Paper 008/79, La Paz, Bolivia.

C.I.D. 1979. Semiannual Report. CID Administrative Report 001/79, June 30, 1979. pp. 23-24.

Revollo, Tito. Thesis in preparation.

Recommendations: The preliminary investigations reported here leave no doubt that *Erwinia* spp. are widespread in Bolivian potato producing soils. What is yet to be determined is the relative importance of these bacteria in the quality and viability of potato seed pieces. It is strongly recommended that a comprehensive crop loss program be developed (possible as a thesis project) to follow through on this initial investigation. Once the relative

importance of these bacteria to clean potato seed production is determined, then appropriate steps (i.e., stem-cutting production, etc.) can be taken if necessary to insure Erwinia seed potato production in Bolivia.

Potato Meristem Culture for Virus-Free Potato Propagation

Justification: The only available method to provide "clean" seed of Bolivian potato varieties and insure that they are free of virus is through the use of meristem culture. Prior to the arrival of the present CID plant pathologist, two Bolivian potato varieties were sent to CIP in Peru for this purpose.

Objective: To obtain Sani Imilla and Imilla Blanca potatoes free from known viruses.

Results: Tubers of these two varieties were sent to CIP in 1977 and placed in their meristem program. In late 1977, I brought the first meristems of this material back to Bolivia under permit from MACA and proceeded to propagate the meristems in isolation in my home in Cochabamba. After multiplying the original 6 meristems up to 50 plants, it became known that the CIP meristem program was contaminated with Spindle Tuber Virus. It was, therefore, considered to be to the best interest of the Bolivian program to destroy the material. I, therefore, autoclaved all plants, pots, soil and stem-cutting tools, thus terminating the attempted introduction in late 1978. No new importations have been attempted.

Recommendations: New meristem introductions should be attempted from CIP provided they are accompanied by a phytosanitary certificate specifically stating the material to be free of all known viruses including Spindle Tuber Virus.

Evaluation of Chemical and Biological Control for Rhizoctonia solani

Justification: Rhizoctonia disease is widespread in Bolivia. No economic and safe controls are presently available to Bolivian small farmers. Recent investigations by plant pathologists in Israel and the author's colleague, Dr. Ralph Baker (Colorado State University), have shown that it is possible to control Rhizoctonia solani on various vegetables by the use of a Tricoderma sp. of fungus.

Objective: To test the fungus Tricoderma sp. and available chemicals for the control of Rhizoctonia solani under Bolivian cultural conditions.

Results: A field with a history of Rhizoctonia solani was selected on the Toralapa Experiment Station. Two different chemical control methods and two different methods of applying Tricoderma were utilized. The results after the first season are inconclusive.

Recommendations: The experimental work with Tricoderma elsewhere has shown that it takes several subsequent croppings for the fungus to develop to a level where it becomes suppressive to Rhizoctonia solani. It is recommended that this research be continued: (a) in the same field utilized in the 1979-80 season, with the same treatments; and (b) trials be established in the greenhouse where subsequent generations of potatoes in pots can be developed more rapidly and under better control conditions.

Virus Diseases of Potatoes

Justification: Virus diseases of potatoes are probably the single most significant problem in a clean potato seed program. The CID plant pathologist has given support in cooperation with the CID potato breeder, Dr. R. Hoopes, to a virology program lead by Ing. Arturo Moreira (M.Sc. La Molina, Peru).

Objective: To characterize new virus diseases of potato; to characterize the virus disease components in the Bolivian germplasm collection; and to determine the prevalence of potato virus diseases in potential potato seed producing areas of Cochabamba.

Results: This area of investigation has concentrated on three thesis study areas. All are now completed and the persons involved are in the process of writing their theses. These areas are: (a) Characterization of Mop-Top, a virus disease new to Bolivia. Thesis investigation by Carlos Quitón, ASAR, Cochabamba; (b) Screening of Bolivian Native Germplasm Collection for Viruses. Thesis study by José Gutiérrez, CID becario*. (c) Determination of virus diseases of potatoes in potential potato seed production areas of Cochabamba. Thesis study by Rosario Claure, CID becaria.

Recommendations: The field of potato virology is a highly sophisticated area of investigation that is essential to the development of a clean seed potato program. It is fortunate that Ing. Moreira has had advanced training in

* Killed in an automobile accident, June 17, 1980. Thesis not completed.

this area and can concentrate on developing a strong virology program. It is strongly recommended that: (a) Ing. Moreira concentrates exclusively on virology problems and guide CID becarios in this area with the cooperation of Dr. Hoopes, the CID plant breeder, and Ing. Paul Egger, the head of the COTESU potato production program. (b) The CID acknowledge the need to strengthen the seed production/virology program through the introduction of improved monitoring techniques such as Enzyme-Linked Immunosorbent Assay (ELISA) and others. (c) That COTESU be encouraged to recruit a Swiss virologist such as Dr. Paul Gugerli to work with the seed production virology program.

Wart (Synchytrium endobioticum) Studies

Justification: Wart disease of potatoes is a very widespread disease in Bolivia. It is generally found in those areas where it is colder and wetter than normal and consequently potato producers living in marginal situations at higher altitudes suffer significant potato losses from this disease. There is little known about what kind of races of the fungus are present in Bolivia, sources of resistance or distribution of this fungus.

Objective: To evaluate potato wart severity and spread throughout the Cochabamba department. Identify races of the fungus present, sources of resistance and the reaction of selected native Bolivian lines to wart infection.

Results: Initial laboratory trials using the Glynne-Lemmerzahl method were failures. Consultation and one short-term visit by CIP wart specialists outlined the most appropriate approach to establishing a cooperative CIP/Bolivian potato wart program. A cooperative CIP/CID/IBTA survey of Cochabamba potato producing areas carried out in 1980 clearly showed this disease to be very prevalent. In some instances, 40-60% of the potatoes were affected in fields that had not had potatoes for at least five years. Clearly rotation is not an appropriate approach to controlling this disease.

Papers and Publications: Torres, H. 1980. Tour Report "Informe de Viaje a Bolivia" - CIP Internal Memo dated May 12, 1980. Lima, Peru, pp. 8.

Recommendations: The survey carried out by the CIP plant pathologist, Mr. H. Torres, and the present CID plant pathologist demonstrated that the potato wart disease is

important and widespread in Cochabamba potato producing areas. More than likely the same situation would be encountered in other areas of the country where potatoes are grown. Therefore, investigative work should begin in the following areas: (a) to determine the races of the potato wart organism by using differential potato varieties that react differently to different wart races; (b) explore potential for obtaining resistant varieties of potatoes (many sources of S. tuberosum are available). Any material imported should be accompanied by phyto-sanitary certificates and specially certified to be free of wart. This is essential to prevent the importation of any wart strains that are not in Bolivia already; (c) test the Bolivian native germplasm collection for tolerance to the wart disease.

A becario has been nominated to pursue some aspect of potato wart as a thesis project. He will work under Dr. Hoopes' supervision until such time as a new CID plant pathologist is designated.

New Potato Disease Survey

Justification: As control programs are developed for the principal potato diseases frequently minor or new diseases become significant. It is necessary to be continually on the alert to the emergence of new disease problems and to appraise their potential before they become major problems.

Objective: To detect new potato diseases and emerging potato production problems.

Results: A continuous survey of potato growing areas in the Cochabamba area has taken place since early in the CID contract. This program has resulted in the detection of Mop-Top virus, Erwinia diseases, leak (Pythium ultimum), Sclerotinia sclerotiorum, and Colletotricum sp. More recently three foliage diseases not previously recorded were noted causing considerable damage in potato fields. Powdery mildew disease (caused by Erysiphe cichoracearum) was noted by Dr. Kunkel, CID potato production specialist, to be especially severe in his field trials. Subsequent observations of other areas by the CID plant pathologist showed the disease to be widespread and potentially a very severe problem. During the potato wart survey with Ing. Torres of CIP, two additional leaf spotting diseases were noted, anular leaf spot (Septoria lycopersici) and another leaf spot caused by a Phoma species. Of the two, the Septoria leaf spot appears to be quite widespread and may be a potentially severe problem as well.

Papers and Publications: Torres, H. 1980. Tour Report "Informe de Viaje a Bolivia" -- CIP Internal Memo dated May 12, 1980. Lima, Peru. pp. 8.

Recommendations: Because the three foliage diseases had not been recorded prior to their recent appearance, there is no information as to how severe they may be. Therefore, it is proposed that field trials be established to evaluate the impact of these diseases. Crop loss trials should therefore be established on the Toralapa Experiment Station, Escalante, and Candelaria. Such crop loss trials should use a standard variety that is susceptible to all the diseases and fungus specific fungicides (i.e., Benlate and Pidomil) used to eliminate one or more of the diseases and thus through yield differences between treatments should determine the relative effect on yield of the different diseases.

Potato Insect and Nematode Research

Nematicide Testing

Justification: *Nacobbus* and *Globodera* species of nematodes attack the roots of potato plants and decrease their ability to effectively take up sufficient nutrients to sustain high yields. Chemical control is one aspect of an integrated pest management system to combat these parasites.

Objective: To economically and safely increase potato yields in nematode infested areas by the use of nematicides.

Results: Field investigations were initiated by Dr. Ken Ellis and Ing. Gerardo Caero in 1976-77 and 1977-78. Preliminary results indicated a possible yield increase and nematode population decrease. Subsequent trials in 1978-79 and 1979-80 have not shown the yield increases with nematicides.

Recommendations: (a) The cost of Temik and its hazard to man and the environment do not justify wide use of Temik under Bolivian small farmer conditions. (b) Increased emphasis and support should be given to the development of varietal resistance. Much progress is presently being centered on breeding for resistance and material is available from CIP that Dr. Hoopes and his IBTA counterpart staff can use.

White Grub Control

Justification: In certain areas of Bolivia (i.e., Colomi), the potato white grub (Phyllophaga sp.) can reduce yields up to 50%. Prior chemical control field trials have not been successful in effectively controlling this pest at the small farm level.

Objective: To obtain the most effective control of white grub.

Results: A field trial was established in 1978-79 in Colomi. Various chemicals were utilized and no clear cut control of an economically significant nature was obtained. In 1979-80, another trial was established in Colomi using chemical pest control materials, but additionally a potential biological control test was included. There was a significant increase in yield using Temik, but it is thought that it was due to control of some soil borne parasites other than white grub.

Recommendations: Additional trial work is needed in this area and should be carried out by the CID entomologist assigned to Toralapa. Chemical agents should continue to be a part of the program, but special attention should be given to biological control agents introduced by the reporting CID plant pathologist. These are: (a) Bacillus popiliae, a bacterium that attacks Phyllophaga sp. (b) Neoaplectana carpocarpsae, a nematode that attacks a very wide variety of insects in Coleoptera, Diptera, Heleroptera, Homoptera, Himenoptera, Isoptera and Lepidoptera.

Manpower Development

The general staff at Toralapa although enthusiastic is not sufficient in number or training to carry on the kinds of programs needed to develop a minimal potato research program in the plant protection discipline. More staff, equipment, budget, and advanced training is critically needed.

Ing. Arturo Moreira is one of the two men at the Toralapa Experiment Station that has a post-graduate degree. He is quite well trained in his area of speciality--potato virology. At the present time, he is far too broadly spread into administration, seed production and general plant pathology. It is strongly recommended that Ing. Moreira be permitted to devote his time exclusively to potato virology. His role should be limited to supervising becarios in virology related programs, cooperative

work with the plant breeding program in its search for virus resistance, and Ing. Moreira would be the prime counterpart for a possible COTESU virologist working on seed potato quality. Under no conditions should Ing. Moreira be deviated from virology studies into other non-virus areas of plant pathology-entomology, germplasm collection and experiment station administration such as is presently the case. Ing. Moreira has been trained to be and is a competent potato virologist. He must concentrate in this area if Toralapa is to have a viable team approach to potato research.

Romulo Claure has not been one of the CID Technician's counterparts, but his present role is such that it comes into contact with the pathology program and as such some comment is relevant here. Mr. Claure is presently involved in the seed production program at Toralapa. He has shown ability in developing his program. In general, he shows good potential and should be encouraged and considered for post-graduate training upon completion of his Ingeniero Agrónomo thesis. His training should be in the area of potato virology for the following reasons: (a) Potato viruses are the most critical problem in quality potato seed piece production; and (b) he has already had some training in virology while at CIP and has shown an aptitude for this area.

Gerardo Caero: This IBTA technician has been the principal counterpart of the previous and the present CID plant pathologist. Mr. Caero has demonstrated a considerable amount of ability and initiative in his work. He has been overdeployed having responsibilities in nematology, entomology, and plant pathology as well as frequently having to assume station management responsibilities due to frequent absences of Toralapa administrative staff. Mr. Caero is presently working at his level of ability and training. I would strongly recommend him for post-graduate work in a field of his choice in the plant protection disciplines as soon as he has completed his Ingeniero Agrónomo thesis. At the present time, I believe a post-graduate study with Dr. Monty Harrison at Colorado State concentrating in potato plant pathology would be the most beneficial to Mr. Caero and to the program of the station. This program should be initiated as soon as possible, but only if the present CID plant pathologist is replaced by a plant pathologist fluent in Spanish.

Manpower Recommendation: The staffing at Toralapa is not only insufficient, it is irresponsible upon the part of IBTA. It is beyond this author's experience and understanding that a program so vital to Bolivian agriculture should be so neglected. This is true for all staffing and is not only limited to the plant protection disciplines. But limiting my recommendations to plant protection, there is an urgent need for a minimum of three more technicians to be assigned to Toralapa. These should be: (a) A nematologist/soil insect position; (b) a general entomologist position; (c) a soil-borne disease position.

If these positions are not forthcoming, then I strongly urge that the CID plant pathology position not be restaffed. My reason for this is: it is neither logical nor right that one Bolivian technician (G. Caero) serve as a full-time counterpart to both a CID entomologist (Dr. Foster) and a new CID plant pathologist. In addition, it is hoped that Mr. Caero would leave for post-graduate training.

Toralapa Station Development and Management

USAID 053 Loan Program: This program, although logically conceived on paper, is the most inappropriate and mismanaged way in which to deploy funds for the development of an agricultural experiment station this technician has seen. The facilities and building are approximately three years behind schedule, poorly designed (even though this technician and other CID staff made repeated trips to USAID/La Paz to assist in design, none of our suggestions were ever incorporated), and poorly built. The experiment station staff and the CID staff were told that equipment ordered under the 053 program would be made available to Toralapa. None of the equipment that has arrived has been deployed to any location other than San Benito. Even there, a very limited amount has been made available to CID plant pathologist and his counterparts. In the experience of the CID plant pathologist, the 053 loan program as a source of support to the CID program in Toralapa is an absolute failure and embarrassment.

Recommendations: It is possible that with a conscientious effort on the part of USAID management staff, the above problem can be corrected by: (a) Increased involvement of USAID engineering staff in the finalization of the 053 building program underway at Toralapa. (b) Sufficient funds be set aside or a special appropriation be established to adequately equip the Toralapa Experiment Station laboratories.

Toralapa IBTA Administration: The administration of the Toralapa Experiment Station is completely inadequate. Day-to-day operations happen more by crisis management than by comprehensive planning. While I admire individual staff members, as a group they do not function as a team. There are several reasons for this, the most critical being:

(a) The Experiment Station Head: Ing. Gonzalo Claure is one of the people in Bolivia who has had post-graduate training (M.Sc. Plant Breeding, Utah State University). Unfortunately, he has not given the Toralapa station and staff the leadership and discipline needed to make it an effective research and development station. The principal reason is that he has had too many responsibilities such as: National Potato Program Leader, Experiment Station Director, Potato Production Agronomy counterpart to Dr. Kunkel and to Mr. Walker before him.

(b) Not enough technicians: There is a critical need for more IBTA staffing at Toralapa. Foreign advisory expertise--both CID and COTESU--is not being adequately utilized.

(c) Lack of timely and sufficient budget support for IBTA staff and experiment station programs: Workers are not paid on time; no money is available for maintenance, repair, or installation of equipment.

Recommendations: (a) Ing. Claure should continue exclusively as Toralapa Experiment Station Director. His agronomic duties should be assigned to newly recruited staff to serve as counterparts to CID and COTESU technicians. (b) Specific management responsibilities should be delegated by the station director at Toralapa to staff and CID/COTESU technicians. A minimum of these management committees should be: laboratories, greenhouse, shops and mechanical, fields and plot management and distribution, potato storage, other building management. In this way, one foreign expert will be working with one IBTA technician in a committee responsibility. This will have a double value in expediting administration effectiveness and giving counterparts station management experience. (c) Expedite appropriate budget support for station staff and activities. This is, of course, beyond the control of USAID/CID, but a reappraisal of the USAID/CID program targets should take place. If IBTA cannot establish and maintain the necessary budget support for the Toralapa Experiment Station, it is doubtful that CID can have any real lasting effect in the development of the station.

Toralapa Summary: The Toralapa Experiment Station and the potato research and development program offer the most promising way to help the Bolivian small farmer of the sierras and the altiplano. The need is very great and already some progress can be seen, but it is just a very little beginning. If IBTA can respond to needed improvement in administration, budget continuity and manpower development, continued USAID/CID support is warranted. Without these responses from IBTA, USAID/CID involvement at Toralapa should be terminated.

San Benito Experiment Station

The San Benito Experiment Station is the national center for cereal and fruit research. The station is located 35 km east of Cochabamba on the main road to Santa Cruz. The upper Cochabamba Valley (Valle Alto) is approximately 2,800 m high and has a climate suitable for a wide range of crops including fruit.

Cereal Disease Research

Studies on the Biology and Control of Helminthosporium Leaf Spot of Wheat

Justification: Considerable wheat production potential exists in the Santa Cruz area, but beginning in 1978 a severe leaf spot and seed decay disease was encountered.

Objectives: To determine the cause and control of the wheat leaf spot and seed decay disease in Santa Cruz.

Results: This problem was selected as a thesis topic by the CID technician's counterpart, Mr. Vidal Velasco. During the period 1978-1980, Mr. Velasco has demonstrated the disease to be caused by the fungus Helminthosporium sativum. He has evaluated the effect of the disease on many varieties and demonstrated a feasible control of the disease by the use of seed treatment. His thesis has been completed and is presently under review by the Faculty of Agronomy at San Simon University.

Publications and Papers: Velasco, Vidal and W. M. Brown, Jr. 1980. Mancha de la Hoja Causada por Helminthosporium sativum - Una nueva enfermedad del trigo en la región tropical de Bolivia. III Seminario Nacional de Investigación Agropecuaria y Forestal, Santa Cruz, March 14-16, 1980.

Velasco, Vidal. Thesis submitted to University of San Simon. CID 1979 Semiannual Report, CID Administrative Report 001/79 for the period January 1-June 30, 1979. pp. 53-54.

Recommendations: (a) The work carried out by Mr. Velasco and the CID plant pathologist has sufficiently defined both the cause and the control of this disease. For the time being, further investigations are not of a high priority to warrant a technician's time or station's budget.

(b) The disease should be taken into consideration when evaluating new wheat introductions for the tropical areas but little more than this is presently necessary.

(c) In the future, further research activity should concentrate on selection and deployment of resistant varieties.

Identification and Control of a New Rust Disease of Barley in Bolivia

Justification: In 1978-79, a new disease of barley was noted attacking barley in Bolivia. Subsequent identification showed *Puccinia striiformis* race 24 to be the causal agent. This disease was first introduced into Colombia in 1974 and for some time had been expected to show up in Bolivia.

Objective: To identify the best control for yellow stem rust (*Puccinia striiformis*) of barley in Bolivia.

Results: Initial work in 1978-79 lead to two conclusions:

(a) There were no resistant varieties readily available to Bolivian growers;

(b) It was economically feasible to control the disease with two well-timed applications of a rust specific fungicide Byleton. Further work in 1979-80 was carried out in two ways: (1) both seed treatment and foliar treatment recommended for the previous years' trials were incorporated into the regional trials program; (2) in addition field trials were established to determine optimum seed treatment, foliar application rates, time and number of spray combinations. This latter investigation was carried out as a thesis study by Pablo España. This study has confirmed prior findings and recommendations.

Publications and Papers: Velasco, Vidal and W. M. Brown. 1980. Incidencia y Control de una Nueva Raza de *Puccinia Striiformis* en Cebada. III Seminario Nacional de Investigación Agropecuaria y Forestal, Santa Cruz, March 14-16, 1980.

España, Pablo. Thesis in preparation.

CID. 1979. Semiannual Progress Report 001/79 for the period January 1-June 30, 1979. pp. 51-53.

Velasco, Vidal and T. Stilwell. 1979. La Roya Amarilla en Cochabamba. Hoja Divulgativa No. 3, Estación Experimental Agrícola de San Benito.

Velasco, Vidal and T. Stilwell. 1979. Control Químico de la Roya Amarilla en Cochabamba. Hoja Divulgativa No. 4, Estación Experimental Agrícola de San Benito.

Recommendations

(a) The work carried out by San Benito and CID staff to date is sufficient to incorporate a stripe rust integrated control program into the cereal recommendations for 1980-81 seasons. This program would involve: (1) use of a tolerant variety--Promesa; (2) seed treatment with Bytan; (3) foliar spraying with Byleton if disease incidence is noted prior to heading. To be effective, spraying would be necessary early in the appearance of the disease (i.e., at first sign).

(b) Other than evaluation of varieties for resistance in the ongoing cereal program no further research on this disease is considered to be of a high priority. Eventually, resistant varieties should be deployed and spraying with fungicides should be discontinued.

Fruit Disease Research

Crown gall on peaches (*Agrobacterium tumefaciens*)

Justification: Crown gall is the most important disease of peaches presently known in Bolivia. A large expansion of deciduous fruit production is presently taking place in Bolivia and this disease is a threat to the long-range success of the emerging fruit industry.

Objective: To define the distribution, method of detection, and control of crown gall under Bolivian conditions.

Results: Several activities have been initiated in the crown gall program. Much of what has been accomplished is part of the thesis study presently being written by Mario Jaimes, a CID becario. In early 1973, a strain of *Agrobacterium* radiobacter inhibitory to the crown gall

bacterial causal agent was discovered by Dr. Kerr in Australia. This bacterial isolate (K-84) has not been subjected to testing in several countries where crown gall is a severe problem and has reached the point of development where it is commercially used for crown gall control. In 1978, this biological control material was introduced into the Bolivian fruit program by the CID plant pathologist. It is now a routine part of the San Benito program when producing trees for local growers. In March of 1980, Dr. Art McCain of the University of California toured peach and apple orchards in the Cochabamba Department and reviewed the San Benito biological control program. The results of his cooperative effort with San Benito/IBTA staff and this author are presently in preparation but can be summarized as follows:

(a) Although crown gall is considered to be widespread in Bolivia, its spread is associated with the movement of infected propagation material;

(b) Bolivia appears to have only one strain of crown gall;

(c) The distribution and preparation of bio-isolate K-84 is being well done and should continue;

(d) More investigation as to crown gall strains present in Bolivia and the effectiveness of bio-isolate K-84 against these strains is necessary.

Publications and Papers

McCain, Arthur. 1980. Short-Term Consultant Report. Crown gall and crown gall control in Bolivia. CID Working Paper in preparation.

Quitón, Mery H. de, and W. M. Brown, Jr. 1980. Agalla de Corona. Hoja Divulgativa No. 13, Estación Experimental Agrícola de San Benito.

CID. 1979. Semiannual Progress Report 001/79 for the period January 1-June 30, 1979. pp. 66-67.

Recommendations

(a) Because of the importance of crown gall disease and its potential for variation and strain differentiation, an integrated control program is necessary. This program should involve: (1) strong quarantine to prevent possible new strains of crown gall from being imported;

(2) treatment of all seed and transplants with K-84 to prevent crown gall from infecting healthy plants at planting time; (3) distribution of only healthy plants with no sign or history of abnormal galls of any kind; (4) routine examination of newly planted orchards to detect crown gall and treatment with petroleum derived chemicals; and (5) careful management programs to prevent wounding of tree crowns and to prevent standing water next to tree crowns.

(b) Further research is recommended to test the use of local petroleum products for control of crown gall in established plantings.

Virus diseases of grapes

Justification: Virus diseases of grapes are common throughout the grape producing areas of the world. These viruses are generally limited to spread through propagating materials and can readily be spread during multiplication programs. Because of the rapid growth and importance of the grape industry to Bolivia, USAID and IBTA requested CID to survey the grape production situation in Bolivia.

Objective: To determine the incidence and distribution of grape virus in Bolivia.

Results: A grape virus disease survey was organized and lead by the CID plant pathologist in Bolivia in February-March of 1979. Dr. Austin Goheen, the ARS/USDA project leader in grape virology at Davis, California, was brought to Bolivia for this survey. A three-week tour of all grape growing areas in Bolivia was carried out in cooperation with MACA, IBTA and the Regional Development Corporations. The results of this survey demonstrated that:

(a) The grape virus diseases--leafroll, fan leaf and corky bark--are very prevalent in Bolivian vineyards;

(b) in most instances, these virus diseases are associated with propagating material originally imported from outside Bolivia under phytosanitary certificates (especially from South Africa and Argentina);

(c) although native Bolivian grape cultivars are comparatively virus-disease free, spread of virus diseases within Bolivia from indiscriminate propagative plant selection is a serious danger;

(d) Bolivia has the facilities, manpower and technology to establish its own virus-free indexing and propagative material program.

Because of the above findings, virus-free indexing plants were imported from the California program and were established in an isolation planting at San Benito.

Publications and Papers: Goheen, A.C. 1979. Short-term Consultant Report. Development of Grape Production in Bolivia. CID Working Paper No. 006/79. La Paz, Bolivia, March 1979. 29pp.

Crespo, Fabian, A.C. Goheen and W. M. Brown, Jr. 1980. Incidencia de Enfermedades Virales de Vid en Bolivia. III Seminario Nacional de Investigaciones Agropecuarias y Forestales. Santa Cruz, Bolivia, March 14-16, 1980.

CID. 1979. Semiannual Report 001/79 for the period January 1-June 30, 1979. pp. 67-68.

Recommendations:

(a) It is strongly recommended that San Benito initiate a virus-free grape propagation program. Virus-free mother plant material can be obtained from the USDA/University of California certification program. This material should then be grown in isolation according to Dr. Goheen's recommendations cited above.

(b) When this program is initiated, Dr. Goheen should be brought back to Bolivia to help initiate mother block planting, and to demonstrate indexing and rapid multiplication methods.

Manpower Development

Cereal Pathology

(a) Vidal Velasco has demonstrated outstanding development both in executing his own research and in contributing to other ongoing research. His thesis study on the Helminthosporium leaf spot of wheat is the best the author has been associated with. I would strongly recommend that Mr. Velasco be sent for post-graduate study as soon as his Ingeniero Agronomo degree is granted and he has developed a necessary level of language competency. I further recommend that his post-graduate study concentrate in cereal disease epidemiology and soil borne cereal diseases. This work should take place at Colorado State University under either Dr. Hill or myself.

(b) Pablo España is a CID becario that has been working on a barley stripe rust thesis problem. He has worked well under Vidal Velasco's supervision and should be considered for a regular appointment. This is especially critical if Vidal Velasco leaves for post-graduate training as I have recommended. Mr. España could work under Dr. Stilwell's direction and upon the return of Mr. Velasco from post-graduate training should be evaluated for graduate training in the U.S.

Fruit Pathology

(a) Fabian Crespo is designated as the San Benito fruit pathologist. Unfortunately, Mr. Crespo has consistently not been active in plant pathological research. The fruit research program at San Benito has suffered considerably because of Mr. Crespo's involvement in non-plant pathology activities. Occasionally, Ing. Crespo has become involved in the plant pathology program but never in a manner consistent with and for long enough period to develop a viable research program. Although he has a M.Sc. from Utah State University, he has never demonstrated either the ability, attitude or reliability necessary to become an adequate researcher. In summary, he appears entirely unsuited for and uninterested in his designated responsibility as a fruit disease research specialist. I strongly recommend that Ing. Crespo be reassigned to a non-research responsibility and that a new IBTA technician be recruited for plant pathology fruit research.

(b) Mario Jaimes began his work at San Benito as a CID becario studying crown gall. Mr. Jaimes is presently on the fruit production research staff and doing an excellent job. While working on his thesis, he demonstrated considerable interest and a sense of responsibility. I recommend that upon completion of his thesis and receipt of his Ingeniero Agronomo degree, he be sent for post-graduate studies leading to M.Sc. degree in fruit tree pathology. This graduate work, if at all possible, should be carried out with Dr. Larry Moore at Oregon State University. Dr. Moore is one of the leading crown gall workers in the U.S. and is already studying crown gall strains which Mr. Jaimes sent him from Bolivia.

(c) Tito Revollo began his plant pathology training at San Benito as a CID becario. Although he was studying a problem in potato pathology, he was involved in

most of the fruit disease investigations conducted by Ing. Quiton, Mario Jaimes, and me. Presently, Mr. Revollo is working as a fruit extension agent with the COTESU/IICA fruit program. Mr. Revollo has demonstrated considerable ability and interest in plant pathology. I would strongly recommend that he replace Ing. Fabian Crespo as the San Benito fruit pathology researcher. After two years working in that capacity, I believe that he should be sent for post-graduate studies in fruit pathology. This program should be carried out at the University of California, Davis, with either Dr. Bill Moller or Dr. Joe Ogawa. The other alternative, and the one most favored by me, is that Mr. Revollo carry out his post-graduate studies at Colorado State University under my direction where I will be leading the State of Colorado Integrated Pest Management Program in Fruit Production.

San Benito Station Development and Management

In the case of the San Benito Experiment Station, the 053 program has given considerable benefit even though it was extremely behind schedule. But again design and construction were very poor. These deficiencies were only corrected by the aggressive and outstanding leadership of Ing. J. Salamanca, the Station Director. As noted previously, the 053 equipment has for the most part been turned over to the new soils laboratory that is being by a FAO/Israel soil project and to date has been generally unavailable to CID technicians.

Recommendations: The 053 program buildings are completed. The construction is fairly adequate. The greenhouse unfortunately does not have the climate control equipment and the roofing material is the wrong kind (even though I advised USAID engineering staff and architects as to the correct type needed and provided addresses and sample materials). It is recommended that USAID more actively pursue the procurement and installation of climate control equipment for the greenhouse and additionally fund the replacement of the present roofing with the correct non-fade, high light transmission roofing, originally recommended by this technician.

San Benito Program and Research Management

(a) Cereals: The cereal team and program at San Benito is the best team research unit in Bolivia. This is in part due to the very active role of CIMMYT in

developing this program and present role of the CID regional trial specialist, Dr. Tom Stilwell. At the present time, the staff is well balanced but short of research funds. (I realize this is a general problem throughout Bolivia at this time.) There is a need for the present cereal staff to finish their Ingeniero Agronomo degrees and pursue post-graduate training. Only one is close to completing his Ingeniero Agronomo degree. The cereal pathology component is only one man, Vidal Velasco, and one becario working under his guidance, Pablo España. There is a need to eventually increase this number, but I believe this should wait for the other areas of cereal entomology and production to be improved. Mr. Velasco is competent to carry on the present pathology component without much supervision.

Recommendations: (1) There is no need for extensive plant pathology assistance to the cereal team above mentioned that already is being provided by CYMMIT and CID under Dr. Stilwell. A new CID plant pathologist should have minimal responsibilities to the cereal program and serve only as a consultant on a need basis.

(2) Mr. Velasco should be sent for a M.Sc. program as soon as possible while Dr. Stilwell is still working with the cereal team. Dr. Stilwell can help out during Mr. Velasco's absence by supervising necessary work in cereal pathology with CID becarios, such as Mr. Pablo España.

(b) Fruit: The fruit program at San Benito is under the guidance of a COTESU team. Although not a CID responsibility, numerous disease problems have continued to arise and the CID pathologist has repeatedly been pressured to assume responsibility for a fruit pathology program. Although I have attempted to assist where possible, the lack of cooperation and unreliability on the part of the IBTA fruit pathologist has made this attempt a failure. Presently, there is no fruit pathology research program. With the importation of large quantities of apples and other planting materials, problems such as crown gall and Phytophthora crown rot and viruses are becoming a serious problem. There is no concentrated program to screen varieties and root stocks. Locally selected materials especially grapes and peaches are highly infected with virus diseases, but yet these materials are being indiscriminately multiplied. There is, therefore, a critical need not only for a strong

fruit disease research effort on the normal problems of chemical control of mildews, rots, etc., but also for a strong virus indexing and a clean propagation of foundation stock. The process of bringing grape and apple materials under phytosanitary certificates from Brazil, Argentina and South Africa has been shown to be not safe. The validity of those phytosanitary certificates is open to severe question.

Recommendations: (1) The new CID plant pathologist should under no circumstances become involved in the fruit research and extension program at San Benito. (2) San Benito should reassign Ing. Fabian Crespo to other duties and deploy a new technician to develop plant pathological fruit research under COTESU direction. Tito Revollo is presently the best qualified person available for this position. (3) If COTESU is to continue to introduce and promote fruit tree production, then they should also assume the responsibility to carry out the research and development necessary to assure the distribution and maintenance of disease free plants. Therefore, COTESU should assign a plant pathologist to the San Benito Experiment Station to work cooperatively with the new IBTA plant pathologist.

San Benito Summary

1. Of the 8 major agricultural experimental stations* in Bolivia that I am familiar with, the San Benito Station is presently the best operated and managed facility for agricultural research in Bolivia.

2. The COTESU fruit promotion program is well managed but is deficient in the area of plant protection support.

3. The cereal program is working extremely well. It is relevant, well staffed and has a balanced approach to cereal improvement.

4. Ing. Salamanca has done an outstanding job in revitalizing the Experiment Station staff and program. His careful supervision of the 053 building program and response to needed charges has resulted in the creation of fairly functional facilities. He is to be complimented for his progress.

5. San Benito will need plant pathology and entomology staff in the future. Staff should be contracted now while the IBTA

* Toralapa, Chinoli, La Jota, Villa Montes, Saavedra, Belen, Patacamaya, and San Benito.

Insect Museum and the Plant Diagnostic Service are still at San Benito. In this way, the new staff could gain experience from these other programs before they are transferred to the new agricultural services complex under construction in Cochabamba.

Extension Support Activities

The lack of resource materials, technical assistance in plant pathology and diagnosis for the extension program and staff were at a critical stage upon the arrival of the present CID plant pathologist. Therefore, a plan was developed to provide essential plant pathology support to the extension service. This program has taken the three following approaches: (1) establishment of a diagnostic facility and staff; (2) initiation of a series of training sessions for extension specialists in on-field diagnosis and control; and (3) preparation of plant disease guides and extension bulletins.

Plant Disease Diagnostic Clinic: In 1978, the reporting CID plant pathologist initiated the IBTA Plant Disease Diagnostic Clinic program presently housed in facilities at San Benito. The San Benito Experiment Station Director has given outstanding support to the development of a suitable laboratory which is sufficient for most diagnostic and plant disease research activities. In 1978, through the efforts of the IBTA Regional Director, Ing. Perez, a plant pathology counterpart was hired to operate the clinic program. Ing. Mery de Quitón had ha little plant pathology experience prior to that time, but has responded extremely well and made outstanding progress. The clinic program is now a well established operation and is giving outstanding service. In its less than two years of operation, the list of known diseases in Bolivia has been more than doubled over the initial Host Index prepared by Dr. Ellis of CID in 1977.

Recommendations

1. The Plant Disease Diagnostic Clinic should be continued and, as soon as the new agricultural service center in Cochabamba is completed, the clinic staff, equipment and program should be moved to that facility. In this way, it will be more accessible to both extension personnel and growers.

2. Ing. Quitón should be given an opportunity for post-graduate study in diagnostic techniques. Because of her family situation (the mother of four children), it is unlikely she could undertake a Master's degree program. However, I would not hesitate to recommend her as the opportunity developed that would allow her to undertake such a study without hardship

and separation from her family. Presently, a special study program and visits to North American laboratories should be arranged for 1981, provided she is able to learn sufficient English to make such a program productive. The program should involve: (a) work experience in the California State Department of Agriculture Plant Clinic in Sacramento, California; (b) work experience in the laboratories of the University of California in Berkeley--specifically with: Dr. Arthur McCain, Extension Plant Pathologist; Dr. Milton Schroth, Crown gall researcher; and Dr. Bill Snyder and Dr. Shirley Nash Smith, Fusarium identification; (c) work experience in the Colorado State University Plant Disease Clinic under my direction. Such a program as this would give her an opportunity to work in several kinds of diagnostic and service situations.

3. Reference material and laboratory equipment for the diagnostic laboratory should accompany Ing. Quitón when the laboratory is moved to the new agricultural service center in Cochabamba. Also at that time, it might be necessary for the present CID plant pathologist to return to Bolivia for a short period to assist in the clinic transition. This will depend upon whether or not a new CID plant pathologist is recruited and what his experience is.

4. A new CID plant pathologist should spend a minimum of 20% of his time in the diagnostic clinic and extension support program.

Extension Training in Plant Pathology

In 1978-79, a series of extension workshops were held for training local extension agents in plant pathology field diagnosis and control. These workshops concentrated on diseases of potatoes, small grains, and fruit. The workshops were conducted using colored slides and field guides prepared by the CID technician. It was felt that this was a very valuable program and should have been continued. Unfortunately, a restructuring of the extension organization and lack of continuity in extension administration caused the workshops to be halted.

Recommendations

1. The extension workshop should be reassumed. Both plant pathology and other plant protection disciplines should be routinely involved.

2. The new CID plant pathologist should take an active leadership role in developing further components in plant pathology for the extension training program. This role could be in cooperation with Ing. Quitón and the plant clinic program.

3. More study and field guides on specific commodities should be prepared. Additionally, complete sets of 35 mm slides of specific diseases should be duplicated from my collection for use in training programs.

Preparation of plant disease guides and extension bulletins

In support of the extension training program, field diagnostic and control guides were prepared for potato diseases and small grain diseases. Also color handbooks on potato diseases and other commodities were obtained from CIP, CIMMYT and CIAT. These types of guides are extremely valuable and more should be developed specifically for Bolivian use. In cooperation with Dr. Stilwell and the San Benito staff, a series of grower bulletins were prepared. Most of the original bulletins are targeted toward specific plant diseases and pesticide safety. A complete list is included in Appendix No. 1. The preparation of such extension oriented pamphlets has been a great problem because of the inability of the IBTA communications office to process publications prepared by field technicians (Dr. Ken Ellis prepared three on potato diseases and nematodes before leaving in 1977 and they still have not been released by the communications department). Developing this responsibility on the regional level and preparing very low cost publications is a major breakthrough in extension communications. Dr. Stilwell and Ing. Luis Hermosa are responsible for this program and should be highly complimented.

Recommendations

1. More extension diagnostic and control guides should be prepared and funds be made available for their printing.

2. Technicians should continue to make use of the communications program now available in Cochabamba and prepare farmer oriented as well as technical bulletins for release through this media.

Special Problems

In the past, most foreign technical aid to extension has involved development of communication systems and use of extension communication experts. This type of activity has its role, but what is more critical is the development of a competent core of extension subject matter specialists.

1. IBTA should review its extension organization and consider the establishment of discipline oriented extension specialist positions on a Department level. Highest priority should go to initiating extension specialist positions in Entomology and in Plant Pathology. These specialists would then be responsible for developing technical support programs in their areas of expertise for the extension service.

2. USAID should fund specific extension subject matter specialist training fellowships to the M.Sc. level. Initial concentration should be in Entomology and Plant Pathology.

University Support Activities

Curriculum development and teaching

In 1977, the previous CID plant pathologist (Dr. Ken Ellis) had initiated a teaching and curriculum improvement program with the Plant Science Department at the San Simon University, La Tamborada campus. The present CID plant pathologist continued this program and actually taught the laboratory and field practical course for two years. The course was reorganized and titled Diagnostic and Field Plant Pathology. Course emphasis was on diagnosis and control of diseases. During the two years that I taught this class, I made the following observations: (1) The classes were very overcrowded and almost impossible to work with adequately in a laboratory/field practical situation; (2) laboratories and equipment were not adequately maintained; (3) laboratory preparations generally were not well prepared and frequently were prepared by the equivalent of a janitor; (4) frequent disruptions and suspensions of classes prevented class continuity; (5) insufficient staff training and number were very common. One professor (an entomologist) teaches entomology, plant pathology and nematology; (6) there are no adequate texts, references and resource materials. The library is almost non-existent; and (7) very little time was actually available for class field trips and funds for travel were also lacking.

Results: I taught the plant pathology practical course for two years and during this time: (1) Kodachrome slide sets were developed on the plant diseases relevant to the course and the area; (2) a mimeographed laboratory guide was prepared for the course that covered various aspects of specimen collection, media preparation, isolation and culture, use of microscope, identification of plant parasites, etc.; and (3) a junior staff member, Ing. Antonio Calderón, was trained to take over the course and now teaches the course independently.

Recommendations

1. Further duplication of Kodachrome slide sets is necessary so that complete units can be left with the University.

2. The present laboratory guide should continue to be expanded and eventually published for use in all Bolivian Plant Pathology courses.

3. The library and reference collection needs considerable development. Long-range subscriptions to essential journals is essential.

4. Class size should be limited to 15-20 and, if necessary, multiple sections taught.

5. A junior staff member (possibly a vocational graduate from ETA*) should be trained and made responsible for laboratory preparations. This same person should be trained in the correct maintenance of laboratory equipment and routine; scheduled cleaning and repair should be initiated.

6. Ing. A. Calderón is highly qualified to pursue graduate work leading to a M.Sc. in plant pathology. I strongly recommend that he attend Colorado State University and undertake these studies at the soonest possible time. Further I recommend that he study a general course in plant pathology on a non-thesis (Plan B) basis to allow him wider subject matter exposure. It would be most desirable if I could supervise his program to assure that it meets the needs of the University as well as of Ing. Calderón.

Ingeniero Agrónomo Thesis Supervision

The Ingeniero Agronomo degree in a South American University degree is generally accepted as the equivalent of a United States B.Sc. In Bolivia, this degree requires 5 years of class and practical work to achieve the Egresado. After this, a thesis research problem and manuscript must be completed before the Ingeniero Agronomo degree is granted. Quality of the thesis research problems varies considerably, but many are of exceptional originality and quality and would easily be equivalent to a M.Sc. thesis at many U.S. universities.

During my two years of association with the University, I have made the following observations relevant to the Ingeniero Agrónomo degree: (1) Most egresados never complete the thesis and the Ingeniero Agronomo degree; (2) there is only one faculty member presently on the staff that is qualified to supervise and judge a thesis in Entomology, Plant Pathology and Nematology; (3) many egresados experience considerable delay and ultimately give up because faculty take too long to review an individual's thesis and then demand that his thesis be reviewed many more times than is appropriate; (4) the inability of the University to help each egresado to complete his thesis and to achieve the Ingeniero

* Escuela Tecnológica de Agricultura is the University of San Simon vocational agricultural training school at La Tamborada.

Agrónomo degree is the major constraint to developing competent agricultural technicians in Bolivia; for without this degree no one can possibly qualify for post-graduate studies.

Results: In 1977, CID began a beca (scholarship) program that was designed to: (1) assist University students in completing the degree; (2) generate more relevant agriculture information for Bolivia; and (3) maximize utilization of CID technical expertise. The plant pathologist has supervised seven student theses by both CID becarios and non-becarios already working in government or industry, and he has been associated with three others. Refer to Appendix 2.

Recommendations

1. There should be a realistic and comprehensive review of the role and value of the Ingeniero Agronomo degree in contemporary Bolivian society. It is my view that this degree has outlived its value, is no longer relevant, and that it cannot serve a developing Bolivian agriculture.

2. If the Ingeniero Agronomo degree is to be retained, then it should have a thorough rennovation. Student supervision and thesis completion should become the priority responsibility and role of University staff. Merit evaluation based on quality and number of thesis completed should become a criterion for University faculty advancement.

3. CID should continue its becario program and working closely with the University staff.

4. Non-faculty and foreign professionals should be immediately brought into the faculty as full participating members for thesis supervision, review and responsibility in examination and approval of student thesis. This is especially critical in those disciplines such as plant pathology, entomology, etc., where local faculty competence and depth is generally lacking.

San Simon University General Summary

The Agronomic Faculty of the San Simon University (similar to other agronomic faculties in Bolivia) is critically suffering from a lack of qualified post-graduate trained faculty, of operational continuity, of budget, and of innovative teaching and student guidance. Without a dynamic faculty and course of studies leading to the production of competently trained agricultural technicians, the Bolivian agricultural sector has no possibility of advancing.

I strongly recommend that the University, USAID, and the Bolivian government develop a suitable Title 12 relationship with a competent U.S. University. The basic objective of the Title 12 program would be:

1. A well ordered, long-range development (minimum of 10 years) of the B.Sc. degree in agriculture. Under no circumstances should an attempt be made to develop a graduate program at this time.

2. All faculty should be evaluated and appropriate placement, further training and teaching responsibilities defined on merit, need and availability. This evaluation should be a joint University Administration/U.S. Title 12 University responsibility.

3. Suitable senior professional, bilingual U.S. staff should be recruited for long-term appointments (minimum 4-5 years) to take the place of and guide curriculum development in the absence of Bolivian staff sent for post-graduate training.

APPENDIX I

Publications and Papers Presented

Erwinia spp. pathogenic to potatoes described from Bolivia. Monty Harrison, Gastón Carvajal, Gerardo Caero, Tito Revollo, and William M. Brown, Jr.* IX International Congress of Plant Protection and 71st Annual Meeting of the Americal Phytophathological Society. Washington, D.C., August 5-11, 1979.

Control de la Enfermedad del Tizón Tardío (Phytophthora infestans) en Papa en Bolivia. Gerardo Caero* and William M. Brown, Jr. III Seminario Nacional de Investigaciones Agropecuarias y Forestales. Santa Cruz de la Sierra, Bolivia, March 14-16, 1980.

Incidencia de Enfermedades Virales de la Vid en Bolivia. Fabián Crespo, Austin Goheen, and William M. Brown, Jr.* III Seminario Nacional de Investigaciones Agropecuarias y Forestales. Santa Cruz de la Sierra, Bolivia, March 14-16, 1980.

Mancha de la Hoja causada por Helminthosporium sp., una Nueva Enfermedad del Trigo en la Región Tropical de Bolivia. Vidal Velasco and William M. Brown, Jr. III Seminario Nacional de Investigaciones Agropecuarias y Forestales. Santa Cruz de la Sierra, Bolivia, March 14-16, 1980.

Incidencia y Control de la Raza Nueva de Puccinia striiformis en Cebada. Vidal Velasco* y William M. Brown, Jr. III Seminario Nacional de Investigaciones Agropecuarias y Forestales. Santa Cruz de la Sierra, Bolivia, March 14-16, 1980.

Patógenos de Especies de Erwinia Encontrados en Papas en Bolivia. Tito Revollo*, Gerardo Caero, Gastón Carvajal, Monty Harrison, and William M. Brown, Jr. III Seminario Nacional de Investigaciones Agropecuarias Forestales. Santa Cruz de la Sierra, Bolivia, March 14-16, 1980 (Spanish translation of Erwinia paper above).

Establecimiento de una Clínica de Diagnóstico como Parte Esencial para Mejorar la Agricultura en Bolivia. Mery Herbas de Quitón* and William M. Brown, Jr. III Seminario Nacional de Investigaciones Agropecuarias y Forestales, Santa Cruz de la Sierra, Bolivia, March 14-16, 1980.

Extension Field Guides

Potato Diseases: A field diagnostic and control guide. Illustrated mimeograph. IBTA/CID, Cochabamba, Bolivia.

Wheat Diseases: A field diagnostic and control guide. Illustrated mimeograph. IBTA/CID, Cochabamba, Bolivia.

* Names underlined are of those authors who presented the papers.

Grower Bulletins (Hojas Divulgativas)

Ideas para el mejor uso de pesticidas. Don Foster and William M. Brown, Jr. Hoja Divulgativa No. 7, Estación Experimental de San Benito, 1980.

Clínica de Diagnosis para Enfermedades de las Plantas. Mery H. de Quitón and William M. Brown, Jr. Hoja Divulgativa No. 8, Estación Experimental de San Benito, 1980.

Moho Gris. Mery H. de Quitón and William M. Brown, Jr. Hoja Divulgativa No. 13, Estación Experimental de San Benito, 1980.

Pudrición de la Corona y del Cuello en Manzanos. Mery H. de Quitón and William M. Brown, Jr. Hoja Divulgativa No. 15, Estación Experimental de San Benito, 1980.

Grower Bulletins (Hojas Divulgativas)(on stencil, not yet printed)

Oidio de la Vid. Mery H. de Quitón and W. M. Brown, Jr. Hoja Divulgativa, Estación Experimental de San Benito, 1980.

Brazo Muerto de la Vid. Mery H. de Quitón and W. M. Brown, Jr. Hoja Divulgativa, Estación Experimental de San Benito, 1980.

Mildiú. Mery H. de Quitón and W. M. Brown, Jr. Hoja Divulgativa, Estación Experimental de San Benito, 1980.

Nectria de Chancro en Manzanos. Mery H. de Quitón and W. M. Brown. Hoja Divulgativa, Estación Experimental de San Benito, 1980.

Publications in Preparation or Planned as Technical Bulletins*

- Control of leaf diseases of potatoes
- Erwinia disease of potatoes in Bolivia
- New foliar diseases of potatoes in Bolivia
- Grape virus diseases of Bolivia and their control
- Cause, etiology and control of Helminthosporium disease in wheat
- Yellow rust in Bolivia. Its characteristics and control

Miscellaneous writings and contributions by the CID Plant Pathologist

- CID Annual, Semiannual and Quarterly Reports 1977-1980
- Role of Plant Pathology in Serving the Bolivian Small Farmers. In-house memo to Richard Peters, RDD/USAID in La Paz, 1979
- Laboratory Guide to Practical Plant Pathology. CID/UBMSS. Mimeograph, 1978-1979
- Commodity Recommendations for Juan Misael Saracho University, Tarija, Bolivia, 1980.

* Where relevant, these subjects will also be prepared in grower bulletin and/or journal article form.

APPENDIX II

Thesis Supervision

Ponciano Camacho: Estudio de algunos métodos de multiplicación vegetativa en cinco variedades de olivo. A CID becario who began under Dr. Ellis' supervision and finished under my supervision. He received his degree in April 1980.

Vidal Velasco Rivas: Estudio sobre la Mancha Gris y Punta Negra del Trigo causada por Helminthosporium sativum en el Norte de Santa Cruz de la Sierra. An IBTA cereal researcher, his thesis is finished and has been submitted to the Faculty.

Tito Revollo Quiroga: Detección de Especies de Erwinia en Zonas Productoras de Papa en Bolivia. He was a CID becario who now is an extension specialist with COTESU/IBTA. He is presently writing the thesis and will submit the first draft in July/August, 1980.

Mario Jaimes V.: Control Biológico de Agrobacterium tumefaciens en Durazneros. Mr. Jaimes was a CID becario who now is an IBTA fruit researcher at San Benito. He has written most of the thesis, but because of some problems with the inoculum in his field trials must carry out more laboratory and greenhouse studies. He will not finish his thesis until November/December at the earliest. Ing. Mery de Quitón will continue to assist and supervise his work.

Pablo España V.: El control químico de la roya amarilla en cebada en el Valle Alto de Cochabamba. A CID becario presently working at San Benito, he has completed his research and is writing the thesis. Vidal Velasco and Dr. Stilwell will continue the supervision of this becario's thesis.

Jesús Ricaldez S.: Caracterización y control químico de Cercospora del maní en la zona tropical de Bolivia. Mr. Ricaldez is a CID becario. His thesis has been completed and submitted to the Faculty.

Carlos Quitón P.: Potato Mop-Top, Una Nueva Enfermedad en Variedades Holandesas Introducidas de Solanum tuberosum. Mr. Quitón is the head field technician with ASAR. His thesis research is completed and he is writing the thesis. He plans to submit the thesis by August-September, 1980. Ing. Arturo Moreira will continue to assist him.

In addition to the above thesis students that I have been directly responsible for, I have actively assisted others with thesis studies in virology and nematology but whose actual thesis supervision was up to Ing. Arturo Moreira (Virologist, IBTA, Toralapa) and Dr. R. Hoopes (CID Potato Breeder, Toralapa).

René Torrico M.: Identificación de especies de Meloidogyne mediante huéspedes diferenciales. Mr. Torrico was a CID becario and has now completed his degree. He is presently looking for a position.

Rosario Vargas V.: Determinación de virus en cultivares comerciales de papa en zonas productoras de Cochabamba. Mrs. Vargas was a CID becaria working under Ing. Moreira's supervision. She has finished the thesis and submitted it to the Faculty.

José Gutiérrez R.: Determinación del porcentaje de cultivares nativos infectados con virus en el Banco de Germoplasma de la Estación Experimental de Toralapa. Mr. Gutierrez was a CID becario who worked under Ing. Moreira's supervision. He had finished his thesis and taken a position with ASAR when he was killed in an automobile accident. It is hoped that Ing. Moreira will publish the work posthumously.