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SEMIANNUAL PROGRESS REPORT (July - December 1980) AND PLAN OF WORK (1980-81)

Contract GOB/AID ~~053~~ 0451-007-HCC

between

the Ministry of Rural Affairs and Agriculture

and

the Consortium for International Development

Period: July 1st - December 31, 1980

SECTION I

INTRODUCTION

Publication of this Semiannual Progress Report and Plan of Work complies with the contract requirements of two such reports annually. This is the fourth semiannual report and is basically an outline of work plans for the 1930-81 growing season, and a report of activities between July 1st and December 31, 1980.

The format followed is the same for the previous reports and reflects the close colaboration between CID activities and those of the IBTA experiment stations.

The change in national governments on July 17, 1980 had significant effects on the administration and work of the contract. There has been a great increase in activity with students working toward Ingeniero Agrónomo degrees supported by MACA scholarships from AID Loan Fund 511-059. This has occurred because the universities were closed and students sought other methods to complete their studies. A separate section is devoted to reporting student activities at the end of each CID staff members' report.

A second significant effect of the revolution was the closure of the Santa Cruz operation. The Administrative Section documents this in more detail.

SECTION II

SEMIANNUAL HISTORICAL REVIEW

The contract has completed 5.5 years of a planned seven-year contract started in 1975. The composition of the technical team and the work agreed by contract has been changed many times. Effort is still directed, however toward the original goals of developing technical information for use by IBTA, MACA, and CIAT.

Contract Reduction

In February of 1980, because of lack of funds, USAID/B requested the contract be reduced from ten positions to four. This was unacceptable to CID and the lead university (USU), and it was finally negotiated at seven positions, which included the closing of the Santa Cruz office and concentration of effort in Cochabamba. An amendment was signed to effect the above on February 5, 1980. A few days later, the Minister of Agriculture was changed and the new Minister was not in agreement with what had occurred. During the months of May-June, discussions among MACA, IBTA, CID, and USAID/B were held and it was agreed to keep the Santa Cruz operation open with one technician (Agronomist) and move the other technician to Cochabamba. The documents amending the contract to restore the Santa Cruz operation were being prepared when the revolution of July 17 occurred.

The U. S. State Department removed support via USAID/B, and even though international contracts, e.g. CID-MACA, were honored, no changes or increases were permitted. The effect was to return to the agreement of February, and Santa Cruz was closed out. Dr. Foster moved to Cochabamba and Mr. Kidman was terminated from the contract's permanent team.

Saavedra Irrigation System

MACA/USAID approved purchase of a sprinkler irrigation system for the Saavedra Experiment Station. It was designed by a TDY consultant from USU, Dr. Richard Griffin (CID Working Paper No. 22/78) and purchased through Utah State University.

The equipment arrived in late September, and it was assembled and installed by Mr. Don Kidman before he terminated from the contract. Final installation and testing occurred in late November, 1980.

The purpose of the system is to provide supplemental irrigation, when needed, for the experiments as well as provide information about double cropping in the Santa Cruz area using irrigation. It will assure that genetic materials are not lost because of drought and give CIAT researchers valuable information and experience in soil moisture management.

Short Term Consultants

The CID contract was able to provide a great deal of short term technical assistance through a separate contract (511-96). The revolution of July made it impossible to renew this contract, and it was, therefore, allowed to expire.

It was originally planned that Mr. Kidman would be at Saavedra sufficient time to teach the local employees and CIAT technicians how to run the irrigation equipment and how to manage the soil moisture using the equipment. Officially closing of the Santa Cruz office prevented this so MACA, USAID, and CID agreed that Mr. Kidman would return for approximately two months beginning January 6 to perform this service on a TDY basis.

At the same time, he could continue advising the students in the Santa Cruz area and help with the soil fertility double/triple cropping study that is currently underway.

Personnel

Due to the changes dictated by the above events, the current composition of the contract team is listed below. It is anticipated that all staff will remain until the end of the contract.

1. J. H. Thomas, Ph.D., Crop Scientist (Party Chief), arrived in Bolivia July 15, 1980 replacing Dr. David W. James. Currently serving as counterpart to the Executive Director of IBTA and the Director General de Asuntos Agropecuarios of MACA. Party Chief and Director of Research for CID.

2. R. W. Hoopes, Ph.D., Plant Breeder-Potato Agronomist. Arrived September 22, 1978.

3. T. C. Stilwell, Ph.D., Soil Scientist-Agronomist. Arrived December 12, 1978.

4. R. R. Kunkel, Ph.D., Agronomist-Potato Research Specialist. Arrived January 11, 1979.

5. D. R. Foster, Ph.D., Agronomist-Entomologist. Arrived January 27, 1979.

6. Victor Otazú, Ph.D., Potato Pathologist. Arrived January 6, 1981.

Local Staff

The reduction in number of expatriate staff and the closure of the Santa Cruz office allowed the local staff to be reduced also. One secretary and two chaufferus were released. At present, the following are local staff.

No.	Position	Name	Location
1	Administrative Assistant	Lydia de Novillo	La Paz
2	Bilingual Secretary	Norah López	La Paz
3	Chauffeur	Edmundo Sánchez	Cochabamba
4	Bilingual Secretary	Magda de Pacheco	La Paz
5	Bilingual Secretary	María Teresa Bernal	Cochabamba
6	Chauffeur	Luis Fernández	La Paz
7	Chauffeur	Carlos Tejada	Cochabamba
8	Bilingual Secretary	María Luisa Tejada	Cochabamba
9	Bilingual Secretary	Marisol Udaeta	Cochabamba
10	Bilingual Secretary	Margot López	La Paz
11	Chauffeur	Jorge Heredia	Cochabamba
12	Janitor-Watchman	Vitalio Alvarez	Cochabamba

SECTION III

ACCOMPLISHMENTS

A. Administration

A.1 Chief of Party

A.1.1 Contract Negotiations. The administrative activities of the contract with reference to the Chief of Party have been much more difficult and frustrating than in past reporting periods. This was due in large part to the interruption and cessation of normal diplomatic and USAID activities between Bolivia and the United States. The U. S. Ambassador and USAID Mission Director were called back to the U.S. As further protest, 20 USAID expatriate employees were withdrawn in addition to numerous other agencies of the U.S. government being withdrawn or severely reduced.

The U. S. State Department instructed that legal contracts be honored but further new activities have a moratorium placed on them. Contractors, including CID, were instructed to refrain from any official meetings with GOB officials and essential meetings be held at the lowest possible level and by permission only. This situation existed throughout the reporting period.

Negotiations were required between CID and MACA and between CID and USAID/B for the renewal of the contract and a continuing budget. Budget authorization continued to November 30, 1980, with the contract due to expire for lack of funds on that date.

To compound administrative problems, in September, GOB fell behind more than six months in payments due the U.S. and the Congressional Law prohibiting additional aid came into effect (620 Q). Fortunately, with the help of USAID/RDO and the USAID Program Officer, there was sufficient time after GOB made some payments to sign agreements and amendments before November 30 and also before 620 Q came into effect again.

With relations between the countries at a minimum level, AID/W sent much less money for extension of the contract and it was extended for only 8 months, until July 31, 1981, instead of the usual 12 months. There was and is considerable concern among the team members about the tenuous situation of the contract.

Dr. Bernie Henrie traveled from Tucson, Arizona to La Paz to sign the extending amendment in November.

A.1.2 Contract Activities. Considerable discussion was held after the July revolution to determine if, in fact, the Chief of Party should move

to Cochabamba where work is concentrated. It was finally agreed that the best location for Chief of Party is in La Paz, but with the understanding that frequent travel to Cochabamba and Santa Cruz would be required. As a result, the Chief of Party has traveled much more than anticipated to solve administrative problems with technical staff as well as advise on research problems. Numerous meetings have been held with students and the Universities of San Simon and Gabriel Rene Moreno.

According to instructions from USAID/B, a minimum amount of time has been devoted to what would be important but routine meetings with MACA and IBTA officials. In fact, there was no Director General de Asuntos Agropecuarios of MACA for many weeks during the reporting period. Our relation will normalize as soon as a Director General is appointed and when relations between the U. S. and Bolivia are more favorable.

A.2 Director of Research

A.2.1 Contract Research Activities. The main activities of the Chief of Party/Director of Research in the area of research direction has been in technical support. The current research activities of the staff were planned in March-May 1980 and were already in progress. The next semiannual report will report the results of these activities.

We are currently planning activities for the 1981-82 growing season.

A.2.2 IBTA Advisement. The reduction of the contract team from 10 to 7 in 1980 and the consolidation of the Chief of Party and Research Director position reduced the amount of contract time that could be devoted to advising

the IBTA/CIAT Experiment Station Directors. The increase in abnormal administrative problems subsequent to the revolution further reduced the time for research oriented advisement to IBTA/CIAT. As a result, fewer visits were made to the stations than was anticipated.

The Research Director made two visits to Belen, two to Patacamaya, six to Saavedra, three to San Benito, three to Toralapa, and one to Sapecho, during which he advised the Station Directors on research and administration. Other visits of a technical nature were made usually with CID technicians.

B. Agricultural Economics

B.1 Short Term Consultant

CID had no Agricultural Economics advisor on staff during the reporting period. However, Dr. Kendall Adams was placed on a short term (two-week) contract for the purpose of writing a summary of the macro and micro marketing procedures presently used in the Cochabamba area. This summary was published as CID Working Paper # 09/80.

In addition, Mr. David Eding, MBA, MS in Economics, was hired on a short term contract for three months to serve as the contract team Ag. Economist. This contract was in anticipation of continuing him as the permanent employee in this position after budget renewal. Reduction in total grant funds to USAID/B prevented this from occurring and Mr. Eding finished his contract after three months. His report is published as CID Working Paper # 08/80.

C. Proposed Plan of Work in Potato Breeding

by R. W. Hoopes - Potato Breeder

C.1 Project: TO-1-P-1-a, Bolivian Germplasm Bank

Leaders: Ing. Israel Avilés, with Robert Hoopes collaborating.

Introduction: Bolivia is an important center of diversity for the cultivated potato and also wild tuber-bearing Solanum species. The use of improved varieties is expected to result in more uniformity and, consequently, less diversity in the varieties cultivated by farmers. Also, genetic erosion of the wild species occurs as habitats deteriorate. There is much worldwide interest in the conservation of germplasm of the potato as well as other crops. The Toralapa Station maintains a collection of several hundred native cultivated varieties of potato, representing seven species of Solanum. In addition, some accessions of wild species are now in the collection as a result of an international collecting expedition in March and April of 1980 in which IBTA technicians participated.

Objectives: (1) Expansion of the Germplasm Bank with collections made on a trip in March, 1981, in which Prof. J. G. Hawkes of the University of Birmingham, Ing. Israel Avilés, and Robert Hoopes will participate. (2) Maintain the material already in the Germplasm Bank. Ing. Avilés is responsible for this work. (3) Continue the work of classification of the material in the Germplasm Bank. CID's contribution to this effort is in the form of becas to three students who are screening portions of the Germplasm Bank for resistance to wart disease, cyst

nematodes, and virus diseases. (4) Use selected varieties in the Germplasm Bank as parents in the breeding program.

Activities to Date: (1) Expansion of the Bank. The collecting trip with Prof. Hawkes is scheduled for March 8-16 of 1981. Most emphasis will be on wild species. Although the material collected will not be of much importance to Bolivian programs in the short term, this work can be of considerable value for Bolivia and the rest of the world if valuable characteristics are found in the material collected. The Bolivian program has contact with the institutions which are screening the wild species for many characteristics and can receive material which proves to be valuable. (2) Maintain the material now in the Bank. This work is being done by Ing. Avilés. (3) Classification. Freddy Caballero, a CID becario, is screening 170 clones of the Germplasm Bank in a search for a native source of resistance to potato wart disease caused by Synchytrium endobioticum. Fernando Rivas, also a CID becario, is screening approximately 400 clones to try to find resistance to the cyst nematode which is of considerable importance in Bolivian potato production. Both of these projects are underway. Victor Alvarez, as one part of a thesis involving resistance to potato virus Y, will screen some clones of the Germplasm Bank for resistance. This has not yet begun as he is still involved with other aspects of his thesis. (4) Use material in the Germplasm Bank as parents. Several clones in the Germplasm Bank, having been identified as outstanding in terms of quality, adaptation, or resistance to the false root-knot nematode, will be used in the crossing program, which will take place in January and February.

C.2 Project: TO-1-P-1-b, Breeding for Yield and Quality

Leaders: Ing. Israel Aviles and Robert Hoopes

Introduction: Although resistance to pests, diseases, and other growth reduction stresses is of great importance in the breeding program, emphasis must also be placed on yield and quality. It is noteworthy that most of the popular potato varieties in the world today do not have outstanding resistance to the diseases and pests that attack potatoes. They maintain their popularity with growers and consumers because they produce good yields of high quality potatoes, given the necessary protection. Although it would be desirable to have varieties with a high level of resistance to the most important problems, yield and quality must be considered in any new variety.

Objectives: (1) Continue testing of 3 Peruvian lines, S11-72, S215-72, and Culpa, which were the survivors of 11 lines received in 1978. (2) Test, for yield and adaptation, the progenies of some interspecific crosses between the diploids S. phureja and S. stenotomum, and the tetraploid S. tuberosum ssp. andigena. (3) Make crosses involving the highest yielding material that came to us in the International Potato Center (CIP) frost trials and the local varieties noted for high quality--Imilla Blanca, Puca Imilla, and Huaicha Paceña. (4) Cross the Cornell material that has been highly resistant to late blight with the high-quality local varieties. (5) Several lines that came to Bolivia in the CIP International Late Blight trials in 1976 have been very resistant to late blight, have produced good yields, and appear to have acceptable quality. These will

be tested more intensively for their acceptability for various uses, their acceptability to consumers, etc., because they could be promoted as new varieties.

C.3 Project: TO-1-P-1-d, Breeding for Resistance to Late Blight

Leaders: Israel Avilés and Robert Hoopes

Introduction: Late blight, caused by the fungus Phytophthora infestans, is a serious limiting factor in potato production in some regions of Bolivia. It causes serious losses in areas where humidity is high and the temperatures are moderate during the growing season. Farmers in some areas do not plant potatoes during the rainy season, probably because of past experience with blight. Chemical controls are becoming more widely used, and will aid considerably if properly used. Another alternative is to develop resistant varieties.

Objectives: (1) Continue testing the best of the CIP clones received in 1976 and 1978. (2) Prepare for the release of at least one of these clones as a variety recommended for blight-affected zones. (3) Test Cornell University material which has shown good blight resistance and agronomic characteristics in one year's trials in Escalante. (4) Grow the progenies of the resistant material and local varieties and expose them to late blight. (5) Produce tubers from the botanical seed obtained from last year's crosses so that they can be tested in the field next season. (6) Continue crossing programs utilizing the CIP and Cornell material, hybrids of this material x local varieties, and local varieties in order to obtain a population with good levels of blight resistance as well as good agronomic characteristics and quality.

Activity to Date: (1) The CIP material has been planted at Escalante by Ing. Avilés. The most promising lines are being multiplied on and off the station to provide a good source of seed if a new variety is named. Specific gravities have been taken to provide one indication of the quality of the most promising clones. (2) Seed multiplication is being carried out on five clones. A large demonstration-multiplication plot has been planted at Escalante. (3) Cornell material which had good resistance and production last year has again been planted at Escalante, and about 10 clones are showing very good plant growth at this time. (4) Tubers from some crosses are now in the field at Escalante. (5) Several thousand seedlings are growing in the Toralapa greenhouse. This material represents crosses in which either one or both parents had resistance to late blight. Many of these families are also segregating for virus Y resistance and Victor Alvarez is attempting to remove as many susceptible seedlings as possible to produce a population of blight and virus resistant tubers to put in the Escalante trial next season. (6) The crossing program will take place in January and February.

C.4 Project: TO-1-P-1-e, Breeding for Resistance to Frost

Leaders: Dr. Juan Landeo (International Potato Center, Lima, Perú), Israel Avilés, and Robert Hoopes.

Introduction: Frost is a severe hazard for the highest-altitude potato producing areas of Bolivia and an occasional hazard for some of the slightly lower areas. Variability with respect to frost tolerance exists among both wild species and cultivated varieties. Breeding for this

characteristic, however, is a very long and difficult task because the inheritance of frost resistance is complex and testing for resistance is not easy. The International Potato Center (CIP) has a large program of breeding for frost resistance and we have chosen to collaborate with their program rather than initiate one in Bolivia. CIP has generously provided the Bolivian program with several hundred promising clones over the past three years. Trials have been conducted at Belen Station on the altiplano as well as Totoracocha and Koari near Toralapa. A number of the CIP clones have performed extremely well here, although in many instances their frost resistance is only slightly higher than that of the local varieties. Their agronomic characteristics have been so good, however, that they may have a place in the Bolivian scene apart from frost resistance. Some of them have produced much more than the local varieties even in the absence of frost. Some of the CIP clones have quite a high level of frost resistance, but relatively poor agronomic characteristics.

Objectives: (1) Plant approximately 44 of the most promising CIP clones in a replicated trial at Koari, 10 km from Toralapa Station, at an elevation of 3500 meters, where frost usually occurs during the growing season, taking data on frost resistance if possible as well as yield and other agronomic characteristics. (2) Utilize the highest yielding CIP clones in crosses with local varieties and introductions from other programs in order to add desirable characteristics and increase diversity in the breeding program. (3) Check the quality of the most promising

CIP clones. (4) Put the most promising clones in unreplicated demonstration plots in farmers fields.

Activity to date: (1) The Koari trial was planted November 11 and was growing well as of this writing, although no frost had occurred. (2) Crosses involving at least five of these clones will be made in January and February. (3) Specific gravities have now been taken and more quality observations will be made after the harvest in April. (4) Due to a good deal of political turmoil in Bolivia and confusion as to the future of the CID contract, demonstration trials were only put in one farmer's field.

C.5 Project: TO-1-P-1-j, Breeding for Resistance to Viruses

Leaders: Robert Hoopes, Arturo Moreira, and Victor Alvarez

Introduction: All over the world, virus diseases are either a major factor in yield reduction or they necessitate an elaborate, expensive seed production program to keep virus incidence to a minimum. Worldwide, leafroll virus is considered the most important of all potato viruses. However, in the Andes, Potato Virus Y (PVY) may well be the most serious of the virus problems. The thesis research of Rosario Vargas (a CID becario) indicated that PVY was extremely prevalent in the production zones she studied in Cochabamba Department. Casual observations in farmers' fields demonstrate the severe damage this virus problem is causing, particularly when it occurs in the plantin combination with PVX.

Single-gene resistance is available in some diploid species, and more recently has been discovered in S. tuberosum ssp. andigena. We have

received several shipments of tubers and botanical seed from the Cornell University potato breeding program. Nearly all of this material is segregating for PVY resistance. Some of it has survived one and sometimes two years' agronomic evaluation in the field and one fairly ineffective test for PVY resistance. In addition, crosses have been made between selected clones introduced from Cornell and local varieties such as Sani Imilla, Imilla Blanca, etc., as well as the CIP late-blight-resistance material. Material was also received from the Max-Planck Institut in Germany with PVY and PVX resistance, but none of the clones had enough adaptation to the Andean zone to use either as potential varieties or as parents, considering that we had quite well-adapted material from Cornell to start out with. This year, a concerted effort is being made to develop a better rapid screening method for screening seedlings at an early stage and also to verify the resistance or susceptibility of material which has survived one or more years of selection for agronomic characteristics, late blight, etc. Most of this work will be a thesis project of Victor Alvarez.

Objectives: (1) Continue PVY resistance checks of the Cornell clones which survive agronomic and late-blight-resistance evaluations at the Escalante site. (2) Conduct mass inoculations of families of botanical seed known to be segregating for PVY resistance. (3) Use, in crosses, the best clones of the material which has survived agronomic evaluation and appear to be PVY resistant also.

Activity to Date: (1) One further check of most of the material has now been made, with another check to be made after this season's harvest, when the number of clones will have been reduced. One of the problems in getting a reliable check has been that the PVY indicator plant, "A6," often becomes contaminated with virus infection under the inadequate conditions of the Toralapa greenhouses. We have solved this by importing from the U.S. Department of Agriculture program at Beltsville, Maryland, seed of an accession of S. demissum which is true-breeding for a local-lesion reaction to PVY. We can work with seedlings from botanical seed, and virus contamination is no longer a problem. This material was kindly provided by Dr. R. E. Webb. (2) Mass inoculations are being made by Victor Alvarez. His technique still has not been perfected, but better results are being obtained. Several thousand seedlings have been planted, inoculated, and at least a proportion of the susceptibles eliminated. (3) Crosses will be made in January and February.

C.6 Project: Breeding for Resistance to the Potato Cyst Nematode

Leaders: Robert Hoopes, Ing. Carlos Alarcón, Gerardo Caero, Fernando Rivas

Introduction: The potato cyst nematode (Globodera rostochiensis and G. pallida) is a serious pest in many parts of the world. Europe and the British Isles have this nematode in most potato producing areas and have large research and breeding programs to combat it. The United States has spent many millions of dollars in programs of quarantine to prevent its introduction into areas which do not now have the nematode and to try to eradicate it where it now exists. It appears to be very widespread in Bolivia. The levels of damage caused by it are now established in Bolivia,

but studies in other countries have shown that it can be quite serious. Breeding for resistance can be complicated by the fact that the nematode has two species and each of the species has several pathological races. Genes for resistance to one race usually do not condition resistance to other races. The few results available indicate that G. rostochiensis is probably more widespread in Bolivia than G. pallida so we have begun looking for resistance to rostochiensis, using a population collected near the village of Tiraque.

Objectives: (1) Screen the Bolivian Germplasm Bank in a search for sources of resistance to G. rostochiensis. (2) Evaluate eight families sent by the International Potato Center (Dr. María Mayer de Scurrah kindly sent this material) for resistance to our population of G. rostochiensis. This work will be done mainly by Ing. Alarcón and Caero. (3) Import and evaluate material from Cornell University's breeding program, some of which has been resistant to all of the Peruvian populations against which it has been checked, and should have a possibility of being resistant to the Bolivian population.

Activity to Date: (1) Screening the Germplasm Bank. Last season, a CID becario, Ruth López de Rodríguez, screened approximately 100 clones of the Bolivian Germplasm Bank against the Tiraque population of G. rostochiensis. All of these clones were susceptible. Another CID becario, Fernando Rivas, is now screening about 400 additional clones in the Toralapa greenhouse. The material is growing well in the greenhouse and the test promises to be quite accurate, based on the early development of cysts on the roots of the

susceptible check varieties. This material will be evaluated over a period of February to April. (2) Evaluating the CIP material. This is being done by Ings. Alarcón and Caero in the greenhouse at Toralapa and in the field in Tiraque. (3) Importing Cornell University material. Dr. R. E. Anderson has agreed to provide the clones from his program which have had highly resistant ratings in tests conducted at the International Potato Center at Huancayo, Perú. The resistance in this material is obtained from several wild diploid species. If we obtain resistance from some of these clones, it remains to be seen how difficult it will be to incorporate it into good varieties. An import permit has been issued by the Ministry. Importation is expected in March.

C.7 Project: Vegetable Variety Introduction and Trials

Leaders: Robert Hoopes, with Thomas Stilwell and Alvin Hamson (USU) collaborating.

Introduction: The UMSS Agronomy faculty, principally Ing. Carlos Cossio, requested assistance from CID in obtaining seed of vegetable varieties that have not previously been tried in Bolivia. The last vegetable variety trials, according to Ing. Cossio, were conducted over 20 years ago. There seemed a good possibility that some varieties developed since that time would be superior to the varieties now being produced here. Seed importers, in the absence of better information, buy the varieties which they know they can sell, i.e. the old varieties. We ordered a large amount of seed, based on requests made by Ing. Cossio and others on the faculty, and modified by Dr. Hamson in Logan, Utah. The plan was for Dr. Hamson to

come to Bolivia on a short-term consultancy and bring the seed with him, later giving some advice on how to conduct the variety trials. He was unable to come as planned and there was considerable delay in getting the seed to Bolivia. Before it arrived, the University system had been closed down by the government, so it has becomenecessary to look for other means to make use of the large amount of seed that was imported, which consisted of a total of 74 varieties of 10 vegetable crops.

Objectives: Obtain information on the potential performance of newly introduced varieties of ten vegetable crops in Bolivia.

Activity to Date: Since the University no longer seems able to carry out the variety trials as planned, it has been necessary to seek other methods of obtaining some information about these varieties. San Benito Station, as well as some technicians on the station who want to produce vegetable seed, have expressed an interest in trying seed of some varieties, and have separated the seed into 10 sets. GEOBOL, which has dug about 25 wells in Valle Alto, has indicated an interest in doing some variety trials in connection with the farmers on whose land the wells have been developed. Two private individuals have indicated an interest in evaluating seed of some of the crops.

C.8 Student Advisory Activity: Robert Hoopes, Arturo Moreira (now replaced by Freddy Ortuño), Gerardo Caero, and Carlos Alarcón.

C.8.1 Victor Alvarez. Screening Segregating Families for Resistance to Potato Virus Y. Victor has mastered many of the techniques in screening for virus resistance. The arrival of an airbrush, an

air compressor, and a true-seed local lesion indicator for PVY have aided in his thesis work. Victor has inoculated and screened several thousand seedlings for PVY resistance. The techniques of mass screening of seedlings are still not perfectly adapted to the environment at Toralapa, but progress is being made. Victor presented a preliminary seminar on his work for the Toralapa technicians and other becarios.

C.8.2 Freddy Caballero. Identification of Physiological Races of Synchytrium endobioticum and Screening Clones in the Bolivian Germplasm Bank for Resistance. Freddy has planted 170 clones from the Bolivian Germplasm Bank in two replicated trials--one near the Toralapa Station and one near the late-blight trials in Escalante. Both sites are known to have potato wart disease problems. In addition, he has begun a test in pots at the Station to determine physiological races of potato wart isolates from several areas of the Cochabamba Department. None of the trials have yet been evaluated. Attempts were made to do screening using the so-called Glynne-Lemmerzahl method in incubation chambers, but it was not possible to get good infection with this method. Freddy has also been experimenting with a wart-resistance screening method adapted to plants grown from botanical seed. It appears that this method will be feasible and that some segregating families from Cornell (for resistance to at least all races found in Canada) can be screened in this way to develop a potential source of resistance if none is found in the Bolivian Germplasm Bank. The pot test to

determine physiological races using differential host appears to be having good results, but it is too early to make the race determinations.

C.8.3 Fernando Rivas. Screening the Bolivian Germplasm Bank for Resistance to the Potato Cyst Nematode Globodera rostochiensis. Fernando has planted and inoculated, in a trial with four replications, about 400 clones from the Bolivian Germplasm Bank. Inoculum was separated from soil obtained from an infested field near Tiraque, using a flotation and acetone extraction method. Enough susceptible checks (Imilla Blanca and Sani Imilla) were planted to establish: (1) Whether the inoculation method was successful, and (2) when to evaluate the clones being screened. It appears that the methodology was very successful, judging from the early development of cysts on the susceptible checks. It is still too early to make the final evaluation of the Germplasm Bank entries. Fernando will also collaborate with Ings. Alarcón and Caero in the evaluation of material sent to IBTA from CIP in Perú and in the evaluation of clones expected from Cornell in the U.S.A. He has presented a preliminary seminar at the Toralapa Station.

C.8.4 Ignacio Huayta. Chemical Soil Treatment and Its Effect on Potato Yields in Three Locations in Cochabamba. Ignacio has planted three locations--Toralapa, Tiraque, and a location near Pairumani (15 km from Toralapa Station). The objective of the trial originally was

to use several soil treatments, some of which would eliminate all harmful soil-borne organisms (insects, nematodes, and fungi), and some of which would selectively eliminate certain of these organisms. This would allow an estimate of how much yield reduction was being experienced attributable to all soil-borne organisms as well as each class of organisms. Mr. Huayta, for personal reasons, did not get his project elaborated and a beca contract signed until somewhat later than the other students. At the time when he was seeking help from the extension agents in finding sites to put experiments on, they were not in the field for extended periods. The result of this was that it was not possible to use certain of the chemicals that were originally proposed because they require a 2-3 week interval between treatment and planting. To have used them would have made the planting much too late. Apparently, on the advice of the Toralapa technicians, the soil fungicide treatment proposed was not applied. The experiments are now only likely to serve as a comparison of several chemical treatments, all of which are insecticides-nematicides. Ignacio is now engaged in studying some soil samples that were taken before treatments were applied to determine the population of cyst nematodes.

D. Potato Agronomy

by Dr. Robert Kunkel, CID Potato Agronomist

D.1 Project: Potato Variety Testing

Leaders: Dr. Robert Kunkel, Ing. Gonzalo Claure

Justification: Potato breeders are continually introducing new potato varieties. The new varieties have different yielding potentials, different climatic needs for maximum production, different degrees of resistance to different diseases and insects, and different nutritional requirements. In Bolivia, potato producing fields are found from the valleys of Cochabamba, the plains of Santa Cruz to the mountain sides above 13.000 to 14.000 feet of elevation. The possibility of finding a new variety better adapted to a given locality than the native variety is ever present, and the only way to discover such a variety is by continuing variety testing in the various localities.

Objective: To discover a variety or varieties better adapted to a given locality than the commonly grown variety.

Status: Two variety trials were planted in the Punata area. There were 13 varieties in each trial. Both trials have been harvested. The potatoes were graded into four sizes, and weighed. Specific gravities are still to be determined. The data have not been tabulated.

A third variety trial with 14 varieties was planted at Iscayachi. It has been sprayed for insects and disease control, but harvest of the tubers is not anticipated for at least a month.

D.2 Project: Soil Fertility and Plant Mineral Nutritional Relationships of Potato Production in Bolivia

Leaders: Dr. Robert Kunkel, Ing. Gonzalo Claure, Ramino Montecinos (Chinoli), Luis Aguilar (IBTA, Tarija), Rodolfo Castro (IBTA, Potosí), Extension Agents and Farmers collaborating.

Justification: In 1979-1980, large statistically significant increases in potato yield were obtained from applying phosphorus to the soil. Phosphorus is essential for both plants and animals. When the plants are phosphorus deficient, the deficiency extends to human nutrition. It is impossible to conduct fertilizer trials on all the farms in Bolivia. The most pragmatic approach to determine whether a given soil will respond economically to applications of fertilizer is through the use of soil analysis. Before a soil analysis can be of value, however, the relationship between a soil index and crop response must be established. Usually it requires an application of phosphorus and/or potassium far in excess of the amount needed for maximum yield production. The residual P and K remains in the soil to be used by subsequent plants. Thus, the cost of the fertilizers should be amortized over more than one cropping season. Before this can be done, however, the residual value of the fertilizer must be assessed. Water for irrigation is available in parts of Bolivia, but other parts must rely on rainfall to keep the plants growing. The fertilizer recommendations for the two kinds of moisture regimes could be very different. Since drought is not likely to limit yield when irrigation is available, more capital can be invested in a crop because the risk of a crop failure is less.

Objectives: (1) To determine soil test and potato yield correlations under irrigated and non-irrigated conditions. (2) To determine if some plant essential mineral elements other than N-P-K might be limiting yield. (3) Determine the residual value of fertilizer applied to potatoes.

Status: Information pertaining to objectives 1, 2, and 3 can be obtained from the following experiments. Soil samples have been taken from all the non-phosphorus fertilized plots. In some experiments, one soil sample was taken from each of the four replication, and in others, there were two soil samples taken from each replication.

1. Four analogous experiments, with 14 treatments in each, were put on farmer's fields. These experiments received supplemental irrigation. The potatoes in one experiment have been harvested, graded into four sizes, and weighed. The data have not been tabulated. Three of the experiments were in the Punata and one was in the Quillacollo areas.

2. Four analogous experiments, with 22 treatments in each, were put on farmers' fields. Three experiments are in the Aguirre, Colomi area, and one is near Puna. These experiments are factorials with four levels of N and four levels of P, but contain supplemental treatments to test the value of manure and the need for K.

3. Eight analogous factorial experiments with two levels of N, two levels of P, and two levels of K were located on farmers' fields as follows: two in Racay Pampa, two near Toralapa, one in Aguirre, two in Iscayachi, and one in Quillacollo. Supplemental treatments to compare

KCl vs. K_2SO, Temik* vs. Curaterr*, and a treatment with six essential minor elements have been incorporated into these experiments. A ninth experiment was put on the Chinoli experiment station. This experiment will be planted to potatoes for at least two consecutive years. The results of the Chinoli experiment would be used to obtain data for objective # 3.

4. In 1979-1980, eleven potato fertilizer experiments were conducted. Four of these have been planted to Promesa barley. Pertinent data as to the residual effect of potato fertilization on the subsequent barley crop seems possible.

D.3 Project: Soil Phosphorus and Potassium Survey

Leaders: Dr. Robert Kunkel, Ing. Gonzalo Claure, Ing. Edgar Gutiérrez (UMSS), Walter Carreras (San Benito).

Justification: Experimental results have demonstrated that in some widely separated areas in Bolivia, relatively large increases in potato yield result from the use of phosphorus. The size and type of plant growth has been indicative of insufficient amounts of phosphorus and perhaps nitrogen. The use of soil analysis is the most practical approach to determine if a need for phosphorus and/or potassium exists. The results of other experiments should establish if a high degree of correlation exists among soil test indexes and potato yields.

Objectives: (1) To collect soil samples from various parts of Bolivia in which potatoes are an important crop and particularly from those areas wherein potato fertilizer experiments are being conducted. (2) Have the

*Trade marks registered

respective soil samples analyzed for pH, P, K, and salt content. (3) Develop "referee" soil samples which can be utilized by all Bolivian soil testing agencies to make certain that all laboratories are obtaining comparable results. (4) Obtain the services of a professional soil chemist as a short term consultant to: (a) Instruct laboratory personnel in the technics of soil analysis, (b) instruct laboratory personnel in the use and care of laboratory equipment, (c) instruct laboratory technicians in the interpretation and use of the results of a soil analysis, (d) assist in arrangement of the facilities of a laboratory to provide a rapid soil diagnostic service for the farmer, (e) conduct a seminar for the benefit of all those interested in the soil and plant sciences.

Status:

1. The collection of soil samples to accomplish objective # 1 were begun in 1980. These were analyzed, but the results of the analysis seem suspect.
2. Representative soil samples were sent to the U. S. for a check analysis. The analyses are complete, but the results have not been received.
3. A soil chemist has been engaged as a short term consultant and he is expected to report for work in Bolivia about April 1.
4. Extensive soil sampling is contemplated in the different areas wherein fertilizer experiments are being conducted, and elsewhere as time permits.

D.4 Project: Consumer Preferences for Large Potato Sizes

Leaders: Robert Kunkel, Gonzalo Claure, and an Economist

Justification: In a preliminary market survey conducted by Dr. Adams, Ex-economist CID, it was found that potato consumers preferred the large size potatoes, and that they were willing to pay a premium for them. This is verified by the price differential that is currently being charged for large potatoes on the Cochabamba city market. Last year, a set of relatively cheap, hand operated sizing screens was developed. These are readily portable, and could be used on the farms. A positive correlation has been found between large yields of potatoes and a large percentage of big potatoes. Thus, when potato yields are increased, there seems to be a corresponding increase in the percentage of large potatoes. The farmer might benefit from selling only his large potatoes and consuming the remainder on the farm. The mechanical potato sizer at Toralapa has been equipped with an electric motor and controls to make possible the rapid sizing of relatively large quantities of potatoes for a size preference marketing study. Furthermore, Marisol of the CID office at Cochabamba assisted Dr. Adams in his study and her experience would be useful in designing and implementing such a study this year.

Objective: To determine the sizes of potatoes preferred by the housewife and to establish the price differential needed to pay sizing cost.

Status: No actual work has been done to date. Attempts have been made to locate a becario who would assist with this work. Consumer size mesh potato bags, in sufficient quantity to conduct such a study, have been

left over from the study conducted by Dr. Adams if it were desirable to use such containers.

D.5 Project: Modification of an existing surplus potato planter into a disk cultivator.

Leaders: Dr. Robert Kunkel, Ing. Gonzalo Claure

Justification: There are a number of old type assisted feed potato planters of European design in various locations in Bolivia. Most of these planters are not being used. These are two row planters that contain fertilizer and insecticide hoppers. They also have the conventional covering disks which are adjustable (within limits). The modified planters could be used for side dressing fertilizers and insecticides, for hilling potatoes and for weed control. There are some areas in Bolivia wherein the potato acreages are large enough to permit plowing the land, planting the potatoes, and cultivating them with tractor powered equipment. An effective mechanical cultivator would not only use obsolete equipment, but reduce the amount of hand labor required, and permit the timely performance of cultural operations.

Objective: To convert an obsolete potato planter into a potato cultivator

Status: The insecticide, fertilizer, and seed hoppers were removed from a planter. The mounts for holding the tool bar to which the covering disks are attached were reversed to increase the tool bar clearance over the plants by about 10 inches. Preliminary field trials for hilling potatoes and eliminating small weeds seem promising, but it lacks the adjustments necessary for a critical setting of the disks. These

adjustments could, however, be constructed without major expense. A part of the problem has been due to the fact that cultivator showels had been used previously and the vertical angles made by the two cultivators were radically different. If the disk cultivator had been used from the beginning, the results might have been excellent. The potato planter can be reassembled without difficulty since no parts were modified.

D.6 Project: Potato Seed Storage and Seed Handling

Leaders: Dr. Robert Kunkel, Ing. Mario Tórrez, Ing. Gonzalo Claure

Justification: The cost of the potato seed is the largest single expense item in the growing of potatoes. Good potato seed must be free from diseases, insects, true to variety, and in good physical condition. The size of the seed tuber and the size of the sprouts when planted also have a big influence on the rate of plant emergence from the soil. The vigor of the plant after emergence and the resistance of the young plant to adverse growing conditions is also influenced by the size and condition of the seed. For two planting seasons, it has been observed that the farmers often plant seed that is too small. Sometimes, it is badly shriveled and often has very long sprouts. All these are factors which tend to produce weak plants and poor stands of plants. Another problem has been the uneven emergence of the plants. The plants from some seed tubers emerge quickly and may be 10 to 12 inches tall before others have emerged from the soil. The late emerging plants appear to be healthy and eventually attain the size of the others, but they have lost several weeks of productive growth.

Objective: To determine the cause or causes of the uneven emergence of potato plants from supposedly uniform seed potatoes.

Status: We have had several discussions of this problem. Several areas for study have been proposed. The seed may be a clonal mixture resulting from mutations. Sprouts may be broken off during handling and planting. The fertilizer in the seed zone caused by faulty seed covering practices may be a factor. Seed tubers in non-fertilized plots have produced quick emerging, uniform stands of plants whereas those in highly fertilized plots have been slow to emerge and have emerged at different times.

D.7 Project: Development of a mechanical method for rapidly and accurately applying fertilizers under farmer conditions.

Leaders: Dr. Robert Kunkel, and Ing. Gonzalo Claure

Justification: Fertilizers and soil applied insecticides must be in solution before they can be absorbed by plants and become effective. Such materials are often applied during windy days and only a part of the material gets into the bottom of the furrow where the soil is most likely to remain moist, and where the preponderance of early plant roots are likely to develop. A machine that is light enough and small enough for one person to manipulate might be of value to farmers as well as experimentors who use large plots of a given treatment or who desire to make "side dressing" studies. It has been observed that in years of limited soil moisture, the plants emerge quicker from the soil and grow most rapidly early in the season when no commercial fertilizer has been used.

Objective: To develop a low cost machine capable of uniformly applying fertilizers and insecticides deep in a furrow.

Status: This machine is constructed of wood--even the bearings. It has been field tested and seems to be adequate for farmers and experimental use. Future modification may be needed to make it more generally adaptable. This suggests that a minimum of fertilizer should be applied at planting and that most of the amount needed should be applied after the plants emerge or after good soil moisture is present. No Bolivian data are available to support this theory.

D.8 Project: Publication of a series of grower oriented potato brochures

Leaders: Dr. Robert Kunkel, Ing. Gonzalo Claure. (Someone from Extension is needed).

Justification: Recently, a brochure entitled, "La Producción de Semilla de Papa" was published cooperatively by MACA and the government of Switzerland. The publication contains much valuable information that not only applies to seed production, but to potato production in general. The material is presented in a technical manner and would not be understood by the farmers. During the past two years, I have noticed farmers violating some of the basic principles of potato production, namely: distance between rows, depth of planting, essentialness of covering the seed properly, proper placement of fertilizer, use of good seed, etc. The use of illustrated, simplified instructional material should be very helpful for the farmer and also the extension agents whose responsibility is to help the farmer improve his status by improving the return on his labor and financial inputs.

Objectives: To develop a series of illustrated, grower-oriented leaflets to show growers how to use the best known cultural practices. The pitfalls and advantages.

Status: Currently in the discussion phase.

D.9 Project: An Economic Evaluation of the Importance of Phosphorus to the Bolivian Economy.

Leaders: Dr. Robert Kunkel, Ing. Gonzalo Claure, (an Economist).

Justification: It has been demonstrated that there are lands in Bolivia that are very phosphorus deficient. Yields of potatoes have been increased in some experiments by several hundred percent. Farmers often leave their land fallow for 3-4 years before a second crop of potatoes is planted. In 1979-1980, a large quantity of potatoes was imported from neighboring countries. Surveys have indicated that the major source of income for the altiplano farmer is his potato crop. The present price of potatoes would classify them as a luxury food item whereas it should be a staple in every diet because of its high nutritional value. A deficiency of phosphorus in the soil could affect not only the production of potatoes, but the physical welfare of humans and animals that rely on the crops and forage produced on the land. If the need for phosphorus is large and general, the need for a source of fertilizer phosphorus within the borders of Bolivia becomes critical.

Reportedly, there is a large deposit of low grade phosphate rock near Oruro. Reportedly, Tennessee Valley Authority (TVA) has developed a method for economically treating low grade phosphate rock to make it available to plant. A new examination of the possibility of utilizing this resources with the improved technology needs to be made.

The development of a phosphate fertilizer industry within Bolivia could have a large humanitarian and economic impact in Bolivia if the need for phosphorus fertilizer were as large as cursory observation indicate.

Objective: To evaluate the total need for phosphorus in Bolivia and assess its economic importance.

Status: Several discussions among CID staff members have occurred. Informal discussions have also been held with several AID members to explore opinions as to the feasibility of such a study.

D.10 Project: Conversion of a Room at Toralapa into a Fertilizer Storage

Leaders: Dr. Robert Kunkel, Ing. Gonzalo Claure

Justification: Most of the fertilizer to be used in the 1981-82 fertilizer studies is currently stored in a room of the CID office complex. The room occupied by the fertilizer is sorely needed for storage of other equipment, furniture, and supplies. In addition, the fertilizer treatments used in the experiments are formulated at Toralapa. Fertilizers require special storage conditions to keep them from hardening into solid lumps that are difficult to regranulate.

Objective: To develop an adequate fertilizer storage at Toralapa.

Status: It has been agreed that such a room is needed at Toralapa and the present fertilizer room will be modified to increase its capacity. Racks will be constructed to keep the fertilizer off the concrete floor and to provide air circulation.

D.11 Students' Advisees of Dr. Robert Kunkel

During the past 24 months, six students were assisted toward an Ingeniero Agrónomo degree. As of this date, four of the six students have completed their degrees. The length of time taken by the different students has varied. Some have taken considerable longer than the 12 months allowed for a beca, but part of this was the result of disruption of activities at La Tamborada and the UMSS. Three students are currently receiving becas.

D.11.1 Students Completing Requirements

Luis Zapata. Formas de Fósforo y Calibración de Métodos en Suelos de Zonas Productoras de Papa. He started on January 1, 1979 and finished his degree in January, 1980.

Florencio Siles. Preparación de Suelos en Siembra de Papa. He started on December 1, 1978 and finished his degree on January 28, 1981.

Ramiro Blacutt. Interacción Fósforo-Zinc en el Cultivo de Papa en Suelos de Toralapa y Piscomayu. He started on October 1, 1979 and finished his degree on January 8, 1981.

Nelson Rodriguez. Análisis del Comportamiento de Cinco Variedades Comerciales de Papa en Silo Semi-Subterráneo. He started on May 15, 1979 and finished his degree on January 26, 1981.

D.11.2 Students Currently on Becas

Ginner Ledezma. Fraccionamiento de Potasio y Calibración de Métodos de Laboratorio para los Suelos de la Zona de Toralapa. He started on December 1, 1978. Laboratory work was completed and draft of thesis reviewed.

Felipe Cantuta. Valor Agronómico de Diferentes Estiércoles. He started on August 1, 1980.

Eduardo Sarmiento. Influencia de la Fertilización Química y del Corte de Follaje en el Rendimiento y Calidad de Dos Variedades de Papa. He started on October 15, 1980.

Rubén Aranibar Iriarte. Análisis del Suelo y Estudio de Correlación en el Rendimiento de la Papa. He started on December 1, 1980.

Andrés Mejía Escalera. Niveles de Fertilización en la Producción de Papa en el Valle Alto y Bajo de Cochabamba. He started on August 1, 1980.

D.11.3 Areas of interest for which becarios are desired:

1. Potato marketing: To determine consumer preferences for potato sizes.
2. Potato physiology: Potato seed storage and handling and the subsequent effects on the tubers.
3. Potato physiology: The effect of flower, seed ball and vine removal on tuber production, grade and specific gravity.
4. Soil phosphorus and potash survey: (a) Collection of samples, and (b) Soil analysis.

E. Cereal Agronomy

by Thomas Stilwell, CID Agronomist

E.1 Project: SB-I-Th-4-a, Verification of Varieties and Technology

Leaders: Eg. Agr. René Gómez and Dr. Thomas Stilwell

Justification: There exist very few data about the profitability of recommended practices when used under farmer conditions. This experiment will compare the profitability of the current farmers' practices with the recommended practices.

Objectives: (1) Verify that the recommended practices perform as well as in the previous experiments. (2) Demonstrate to the farmers in their own fields that the recommended practices are profitable.

Status: A total of five locations have been planted with this trial, Tica Pampa, Pilancho, Mendez Mamata, Pampa Mamata, and Sunchal. Preliminary field observations indicate normal germination and growth.

E.2 Project: SB-I-Th-1-b, Weed Control in Wheat.

Leaders: Eg. Agr. René Gómez and Dr. Thomas Stilwell, with Eg. Agr. Hugo Díaz collaborating.

Justification: The strong infestations of weeds in wheat reduce the yield and grain quality of wheat, increase harvesting labor and cause problems in large plantings of wheat. The use of herbicides has the potential to solve all of these problems.

Objectives: To determine the proper herbicide for use for weed control in wheat.

Status: Planting of this experiment was delayed due to delayed rains. As of the date of writing a total of four locations have been planted: Coluyu, Tica Pampa, Pampa Mamata, and Mendez Mamata. Field observations indicate adequate weed infestations in most locations. The data from these experiments will be used for thesis purposes by Hugo Díaz.

E.3 Project: SB-I-C-1-b, Weed Control in Barley

Leaders: Eg. Agr. René Gómez and Dr. T. Stilwell, with Eg. Agr. Hugo Díaz collaborating.

Justification: The strong infestation of weeds in barley reduce the yield and grain quality of barley, increase harvesting labor and cause problems in large plantings of barley. The use of herbicides has the potential to solve all of these problems.

Objectives: To determine the proper herbicide for use for weed control in barley.

Status: As of the date of this report, this experiment has been planted in only one location: Coluyu. There is normal germination and growth and the weed infestation appears average. Further locations are planned for this experiment utilizing established planting of barley.

E.4 Project: SB-I-Av-4-a, Verification of Oats Varieties

Leaders: Eg. Agr. René Gómez and Dr. Thomas Stilwell, with Eg. Agr. Juan Córdova collaborating.

Justification: There exist very few data about the profitability of recommended varieties when used under farmers conditions. This trial

will compare the profitability of the current farmers variety with the recommended varieties.

Objectives: (1) Verify that the recommended varieties perform as well under farmers conditions as when under experimental conditions. (2) Demonstrate to the farmers in their own fields that the recommended varieties are profitable.

Status: Two recommended varieties are included in this trial. This trial has been established in six locations: Loma Pata, Waca Huasi, Payco Mayo, and Pucara (3 sites). Preliminary field observations indicate normal germination and growth.

E.5 Project: SB-I-C-4-a, Verification of Barley Varieties

Leaders: Eq. Agr. René Gómez and Dr. Thomas Stilwell, with Eg. Agr. Juan Córdova collaborating.

Justification: There exist very few data about the profitability of recommended varieties when used under farmers conditions. This experiment will compare the profitability of the current farmers variety with the recommended varieties.

Objectives: (1) Verify that the recommended varieties perform as well under farmers conditions as when under experimental conditions. (2) Demonstrate to the farmers in their own fields that the recommended varieties are profitable.

Status: A total of four recommended varieties are included in this trial. This trial has been established in nine locations: Coluyu, Tablon (2 sites),

Hornillos, Rodeo Grande, Plano Bajo, Loma Pata, Chaco, and Payco Mayo. Field observation indicates that three of the recommended varieties have germinated very well and are growing quite well under farmer conditions.

E.6 Project: SB-I-Av-2-a, Variety x Density Trial for Oats

Leaders: Eg. Agr. René Gómez and Dr. Thomas Stilwell, with Eg. Agr. Juan Córdova and Eg. Agr. Raúl Nuñez collaborating.

Objectives: (1) Determine the optimum combination of variety and seeding rate in terms of yield under farmer conditions. (2) Determine the optimum combination of variety and seeding rate in economic terms under farmer conditions. (3) Develop an agronomic recommendation for farmers for the factors of variety and seeding rate for the production of oats forage.

Status: A total of three locations have been planted with these experiments: Waca Huasi, Payco Mayo and Pucara. Field observations indicate normal to heavy weed infestations. Detailed observations of weed population have been started.

E.7 Project: Seminar: Methodologies for Production Research

Leaders: CIMMYT-IDIAP, with the collaboration of Bolivia, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Panamá, Perú, and Venezuela.

Justification: Nearly all previous conferences concerning on-farm production research in developing countries have been composed of participants from more developed countries with a few observers from developing

countries. There is a need for information exchange among national programs of developing countries.

Objectives: (1) Present descriptions of the methodologies in use by various national on-farm research programs. (2) Exchange ideas and information about national on-farm research programs.

Status: This conference took place from November 25-27, 1980 in Panama City, Panama. Participants from Bolivia included Eg. Agr. René Gómez (sponsored by CID), Ing. Alan Bojanic (sponsored by CIMMYT), and Dr. Thomas Stilwell (sponsored by CID). Each participated in different sections of the conference. Various novel and useful methodologies were presented and the conference was well concluded.

E-8 Project: Computer Analysis of Experimental Results

Leader: Dr. Thomas Stilwell

Justification: At present, each experiment station technician spends a total of 2-3 months analyzing the results from his experiments, arranging them in a useable format, and writing the results and interpretations for various reports. If results ever do get to a farmer, they are 3-4 years old. This project is designed to greatly speed up and standardize technician report writing and the consequent reporting of results to farmers.

Objectives: (1) Develop a series of computer analysis programs for use by technicians without previous computer experience, and (2) distribute these programs, and instruct the technicians in their use.

Status: The development of these programs continues in progress. The programmer contracted for this purpose is still developing many of the programs for individual experimental designs. At the present time, there are 12 general purpose programs which serve for all experimental designs. In addition, there are 4 specific programs which serve only randomized complete block designs and 4 specific programs which serve only latin square programs. Specific programs to handle split plot and factorial experiments are being tested.

The functions which are presently programmed and in operation include:

- Data entry and storage
- Analysis of variance calculations and printing
- Printing of results in bar graph format
- Printing of results in a data summary table
- Calculation and printing of economic analysis
- Recovery and printing of results previously stored

In addition to the functions noted above, there are various support programs which are used to control the experiment coding system, storage system, correct data, print necessary forms, etc.

It is expected that these programs will be ready for use by technicians for the next harvest. Use of the programs last year was not possible due to the closing of the university and the associated computer facility.

E.9 Project: SB-I-Th-C-Av-4-a, Agro-Economic Survey

Leaders: Dr. Thomas Stilwell and Eg. Agr. René Gómez, with Ing. Gerardo Ramírez and Dr. Edgardo Moscardi collaborating.

Justification: There currently exists no base of reliable data about the production practices used by wheat, barley and oats producers in Cochabamba. This data is necessary to guide the planning and execution of on-farm experiments. This survey will provide this data.

Objectives: (1) Describe the problems of farmers in the production of wheat, barley and oats for the purpose of establishing the priorities of research in these crops. (2) Define farmer practices so that on-farm experiments can be done in a similar manner. (3) Estimate costs of production to be used in estimating profitability of new practices. (4) Gain knowledge of the economic problems of these farmers to aid in the formulation of rational and effective national policies affecting wheat, barley, and oats.

Status: The formal survey was completed and the data tabulated in 1979. During the first part of 1980, a data summary report was published as a technical report of San Benito. During the period covered by this report, further analysis was done by student assistants. As a result, several publications were prepared and are currently being reviewed for publication as San Benito technical bulletins. The subjects covered by these bulletins are:

- Weights and measures used for cereals
- Varieties of wheat, barley and oats in Cochabamba
- Weeds of wheat, barley and oats in Cochabamba
- Costs of production of wheat, barley and oats in Cochabamba
- Recommendation domains for wheat, barley and oats in Cochabamba

In addition, two students have completed their thesis drafts concerning risk in the production of wheat and factors which affect the adoption of new technology in wheat. These are described more fully in the Section "Student Advisees."

E.10 Project: Systems of Production Survey

Leaders: None. Collaborators: Dr. Thomas Stilwell, Dr. Edgardo Moscardi, and Dr. Gonzalo Avila.

Justification: In spite of many fragmented studies, there exists no reliable data about production practices and their interactions within the small farm system. This data is necessary to guide the planning and execution of on-farm experiments. This survey will provide this data.

Objectives: (1) Define the principle systems of production being used by small farmers in selected valleys of Cochabamba. (2) Describe in detail representative systems of productions. (3) Formulate priorities for research programs of UMSS Faculty of Agronomy on the basis of these results.

Status: Due to drastic changes in the Faculty of Agronomy, all UMSS leaders of this project were discharged. Daily supervision and leadership has been undertaken by Dr. Thomas Stilwell.

The formal survey was completed in July, 1980. Preliminary data cleanup has been completed, and some analyses have been done. Many problems have been encountered with respect to the computer analysis of this data, and to date only partial analysis has been possible.

E.11 Project: Publication of Research Results

Leaders: Ing. Jaime Salamanca, Ing. Luis Hermosa, and Dr. Thomas Stilwell.

Justification: Presently, there is a lack of printed technical materials for farmer and extension use. Research results are available and more are constantly being developed, but their distribution to farmers remains a problem.

Objectives: (1) Develop and print quantities of informational materials directed towards farmers. (2) Distribute these materials to farmers.

Status: At the present time, over 20 titles have been prepared by the San Benito staff. The majority are leaflets directed to farmers to help solve a specific problem. Since July 1980, a total of 9 leaflets have been reprinted in quantities ranging from 500 to 3000 copies.

The titles printed were:

- Poda del Duraznero (Sistema Vaso Abierto)
- Control Químico de la Roya Amarilla en Cebada
- Cómo Tomar Muestras de Suelos para un Análisis Químico
- Ideas para el Mejor Uso de Pesticidas
- Oidio de la Vid
- Promesa 76 - Cebada Tolerante a Roya Amarilla
- Mildiu de la Vid
- Clínica de Diagnosis para Enfermedades de Plantas

A manual was also printed under the title, "Manual de Poda del Duraznero."

Approximately, 11 leaflets and bulletins are in the final stages of preparation for publication at this time. An estimated 10-15 leaflets and bulletins are also being prepared by technicians of the station.

In December, 1980, an artist-mimeographer was hired by San Benito to specifically produce these publications. Since this date, progress has been encouraging.

E.12 Student/University Projects

E.12.1 Current Student Advisees. In this listing of students, there are two general groups. The first group consists of students who are working on San Benito projects. The second group consists of students who were originally working on projects of the UNSS Faculty of Agronomy. Nearly all of the original advisors of this group have been fired from the university and I am the sole remaining advisor.

E.12.1.1 San Benito Projects (students):

Hugo Díaz. Chemical Control of Weeds in Wheat in Valle Alto. Hugo has planted several sets of his experiments and is also collaborating with the planting of other San Benito experiments.

Raúl Nuñez. Interaction Between Variety and Planting Density of Oats. Raúl has completed planting of his experiments and is presently assisting with the planting work in other experiments.

Gregorio Pinto. Interaction Between Lime and Fertilizer in Barley. All the planned experiments have been planted. Gregorio is now starting the laboratory analysis of soil samples.

René Santa Cruz. Etiology of BYD in Oats. René continues his field and laboratory work under the direct supervision of Vidal Velasco.

Emilio Ormachea. Socio-Economic Study of Wheat Producers in the Sub-Tropical Zone of Santa Cruz. Emilio is presently entering the field work phase of his study. A rough draft of the questionnaire has been finished and approved.

José Ríos. Survey of Small Scale Millers in Valle Alto. José has completed most of the necessary interviews and will probably finish data collection this month.

Eloy Sanabria. Eloy was previously registered as an economics student working under Dr. David Eding. Because of the termination of the economist position, Eloy has changed to a project concerning Yellow Rust in Barley supervised directly by Vidal Velasco. A new project will be submitted this month.

Rosario Medrano. Socio-Economic Analysis of Tiraque as a Barley Production Center. Rosario initiated her project under the direction of David Eding. She apparently spent most of December doing office work and has yet to start field work.

Juan Echalar Chemical Control of Oidio in Peaches. Juan is working under the direct supervision of Mery Quiton, in San Benito, and appears to be doing satisfactory work.

E.12.1.2 UMSS Faculty Projects (Students)

Under this classification, there are various projects which were initiated as UMSS projects in collaboration with CID.

Mario Altamirano. Factors Affecting the Election of Wheat Varieties in Valle Alto. Mario has completed the majority of analysis necessary, and is now finishing additional analyses as suggested by the results.

Alejandro Mérida. Factors Affecting the Election of Maize Varieties in Valle Alto. Alejandro has made little progress in his data analysis because of a computer malfunction. The computer has been fixed, and results should be available soon to continue his work.

Esteban Antezana. Interaction Between Levels of Moisture and Fertilization in Onion. Esteban continues his experiments and will be harvesting soon.

Freddy Corrales. Sources and Levels of Organic Fertilizer in Cabbage. Freddy has nearly completed the experiments. He will begin harvest of selected plants as soon as weather conditions permit.

Luis Pedrazas. Soil Moisture Levels in Maize for Choclo in the Valle Central. This experiment has recovered to some extent from the germination problems. There is the possibility that treatment differences can be observed. There are definite problems with poor choice of variety. The variety used is irregular and

not good experimental material. It would have been better to use a farmer variety.

Juan Arana. Study of the Effect of Ferrous Sulfate on the Addition of Cotton Seed Meal to Diets of Pigs. This experiment is about to be finished since the pigs are reaching marketing weights. There are definite treatment differences and analysis of the data will begin shortly.

José Terceros. Effects of Seeding Density on Seed Production in Lettuce. This experiment has been harvested and data analysis will begin soon.

Claudio Ticona. Study of Subsoiling and Application of Organic Matter in Compacted Soils. I have not been able to personally talk with Claudio, but his experiment appears to be progressing reasonably well.

E.12.2 Students Completing Degrees. In addition to the students noted in the previous section, two more students (who were previously CID becarios) have completed their rough draft thesis and are preparing for the defense of their thesis.

Freddy Claros. Correlation Between Risk Perception by Farmers and Adoption of New Practices for Wheat in Valle Alto, Pilancho, and Sacaba.

Oscar Omonte. Correlation Between Agro-Economic Factors and Technology Adopted by Wheat Producers.

Note: As of the date of this writing, both have successfully defended their thesis and have received their degrees.

E-13 Major Time Allocations Programmed for January - July, 1981

January - Planting and maintenance of on-farm experiments

February - Maintenance of on-farm experiments

Analysis of systems of production survey

Printing of San Benito publications

March - Maintenance and harvest of on-farm experiments

Checking of computer analysis programs

Printing of San Benito publications

April - Harvest of on-farm experiments

Printing of San Benito publications

May - Harvest of on-farm experiments

Analysis of experimental data

Printing of San Benito publications

June - Planting of wheat on-farm experiments in Santa Cruz

Analysis of experimental data

July - Maintenance of on-farm experiments in Santa Cruz

Analysis of experimental data

Writing of reports and technical bulletins

F. Entomology and National Insect Museum
Plan of Work and Progress Report

by Dr. Don Foster, Entomologist

F.1 Toralapa

F.1.1 Biology and populations of insects in aerial parts of the potato plant - Egr. Raúl Saravia and Dr. Don Foster

Very little data exists for Bolivia on the actual population levels of insects in potatoes during the growing season. Stories exist which say that certain kinds of weather cause certain pests but none of these stories are backed up with data that is necessary for scientific evaluation and communication.

Many of the insects which occur in potatoes in Bolivia have not yet been properly identified so that literature searches can be done to find out what studies have already developed information about our insects problem. Also, many of the insects encountered in the field are found in the immature stage, and must be reared to the adult for identification.

As a beginning for developing information about Bolivian potato insects, plots in two locations (Toralapa Experiment Station and Tiraque) have been established to determine the population development of insects on potatoes. Insects are counted in these plots twice weekly. For comparison purposes, when high populations of pests are found in other areas, these will be counted, and the

amount of damage recorded. Thus a measure of maximum insect pressures expected on potatoes can be developed.

Insects encountered on potatoes will be returned to the laboratory and reared through its life cycle. There are two reasons for this. First, knowing the duration of each stage of the life cycle can allow us to use control measures more effectively; and secondly, we need to know what each stage in the life cycle of each species looks like so we can identify immature stages in the field. Adults will be sent to experts in the United States for identification. At this time, several insect species are being grown in the open laboratory since no growth chambers are available.

F.1.2 Biology and populations of soil insects infesting potatoes.
Egr. Jaime Herbas and Dr. Don Foster.

Soil insects of potatoes are poorly understood. The term "gusano blanco" is used to refer to larvae of at least ten different species. Certain areas always have "bad" infestations of gusano blanco. "Bad" is hardly ever quantified, and the gusano blanco seldom identified so the information of the reports is useless for scientific purposes.

In order to develop data for scientific evaluation and comparisons, the soil insects of potatoes are being studied in the same plots and in much the same way as the aerial insects. Soil insect populations are being counted, larvae are being reared, and life cycles are being studied.

F.1.3 Chemical control of aerial pests in potatoes. Egr. Raül Velázquez and Dr. Don Foster.

Plots have been established on the Toralapa Experiment Station to evaluate the effectiveness of four insecticides in controlling insects on potatoes. Insect counts will be made the day before application and weekly after application. Yields from each plot will be measured to determine if increases result from insect control.

F.1.4 Pheromone monitoring of potato tuberworm populations. Egr. Jaime Herbas, Egr. Raúl Saravia, Ing. Carlos Quitón, and Dr. Don Foster.

One of the major pests of potatoes in Bolivia is the potato tuberworm moth, Phthorimaea operculella (Zeller). The moths of this species lay their eggs on the stems of potato plants or in the soil, and the young larvae find their way to the tubers, and feed there. One of the biggest problems in controlling this pest is learning when to apply insecticides. The moths are active primarily at night and, although they can be seen during the day, are difficult to count.

Recently, a new method for evaluating tuberworm populations has been developed using sex pheromones. Males are attracted to the chemical and collected in a water trap for counting. We have placed traps in various fields and will compare the numbers of infested tubers with the population levels of tuberworm moth.

F.1.5 Biological control of soil pests in potatoes with Neoaplectana sp. Egr. Jaime Herbas and Dr. Don Foster

Most of the insects which are pests on potatoes pass a part of their life cycle in the soil. While in the soil, these pests may be susceptible to attack by the soil dwelling nematode Neoaplectana sp. This nematode attacks primarily larval stages of insects and does not attack plants.

We now have a culture of this nematode in the laboratory and will test it for ability to kill larvae of potato pests under laboratory conditions. If this is successful and if we can rear large numbers of nematodes, then field trials will be initiated. This kind of control, if successful, should be very beneficial for the campesino because it is cheap and long lasting.

F.2 San Benito

F.2.1 Museum: Insects associated with Bolivian crops. Egr. Jaime Silva and Dr. Don Foster

The primary purpose of the Bolivian National Insect Museum is to serve as a source for identifications of insects encountered by Bolivian agricultural workers in crops of the country. There are thousands of insects associated with Bolivian crops and the pest status of nearly all of these has yet to be determined. Some of the insects associated with crops do not consume the crop but transmit viruses which kill the plants. There is to be learned about the insects which affect the crops of Bolivia. This must

begin with the study of a particular insect's correct identification. With a correct identification, the literature can be searched describing previous studies on the insect in other countries giving ideas for control, and studies already done will not be repeated needlessly.

With this goal in mind, the museum is accumulating literature on insects which we have identified for Bolivia. As new insects are identified, literature will be sought for these.

At the present time, there are two major problems in the museum. First, the museum is still located far from Cochabamba, where few people are able to use it and where it is difficult to find volunteers to help with the large amount of work involved in pinning, labeling, and sorting insects to be put in the museum. The museum should be moved to Cochabamba as was planned when the museum was started. If the rooms in the new Agricultural Service Center, which were originally designated for the insect museum are no longer available, then other space should be found. Second, an IBTA technician needs to be assigned full time to the museum. At the present time, there is one IBTA technician assigned 20% of his time to work on the museum. This is simply not enough time to develop the museum. The technician will have to spend several years learning to distinguish the families of insects and organization of an insect collection. As literature is accumulated, the technician will have to file this literature in an organized manner so that it can be retrieved when needed. This could be done

by CID personnel, but this will not train an IBTA technician. In learning insects and their literature, one must study them every day and technician time is simple not being provided for this at the present time.

In spite of the lack of technician time provided by IBTA, there have been many new insects collected, prepared for the collection, and identified. Many of these are insects associated with student projects.

F.2.2 Museum: Beneficial insects

Some of the most important insects in Bolivia are the beneficial insects which predatorize the pest populations. Collection and identification of all these insects are important so that projects can be developed using the new techniques of Integrated Pest Management.

F.2.3 Museum: Stored product pests

In the past year, serious problems were created by the discovery, in rice, of dermestid beetles which resembled the serious pest Trogoderma granarium, the Khapra beetle. Peru refused to import rice from Bolivia and a quarantine was placed on exports until a positive identification of the insects could be made.

At that time, a search in the museum for dermestid specimens revealed only two beetles and neither were identified to species. The museum was obviously not prepared to do this identification which was requested. Specimens of the dermestids from rice were sent to

Dr. Lloyd Knutson of the U.S. National Museum and technicians there determined quickly that these were not Khapra beetle. This relieved the pressure on Bolivian agricultural exports, but has not solved the problem of dermestids infesting rice. Further work has disclosed that the dermestids from Bolivian rice are actually two new species. These are now being described with new names. Because these are new species, we do not know if the destructive potential of these insects is greater or less than that of the Khapra beetle, and intense study of these beetles will be required to determine their potential impact on Bolivian commerce.

We are also collecting other insects associated with stored Bolivian crops so that we can be better prepared for the next emergency which occurs.

F.2,4 Biological and chemical control of peach tree borer, Chrysobothris sp.

Egr. Jaime Silva and Dr. Don Foster

The species of this pest has not been determined yet, but we anticipate the return of identified specimens soon.

Peach trees may become infested with as many as 300 larvae of this pest and many trees are killed each year by infestations of Chrysobothris sp.

The biology of this insect must be known to determine the optimum time to apply controls. Monthly samples are being collected from peach trees to determine development of the insect in the field.

When growth chambers become available for growing insects, the life cycle can be followed more closely in the laboratory.

Larvae of Chrysobothris sp. have been found parasitized by two species of wasps. The biology of these parasites needs to be studied in the laboratory. Also the culture of the nematode parasite of insects, Neoaplectana, which will be tested as a potential control agent for Chrysobothris sp. Several insecticides will be tested to determine their ability to control these insects within the peach tree.

F.2.5 Biological control of mites on peaches. Egr. Jaime Silva and Dr. Don Foster

One of the most serious pests of peaches in Bolivia is mites. These can be controlled by chemicals now, but continued reliance on chemicals will lead to resistance and other problems. Beneficial insects have the potential of keeping the mite populations low enough so that they do not cause decreases in yields. Unfortunately, there are few beneficial insects in peach orchards. To correct this, we are writing to other countries in a search for effective biological controls for mites on peaches.

F.2.6 Chemical control of woolly apple aphid in apples. Egr. Jaime Silva and Dr. Don Foster

The woolly apple aphid is a pest of apple trees throughout the world. At the San Benito Experiment Station, there are heavy

infestations. Seedling trees which are to be transferred to farmer fields are heavily infested and should not be moved until they have been treated for the removal of aphids. Chemicals have been applied to one field of these trees to determine a method of control.

F.3 La Tamborada

F.3.1 Biology and control of Aestylus lineatus in corn. Egr. René Andrew and Dr. Don Foster

Aestylus lineatus is a common beetle whose larvae feed on newly planted corn seed and cause failure of germination. The biology of this insect is not known. The purpose of this study is to determine: (1) the life cycle, biology, and populations that are damaging to corn, and (2) methods for controlling this pest. Insects are being reared in the growth chambers at the university on both natural and artificial diet.

F.3.2 Biology and control of Euxosta masorca in corn. Egr. Armando Ferrufino and Dr. Don Foster

Euxosta masorca is a fly whose larvae attack maturing corn ears. Up to 60% of the corn ears may be infested at harvest time. Studies are being carried out on this insect in much the same way as Aestylus although the problems with rearing and control are distinctly different.

F.3.3 Biology and populations of Stethorus sp. in peaches. Egr. Eybar Gorena and Dr. Don Foster

One of the few biological controls of mites in peaches is the coccinellid Stethorus. This tiny black insect is found feeding

on mites in both sprayed and unsprayed trees. It is obvious that this insect alone does not control mite populations at levels low enough to prevent economic damage. The purpose of this study will be to determine exactly how many mites are consumed by this insect and learn the life cycle of this predator so it can be used more effectively with other beneficial insects for integrated control of mites in peaches.

F.4 CID "Backyard" Project on Resistance to Insects in Potatoes. Dr. Robert Hoopes and Dr. Don Foster.

F.4.1 Breeding for resistance to insects

A novel resistance mechanism was discovered in several wild Bolivian Solanums by Dr. R. W. Gibson of Rothamsted Station in England. It is based on the presence of grandular leaf hairs which exude a sticky substance. When insects attempt to move about on the leaf or feed on it, their feet and mouthparts become coated. Since the insects are unable to feed or move, both direct damage to plants and the spread of viruses from plant to plant are reduced. This resistance mechanism seems quite effective against aphids, leafhoppers, flea beetles, and spider mites. The diploid species, S. berthaultii, appears to be most useful for breeding. Shawn Mehlenbacher, a Ph.D. student at Cornell University, has kindly provided us with botanical seed of five families segregating for presence of glandular hairs, density of hairs, and size of sticky droplets on the hairs. The families represent combinations of

S. berthaultii, S. tuberosum ssp. tuberosum, and S. tuberosum ssp. andigena. Some individuals from these families have produced quite good yields of well-formed tubers under Ithaca, New York conditions.

Initial trials will be conducted using thrips, fleabeetles, and leafhoppers which attack potatoes and have the potential for killing susceptible plants. Because these studies will require daily attention, they will be established and maintained in cages at the CIP office. If these cage trials yield promising results, then field trials will be conducted at Sacaba.

F.4.2 Influence on successive potato crops on suitability of soil for growing potatoes. Dr. Victor Otazú, Dr. Robert Hoopes, and Dr. Don Foster.

Refer to Plan of Work - Phytopathology: 1981-1982 by V. Otazú.

F.5 Students

Becarios working with these projects are indicated at the beginning of each sub-section. Field or laboratory work will be completed by July and the theses will be prepared.

G. Plan of Work - Phytopathology: 1981-82

by Dr. Victor Otazú - CID Pathologist

G.1 Introduction

In recognition of the work completed before my contract in Pathology, I will devote 80 percent of my time to the Toralapa Experiment Station, and 20 percent to San Benito. Also, in accordance to the recommendation of the contract, I will try to concentrate my work on as few problems as possible to avoid diluting the effort. I hope through this task to obtain more concrete results, especially considering the short time of my contract.

In Toralapa as well as in San Benito, there already exists research projects in phytopathology. In particular, there are theses projects of students who graduated from UMSS and who received supervision from technicians of IBTA and advisement from CID technicians. Unfortunately, some of these projects were not well planned, and there is little that can be done to improve them.

Even though there are a number of phytopathological problems in the technical production of seed potatoes in Toralapa, I have observed that there are two most common: first, the alarming level of incidence of the bacteria Erwinia carotovora in apparently healthy plants (see Working Paper CID # 008/79); and second, the possibility of increasing the income of the small farmer in potato areas of the zone; this last, taking into account the fertility and plant health.

My preliminary visits to the fields around Toralapa and Escalante showed not only the presence of disease caused by E. carotovora, but also the seriousness of this disease in the production of seed. Nontypical symptoms of the disease appear to predominate in the zone. This probably resulted in erroneous diagnosis of the disease by technicians who are not familiar with it. Because of this, it is necessary to continue the work started by M. D. Harrison and W. M. Brown. The second project is a study of the feasibility of increasing potato production in the zone by trying to eliminate "resting" soils. This type of study will loan itself to a cooperative CID effort by the experts in soil fertility, entomology, and pathology.

With respect to my work at San Benito, my work will concentrate in determining and reporting the diseases not yet reported on in Bolivia. Thus I hope to devote the major effort to the regional diagnostic laboratory in diagnosing plant diseases, which will also result in the publication of a new plant disease index, an indispensable tool for any phytopathologist or agronomist that work in Bolivia.

G.2 Project: Toralapa

G.2.1 Effect of Erwinia carotovora in the potato seed production

Duration: 1.5 to 3 years

Leader: Dr. Victor Otazú with Ing. Gerardo Caero and one becario collaborating.

Introduction: In 1979, a sampling of the principal production areas of Toralapa detected, for the first time in Bolivia, a disease

called "black leg." Suprisingly, it was found that 30-40 percent of the apparently healthy plants contained causal agents of this disease, bacterium E. carotovora. The author of this project found, in preliminary visits around Toralapa made at the beginning of this year, that almost all the fields were totally affected by this disease.

The disease can be manifested in various forms:

I. Soft rot of tubers before seeding.

II. Soft rot of seed tubers before emergence.

III. Soft rot of seed tubers after emergence causing "black leg," a typical symptom.

IV. Soft rot of seed tubers after emergence without causing "black leg"--an atypical symptom.

The atypical symptoms appear to be most predominant in the area. These consist mainly of irregular emergence and clorotic dwarfism of emerged plants.

All this suggests that the above disease is important, i.e. detrimental in the zone. To date, there exists no studies which address the problems of this type in seed potato production systems in Bolivia.

Objectives

- Determine the incidence of E. carotovora in potato fields and its effect on yields.

- Determine the incidence of E. carotovora in potato storage and its effect on tuber quality during storage.

Work Plan

- Sample and identify potato fields to obtain crops with different levels of disease incidence; process the samples in the laboratory.
- Obtain potato tubers from identified fields for storage.
- Determine the incidence of the disease in storage using humidified chambers to incubate the tubers.
- Seed experiments in four localities: 2 in high altitude zones, and 2 in low altitude zones. Treatments will consist of tubers with different levels of the disease. A check plot will be planted of material from esquejes.
- Determine the incidence of disease in fields and compare the relative yields.

G.2.2 Project: Study the feasibility of more intensive use of fields for potato production in higher zones of Bolivia.

Duration: 1-3 years

Leader: Dr. Victor Otazú, with Dr. Robert Kunkel, Dr. Donald Foster and Ing. Gonzalo Claure collaborating.

Introduction: Potatoes are the most profitable crop in the higher zones of Bolivia. It is traditional to allow soils to "rest" in the production rotation. Thus, it is common to see plots of land that are left to rest for 2-5 years. This practice probably became traditional because of many years of experience, and without an

alternate production technology, undoubtedly produced the best results. The scientific explanation of the relative success are probably as follows:

(1) The practice avoids nutrient mineral erosion of the soil giving it an opportunity to revitalize itself from the fertility aspect.

(2) During this "rest," there was also a reduction in population of adverse biological agents of the potato crop.

The fertility factor is the most easy to manage. Therefore, an adequate fertilization can easily replace, and perhaps more successfully, the practice of "resting". There exist no phytosanitary studies that show the losses in yield in this area, even though it is believed that diseases and nematodes could be limiting factors. If this is true, the possibility of including nonsusceptible crops in the rotation might be feasible. So it is possible to eliminate "resting" soils whether it be for continuous potato production, which is most profitable, or in rotation with other crops. In one way or the other, the small farmer could significantly increase his income by using his fields more intensively and rationally.

Objectives

- Study the level of fertility of the selected fields before and after the "rest" period.
- Determine the yield response to fertilizers in continuously cropped fields of potatoes.

- Determine the effect of continuous cultivation of potatoes in the insect populations and the economic impact.
- Determine the effect of continuous cultivation of potatoes on the incidence of plant diseases and their economic impact.
- Perform an economic feasibility study of imposing a more intensive system of cultivation in the higher zones of Bolivia.

Plan of Work

- Locate areas having field in production and "resting."
- Because of the lack of time, it will be advantageous if the winter season is used to establish experiments in the lower zones around Cochabamba. Later, these can be repeated in the higher areas in the 1981-82 agriculture season.
- In each area, paired fields will be located, one in "rest" and the other in production.
- Soil sample will be taken and analyzed for N-P-K.
- Establish a split plot experiment with six blocks: two plots and three sub-plots. The plots will consist of treated soils to eliminate soil micro-organisms and insects, and untreated soils. The sub-plots will consist of different levels of fertilizer application of N and P.
- Take readings on the incidence of insects and diseases during the growing season.
- The incidence of product infestation at harvest time will be determined.
- The yield from two central rows of each sub-plot will be measured.

G.3 Project: San Benito

G.3.1 Compendium of Plant Diseases that Occur in Bolivia

Duration: 18 months

Leaders: Dr. Victor Otazú, with Ing. Mery H. de Quitón and student as collaborators.

Introduction: Other than an incomplete list of plant diseases, published by Ken Ellis, there exists no published document of the diseases that occur in Bolivia. This publication, if though it is very useful, represents less than 10 percent of the diseases that occur in Bolivia. It is, therefore, essential that a more complete survey and publication be made to serve as a tool to help phytopathologists and other workers in agriculture. With this in mind, we will proceed to compile data on diseases identified in previous years, and also process samples from the most important production areas of Bolivia, and analyze them at the San Benito laboratory. It is hoped that this will be the main activity of the laboratory along with better training of the persons working there.

Objectives

- Compilation of the diseases of plants already identified in Bolivia.
- Determine the unidentified diseases of Bolivia.

Work Plan

- Travel and sample the most important production areas.
- Process the samples in the laboratory.

- Apply Koch's postulates in case of doubt or in case of new diseases.

G.4 Cooperative Activities

G.4.1 Toralapa - Dr. Robert W. Hoopes

- Determination of virus Y resistance in potatoes.
- Determination of races of Synchitrium endobioticum.
- Evaluate potatoes for nematode attack.

G.4.2 San Benito

- Etiology of yellow dwarf in oats. R. F. Santa Cruz, V. Velasco, Victor Otazú.
- Response of two varieties of barley, with different susceptibility, to the application of fungicides. F. Sanabria, V. Velasco, Victor Otazú.
- Chemical control of powdery mildew of peaches. J. M. Echalar, Mery H. de Quitón, Victor Otazú.
- Chemical control of P. destructor in onions. E. F. Gallardo, T. Stilwell, Victor Otazú.
- Biological control of the crown gall in peaches. M. Jaimes, W. Brown, M. Quitón, V. Otazú.
- Identification of potato black leg in Bolivia. T. Revollo. W. Brown, G. Caero.

SECTION IV

TRAINING ACTIVITIES

Student Scholarships

The closure of the universities in July, 1980, left many Agronomy and Ag. Economics students from UNSS and UGRM with no recourse to continue their studies. As a result, CID received more than 100 applications from Egresados for a scholarship to work on research which would lead to a thesis for the Ingeniero Agrónomo degree. After the universities opened for administrative purposes, CID held discussions with the Interventors and other administrators and decided to accept more students than was originally intended until the universities opened for classes again.

The requirements for accepting the students as becarios were as follows:

1. Acceptability to CID as to ability and desired field of study.
2. Availability of a CID staff member to serve on the thesis committee or to be the major professor.
3. Submission of an acceptable, detailed project proposal.
4. Approval of the university administration and a university department member who could serve on the committee or be the major professor.
5. Final approval of the CID Chief of Party and signing of the MACA/Student contract.

Monthly reports are required, and periodic review by CID staff occurs.

At present, there are 36 students receiving scholarships. Since the universities opened for exams, there have been 8 former CID becarios who have

presented their theses and passed the tribunal. All have received passing marks; a few have excelled.

MACA, CID, and the Universities are very pleased with the progress of this program. It has required much more of CID staff time, but it is obvious that a great impact has been made on the abilities of these graduates. They will be much more valuable employees whether they work for IBTA/CIAT, private industry or in one of the Development Corporations of Bolivia.

Current Students on Scholarships

There are currently 36 students receiving scholarship; 30 in Cochabamba and 6 in Santa Cruz.

Student	Location	Date Scholarship Started	Current* ending date	CID advisor
1. Eddy Victor Alvarez M.	Cochabamba	15/5/80	28/2/81	Hoopes
2. Esteban A. Antezana L.	Cochabamba	1/5/80	30/4/81	Stilwell
3. Mario Altamirano O.	Cochabamba	1/6/80	31/5/81	Stilwell
4. Alejandro Mérida Villarroel	Cochabamba	1/6/80	31/5/81	Thomas
5. Luis Pedrazas A.	Cochabamba	1/5/80	30/4/81	Stilwell
6. Freddy Corrales M.	Cochabamba	1/5/80	30/4/81	Stilwell
7. Freddy Caballero L.	Cochabamba	15/6/80	28/2/81	Hoopes
8. Jaime A. Herbas C.	Cochabamba	1/7/80	30/6/81	Foster
9. Raúl Saravia Zurita	Cochabamba	1/7/80	31/3/81	Foster
10. Fernando Rivas A.	Cochabamba	15/7/80	31/3/81	Hoopes
11. Andrés Gregorio Mejía	Cochabamba	1/8/80	30/4/81	Kunkel
12. Edwin Fructuoso Gallardo T.	Cochabamba	1/9/80	30/4/81	Stilwell
13. René Eduardo Andrew	Cochabamba	1/10/80	31/3/81	Foster
14. Juan Humberto Arana	Cochabamba	1/9/80	31/5/81	Thomas
15. Armando Ferrufino C.	Cochabamba	1/10/80	31/3/81	Foster
16. Ignacio Huayta C.	Cochabamba	1/10/80	31/3/81	Hoopes
17. Raúl Nuñez Cruz	Cochabamba	1/10/80	31/3/81	Stilwell
18. Eloy Sanabria O.	Cochabamba	1/10/80	31/3/81	Stilwell
19. Gregorio Pinto V.	Cochabamba	1/10/80	31/3/81	Stilwell
20. José Roberto Terceros H.	Cochabamba	1/8/80	30/4/81	Stilwell
21. Claudio Ticona M.	Cochabamba	1/9/80	31/7/81	Thomas
22. Raúl Velásquez A.	Cochabamba	15/10/80	31/3/81	Foster
23. José Luis Ríos A.	Cochabamba	1/10/80	31/3/81	Thomas
24. Rosario M. de Aparicio	Cochabamba	1/11/80	30/4/81	Stilwell

Student	Location	Date Scholarship Started	Current* ending date	CID advisor
25. René Fernando Santa Cruz S.	Cochabamba	1/11/80	30/4/81	Stilwell
26. Eduardo Sarmiento J.	Cochabamba	15/10/80	31/3/81	Kunkel
27. José Villarroel Coca	Cochabamba	1/11/80	31/7/81	Stilwell
28. Rubén Tito Aranibar I.	Cochabamba	1/12/80	31/3/81	Kunkel
29. Juan Manuel Echalar T.	Cochabamba	1/12/80	31/5/81	Kunkel
30. Eybar Gorena Donoso	Cochabamba	1/12/80	31/5/81	Foster
31. Emilio Ormachea V.	Santa Cruz	1/7/80	31/3/81	BTAM
32. Hortensia León Hurtado	Santa Cruz	15/8/80	31/7/81	BTAM
33. Nelson A. Rodríguez M.	Santa Cruz	15/8/80	31/7/81	BTAM
34. Rubén Herbas Canelas	Santa Cruz	15/10/80	31/7/81	Thomas
35. Elia Rojas Ricaldez	Santa Cruz	15/10/80	31/7/81	Thomas
36. Edgar Daher Villarroel	Santa Cruz	15/10/80	31/7/81	Thomas

* May be renewed up to a maximum of 12 months total assistance.

Dr. Foster	=	6 students
Dr. Hoopes	=	4 students
Dr. Kunkel	=	4 students
Dr. Stilwell	=	12 students
Dr. Thomas	=	7 students
British Mission	=	3 students
		36 students

SECTION V

PUBLICATIONS

Working Papers

07/80 - Planning of Research Priorities by Thomas C. Stilwell, April 1980.

08/80 - Short Term Consultant Report by David Eding, November, 1980.

09/80 - Marketing Processes Observed in Bolivia with Recommendations for Change by Kendall A. Adams, December, 1980.

Administrative Report

03/80 - Semiannual Report for the period January 1 to June 30, 1980.

04/80 - End of Tour Report by William M. Brown, July, 1980.

05/80 - End of Tour Report by Don C. Kidman, November, 1980.

Extension and Technical Pamphlets

Hoja Divulgativa - Poda del Duraznero (Sistema Vaso Abierto), July 1980.

" " - Control Químico de la Roya Amarilla en Cebada, August, 1980.

" " - Cómo Tomar Muestras de Suelos para un Análisis Químico, August, 1980.

" " - Ideas para el Mejor Uso de Pesticidas, August, 1980.

" " - Oidio de la Vid, September, 1980.

" " - Promesa 76 - Cebada Tolerante a la Roya Amarilla, September, 1980.

" " - Mildiú de la Vid, October, 1980.

" " - Clínica de Diagnosis para Enfermedades de Plantas, November, 1980.

Publications Planned

During the next 18 months, CID contract employees will reduce field work somewhat and concentrate on publication of the technical results of the investigative work performed. These will be in cooperation with IBTA counterparts. Where necessary, publication of bulletins and technical reports will wait for completion of field trials, but where information is already available, the reports and publications are planned and can be produced.

CID anticipates publication of the following:

1. Experiment Station Bulletins

   3 - Biology of individual crop pests

   1 - Insecticide recommendations and use

   1 - Plant disease index for Bolivia (update)

   1 - Phytophthora resistant varieties

1 - Oat research and production in Bolivia

1 - Barley research and production in Bolivia

1 - Wheat research and production in Bolivia

1 - Update of wheat production in Santa Cruz

6 - Systems of production (Valle Alto de Cochabamba)

1 - Fertility requirements for potatoes (N, P, K + pH)

2) Pamphlets for Extension

- Approximately 25 dealing with a wide range of topics. Example: Description of new potato varieties resistant to late blight disease.

3) Manuals

- Photography for research
- How to collect and prepare insects for classification
- Insecticide research manual
- Potato breeding--Bolivian goals, techniques and status
- Manual for statistical systems in agriculture for on-farm testing
- Potato production systems for Bolivia
- Potato diseases in Bolivia--Identification and control

4) Research Results

- Some to be included in Semiannual Reports, but important discoveries and implications to be reported separately.

5) Position Papers

- Status of entomology research in Bolivia
- Entomology Museum--Need for accessibility and continued support

- Status of plant disease research in Bolivia
- Potato Germplasm Bank report and listing of genotypes available
- Need for development of supply of phosphorus in Bolivia
- Status of agricultural research in Bolivia
- Manpower needs for agricultural research in Bolivia

The above are planned in addition to the required reports of the contract.

SECTION VI

GENERAL

MACA/CID/USAID-B Working Relationship

United States-Bolivia diplomatic relations prevented USAID/B personnel from making direct contact with the Ministry of Rural Affairs and Agriculture personnel resulting in CID being somewhat of an intermediary. USAID/B, especially the ROD, was very helpful during the "620 Q" problems and budget negotiations and, when it became possible, the contract continuing agreements were prepared and processed with alacrity.

CID's working relations with MACA/IBTA in La Paz have been at a low administrative level, and infrequent contacts have been made. This was partly due to the instructions from the State Department, but also due to the vacancy of counterpart positions in MACA-IBTA.

In Cochabamba and Santa Cruz, CID has worked exclusively at the IBTA/CIAT technician level, and contacts made with departmental directors of IBTA/CIAT have been made by the Chief of Party.

Basically, CID's working relationships with MACA have been excellent at the technical and counterpart levels, where counterparts were available.

Counterpart Relationships

The change in government compounded our problems relating to frequent changes in counterparts and/or the lack of assigned counterparts. It has become necessary in some cases for CID staff to move ahead with necessary contract work with a counterpart or doing the work while counterparts are assigned elsewhere.

The problems outlined in the most recent Semiannual Report, Section VI on Counterpart Relationships, still have not been solved and CID still feels a significant training possibility is being lost.

Computer Services

Dr. T. Stilwell continues to work with the UMSS and IBTA computer programs. Administrative difficulties in working with UMSS has made it necessary for him to tape all the programs which are currently stored in the UMSS computer. These were developed by CID and Mr. Stambuck (Computer Consultant to CID), and will be stored in the IBTA computer on permanent tape.

A complete list of programs is being made available to IBTA.

SECTION VII

SUMMARY OF CONTRACT STATUS AND ACCOMPLISHMENTS

General

This section is used to report important findings from the field work which should be noted by administrators and technicians in MACA and USAID/B. The very

nature of this Planning and Progress Report indicates that final reports are not available and that complete reports will be made in the next semiannual report.

It should be noted, however, that the contract activities are on schedule. One full growing season is planned in addition to the current one and most, if not all, contract objectives will be met.

The growing season, which affects the field work profoundly, started out very dry. Some experiments had to be sown in dry soil to wait for rains. The rains that followed have been sufficient up to this time to produce good crops and most expected experimental results are visible to the eye. Only one or two experiments will actually be lost due to climatic conditions.

Success with field trials in farmers' fields will probably be high this year because forage growth has been above average and farmers will not cut the experimental plots of potatoes and cereals for livestock feed before they can be harvested for experimental purposes.

The value of our experimental plots as demonstration sites and extension contact locations is obviously very high this year. In many experimental areas CID plots are outstanding and in some locations they are the only "green" patches to be seen. There is a great deal of interest in the experiments.