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CONSORTIUM FOR INTERNATIONAL DEVELOPMENT

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REPORT No.
ADMINISTRATIVO No.

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SEMIANNUAL PROGRESS REPORT

Contract GOB/AID 053-007-HCC

between

The Ministry of Rural Affairs and Agriculture

and

The Consortium for International Development

Period: January 1 - June 30, 1982

SECTION I

INTRODUCTION

This is the seventh and final semiannual report of the contract between the Government of Bolivia and the Consortium for International Development. The contract has been funded by USAID under a host-country agreement GOB/AID 511-007-HCC (formerly 511-101). The original contract 511-002 was signed for two years in 1975 with planning to continue through June, 1982. In 1977, a new contract was written and continued through the end with appropriate amendments.

The contract specifies a separate report covering the seven years be submitted prior to June 30, 1982 (in draft). Therefore, this semiannual report will cover current activities and research in the established format.

Research and other contract activities reported herein were performed during the agricultural year July 1, 1981 to June 30, 1982. Research findings are reported in some cases as a status of ongoing research which will be continued by our IBTA counterparts, and in other cases, will give findings of research which will not be continued.

A summary of contract accomplishments is included below for the year ending. Overall, contract accomplishments for the seven years of the contract are being reported in the terminal report required by the contract.

SECTION II

SUMMARY OF CONTRACT ACTIVITIES AND ACCOMPLISHMENTS

General

During this final 6-month period of the contract, actual field work in research was maintained at higher than expected levels and was discontinued as planned in only one position (cereal off-station testing). Some statistical analysis and interpretation will not be reported due to lack of time between harvest and contract termination. Data tables are presented, however, and interested parties can combine 1981-82 data with prior years data and make appropriate analyses.

Review of the research and contract activities indicate that the contract terms are being met and the large body of information developed should be adopted and prepared for extension publications.

CID/IBTA Seminars

As reported in the Progress Report (CID Publication 02/81), the original contract plans were changed somewhat during the final 6 months. The planned seminars were presented and are reported in a late section.

Approximately 300 persons participated in the five regions and CID prepared and distributed 350 "Summary" publications of CID activities. The seminars were very well received and created a great deal of interest in CID's activities demand for CID technical bulletins has sharply increased.

Agricultural Economics

Dr. Frank Conklin, Professor of Agricultural Economics at Oregon State University and currently CID scholar provided one-month of expert help to the contract in March-April in data analysis and publication preparation. His analysis helped our Ag. Surveys work and the analysis of economic viability of fertilizer use on potatoes.

Communications-Publications Expert

Ing. Inés Ortiz from Oregon State University worked for CID for 10 weeks in advising the Communications department of IBTA. She helped provide materials for the seminars and developed a presentation for a Communications-Publications workshop sponsored by CID.

Communications-Publications Workshop

Under CID sponsorship and with CID help, IBTA prepared and presented a workshop for national leaders in IBTA/MACA to develop ways and means to increase information distribution in the Ministry. This was held May 25 and 26 and was attended by over 60 participants.

Special Publications

During the final 6 months, CID technicians wrote and produced a number of special publications dealing with the research and technology transfer activities. These were in Plant Pathology, Entomology, Computer Programming, Extension bulleting preparation, Potato Breeding, Potato Agronomy, Research Administration.

Potato Breeding - Toralapa

Botanical seed was produced for several new accessions and species were obtained. This will allow easier and more secure preservation of genetic

material although exact genotypes will be somewhat altered. The three species are S. phureja, S. achacachense, and S. yungasense. Botanical seed of the last two is provided for the first time ever, and has not been sent to England and Germany.

Four-hundred additional accessions were grown for botanical seed to facilitate storage.

One-hundred and fifty accessions were tested for wart disease, and elite clones will be included in the breeding program.

Evaluation for yield and quality continue on promising breeding lines as well as evaluation for other desirable characteristics.

Two-hundred seedlings from crosses of frost resistant lines and 3000 seedlings from blight resistant lines were grown out for evaluation and selection.

Taste testing is being done on promising lines to ensure consumer acceptance if the lines further develop into varieties.

Frost resistance breeding continues and some excellent genetic material has been identified. Heavy frosts in experimental areas allowed the CID breeder to select heavily for frost resistance.

Late blight resistance breeding continues, and some excellent possibilities for blight resistant varieties exist.

Virus Y continues to be of major importance as a limiting factor in potato production in Bolivia. Materials from Germany, Holland, and the U.S. are being evaluated for resistance and some excellent breeding lines have been identified.

Genetic material resistant to the cyst nematode (33 lines) were tested and clones from the U.S. were received for testing, but were lost due to greenhouse

difficulties. New lines have been requested from the U.S. and will be evaluated by IBTA.

Plant Pathology - Toralapa

Research continued and is reported in potato storage diseases. Dry rot (Fusarium and Phoma species) have been studied and it appears that Fusarium is an important causal organism in general, but Erwinia has the highest incidence in lowland production areas.

Alternate hosts for Nacobbus (nematode) organisms have been identified and include at least two common weeds. Soil fumigation with "Telone C" was statistically ineffective, but weed population in potato fields was significant in "carrying over" the organism. Research on transmission, inoculation, and control continued.

Plant Pathology - San Benito

The biological control program for crown gall in peaches appears to have been effective. Experiments and larger plantings using K-84 isolate of A. radiobacter show significant reduction in gall formation in treated plantings.

Leaf spot (Camachaca) disease in onions was studied and a chemical control method developed.

Plant Pathology - Diagnostic Clinic

A significant increase in clinic activity was noted during 1981-82. Logistics continue to be a problem for receiving samples on a timely basis, but improvements have been made.

Computer Programming

The computer program for analysis of experimental data, which CID has called ESTAD, and which was developed by CID for use by technicians untrained in computer use is now recorded in Santa Cruz, Cochabamba, and Oruro at the universities. Contractual agreements will allow IBTA research technicians to use the programs. The objectives of this activity have been met. Users, support, and program manuals are available.

There is a lot of demand from other agencies for the program. Dr. Stilwell and his counterpart gave professional papers in the U.S. on the use of the program in developing countries.

Agro-Economic Survey

Although the survey was completed in 1979 analysis continues. One additional publication on "Economics of Wheat, Barley, and Oat Production in Cochabamba" has been completed. CID is cooperating with CIMMYT on this survey.

Systems of Production Survey

This survey, completed in 1980, was a cooperative effort with CIMMYT, CID, IBTA, and the University at Cochabamba. Political changes resulted in all the UMSS people being released from their positions. CID has carried the project. One student thesis has resulted from the survey and the balance of the information is being sent to Oregon State University for further analysis and use by Dr. Frank Conklin--CID Scholar in Ag. Economics

National Insect Museum

Work continued in development of the insect museum. Nine species of insects were newly identified in Bolivia and placed in the collection.

Field Entomology Trials

Work continued in the field on soil insect control, life cycle studies, and population survey work. "Currater" is identified as an effective treatment when applied both at planting and hilling.

Potato Variety Testing

Two tests of varieties were carried out in 1981-82. Differences in yield were very high. Statistical analysis was not done but significance was obvious although some differences are attributed to difference seed sizes among varieties. Cardinal, Desiré, and Estima were the best yielding in the tests. CID recommends that more promising breeding line clones be included in future tests.

Soil Fertility and Plant Nutrition Relationships in Potato Production

Bolivia needs a soil test x yield correlation system to estimate fertilizer needs on the 280,000 potato fields and determine approximate residuals. CID results show that the national general recommendation for phosphorus on potatoes is about one-third too much while the other elements are adequate.

One recommendation for the nation is too general; at least three are recommended.

Fertilizer experiments indicate that the climatic yield potential of different areas ranges from 15-57 Ton/Ha. The six highest yielding plots averaged over all locations 29 tons per hectare. Yields were usually very low when phosphorus was not added.

In January, frost affected almost all areas in 1981-82. Plots heavily fertilized regrew in most cases while those with no fertilizer did not recover.

Tuber size was affected by fertilization. The more fertilizer added up to the optimum, the higher the percentage of large tubers produced ($\geq$ 5.5 cm.).

Residual effects were significant as measured in the experiments between 1980-81 and 1981-82. Potatoes following potatoes on plots heavily fertilized in 1980-81 yielded very low, while those plots which received no fertilizer in 1980-81 had higher yields. Apparently, the phosphorus in the first planting was exhausted by the heavy production in 1980-81, and the available phosphorus in the second was not used because nitrogen was not available. Barley following potatoes on plots fertilized in 1980-81 showed an interaction between nitrogen and phosphorus. Highly significant treatment mean differences are noted.

SECTION III

ANNUAL HISTORICAL REVIEW

Contract Progress

The amendment (# 10) providing funds for the final six months of the contract was signed December 14, 1981 to cover the period January 1 to June 30, 1982. The amount of the budget increase was $474,000 (U.S.) or $79,000 per contract month. The funds were more than adequate for contract operation and termination costs. In comparison to the previous 5-month budget of $326,000 ($65,200 per month), the present budget was much easier to manage.

Plans for the final six months (current reporting period) of contract activities were made in November-December of 1981, and in addition to a slightly reduced field operation, they included essential as well as optional termination activities. As the work developed, the field program eventually reached or

exceeded last year's efforts in all except one position even though less work was planned. In addition to the heavy field research schedule, CID personnel were involved in a series of seminars and a workshop.

The original contract scope of work called for a permanent extension position to help IBTA and CID adapt developed technology into information that could be extended to producers. When the program was reduced in 1980, the extension position was eliminated. CID and USAID/B, in recognition of the need for distribution of the available information, agreed with IBTA to include the following activities in the plan of work for the final six months.

1. CID would prepare and present five seminars in the major agricultural centers (i.e. Cochabamba, Sucre, Oruro, Tarija, Santa Cruz) for IBTA Research Technicians, Extension Agents, Administrators, Regional Development Corporations, and private interested parties. These seminars would summarize the CID activities over the life of the contract and provide written materials for distribution.

2. CID would provide 1 M/M of expert help in Agricultural Economics to help analysis research data produced by CID and help prepare it for presentation in the seminars.

3. CID would provide 3 M/M of expertise in communications and publication preparation to facilitate the seminars and help the communications departments of IBTA in training and manuscript preparation.

4. IBTA would plan and sponsor the seminars in the five locations for a total of approximately 300 participants.

5. USAID/RDD agreed to provide additional publication materials and supplies.

The seminars were presented in April and May, 1982. Dr. Frank Conklin performed expert services in a TDY in March-April, and Ing. Inés Ortiz provided services in Communications during March, April, and May, 1982.

Separate sections at the end of this report present the activities of the above experts and summary of the seminars.

Evaluations

In March-April, the CID central office provided a two-man internal (CID) evaluation team in the persons of Dr. Frank Conklin, CID Scholar, and Dr. David James, Project Coordinator, and former Chief of Party. The report is due in June, and will be distributed to interested parties.

One original goal of the contract was to have a positive impact on IBTA as an institution in the areas of research, extension, and administration. Funds were available and permission was received for Dr. William Furlong, Professor of Public Administration, to evaluate CID's impact on IBTA personnel. His TDY was June 8-21. The impact report will be published in July and distributed.

USAID/B-CID Relations

The working relationship between CID, as the contractor in the GOB/CID host country contract, and USAID/B was excellent. Within the guidelines established by the U.S. Department of State for USAID/B activities, USAID/B gave the contract every support and consideration.

When GOB fell behind in required payments to the U.S. government and Regulation 620-Q and the Brooks amendment were invoked, it was doubtful if CID's contract could receive continued funding. USAID/B worked intensively with the

GOB on behalf of CID and other agencies to get the required payments made so the restrictions could be lifted in time for CID's contract funding to be renewed. This was much appreciated and allowed CID to bring the contract to a logical and orderly conclusion. Personnel of the Rural Development Division were especially helpful in contract management.

University Relations

Political problems in Bolivia continued to affect CID's work with the universities when changes in University administrative and technical personnel were ordered. CID staff no longer taught classes at Cochabamba, and our only cooperative work was with students who had CID scholarships. Many thesis committee members of individual students were discharged from the university resulting in serious problems with thesis acceptance and/or advisement. Several students had their thesis projects summarily rejected by new committee members simply because they were not party to the original proposal. The Chief of Party in discussions with University officials was able to rectify this in some cases, but in others, he was unsuccessful.

Scholarships

There were no new scholarships given during the reporting period. Current becarios were encouraged to finish their thesis before March 31 to leave time for CID staff to complete the required reports before June 30.

However, a number of students completed their theses and successfully defended their research and projects, and were awarded their Ingeniero Agrónomo degree.

Several students continued to receive the financial support through June although student advisement was minimal.

The CID staff has tried to leave students with material and suggestions so they will be able to finish after the contract terminates.

Personnel

No changes were made in the CID staff positions during the reporting period. All six staff members remained in Bolivia until the final week of June.

All the local Bolivian employees remained full-time with the contract with the exception of the Administrative Assistant, who took another position beginning April 1. Rather than hire and train a new Assistant for 3 months, CID contracted with Mrs. Novillo to work evenings and weekends to complete the contract time and provide the continuity.

The current full-time local employees are:

Name	Position	Location
Norah López	Bilingual Secretary	La Paz
Magda Alborta	Bilingual Secretary	La Paz
María Teresa Bernal	Bilingual Secretary	Cochabamba
María Luisa Tejada	Bilingual Secretary	Cochabamba
Margot López	Bilingual Secretary	Cochabamba
Marisol Udaeta	Bilingual Secretary	Cochabamba
Luis Fernández	Chauffeur	La Paz
Edmundo Sánchez	Chauffeur	Cochabamba
Carlos Tejada	Chauffeur	Cochabamba
Jorge Heredia	Chauffeur	Cochabamba
Vitalio Alvarez	Janitor-Watchman	Cochabamba

Administrator's Visits

Mr. Bernard Henrie, CID Deputy Director and Central office coordinator, made two visits to Bolivia during the reporting period to review progress and help plan termination activities and logistics.

Lead University President's Visit

President Stanford Cazier, President of Utah State University, visited Bolivia May 9-13 representing the lead University. The President had interviews with General Celso Torrelio V., President of the Republic of Bolivia, the Ministers of Education, Finance, Agriculture, and the U.S. Ambassador, and was made an honorary citizen of La Paz by the Mayor. President Cazier also met with the parents of current Bolivian students at USU and former USU Bolivian students residing in La Paz and Cochabamba. The visit received intense press coverage and the Utah-Bolivia Partners central committee had a session with the President to inform him of current activities.

The visit was very beneficial to the Utah-Bolivia relationship.

SECTION IV

ACCOMPLISHMENTS

A. ADMINISTRATION

A.1 Chief of Party

A.1.1 Contract negotiations

No negotiations were required during the reporting period. The contract's originally planned termination date is being honored.

A.1.2 Contract activities

The logistics of contract termination required repeated and, sometimes, lengthy contacts with IBTA and MACA officials. Increasing concern about CID's eminent departure was manifest and lengthy informal and formal meetings were held to try to avoid termination. When it became obvious that continuation was impossible, even more meetings were required to coordinate the CID seminars, workshop, and inventory turn over and disposal of supplies and technical instruments.

A.1.3 Inventory release procedures

Household furniture, research equipment, office equipment and furniture, vehicles, and contract supplies were completely inventoried using original and local records of purchases. Complete lists were given to MACA/IBTA along with suggested disposition. Final decisions remained with MACA and all items were turned over as goods of the GOB as instructed.

A.2 Director of Research

A.2.1 Research activities

The administrative duties required by the contract consumed essentially all the time of the Research Director. Termination of the contract minimized any "direction" of research and all the staff concentrated on finishing research projects already started.

A.2.2 IBTA

Administrative visits were made to Belén, Patacamaya, Coroico, San Benito, Toralapa, La Tamborada, Chinoli, and Saavedra.

B. AGRICULTURAL ECONOMICS

B.1 A CID Economist served the contract for one month in analyzing research data for publication and seminar purposes.

C. POTATO BREEDING

by

Dr. Robert W. Hoopes, Potato Breeder

C.1 Project: Bolivian Germplasm Bank

Leaders: Israel Avilés, with Robert W. Hoopes collaborating

Introduction: Bolivia is a center of origin and diversity of cultivated potatoes as well as many wild related species of *Solanum*. Collections from Bolivia have made important contributions to germplasm banks and breeding programs throughout the world. CID has collaborated over the last two years in making collections which have added significantly to the amount of wild material available to breeders in Bolivia and the rest of the world. In addition, CID becas have aided several students to obtain a thesis project by evaluating portions of the Bolivian Germplasm Bank for certain characteristics.

Objectives

1) Continue to expand the Bolivian Germplasm Bank and send more Bolivian material to botanists and germplasm specialists in England and Germany.
2) Maintain the present Bolivian Germplasm Bank.
3) Continue the work of evaluating varieties in the Bolivian Germplasm Bank for specific characteristics.
4) Utilize varieties in the collection as parents in crosses to obtain certain desired traits in breeding lines.

Activities

1) Plants from several accessions from which botanical seed was not obtained were grown in the Toralapa greenhouse and intercrosses were

made. Botanical seed was obtained from the species Solanum phureja, S. achacachense, and S. yungasense, and sent to Prof. Jack Hawkes in Birmingham and Ir. Loek van Soest in Braunschweig. The botanical seed of the last two species is the first that has been collected from these species. In addition, permission was obtained to send tubers of several accessions to Ir. van Soest in Germany. This has been done. Hawkes and van Soest have sent to the Bolivian program seed of several accessions collected in Bolivia in 1980 for which seed was not then available to leave here. They have also sent copies of several publications based on the 1980 expedition, lists of their institutions' collections, etc. The collaboration with these specialists has been and will continue to be very valuable to the Bolivian program.

2) The collection was grown and maintained on the Toralapa station under the direction of Ing. Avilés. To avoid losses of the collection because of virus diseases, frost, or other hazards, botanical seed has been collected from more than 400 accessions in the Germplasm Bank. Botanical seed does not preserve the exact genetic combinations that exist in the original varieties, but does preserve almost all of the genes in a form which is far easier to maintain than tubers.

3) Approximately 150 clones from the collection were planted in a pot test at the Toralapa Station and also in a field near Escalante to be evaluated for wart resistance. Forty-two of these clones were apparently resistant to wart disease in an experiment conducted by Freddy Caballero for a thesis. Their reaction to wart was re-tested this season. This work is being done entirely by Ing. Gerardo Caero and the results were not collected in time to be included in this report.

4) Some diploid and tetraploid native varieties in the collection were used in crosses with local varieties.

C.2 Project: Breeding for Yield and Quality

Leaders: Israel Avilés and Robert H. Hoopes

Introduction: Although the breeding program has concentrated on resistance to various diseases and physiological stresses, high yields and good quality are the ultimate objectives of the program. Some of the breeding lines are not being tested for resistance to anything and their evaluation falls under this heading. Others are being evaluated for frost, late blight, virus resistance, and are listed under those sections even though they are also being evaluated for high yield and good quality in addition to resistance.

Objectives

1) Continue agronomic evaluation of the Peruvian clones S11-15, S215-72, and S207-72, which have survived two previous years' tests.

2) Evaluate progenies of inter-specific crosses involving *S. phureja* x *S. tuberosum* and *S. tuberosum* x *S. stenotomum*.

3) Produce seedlings of some progenies of high quality local varieties x CIP varieties brought to Bolivia for frost resistance.

4) Grow seedlings of the progenies obtained by crossing local, high-quality varieties x Cornell late-blight resistant clones.

5) Continue taste preference tests of all varieties which perform well agronomically.

Activities

1) The three Peruvian clones S215-72, S11-72, and S207-72 were included in an unreplicated observation block on the Toralapa Station. Two of the three, S215072 and S11-72 performed well. The third clone, S207-72, did not yield any more than the check variety, Sani Imilla, and will not be selected.

2) Progenies of the interspecific crosses are being managed and evaluated by Ing. Avilés.

3) Approximately 200 seedlings from crosses involving CIP frost resistance material were grown in the greenhouse at Toralapa this season. One tuber will be harvested from each seedling to plant in the field next season.

4) Approximately 3000 seedlings from crosses of Cornell late blight resistant clones x local varieties were grown in the greenhouse at Toralapa. One tuber from each will be available to plant in the field next year.

5) Some taste tests have been conducted by Mr. Mario Coca, an ex-student of CID who was hired to do quality evaluations. This work is now being continued by Mr. Alberto López, another ex-becario of CID. The quality tests will continue until the end of the CID contract in June, 1982. IBTA will conduct them in future years.

6) An unreplicated observation block was planted at Toralapa to make selections of several groups of clones in the second and third year of selection: (a) clones derived from crosses among various local varieties, such as Sani imilla, Imilla blanca, and Condor imilla;

(b) Cornell Tuberosum-Andigena hybrids; (c) Cornell Andigena clones; (d) Clones selected from crosses made by R. Hoopes in Perú in 1977, involving various combinations of Andigena and Tuberosum genotypes. In spite of a fairly severe frost in late January, followed by a month of dry weather, about 50 clones in this trial performed very well. Some yielded over 2 kg per plant, in contrast to the check variety, Sani Imilla, which produced an average of 0.79 kg/plant. The selected clones had a tendency to produce larger tubers than the standard varieties, which would tend to place them in higher price classes in the market. They also had, in general, very attractive tuber shapes, shallow eyes, etc. The Tuberosum-Andigena clones in many cases had about the same yields as "Sani imilla" but were ready for harvest in 100 to 110 days, as opposed to 150 days to maturity for Sani imilla. Farmers who grow these varieties could expect to harvest more than a month earlier than the main harvest and take advantage of higher prices, better availability of labor, etc. The Tuberosum-Andigena varieties tend to set fewer tubers than the local varieties and these tubers are considerably larger than those of local varieties at maturity. The quality of these clones has not been tested in previous years because of so little material available, but is being done at present by Mr. López.

C.3 Project: Breeding for Resistance to Late Blight

Leaders: Israel Avilés and Robert W. Hoopes

Introduction: Late blight, caused by the fungus Phytophthora infestans, and favored by high humidity and moderate temperatures, is among the most

important plant diseases in the world. The extremely high altitudes, where much of Bolivia's potato production takes place, are too cool and dry for late blight to be a major problem. A good deal of potato production, however, takes place at lower elevations. Nearly all of the production zones along the eastern slopes of the Andes are very vulnerable to this disease. Morochata, Colomi, Sorata, and Escalante are a few of the areas where this disease occurs severely and frequently. Effective chemical controls are available, but not always used effectively by the farmers. The recent drastic price increases in imported products, such as fungicides, has made any chemical control much more expensive than it was in previous seasons. Resistant varieties provide the potential for an essentially cost-free method of controlling this disease.

Objectives

1) Continue to evaluate material from several sources for late blight resistance, yield, and quality.

2) Continue the crossing program, utilizing imported resistant varieties, local varieties of high quality, and hybrids of these two groups, to obtain high-quality, well-adapted resistant varieties.

Activities

1) A trial was established in Escalante, a region where late blight is severe every year. This season, late blight was very severe and the plots also suffered from a long dry period in February. The most interesting results were those of several clones which were selected from several thousand individuals sent from Cornell University in the form of tuber families in 1979. Table 1 shows the yields, weight per

Table 1. Clones from Cornell University, International Potato Center and Bolivia, grown in Escalante, under severe pressure from late blight, 1981-1982.

Clone*	Yield (kg/plant)	Grams/tuber	Specific gravity	Preference** rating
A125-5	0.59	85	1.091	3.29
A125-5A	0.51	97	1.073	2.62
A125-8	0.61	97	1.097	3.38
A174-9	0.43	57	1.096	2.43
A174-11	0.66	53	1.094	2.57
A196-5	0.54	63	1.085	3.29
A196-13	0.60	111	1.080	3.64
A217-8	0.50	74	1.086	2.95
A225-10	0.56	51	1.089	4.00
720055	0.60	41	1.097	2.43
575031	0.47	45	1.098	3.57
720045	0.19	21	1.080	2.71
Huaycha paceña	0.42	42	1.093	3.57
Sani imilla	0.32	41	1.089	3.36
Imilla blanca	0.29	31	1.095	3.61

* Clones A125-5 to A225-10 originated with the Andigena breeding program of Dr. R. L. Plaisted at Cornell University, U.S.A. They were received as individual tubers with no selection. Out of approximately 4000 clones originally received, these have been the most outstanding. Clones 720055, 575031, and 720045 are among the best clones from the breeding program of the International Potato Center in Lima, Peru. Huaycha paceña, Sani imilla, and Imilla blanca are local varieties susceptible to late blight.

**Preference tests were made using boiled potatoes prepared at the Toralapa Station dining room, using laborers and technicians as tasters. Rating is the average of at least 7 scores. Scores were given on a scale of 1 (very bad) to 5 (excellent).

tuber, and tentative preference rating, of these clones, three clones from CIP which have been among the best in several years' testing, and three local varieties.

All of the yields in this trial were somewhat low because of the dry growing season. The Cornell clones, those whose numbers begin with A, tend to be quite early maturing and tended to escape to some extent, the effects

of the drought in February. These clones all have the tendency to produce large tubers in relation to the CIP clones (720055, 720045, and 575031), and the local varieties. This would mean higher prices to the grower because of more of the crop being classified in a higher grade.

The results of a taste panel conducted at the Toralapa Station are also encouraging for several of the Cornell clones. Several of the clones have been rated equal to or better than the variety Sani imilla, which is considered to be of good quality. One clone, A225-10, appears to have outstanding quality. It tends to be rated higher than the variety Imilla blanca, which is the variety most noted for good quality.

2) A number of crosses were made, using a bulk pollen from the best of the A-numbered clones, as females, local varieties such as Imilla blanca, Huaycha paceña, etc. Several individual crosses were made between outstanding clones in the A series, CIP clones, etc. Open-pollinated seed was collected from the most blight-resistant A clones, seedlings from last year's crosses involving this material were grown in the greenhouse at Toralapa and their tubers will be planted in the field at Escalante next growing season.

C.4 Project: Breeding for Resistance to Frost

Leaders: Ing. Israel Avilés and Robert W. Hoopes. (Material for this program came originally from the International Potato Center through the cooperation of Drs. Nelson Estrada and Juan Landeo).

Collaborators: Ing. Juvenal García (CADEA), Ing. Delfín Cavero (Belén), Ing. Hugo Mendieta (Patacamaya).

Introduction: Frost is one of the most severe and least controllable hazards of potato production in the highlands of Bolivia. Frost resistance, however, is one of the most difficult traits to manage in a breeding program because of the complexity of inheritance and the difficulty of evaluating varieties at early stages of development. The Bolivian program has had the benefit of being able to collaborate with the International Potato Center, which has generously provided over 200 clones with some selection for evaluation under Bolivian conditions. These clones have been tested for three years at Toralapa and the Belén experiment stations. Most of them have been discarded, and a few of the most promising ones retained. After the past two seasons of work at Toralapa, a number of clones appeared very promising from the standpoint of yield and quality. Unfortunately, in both of the last two years, the frost has come so late in the season that it had no effect on the productivity of the clones. We have been able to evaluate the material under favorable conditions, but not under unfavorable conditions. Some of these clones appear to have considerable potential as varieties in Bolivia apart from any frost resistance they might have, as they are high yielding and have acceptable quality.

Objectives

1) Establish another trial at Koari (elevation 3500 meters) of the CIP clones which have shown the best performance in yield and quality in two previous trials.

2) Grow the most promising of these clones on a larger scale to begin multiplication of seed.

3) Continue to evaluate the quality of the clones that have shown best performance in other areas.

Activities

1) In addition to the planned trial at Koari, smaller trials were planted with extra seed at the Patacamaya Station on the altiplano and at the CADEA-CORDEOR station outside of Caracollo. A fairly heavy frost took place at the Koari site on January 25. No recording equipment was on the site to measure the temperature, so observations on frost damage have to be made in comparison with the check varieties. A severe thunderstorm occurred during the planting at the Patacamaya Station and resulted in several rows of the trial not receiving any fertilizer. The difference in growth and re-growth in fertilized vs. non-fertilized rows was so drastic that it was impossible to make any statistical analysis of this trial. Instead, Table 2 shows only the yields per plant of the best replication of each variety.

The frost-damage ratings shown in Table 2 indicate that, of all of the CIP introductions, only one clone (374032-10) has the same high level of resistance of the frost-resistant Bolivian varieties Choquepitu or Yari. Unfortunately, frost resistance is practically the only good characteristic of that clone. Its tuber form is very unattractive, it has considerable internal pigmentation, and its yields are very low. Most of the CIP lines are not any different from the local varieties in their frost resistance, expressed in terms

Table 2. Yield and frost-damage ratings of 44 CIP clones grown at Koari, Patacamaya, and CADEA (Caracollo) in 1981-82.

Clone	Yield (kg/plant) Koari	Patacamaya*	CADEA	Frost Damage Rating**
375517-1	0.58	0.62		4.00
375512-5	0.44			4.25
374068-4	0.42	0.30		5.25
375540-3	0.37	0.23		5.25
374067-2	0.36	0.34	0.22	6.00
375089-32	0.36	0.26		4.00
375059-9	0.50	0.70	0.24	5.25
375597-15	0.40	0.41		5.50
375559-9	0.57	0.50		5.50
377413-2	0.45	0.64		4.50
375512-26	0.42	0.19	0.32	5.00
375517-2	0.41	0.29		4.75
375512-24	0.50	0.28		5.50
374102-4	0.44	0.39		5.50
377413-7	0.49	0.52	0.38	4.25
375514-3	0.52	0.46		4.50
375512-23	0.57			4.75
375517-6	0.46	0.39		4.50
374066-4	0.43		0.26	4.50
375567-15	0.44	0.32		5.25
375519-5	0.50	0.39	0.32	5.50
374080-5	0.53	0.37	0.42	5.25
375518-1	0.35			5.00
375517-5	0.19	0.35		6.25
375596-6	0.39	0.34	0.17	6.00
374032-10	0.26			2.00
376173-3	0.30			7.00
375541-1	0.17	0.32		
R793-7	0.32	0.30	0.24	
375528-1	0.38	0.27	0.34	
375057-39	0.29	0.41		
374123-3	0.44	0.34		
375080-5	0.12	0.47	0.34	
375597-31	0.28	0.37	0.19	
R214-5	0.31	0.33	0.50	
375608-8	0.27	0.33	0.28	
375080-40	0.19	0.34		
375608-26	0.30	0.26		
375608-6	0.38	0.21		
Imilla blanca	0.26			4.25
Sani imilla	0.34	0.50	0.23	4.75
Huaycha paceña	0.41			4.25
Choquepitu	0.38	0.44	0.22	2.00
Yari	0.18			1.75

*Yield of best replication only

**At Koari only; mean of 4 replications; damage ratings given on a scale of 1-10, according to % of foliage damaged.

F values: Frost damage--18.84**; Yield, Koari--6.87**; Yield, CADEA--2.30*; Patacamaya yield not statistically analyzed because of errors in fertilizer application. (** indicates significance at 1% level, * indicates significance at 5% level.)

of the percentage of foliage initially damaged by frost. Some of them are fast to recover from frost, however, and tend to produce high yields in spite of foliar frost damage.

Among the noteworthy clones in this trial are 375517-1, which is slightly more resistant than the local varieties and produces quite high yields of attractive tubers; 375559-9, which consistently produces good yields of very attractive tubers; and 377413-7, which resulted from a cross with Sani imilla, has tubers almost identical to Sani imilla, quality equal to or better than Sani imilla, and has consistently outyielded Sani imilla in favorable and unfavorable years.

2) The clones which were most promising in previous years were planted at Koari in fields outside of the experiment to observe their behavior on a large scale and also multiply seed. Some extra seed was also planted at CADEA to be used in multiplication of the most promising lines.

3) Specific gravity and taste-preference tests are now being conducted by Mr. Alberto López on all of these clones, but the results will not be compiled until after the submission of this report.

In addition to the trials listed above, all of the clones in the Koari, Patacamaya, and CADEA trials, plus many more from other breeding projects, are being tested at the Belén station. In previous years, CID participated more heavily in this work, but because of the contract uncertainty which prevailed at planting time in October of 1981, it was not possible to travel to Belén. Trials were, however, conducted there, and the CID breeder and the Toralapa technician, Ing. Avilés, will travel to Belén during the month

of June to review the results of all the frost-resistance trials in Bolivia over the past years, conduct quality tests, and collaborate in making decisions of which clones should be kept in which areas of the countries.

C.5 Project: Breeding for Resistance to Virus

Leaders: Carlos Alarcón, Robert W. Hoopes, Israel Avilés, Victor Alvarez, and René Torrico

Introduction: Virus diseases are among the principal causes of decreased potato yields in developing countries where there are usually no organized seed production systems. Worldwide, leafroll is the most serious virus disease, but in the Andes, it appears that Potato Virus Y (PVY) is the most important virus problem. The work of CID becaria Rosario Vargas indicated that PVY is very widespread in potatoes in all areas of the Cochabamba department. We have received material in the form of botanical seed and tuber families from several sources (Max-Planck Institut, Cornell University, and Wageningen), which is segregating for PVY immunity. CID becario Victor Alvarez tested much of this material for resistance as a thesis project. A considerable number of varieties were discarded for apparent susceptiblity to the virus, but several hundred seedlings or clones were apparently resistant in one test. There are also many clones with PVY-resistant parents which have not been tested for PVY reaction but which have been found to be very promising for late-blight resistance and agronomic characteristics. Some 50 percent of these clones should also be PVY immune.

Objectives

1) Confirm the resistance or susceptibility of material tested by Victor Alvarez the past growing season.

2) Test the most promising Cornell clones which have survived a previous test for virus resistance, and have also shown good yield and late blight resistance, once more for PVY resistance.

3) Continue to plant seedling progenies and evaluate individual plants for PVY resistance.

Activities

1) Apparently, resistant material was planted at Toralapa but the results, according to Mr. Alvarez, were rather difficult to interpret because of the lack of certain equipment to do a serological test. Most of the apparently resistant material continue to appear resistant as far as could be determined through the use of indicator plants.

2) These clones were planted in the Toralapa greenhouse but were never inoculated or evaluated by the virology team because of an apparent misunderstanding on the part of the worker who was told to perform the PVY inoculations.

3) Only a small portion of the seedlings which should have received evaluation for virus reaction were ever inoculated. Of those which were inoculated, not all were evaluated by the Toralapa virology team. The CID breeder had to leave the country due to a death in the family in January and was not able to supervise this work adequately.

C.6 Project: Breeding for Resistance to Cyst Nematode

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

Introduction: In a thesis study, Fernando Rivas identified 33 potentially resistant clones, using the Tiraque population of *Globodera rostochiensis* as the reference nematode population. In addition, clones were received from Dr. R. E. Anderson of Cornell, which have shown resistance to cyst-nematode populations from Peru. This material was lost due to problems in the greenhouse, but new material has been ordered.

Activities: The requested clones had not been received from Cornell at the time of the submission of this report. There was not enough time to re-confirm the resistance of the clones identified by Mr. Rivas this year.

C.7 Project: Introduction of Vegetable Varieties

Leaders: Robert W. Hoopes, Thomas C. Stilwell, Alvin Hamson (USU)

Introduction: Ing. Carlos Cossío of UMSS requested the collaboration of CID to obtain seeds of vegetable varieties which had never been tested in Bolivia. Seed was obtained from Northrup King Co. of tomatoes, cucumbers, cauliflower, cabbage, radish, onions, squash, carrots, beets, and lettuce. By the time the seed arrive in the country, the university had been shut down for a prolonged period and other outlets for it had to be sought.

Objective: Distribute vegetable seed to people willing to plant it and try to get information on any varieties which could prove useful to Bolivia.

Activities: Seed was distributed to the following people: (1) Mr. René Gómez of the San Benito Experiment Station, (2) the San Benito Experiment Station, (3) the Extension Agent for Capinota, (4) Mr. Bernardo Encinas of Centro de Desarrollo Social de Cochabamba Tropical, (5) Ing. Nancy Lizárraga of UMSS, (6) Mr. Salaues of a technical school in the Chapare, (7) Mr. Freddy Villazón of the Toralapa Station.

Very little information has been returned to CID regarding the performance of these varieties and because our work has not been in vegetable crops, it has not been feasible to spend the time necessary to ferret out the information. The onion variety Texas Grano is said to give extremely high yields in the Capinota area and a number of radish varieties that were imported were well-adapted.

C.3 Project: Student Advisory Activity

No students in breeding were still on their becas during the last 6 months of the project, but considerable time was spent assisting them in their thesis preparation. The current status of ex-becarios follows:

Victor Alvarez--"Classification of Segregating Families with Respect to Resistance to Potato Virus Y"--Victor has nearly finished a second draft of his thesis. He is now working as the virologist on the Toralapa Station. He should be ready to defend the thesis within a reasonably short time.

Freddy Caballero--"Identification of Physiological Races of Synchytrium endobioticum and Screening Clones of the Bolivian Germplasm Bank for Resistance." Freddy has finished writing his thesis and at last report had the approval of two of three members of his committee to set a date

for the thesis defense. He is now working as a technician at the Patacamaya Station on the quinoa project.

Fernando Rivas--Fernando has written up only parts of his thesis on screenning part of the Bolivian Germplasm Bank for resistance to the cyst nematode. He is presently working as a technician for Sanidad Vegetal in Santa Cruz. He recently was able to come back to Cochabamba where we worked together to complete the statistical analysis of his data, which had been holding back his work.

Ignacio Huayta--"Chemical Soil Treatments and their Yield Effects on Potatoes in Three Locations in Cochabamba." Ignacio has made little progress in the writing of his thesis since he finished his beca with CID. He is working as a technician on the Belén Station at the present time.

René Torrico--"Identification of Species of *Meloidogyne* in Bolivia"--René has written a complete draft of his thesis and supposedly has finished the revisions requested by his committee. He should be ready to defend the thesis at any time. He is now working as a potato seed production specialist on the Toralapa Station.

Rosario Vargas--"Identification of Potato Virus Infections in the Cochabamba Department." Rosario finished the writing of her thesis to the satisfaction of her major thesis advisor Arturo Moreira. At the point she and her husband moved to La Paz where they went into private business. Despite considerable effort, we have never been able to locate her since that time. It appears unlikely that she will ever finish her degree.

Ruth López--"Determination of Chromosome Number of 100 Varieties in the Bolivian Germplasm Bank." Ruth finished her thesis and defended it successfully. She is now working in the Fitotecnia Department at UMSS.

D. POTATO AGRONOMY

by

Dr. Robert Kunkel, Potato Agronomist

Introduction

The 1981-82 experimental potato growing season began with many uncertainties. In fact, the Consortium was not plagued with a shortage of funds but with the likelihood that the project would terminate by the end of November, 1981. A crucial decision had to be made. If no experiments were put in, there could be no harvest even if the frustrating situation were alleviated. Another year's data to confirm some of the previous findings was badly needed. I, therefore, decided to gamble some of my own resources with the belief that eventually the situation would be solved, that I would be reimbursed and that there would be experimental crops to harvest before the termination of the project. Another complication was that even if there were crops to harvest, there was no assurance that would there be sufficient time to tabulate and analyze the data.

In total, 16 potato fertilizer experiments were put on farmers' fields, and two potato variety tests were planted. Twelve 1980-81 potato fertilizer experiments were observed with the hope of obtaining information on the value of the residual fertilizer following potatoes, which is often the farmer's main crop.

A text and visual aids were prepared for a series of seminars held at various locations in Bolivia. The information was presented by Dr. James H. Thomas, CID Chief of Party, and my counterpart Ing. Gonzalo Claure. This

enabled me, with the aid of a translator, to complete all the 1982 potato harvests, and to harvest three small grain experiments, and a residual potato fertilizer experiment.

All data are in bound notebooks and are to be given to my counterpart for further study and whatever use he can make of them.

D.1 Project: Potato Variety Testing

Leaders: Dr. Robert Kunkel and Ing. Gonzalo Claure

Justification: Potato breeders are continually developing new potato clones that need to be tested in areas where they might be superior to existing varieties.

Objective: To assist potato breeders in testing their promising clones for adaptability to potato growing areas of Bolivia.

Status: Two variety trials were planted this year: an early planting at Comarapa, and a later planting at Pocona. The first is a good variety test even though large differences in seed size will obscure variety differences. The second was planted interspersed among fruit trees and the results are questionable. The Comarapa test was harvested in January.

Results: No statistical evaluation of the data seems justified because of the large differences among the sizes of the seed-tubers planted. As a result, it is impossible from this study to determine if the differences among the varieties are due to seed size or genetic yielding potential.

Each year, since I arrived in Bolivia, I have cooperated in one or more variety trials. Each year the same varieties were compared and the same

seed size differences occurred--there has never been enough seed of the same size of each variety to make a valid estimate of the genetical yielding potential of the varieties. This was the first year, however, that the varieties were planted at Comarapa--there were large differences in total yield as well as in the percentage grades of each size (see Table 1). The test was adjacent to the Comarapa No. 1 fertilizer trial. The fertilizer trial was planted with the cooperator's variety (Americano) and the yield was generally low regardless of the fertilizer treatment, but this may have been due to the fact that the grower failed to apply the insect and disease control chemicals that were provided to him and the plants died prematurely. Early blight, late blight, and powdery mildew were present on the plants earlier in the season. The variety Alpha was used in two fertilizer experiments. The yield of tubers and the percentage grade of large tubers was impressive. In one experiment, the seed was poorly covered, there were skips between plants, and the large tubers often were hollow in the center. In the Chullchuncani experiment, the stand of plants was quite uniform and the yield of tubers was very high, and the percentage of excessively large tubers was minimal. This variety is being commercially tested by ASAR.

Recommendations

1. That enough relatively disease-free seed of the clones be grown on the experiment stations to provide ample quantities of uniform-size seed of each clone to make several variety trials in an area so that the genetical productivity potential can be determined.

TABLE 1 : Comparison of 12 Potato Varieties at Comarapa in 1981-1982
(Values are Means of four replications)

Potato Varieties	Total yield tons/Ha	Percentages of tuber in various - centimerter - size categories over 5.5 cm	4.5-5.5 cm	3.5-4.5 cm	under 3.5cm
Cardinal	29.1	28.8	38.8	29.8	4.5
Desiré	27.9	27.9	33.9	28.3	9.2
Estima	23.4	21.8	30.6	35.1	12.6
Baraka	20.5	46.2	32.3	18.1	3.4
Radosa	15.5	20.4	35.5	35.8	8.5
Bintje	14.1	14.9	32.5	40.5	12.1
Carina	12.9	27.3	33.0	33.2	6.5
Sounta	12.8	42.6	25.1	23.9	8.3
Americano (Local)	12.3	22.7	33.2	32.5	11.6
Blanka	12.2	42.6	33.7	17.2	4.3
Alpha	9.1	8.3	34.5	43.1	14.2
Huaycha	3.8	0	8.7	54.2	37.1

2. Put into the variety trials some of the newer blight resistant and nematode resistant clones to compare their performance with those clones that have been tried for years but never adapted commercially. A lack of adequate supplies of seed of a new variety may be the limiting factor. Developing adequate supplies of seed of the promising clones in a breeding program should be the responsibility of the experiment stations.

3. Test the most promising clones at different levels of fertilization. Present breeders are so engrossed in the number of clones in a breeding program that none of the clones are adequately tested. Large yields of tubers remove large quantities of nutrients from the soil. In experimental work, if the nutrients are not adequately supplies, the genetic yielding potential of a clone may never be measured.

4. Include in the variety trials one or all of the standard Bolivian varieties, i.e. Runa, Imilla blanca, and Sani imilla. A known standard of performances is needed.

D.2 Project: To-I-P-31, Soil fertility and plant nutritional relationships of potato production in Bolivia.

Leaders: Dr. Robert Kunkel, Ing. Gonzalo Claure, Dr. James H. Thomas, Ing. Ramiro Montecinos, Ing. Luis Aguilar, and Ing. Walter Carrera.

Cooperators: County agents and farmers.

Justification: The Bolivian potato crop is a major source of farmer income. Growing potatoes requires a major expense in seed, fertilizer, and pest control if the farmer is to receive the maximum return on his investment.

Profit is closely related to yield. During the past three years, it has been demonstrated that farmers on the average are producing far less potatoes per hectare than the climatic potential. It has also been demonstrated that there is a general deficiency of nitrogen and phosphorus. In 1981, a deficiency of potassium was discovered at a large majority of the experimental sites. This could be related to the method of fertilizer application. The most practical approach to determining if a farmer needs a certain kind of fertilizer and how much is needed is the yield. The most practical solution is by use of a dependable soil analysis. Unfortunately, the relationship of the results of soil analysis and potato yield has been discouraging and, therefore, not usable by the farmer for predicting his fertilizer needs.

For the last three years, soil samples have been taken from the experimental sites from diverse areas of Bolivia and on various soil types. Soil samples taken during the past two years are being analyzed at La Tamborada and at San Benito. The 1981-82 samples are now being collected for analysis.

If the yield/soil test correlations continue to be low, an intensive laboratory study is needed to discover the cause. The soil samples that have been collected are relatively large and repeated analyses could be made.

It has been estimated that there are 280,000 potato fields in Bolivia. It is impossible to conduct an experiment or even a demonstration on more than about 20 locations in any one year, but many soil samples could be

collected by an extension agent and analyzed in a competent laboratory in a relatively short time.

The residual value of fertilizers applied to potatoes is an important part of assessing the economic value of a potato fertilizer program.

Results of the past two years have failed to support the Toralapa fertilizer recommendation as the sole recommendation for potatoes. The results indicate that in most cases the Toralapa recommendation for phosphorus is about one-third too high. If this proves to be true, the lesser amount would be a substantial saving in farmer's fertilizer costs. On the basis of last year's data, it is doubtful that a single fertilizer recommendation for potatoes would be the most productive or the most economical for all areas in Bolivia. At least three recommendations may be needed.

Objectives

1. To conduct potato fertilizer experiments in various parts of Bolivia.
2. To collect soil samples from each experimental site for chemical analysis to establish soil test and yield correlation with which to predict farmer fertilizer needs.
3. To obtain data for estimating the residual value of a good potato fertilizer program.
4. To develop a grower-oriented brochure on potato production.

Experimental Methods

The fertilizer treatments were premixed and the amount needed for a 10 m row was weighed into a paper bag. Urea, 45% phosphate, and 60% muriate

of potash were used in all treatments except the one receiving sulfate of potash. The fertilizers were uniformly distributed along a continuous belt that rotated about half its length in 10 m. The soil insecticides (Curaterr at 50 Kg/Ha or Temik at 35 Kg/Ha) were distributed along the surface of the fertilizer. After the fertilizer and insecticides were deposited in a narrow band in the bottom of the furrow, they were covered by the applicator with about a one-centimeter thick layer of soil.

The experimental design was a randomized block with four replications. Each plot was three rows wide and 10 meters long. The rows were about 0.7 m apart but not uniformly so. Considerable variations among the rows resulted from the use of oxen drawn plows.

Thirty seed tubers were planted in each 10 m row. Afterwards, the seed was covered by ox plow. Often the seed was not adequately covered and some hand covering was needed. Only the center row in each plot was harvested for data. The tubers were graded into four sizes: over 5.5, 4.5-5.5, 3.5-4.5, and less than 3.5 cm in diameter.

The spray schedule was on a preventive basis because of the time and distances involved. The insecticides controlled the common insects although, in two experiments, Perfekthion and Meta-systox, failed to give good control of flea beetle type insects. The fungicides used (Benlate, Antracol, Ridomil 25% WP, and Ridomil MZ) controlled the foliar diseases when used according to recommendations by the manufacturer. The insecticides and fungicides were applied as a mixture. Citowet was used as the "spreader-sticker" in all experiments. Sencor was used at 0.5 Kg/Ha for weed control

in four experiments. Excellent control of weeds resulted, including the control of Spergula arvensis. With proper timing, a lower rate of Sencor might be adequate. All the spray materials were applied with a "Solo" back-pack power sprayer.

Soil samples

Six soil cores, 0 to 10 inches deep, were taken from each 0-0-0 check plot and each 80-0-80 treated plot. The samples, except as noted in the table, were taken when the plants were sprayed the first time. In this procedure, the soil cores were taken directly from the area in which the potato yields were to be correlated with the soil analyses. The soil analyses were made by the San Benito Soil Laboratory in exchange for laboratory chemicals.

Residual Fertilizer Studies

The perimeters of twelve of last year's potato fertilizer experiments were staked to make it possible to relocate the respectively treated plots from which to obtain residual fertilizer data. Seven of the experiments, two at Iscayachi, three at Aguirre, one at Colomi, and one near Toralapa were planted to haba beans. Experiments at Puna (Kepallo), Rakay Pampa, Toralapa, and Kotani Alto were planted to Promesa barley. An experiment at Rakay Pampa was planted to wheat and one at Chinoli was planted to potatoes. A 1979 potato fertilizer experiment near Toralapa was planted to Promesa barley for the second time.

Details of the 1981-1982 fertilizer experiments are shown in Tables 2 and 3.

TABLE 2 : Details of the 1981-82 fertilizer experiments.

	Location	Date planted	Date harvested	No. days	No. Treat.	No. Rep.	Soil insecticide	Variety	Source of seed	Date soil sampled
1.	Punata	17 Sept.	16 May	181	16	4	Curaterr	Runa	Grower	26 Nov.
2.	Comarapa	23 "	13 Jan.	112	"	"	"	Americana	Grower	11 "
3.	Morochata	25 "	18 March	174	"	"	"	Imilla Blanca	Toralapa Sta.	25 "
4.	Comarapa	29 "	abandoned	-	"	"	"	Totoreña	Grower	-
5.	Toralapa	21 Oct.	10 May	201	"	"	"	Sani Imilla	Toralapa Sta.	10 Dec.
6.	Toralapa	22 "	10 "	200	"	"	"	Imilla Blanca	Toralapa Sta.	10 "
7.	Piscomayu	28 "	6 "	190	"	"	"	Imilla Blanca	Toralapa Sta.	15 "
8.	Tiraque*	29 "	11 "	194	"	"	"	Sani Imilla	Toralapa Sta.	17 "
9.	Chulchuncani	4 Nov.	6 April	153	"	"	"	Alpha	ASAR	17 "
10.	Kotani Alto*	9 "	14 May	186	"	"	"	Sani Imilla	Toralapa Sta.	28 "
11.	Comarapa*	12 "	2 April	172	"	"	"	Alpha	ASAR	14 Jan.
12.	Patacamaya	18 "	21 "	154	"	"	"	Sani Imilla	Patacamaya Sta.	21 April
13.	Belén	19 "	20 "	152	"	"	"	Sani Imilla	Belén Sta.	20 April
14.	Colomi*	24 "	13 "	170	"	"	"	Imilla Blanca	Toralapa Sta.	15 Jan.
15.	Yanamoco Chinoli	30 "	28 "	149	"	"	"	Sani Imilla	Chinoli Sta.	21 "
16.	Iscayachi	3 Dec.	29 "	147	"	"	"	Runa	Grower	22 "

*Used 0.5 Kg Sencor per hectare and obtained excellent weed control included.

TABLE 3 : Details of 1981-1982 Insect and Disease Control Program*

Location	Number of applications					
	Insecticide applications		Fungicide applications			
					Ridomil	
	Perfekthion	Meta-systox	Antracol	Benlate	25% WP	MZ
1. Punata	2	3	3	4	2	2
2. Comarapa		1	1	1	1	
3. Morochata	1	3	2	4	2	1
4. Comarapa	Abandoned because of weeds					
5. Toralapa	1	3	3	4	2	2
6. Toralapa	1	3	3	4	2	2
7. Piscomayu		3	3	3	3	
8. Tiraque	1	4	2	5	2	3
9. Chulchucani	1	3	2	4	2	2
10. Kotani alto	2	4	1	6	1	5
11. Comarapa	1	4	3	5	3	2
12. Patacamaya	1	2	2	2	2	1
13. Belén	1	2	2	2	2	1
14. Colomi	1	4	1	5	1	4
15. Chinoli	Station applied					
16. Iscayachi	IBTA applied					

* This program seemed to adequately control the insects and diseases. However, the three-week interval was a bit too long for good insect control. Ridomil 25 WP was applied every three weeks but became unavailable, so Ridomil MZ, which was applied every two weeks, was substituted.

Results

The climatic potential yield data for the various areas in which experiments were conducted are shown in Table 4. In only one location, Piscomayu, the potential yield (9.9 Ton/Ha) was as low as that of the average yield of potatoes for Bolivia. Two fertilizer treatments averaged close to the climatic potential. These were treatments 4 and 13. In this experiment, there was no increase in yield if phosphorus was not added (compare treatments 11 and 15). The plants in the plots receiving no phosphorus, or only manure, were killed by the January 29 frost. Even though the well fertilized plants recovered somewhat from the frost, they failed to produce many tubers. A study of the main effects of treatments, from the factorial part of the experiment, showed that 120 Kg N/Ha had a despressing effect on yield whereas using 120 Kg of P_2O_5/Ha and 80 Kg/Ha of K_2O tended to increase yield. Though the "F" value for the statistical differences among the 16 treatments was highly significant statistically, the coefficient of variation was excessively large. The results for each of the 16 experiments can be evaluated from Table 5 with a procedure similar to the procedure described above.

In four of the 15 experiments, the "F" value for treatment was not significant at the 5% level. These were experiments 1, 2, 12, and 15, and for each of them, there is an explanation (Table 4) why the fertilizers did not cause an increase in yield. The design of the experiments, however, provided a more critical evaluation of the effect of the three nutrients than was possible when only the mean of four replications was used to measure the nutrient effects as was done in the replication by treatment

TABLE 4 : Climatic Potential Yields are the Average of Six Highest Yielding Plots in each Experiment Regardless of treatment

Location	T/Ha	C O M M E N T S
1. Punata	20.4	Plants took too long to emerge. Was flooded twice by rain.
2. Comarapa	15.8	Very weedy. Grower did not apply pest control chemicals. We left him.
3. Morochata	34.5	A good season. Plants lived much longer than those in the area and were much larger.
4. Comarapa	-	Abandoned because of weeds.
5. Toralapa	28.4	Frosted last week in January. Very wet at times and very dry at others.
6. Toralapa	24.0	Frosted last week in January. Zero-P-plants were killed.
7. Piscomayu	9.9	Plants on low fertility were killed by late January frost. Very dry season.
8. Tiraque	29.9	A good season. Sprays controlled diseases, insects and weeds.
9. Chulchucani	57.0	A good season. Sprays controlled diseases and insects. No herbicide was used.
10. Kotani Alto	33.6	A good season. Sprays controlled diseases, insects and weeds. Very dry at times.
11. Comarapa	36.1	Severe late and early blight but these were controlled as were insects and weeds.
12. Patacamaya	18.5	Very dry season. Was irrigated once.
13. Belén	18.5	Very dry season.
14. Colomi	29.1	Good season. Sprays controlled diseases, insects and weeds.
15. Chinoli	19.5	Very dry season, killing frost in late January.
16. Iscayachi	17.4	Very dry season, killing frost in late January

TABLE 5

LOCATIONS WITH POTATO FERTILIZER EXPERIMENTS IN 1981-82
(Mean Total Yields in Tons per Hectare)

	Nutrients in Kg/Ha N	P_2O_5	K_2O	Punata	Comarapa # 1	Comarapa # 2	Comarapa # 3	Toralapa # 1	Toralapa # 2	Tiraque	Chulchu-cani	Kotani Alto	Pataca-maya	Belén	Chinoli	Morochata	Iscayachi	Colomi	Piscomayo
1.	80	80	0	14.9	9.4	Pendanda	22.5	17.6	16.0	23.4	42.4	19.7	19.2	10.5	11.7	25.7	9.0	19.0	3.4
2.	80	80	80	14.2	12.2		25.3	19.3	18.6	20.4	48.9	23.5	22.0	13.0	12.2	26.7	8.4	25.5	4.8
3.	80	120	0	15.0	12.1		25.9	19.1	15.8	27.2	50.3	21.4	23.1	11.0	10.5	29.3	8.5	22.6	5.2
4.	80	120	80	15.7	10.6		25.8	21.3	17.5	26.0	49.3	23.6	22.8	12.5	13.2	28.4	11.5	23.1	8.7
5.	120	80	0	15.4	10.3		23.3	15.2	14.7	[illegible]	45.1	22.4	21.3	11.4	10.8	27.6	9.4	20.5	2.3
6.	120	80	80	16.1	10.5		20.8	24.8	22.1	25.3	51.9	25.3	23.4	10.3	17.4	31.6	12.7	23.3	3.0
7.	120	120	0	14.2	9.5		22.3	19.7	18.0	23.3	48.0	23.5	24.3	7.5	16.2	27.9	10.8	20.6	2.7
8.	120	120	80	14.2	11.3		28.6	23.2	21.2	25.1	48.7	25.6	21.6	11.1	13.8	29.6	10.4	25.4	4.3
9.	130	120	80	18.8	11.1		26.7	19.0	14.4	25.9	49.1	26.6	22.6	14.0	13.1	30.3	12.8	23.0	4.6
10.	130	140	80	13.5	12.5		26.1	21.2	20.0	25.0	51.0	26.1	21.7	11.3	12.3	29.6	10.4	22.7	3.0
11.	80	0	80 (K_2SO_4)	12.4	11.2		15.0	10.8	6.5	15.6	21.4	13.9	17.9	9.8	12.9	12.3	7.7	19.0	1.4
12.	80	120	80 Temik	14.7	9.2		19.1	19.5	19.3	25.0	45.9	27.8	21.5	12.7	12.5	26.6	12.9	22.8	5.1
13.	80	120	80	12.5	14.3		27.1	23.4	18.3	24.5	47.0	30.4	19.1	14.1	13.8	28.9	11.0	26.0	7.8
14.	Local			13.3	10.2		20.2	8.8	9.0	23.6	49.6	24.3	16.8	12.3	11.1	15.9	4.7	23.4	3.6
15.	0	0	0	3.5	10.5		16.1	6.6	5.4	14.8	23.7	8.1	10.7	11.7	5.9	10.7	2.7	11.9	1.2
16.	Manure 10T/Ha			14.9	11.7		24.6	11.1	11.4	17.4	38.4	32.8	15.6	13.7	9.4	17.7	6.1	25.7	0.6
	Sig. of "F"			* =	5%,**		= 1%,	***	1/2%,	N.S. Less than 5%									
	Treatments			N.S.	N.S.		***	***	***	***	***	***	***	N.S.	*	***	***	***	***
	Blocks			**	N.S.		***	N.S.	N.S.	***	***	***	*	N.S.	N.S.	***	***	N.S.	N.S.
	C.V.			23.4	24.9		19.9	22.6	18.5	13.0	11.0	9.9	16.4	22.8	32.0	13.3	44.0	14.6	55.6
	MAIN EFFECTS OF FACTORIAL																		
	N @ 80			15.0	11.1		24.9	19.3	17.0	24.2	23.9	11.1	21.8	12.0	11.9	27.5	9.4	22.6	5.5
	N @ 120			15.0	10.4		23.8	20.7	19.0	24.2	24.2	12.1	22.7	10.1	14.6	29.2	10.8	22.5	3.1
	P_2O_5 @ 0			10.4	10.8		15.5	8.7	5.9	15.2	22.5	11.0	14.3	10.7	9.4	11.5	5.2	15.4	1.3
	P_2O_5 @ 80			15.2	10.6		23.0	19.2	17.3	23.0	47.1	22.8	21.5	11.3	13.0	27.9	9.9	22.1	3.4
	P_2O_5 @ 120			14.8	10.9		25.7	20.8	18.1	25.4	49.1	23.5	23.0	10.8	13.5	28.8	10.3	22.9	5.2
	K_2O @ 0			14.9	10.3		23.5	17.9	16.1	24.3	46.5	21.8	22.0	10.3	12.3	27.6	9.4	20.7	3.4
	K_2O @ 80			15.1	11.2		25.1	22.2	19.9	24.2	49.7	24.6	22.5	11.7	14.2	29.1	10.8	24.3	5.2

analysis of variance. For example, in the mean for the effect of the difference in yield between 80 and 120 Kg N/Ha, there are 16 values in each mean, as is the case for each main effect comparison--time did not permit a detailed statistical comparison of all the effects and differences between treatments, but a study of the main effects is quite conclusive even without statistical proof.

Nitrogen Effects

For a general recommendation, 80 Kg/Ha is about correct. Among the 15 completed experiments, there were some slight increase in yield when the rate of N applied was increased to 120 Kg/Ha, but there were also some minor decreases in yield. The effect of the 130 Kg/Ha rate of N was very similar to that of the 120 Kg rate. As will be shown later, the nitrogen not used by the potato crop remains in the soil to be used by succeeding crops.

The amount of nitrogen that can be economically used, with phosphorus and potassium, however, will depend upon the past fertilizer practices and the kind of growing season that prevails. The growing season largely determines the size of the crop produced if soil fertility is adequate.

Phosphorus Effects

In all of the 16 experiments, there was some increase in yield of potatoes when 80 Kg of P_2O_5/Ha was applied. In some experiments, the increase in yield was large. The increases in yield were primarily between not adding any phosphorus and the 80 Kg rate of P_2O_5. There were some increases in yield when the P_2O_5 rate was increased to 120 Kg/Ha, however, the increases

may be within experimental error, which was not determined. There is an indication that in experiment No. 2 at Toralapa, more P_2O_5 than 120 Kg/Ha might produce an economical increase in yield. At this particular site, the yield of potatoes was very low if no phosphorus was applied. Nevertheless, as a general recommendation, 80 Kg of P_2O_5/Ha seems inadequate. This is in contrast to the Toralapa recommendation of 120 Kg of P_2O_5/Ha. The lower amount is also supported by the results of the 1980-81 experiments. As mentioned under Nitrogen effects, the kind of growing season determines the amount of fertilizer needed by its effect on yield. In many areas of Bolivia, a frost of varying degrees of severity occurred the last week of January (see Table 4).* The variable response of potatoes to the application of phosphorus on different farms emphasizes the need for a good soil testing program.

Potassium Effects

Potassium like phosphorus is an essential element for both plants and animals. Fourteen of the 15 completed experiments gave a positive response to potassium when applied at 80 Kg of K_2O/Ha. Indications of a need for potassium on some soils has been obtained during the past two years. The increased yields on some farms due to the addition of potassium in the fertilizer is substantital. Time does not permit a critical statistical evaluation of the differences. A soil test program is needed.

Manure

The effect of applying 10 tons of manure per hectare on the total yield of potatoes varied from farm to farm. The manure was supplied by the

* Those plots receiving high levels of fertilizer had high regrowth and considerable yield. Those receiving no fertilizer never regrew.

cooperator and no doubt varied in composition from experiment to experiment. The value of the manure as a fertilizer is known to vary from year to year and from kind to kind, and therefore, cannot be relied upon to supply the necessary plant nutrients.

Block Effect

At eight of the experimental locations, the differences in yield among the blocks was statistically significant. In all but one case the differences were significant at the 1% or the 1/2 % level. Large variability among the blocks suggests that there might be significant block by treatment interaction. In other words, a given treatment may not be equally good in all blocks. Variability of this kind also complicates the problem of obtaining an adequate soil sample. A random soil sample in which the cores of soil from the different parts of a field are mixed could provide very misleading soil test information.

Soil Test by Potato Yield Correlation

This portion of the fertilizer studies is of major importance and still it has been the most disappointing and frustrating, primarily because the outcome depended upon the services of others. The analyses were performed exasperatingly slow. Twice the results of the analyses were suspect. The first time soil sub-samples were sent to Logan, Utah, for verification, and the Logan results confirmed the San Benito analysis. The results nevertheless failed to correlate with the respective potato yields. The second set of analyses were examined by Dr. James while he was here on a short-term consultantship and the analyses for phosphorus were unrealistically high. Fortunately, the soil samples are large so that repeated analyses

can be made. These results were returned to San Benito for confirmation on June 9, and the results have not been returned. Consequently, correlation analyses will need to be made at a future date.

Effect of Fertilization on Potato Tuber Size Distritribution

In all of the 16 fertilizer experiments and the Comarapa variety trial, the potatoes were sized into those over 5.5 cm in diameter, those between 4.5 and 5.5 cm, those between 3.5 and 4.5 cm, and those less than 3.5 cm in diameter. It is well known that varieties differ in their tendency to produce different size potatoes. It is also known that within a variety fertilization can have a large effect on the amount of potatoes of a given size.

In the January 1 - June 30, 1980 report, regression lines were computed to show the relationship between yield per hectare and the percentage of large and small potatoes. The relationship was inverse; the larger the yield, the fewer small potatoes. This relationship was verified in 1980-81 and the data obtained in 1981-82 also support the previous findings.

Two studies, one made by Dr. Kendall Adams and the other made by a student as a thesis project, both strongly indicate that consumers prefer the larger size potatoes and are willing to pay a premium for them. The extra premium paid for the larger size potatoes should be taken into consideration when determining the economic value of a good potato fertilizer program. Furthermore, a change in the marketing practices of potatoes could materially benefit the potato industry.

Results of Residual Fertilizer Experiments

Experiment No. 1 was with potatoes at Chinoli. The growing season was very dry. None of the treatments caused differences in total yield that were statistically significant at the 5% level. In 1981, the mean potato yield on this experimental site was 24.9 Ton/Ha. In 1981, there was a highly significant increase in the yield of potatoes due to phosphorus. In 1982, the mean yield of potatoes was only 2.6 Ton/Ha. Apparently, a lack of water was the controlling factor. Of interest, however, was those plots receiving no chemical fertilizer average 3.2 Ton/Ha whereas those receiving 120-0-80 fertilizer averaged only 0.97 Ton/Ha. The plants grown the previous year with N and K possibly exhausted the soil of any P that was left from previous fertilization. The effect of the 120-0-80 fertilizer was also reflected in the percentage of large tubers. Only 3% of the tubers were between 4.5 to 5.5 cm in diameter and none were larger.

Experiment No. 2 was with barley at Puna (Kepallo). An effort was made to select a square meter of plants that were most representative of the plants in the entire plot. But the variation in the weight of the plants in a square meter among the replication of the same treatment often varied by a 100% or more. This made means calculated from only four plots somewhat suspect. Mean values from 16 plots are considered to be more reliable. Therefore, the number of values in a mean is indicated.

Data from the Puna Experiment

(Yield in Tons per Hectare)

Nitrogen Kg/Ha	No. of plots	Total plant	Grain	Straw
40	16	3.15	1.31	1.76
80	16	3.35	1.34	2.01
120	16	3.24	1.23	2.01
160	16	3.16	1.22	1.94
P_2O_5 Kg/Ha				
0	8	3.07	1.19	1.83
40	16	3.33	1.25	1.83
80	16	3.34	1.30	2.01
120	16	3.16	1.27	2.01
160	16	3.18	1.29	1.95
Auxiliary treatments				
160-120-0	4	4.24	1.58	2.66
160-160-160	4	3.87	1.26	2.61
Manure 240 qq	4	3.08	0.92	1.98

In this experiment, 80 Kg/Ha of nitrogen, and 80 Kg/Ha of P_2O_5 seem to have produced the most benefit when both grain and straw are considered. Potassium was not a part of the factorial experiment hence the means of treatments with potassium contain only the values of four plots. The main effects of 160 Kg N/Ha and 120 Kg/Ha of P_2O_5 when acting alone appear to have reached the maximum yield, but when the two nutrients are applied together at the 160 and 120 Kg/Ha rates, the maximum yield was produced. A critical statistical evaluation of the data is needed.

Experiment No. 3 was with barley. It was previously designated as Rakay Pampa potato experiment No. 2.

Data from the Rakay Pampa Experiment No. 2

(Yield in Tons per Hectare)

Nitrogen Kg/Ha	No. of plots	Total plant	Grain	Straw
80	16	2.31	1.21	1.10
120	16	2.54	1.27	1.27
P_2O_5 Kg/Ha				
0	8	1.91	0.91	1.00
80	16	2.25	1.22	1.03
120	16	2.61	1.26	1.35
K_2O Kg/Ha				
0	16	2.46	1.31	1.15
80	16	2.40	1.16	1.24

The main effect of potassium on the yield of potatoes was highly significant on this experimental site last year.

Experiment No. 4 was with wheat. It was previously designated as Rakay Pampa Potato Experiment No. 1.

Data from Rakay Pampa Experiment No. 1

(Yield in tons per hectare)

Nitrogen Kg/Ha	No. of plots	Total plant	Grain	Straw
80	13	4.01	1.22	2.79
120	12	4.34	1.17	3.17
P_2O_5 Kg/Ha				
0	5	3.16	0.74	2.42
80	12	4.12	1.14	2.98
120	13	4.21	1.25	2.96

K_2O Kg/Ha	No. of plots	Total plant	Grain	Straw
0	11	3.99	1.11	2.88
80	14	4.31	1.27	3.04

The cooperator harvested part of this experiment. There were two complete blocks left. Because of the differences in yield of plants among the plots receiving the same treatment, it was decided to use the data from all plots from which it was possible to obtain a sample of plants and use this data as the most reliable indicator of the treatment effect. There was a significant phosphorus by potassium interaction on potatoes in this experiment last year. But the main effect of potassium on potatoes was highly significant in Rakay Pampa experiment No. 2. The average yield of potatoes on experimental site No. 1 was 9.1 Ton/Ha whereas it was 14.5 on site No. 2. The potash situation in the Rakay Pampa area needs further study.

From these data, it is obvious that the soil can be considered as a bank for plant nutrients. And that the residual value of the potato fertilizer should be taken into consideration when assessing the economic value of a fertilizer application. The results of two residual fertilizer studies were included in the last year's report and they tend to confirm this year's findings.

The question should also be asked, "Does a farmer leave his land idle for 3 and 4 years because of a fertility or a soil disease problem?"

Students

During the last year, six students have completed their projects and are now writing their theses. Three students did their thesis projects under the supervision of the Faculty of Agronomy at La Tamborada. The other three students did their thesis work under the supervision of the Economics Department at San Simón University. operation on all projects was obtained from IBTA personnel.

Names of the students and title of their projects as well as the dates their becas were developed are as follows:

Eduardo Sarmiento Jaldín - "Effects of levels of fertilization on potato yield" - October 15, 1980 to October 14, 1981.

Rubén Aranibar Iriarte - "Soil analyses and yield correlation studies on potatoes" - December 1, 1980 to November 30, 1981.

Gustavo Franco Maldonado*- "Consumer preferences for potato size" - June 1, 1981 to May 31, 1982.

Filemón Iriarte Montaño - "Comparative analysis of potato production costs in Bolivia" - June 1, 1981 to May 31, 1982.

José Prado Crespo - "Phosphorus requirements in Bolivia" - June 1, 1981 to May 31, 1982.

Alberto López Valencia - "Chemical and physical treatment of potato tubers for reducing dormancy and stimulating early plant emergence" - July 1, 1981 to May 30, 1982.

All these students have completed their projects and have written at least a rough draft of their thesis. All of the students have encountered thesis

* The thesis of Gustavo Franco has been accepted.

problems at the University and at La Tamborada. Changes in the Faculty have resulted in requests for changes in the requirements for the Ingeniero degree, but hopefully with some alterations in the thesis write-up the projects will be accepted. The problem has been particularly accute in the Economics Department at San Simón University.

Other

1. The belt fertilizer applicator was rebuilt to make it about half as long as the original model. This added greatly to the maneuverability in the field and the ease of transporting it in the van. The machine is now a double-deck unit. The wheels are attached to the bottom frame and the revolving belt is attached to the upper frame where it remains relatively free of dirt. The fertilizer spout was attached slightly in front of the front wheel. Mounting the spout in front of the wheel, resulted in a more uniform depth of fertilizer and insecticide placement, because the pointed shoe on the spout pushed aside clods and rocks that had rolled into the furrow.

2. The bulk fertilizer applicator was used in two relatively large potato experiments. It performed well mechanically and distributed the fertilizer accurately. It would be valuable for demonstration purposes and hopefully would eventually be adopted for commercial use. It is constructed mostly of wood and would be relatively cheap to build.

3. The potato sizer has attracted considerable interest among the various potato researchers at the stations as well as potato growers, who have seen it used when we were grading lots of experimental potatoes. Requests were

made for one at each of the four stations where potato studies are in progress. The shortness of time will not allow CID to construct them.

4. There have been a number of disappointments. The tentative situation of CID both as to tenure and finances has been distressing. The lack of IBTA support for the potato agronomy program is incomprehensible because it is the one area of research that can have large benefits to the Bolivian people in a relatively short time. The biggest disappointment of all, however, is the attitude and shifting of emphasis from an ongoing productive program to a new program by USAID. The present CID program is just beginning to "bear fruit," the facilities are intact, the secretarial staff and the driver-mechanics are competent, the shut-down is both wasteful and expensive. My leaving Bolivia is necessary because of family health problems. However, I am not indispensable and others can build from the results that have been obtained. The results indicate a need for an adequate soil testing facility, a fertilizer industry within Bolivian borders and a restructuring of the potato marketing system. A soils-agronomist and a plant physiologist are sorely needed in Bolivia.

E. CEREAL AGRONOMY, COMPUTER PROGRAMMING AND ANALYSIS, AND CEREAL PRODUCTION SURVEYS

by

Dr. Thomas C. Stilwell

In 1981-82, IBTA was severely restricted in the number of off-station field experiments that they could perform due to lack of budget. CID, therefore, had no off-station testing in cereals for 1981-82, and concentrated on surveys, computer work, and student advisement.

The projects reported below were all in process during past seasons, and during the last 6 months have been brought to a logical stopping point even though much remains to be done and IBTA will continue as best they can.

CID Administrative Report # 02/81 indicates that Projects E.1-E.7 were discontinued hence E.8 is the first of this report.

E.8 Project: Computer Analysis of Experimental Results

Leaders: Dr. Thomas Stilwell and Ing. Rafael Vera

Justification: At present, each experiment station technician spends a total of 2-3 months analyzing the results from his experiments, arranging them in a usable 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 was 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 who have had no previous computer experience.

2. Distribute these programs and instruct the technicians in their use.

Status

The program has been developed completely and both objectives have been met. The program has been identified as ESTAD. It is available on disket and tape, and all the necessary manuals have been published. The program is available for all IBTA/CIAT technicians and should be used. It will save thousands of man hours.

A copy of the program package was delivered to CIAT in Santa Cruz and modified for the computer system in the university. Their technicians were instructed in the use of the package by Sr. Antonio Stambuk. Response was very good and they have asked for a second round of demonstration and instruction by Sr. Stambuk.* In addition, orders have been received from the university in Oruro and from Oregon State University. Translation into English is now being done for the Crop Science Department in Oregon. Delivery of the program package to Oruro will depend on time and availability of IBTA funds.

A partially functioning version of the program package was demonstrated to an international meeting in Michigan in May 1982 using the Osborne micro computer. There was much interest and several persons have asked for copies of the final version. Further development of this version is not anticipated under the CID contract.

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* This will be delivered in July, 1982 at Saavedra experiment station.

In December of 1981, a paper was presented at the general meetings of the American Society of Agronomy in Atlanta describing these programs.

E.9 Project: Agro-Economic Survey

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

Collaborators: Ing. Gerardo Ramirez and Dr. Edgardo Moscardi.

Justification: There existed no base of reliable data about the production practices used by wheat, barley, and oats producers in Cochabamba. This data was necessary to guide the planning and execution of on-farm experiments.

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 published in 1979. Several other publications have been prepared since then. During the

period covered by this report, one additional publication was completed: "Economía de la Producción de Trigo, Cebada y Avena en Cochabamba." This completes the analysis and publication of results of this survey.

E.10 Project: Systems of Production Survey

Leader: Dr. Thomas Stilwell

Collaborators: Dr. Edgardo Moscardi and Dr. Gonzalo Avila

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

Objectives

1. Define the principle systems of production being used by small farmers in Valle Alto.
2. Describe in detail representative systems of production.
3. Form priorities for research programs of UBMSS Faculty of Agronomy on the basis of these results.

Status: Due to changes in the faculty of Agriculture, all UBMSS leaders of this project were discharged. The supervision and daily leadership was undertaken by Dr. Stilwell.

One thesis based on the data of the survey has been completed (see Mario Altamirano). A data summary has been printed and is available for distribution as working paper # 7/81 (Encuesta sobre Sistemas de Producción en Valle Alto - Cochabamba).

Because the CID contract terminates in June, no further analysis is anticipated. The raw data has been given to Dr. Frank Conklin of CID/Oregon State University (Corvallis, Oregon) for possible further analysis.

E.11 Project: Publication of Research Results

Leaders: Ing. Jaime Salamanca and Dr. Thomas Stilwell

Justification: The lack of printed technical materials for farmer and extension use has seriously hindered IBTA's technology and information transfer. 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: During the first part of 1982, the printing operations were sharply reduced in part due to lack of paper and other supplies to back up the printing process. Much of the printing work focused on publications for CID and the annual reports of the San Benito Station. Only one technical bulletin was published: Economía de la Producción de Trigo, Cebada y Avena en Cochabamba.

The lack of an IBTA budget for this activity plus the refusal of IBTA to grant an item for the person in charge of the printing facility has greatly hindered the expansion of this activity.

E.12 Student/University Projects

Student Advisees: In this listing of students, there are two general groups. The first group consists of students who are working on San Benito Experiment Station projects. The second group consists of students who were originally working on projects of the UBMSS Facultad de Agronomía. Nearly all of the original advisors of this group were fired from the university and CID became the sole advisor.

Raúl Nuñez: "Interaction Between Variety and Planting Density of Oats." All data collection and analysis has been completed on these experiments but Raúl has not progressed in his writing. It is probable that it will not be completed before the June 30th CID deadline.

Gregorio Pinto: "Interaction Between Lime and Fertilizer in Barley." Gregorio has now finished his rough draft and his thesis has been tentatively approved for the defense.

Emilio Ormachea: "Socio-Economic Study of Wheat Producers in the Sub-Tropical Zone of Santa Cruz." All field work and analysis has been completed and a rough draft is in the reviewing stages. It is not possible to predict when the thesis will be approved.

José Rios: "Survey of Small Scale Millers in Valle Alto." José now has a completed rough draft of his thesis in review. Because of the very long time that his thesis has been in review, he may not complete his defense this year. A CID working paper has been published as a thesis summary.

Rosario Medrano: "Socio-Economic Analysis of Tiraque as a Barley Production Center." All data collection has been completed. There has been little

visible progress on this project since the completion of data collection and it is doubtful that Rosario will finish the thesis.

UBMSS Projects

Mario Altamirano: "Factors Affecting the Election of Varieties of Wheat, Potatoes and Alfalfa in Valle Alto." The rough draft of this thesis has been approved for defense after nearly one year of revision.

Esteban Antezana: "Interaction Between Levels of Moisture and Fertilization in Onion." The draft has been approved for defense and a working paper has been published summarizing the thesis.

Freddy Corrales: "Sources and Levels of Organic Fertilizer in Cabbage." All data collection and analysis has been completed but no visible work has been completed on the thesis draft.

Luis Pedrazas: "Soil Mosture Levels in Maize for 'Choclo' in the Valle Central." Luis has completed the revision of the rough draft and has been approved for defense of his thesis.

Juan Arana: "Study of the Effect of Ferrous Sulfate on the Addition of Cotton Seed Meal to Diets of Pigs." Juan has completed his thesis and has received the title of Ingeniero Agrónomo.

E.13 Project: Professional Presentations

During the month of December, two professional papers were presented at the annual meetings of the American Society of Agronomy in Atlanta, Georgia. Both topics presented concerned work done under the CID-IBTA program in Bolivia. The papers were:

ESTAD: A Statistical Analysis System for Developing Countries by A. Stambuk and T. Stilwell.

Establishing Research Priorities Using Experimental Data by Thomas Stilwell.

During the months of April and May, a total of five presentations were given in different locations of Bolivia. The presentations covered two subjects: the methodology and results of the on-farm trial program and a description and demonstration of the statistical analysis package on a micro computer.

In the month of May, a presentation was made in Michigan, U.S.A., with Ing. Rafael Vera describing the statistical package developed in Bolivia. The paper was presented at an international meeting on the use of micro-computers in developing countries. There was a very favorable reception and several persons have asked for copies of the micro-computer programs.

F. ENTOMOLOGY, PEST CONTROL, AND NATIONAL INSECT MUSEUM

by

Dr. Donald Foster, Entomologist

Activities in Entomology in the CID contract have been concentrated principally in work with the National Museum. Only two field activities were planned and executed in research.

F.1 Project: National Insect Museum

Leaders: Dr. Donald Foster, Jaime Silva and Ing. David Villarroel

Several new names have been aded to the list of insects which are pests on Bolivian crops (see Table 1). Some of these have never been given species names because they have only recently been collected. Specimens are now in the hand of taxonomic specialists and should receive new names soon.

The use and management of the Insect Museum was explained in the CID seminars and the National Entomology Program (which CID helped to plan) was introduced.

F.2 Project: Soil Insecticide Trials - Belén Experiment Station

The most serious pest problems in Bolivian potato production come from soil insects. These pests are difficult to control and normally their damage is observed after the product has been harvested. A trial was established at the Belen Experiment Station to determine the effectiveness of currently available methods using Curaterr and Temik in granular

formulation for soil application and to test a new method with Curaterr liquid seed dressing. Insecticides were applied at rates recommended by local distributor.

Insecticides were applied at (1) planting, (2) planting and hilling, or at (3) hilling to determined if there was any advantage in timing of application(s).

Plots consisted of three rows of 10 m each. Insecticides were applied to each row in each plot. In plots for testing Curaterr in liquid, the seed potatoes were completely covered with this liquid formulation just prior to planting. The center row of each plot was harvested, weighed, and 20 potatoes from the row were dissected to determine the percentage of infestation.

Table 2 shows the yields and percentage infestation of tuber obtained from this study. There were no significative differences in the weights of potatoes in these plots and the weights were highly variable. The numbers of infested tubers from each plot did show significant differences. Potatoes were infested with larvae of both Premmotripes lattithorax (Coleoptera: curculionidae) and Phthoremea operculella (Lepidoptera: Gelichiidae). While infestations were also highly variable, the results show that the lowest levels of tuber infestation occurred when Curaterr was applied at both planting and at hilling. The highest levels of infestation occurred in the check plot and when Curaterr was applied only at hilling. Because of the variability encountered in this type of study, this test should be repeated using larger plots, more replications, and several locations.

Table 1. Insects recently identified for Bolivia

Epicauta willei	Meloidae	
Epicauta latitarsis	Meloidae	
Rhigopsidius tucumanus Heller	Curculionidae	Potato
Listroderes sp.	Curculionidae	Potato
Listroderes sp.	Curculionidae	Potato
Pleurotini	Oecophoridae	Potato
Symmetrischema sp.	Gelechiidae	Potato
Solenopsis sp.	Formicidae	Pasture
Solenopsis sp.	Formicidae	Pasture

Table 2. Results of insecticide trial at Belén

Insecticide	Yield	% Infestation
Curaterr G (siembra)	482 ± 140 a	41.7 ± 23.1 b
Curaterr G (siembra and aporque)	250 ± 65 a	11.7 ± 12.6 c
Curaterr G (aporque)	314 ± 79 a	63.3 ± 10.4a
Temik (siembra)	372 ± 2 a	31.7 ± 10.4 b
Temik (siembra and aporque)	351 ± 100 a	38.3 ± 7.6 b
Temik (aporque)	431 ± 50 a	48.3 ± 7.7 b
Testigo	351 ± 104 a	66.7 ± 14.4a

F.3 Project: Stem Weevil Damage Analysis

Leaders: Armando Ferrufino and Donald Foster

A weevil which attacks stems of potatoes and kills the plants has been found in the lower part of the Cochabamba valley. This weevil is tentatively being called Trichobarius sp. until a positive identification of collected and reared adults can be obtained. A survey was conducted in the Cochabamba area to identify the distribution of this weevil and quantify the damage done. From each location a field was selected and 30 stems were removed from each of three sites in the field. The stems were returned to the laboratory and dissected to determine weevil damage. Table 3 gives the results of this survey.

Weevils were found in the lower Cochabamba valley and at Tarata, but no weevils were found in the upper Cochabamba valley, Tiraque or Toralapa. The highest infestation levels were at Suticollo and Bella Vista.

Table 3. Results of survey of stem weevil distribution and damage in the Cochabamba area.

	% Infestation
Bella Vista	95.9 + 7.0 a
Suticollo	92.2 + 5.2 a
Tarata	83.2 + 7.9 ab
Parotani	62.1 + 8.3 b
Capinota	47.3 + 9.9 b
Tiraque	0.0 + 0.0 c
Colomi	0.0 + 0.0 c
Sacaba	0.0 + 0.0 c
Toralapa	0.0 + 0.0 c

G. PLANT PATHOLOGY

by

Dr. Víctor Otazú, Plant Pathologist

Most of the reporting period was devoted to completing the research activities started in 1981. Considerable time was also spent in preparing material for the series of seminars delivered in five locations, and for the publication of bulletins. This report will consist mostly of final results and conclusions and recommendations for each project. Justifications, objectives and partial results are included in the previous report (CID Administrative Report # 01/81). As before, the material presented here will be divided by the activities in each of the two experiment stations and the University of San Simón.

A.1 Project: Potato Storage Problems - Toralapa Experiment Station

A.1.1 Fungal diseases

a. Leaders: V. Otazú, T. Villarroel, and G. Caero

b. Results: Four potato cultivars (Two native: Imilla blanca and Sani imilla; and two European: Alpha and Radosa) were tested for dry rot susceptibility by inoculating them with spore suspensions prepared from pure cultures of *Fusarium*. It was evident that the native varieties were the most susceptible. This agreed with previous results, where these same varieties had the highest dry rot incidence in local storages. An overall figure of storage losses due to dry rot was calculated at 8-10%. This was difficult to estimate in growers' storages because they sort and discard the rotted tubers periodically.

Principally, two fungi were associated with the dry rotted tubers: Fusarium and Phoma (Table 1).

Table 1. Incidence in % of dry rot causal agents in two native and two European potato varieties in Bolivia.*

Cultivars	Fusarium spp.	Phoma exigua
Native: Sani and I. Blanca	97.2	2.8
European: Alpha and Radosa	79.0	21.0

* Results were obtained by isolating fungi from 150 dry rotted tubers.

Fusarium spp. can be frequently isolated from most dry-rotted tubers. Phoma - dry rot is a problem in European potato storages. Table 1 shows evidence that the European potatoes had a considerable incidence of Phoma rot, thus indicating that this problem may be introduced into Bolivia with "seed" potato importations from Europe.

Preliminarily, the following Fusarium spp. were identified: F. solani, F. oxysporum, F. sambucinum, F. sambucinum var. coeruleum. Cultures have been sent to the Fusarium Research Center - Pennsylvania, for species confirmation.

c. Conclusions and recommendations

- Incidence of dry rot in Bolivian potato storages is high; therefore, control systems should be devised through experimentation, especially in those areas where potatoes are stored for long periods of time.

- Species of Fusarium were predominantly causing dry rot although Phoma exigua was also present, especially in Dutch (European) varieties.

- Since there are many Fusarium species involved in this disease in Bolivia, it may be difficult to introduce genetic resistance.

- The storage system used by the common grower of the highlands (campesino) has proved to be slightly better for less incidence of dry rot and least weight loss, especially during the first two months of storage.

- The native varieties Imilla blanca and Sani imilla are more susceptible to Fusarium dry rot than the Dutch varieties Alpha and Radosa.

A.1.2 Erwinia-related problems in potatoes

a. Leaders: V. Otazú, M. Coca and G. Caero

b. Results: Table 2 shows the incidence of Erwinia-soft rot in potatoes sampled from various storages in Bolivia. It can be observed that Erwinia represents a problem in the lower elevation production areas of Bolivia. Black leg, another disease caused by the same bacterium, was also observed more frequently in those areas. A few potato storages in the Santa Cruz area failed completely because of Erwinia soft rot. In the highlands, although Erwinia is also present, it does not seem to cause any effect in the potato crop in storage or in the field.

Table 2. *Erwinia*-soft rot incidence in potato storages sampled from different Bolivian locations

Areas sampled	Altitude meters a.s.l.	Average % of tubers infected by Erwinia	Standard deviation
Highlands (>3,000 m)			
Altiplano (La Paz	3,800	1.4	1.9
Cochabamba highlands	3,500-3,900	4.2	4.9
Potosí	3,200	1.8	1.4
Average		2.5	2.7
Lowlands (3,000 more or less)			
Escalante (Cochabamba)	3,000	12.8	1.8
Sorata valley (La Paz)	2,700	4.9	3.8
Santa Cruz	1,800	41.1	7.1
Tarija valley	2,300	7.6	4.2
Average		16.6	4.2

After testing three types of storage systems, i.e. industrial, semi-subterranean, and *campesino* type* commonly used by highland growers, the *campesino* type had tubers with the highest incidence of *Erwinia* soft rot. Observations in storages and inoculation experiments demonstrated that the Dutch varieties Alpha and Radosa were more susceptible to *Erwinia* soft rot than the native varieties. It was not possible to run biochemical tests to identify *Erwinia* varieties because of the lack of some chemicals.

* Storage above ground with potatoes covered with stiff grass straw.

Yield experiments using "seed" lots having different Erwinia infection levels did not provide enough information to reach a valid conclusion. Other factors, i.e. virus infection and other diseases, may have influenced the results. Poor yields were expected in plots planted with "seed" having high Erwinia infection. This did not happen. The tubers harvested from this planting should be checked for Erwinia to determine transference and subsequent storage incidence.

c. Conclusions and recommendations

- Soft rotting Erwinia appears to be present in all potato fields and storages in Bolivia.
- The incidence of Erwinia is low in the highlands and probably causes very little damage to the potato crop in those areas.
- Blackleg and Erwinia soft rot are important diseases in the lower elevation production areas of Bolivia. The losses due to such diseases are variable, depending on the environment. It was verified that in some areas these diseases can be devastating, causing total losses.
- Lowland farmers should not use "seed" from the same geographical region.
- Highland "seed" growers should be careful and take measures against Erwinia if their production is geared towards the lowland market.

A.2 Project: Nacobbus Research - Toralapa Experiment Station

Leaders: V. Otazú, R. W. Hoopes and G. Caero

Activities: This pest is considered one of the most important potato production problem in Bolivia.

Field surveys were made to determine the weeds that were the most important hosts for this nematode. Spergula arvensis and Calandrinea sp. persisted in most fields. Random sampling of four cultivated fields (two potato fields and two fields with leguminous crops) indicated that Spergula covered an average of 40% of the field area (0-82%). An average of only four Calandrinea plant/m^2 (1-7) were present in these fields.

Ten fields planted with potatoes in 1980 were checked for Spergula colonization and presence of Nacobbus root nodules during 1981 and 1982. Fields that initially had the potato false root-knot nematode in 1980 also had Spergula with root-knots in subsequent years. However, fields that were Nacobbus-free in 1980 had Spergula with healthy roots, in any type of rotation system. This indicates that Spergula is an important alternate host for Nacobbus. A small experiment using the herbicide Sencor demonstrated that the use of chemicals for weed control is practical and economical and it is efficient against Spergula. Weeding by hand causes soil disruption. This situation favors the weed because Spergula grows quickly in recently distrubed soils.

Two different infested potato fields were selected for periodical sampling in order to determine infestation curves. Eighteen plants/field were sampled on January 7, 1982 and the number of nodules/plant determined.

Samplings from the same fields were subsequently performed every two weeks. Figure 1 shows the infestation curves for these two fields. It can be observed that tuber formation in the potato plants starts at a time when the false root-knot infestation is high. From this curve, it is obvious that yields may be affected since the root system of the plants are being damaged at a critical time.

Soil fumigation experiments using Telone C were useful to estimate yield losses due to Nacobbus. Figure 2 shows the effect of soil fumigation on the number of Nacobbus nodules/plant in two locations. Treated plots had considerably less number of nodules/plant than untreated plots. One Nacobbus-free field received also the same treatments. No nodulation was evident in these plots.

Figure 3 shows the effect of Nacobbus infestation on yield. No significant differences in yield between treated and untreated plots were observed in the Nacobbus-free field. Whereas in the Nacobbus-infested fields, the differences were significant. A noticeable effect of Nacobbus was detected because of the production of big size tubers. An average of 63% reduction in yield of big size tubers and 39% in total yield was estimated to be caused by Nacobbus infection.

An experiment was designed to determine the importance of "seed" as a source of Nacobbus inoculum. Two "seed" lots of Imilla blanca, one originating from an infested field and the other from a Nacobbus-free field were used. Tubers were planted in a Nacobbus-free field and in pots containing sterilized soil in the greenhouse. Results are given in Table 3.

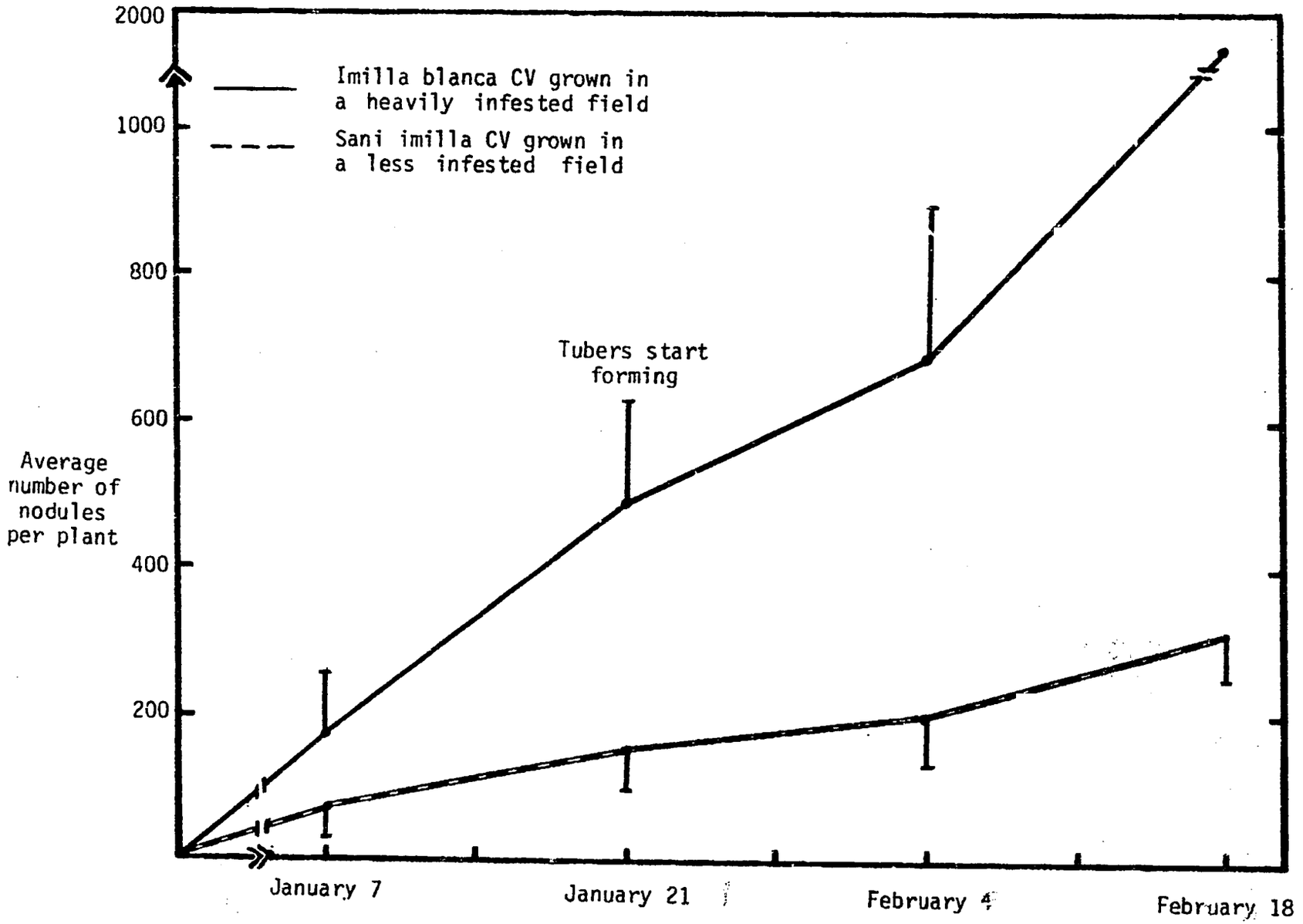

Fig. 1 : False root knot development in potatoes during a growing season in two different infested fields. Bars represent standard deviation.

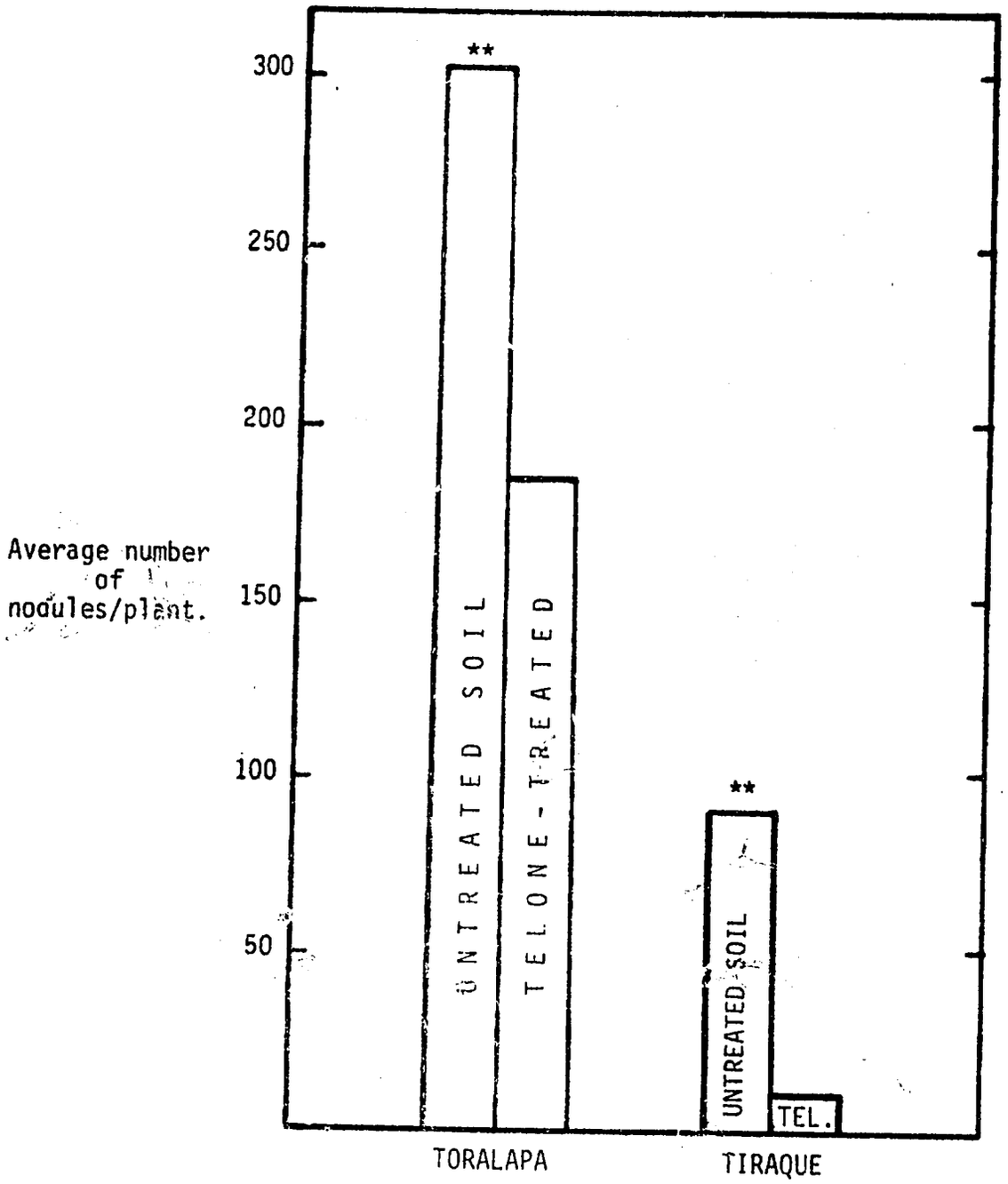

Fig. 2 : Effect of soil fumigation with TELONE C on the number of nodules/plant in two Nacobbus-infested potato fields. Asterisks denote significant differences (P=0.01) between treated and untreated plots.

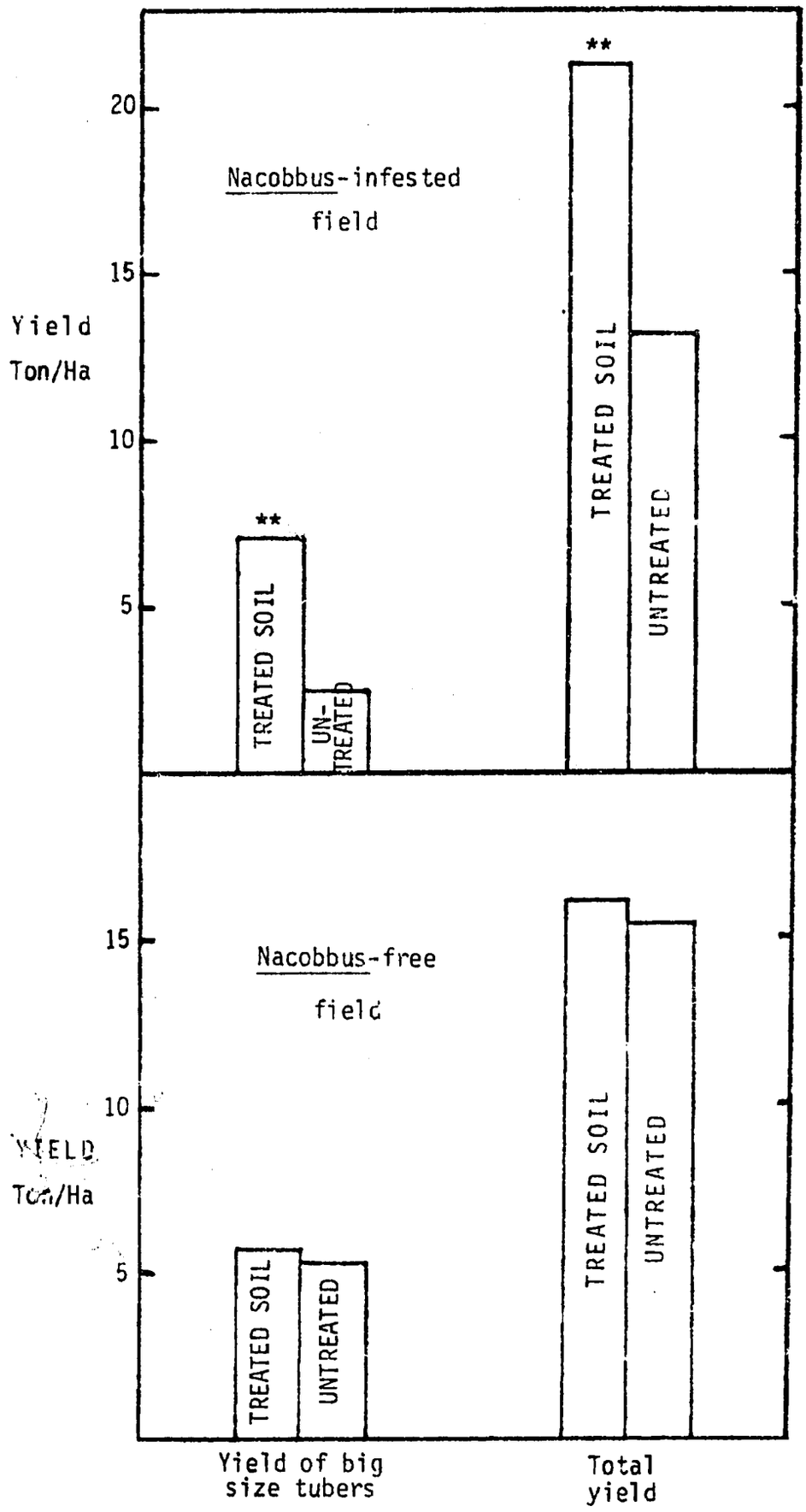

Fig. 3: Effect of the false root-knot nematode on potato yields in Telone-treated and untreated plots in Nacobbus-infested and Nacobbus-free soils.

Table 3. Effect of Nacobbus-infested "seed" on the establishment of false root-knot in Nacobbus-free soils.

	Infested seed N° nodules/plant	Healthy seed N° nodules/plant
Field experiment	2.1	0.0
Greenhouse experiment	22.0	1.0

There was more Nacobbus transmission through "seed" in the greenhouse than in the field, but the presence of nodules was consistent only in plots where infested "seed" was planted, indicating that "seed" can be an important source of contamination for those fields that are still free of Nacobbus.

A different greenhouse experiment was designed to determine the effect of various "seed" treatments on Nacobbus populations. Toralapa technicians reported that thermoterapy was effective in decreasing Nacobbus populations in the "seed." However, there was no printed or unpublished data supporting this statement. Results indicate that "seed" immersed in cold water is just as effective as hot water immersion in decreasing tuber-borne Nacobbus inoculum (Figure 4).

Conclusions and recommendations

- The false root-knot nematode is one of the most important pests of potatoes in Bolivia.
- Spergula and Calandrinea are the principal weed hosts for Nacobbus in Cochabamba. Calandrinea and Chenopodium are more prevalent in the Altiplano area.

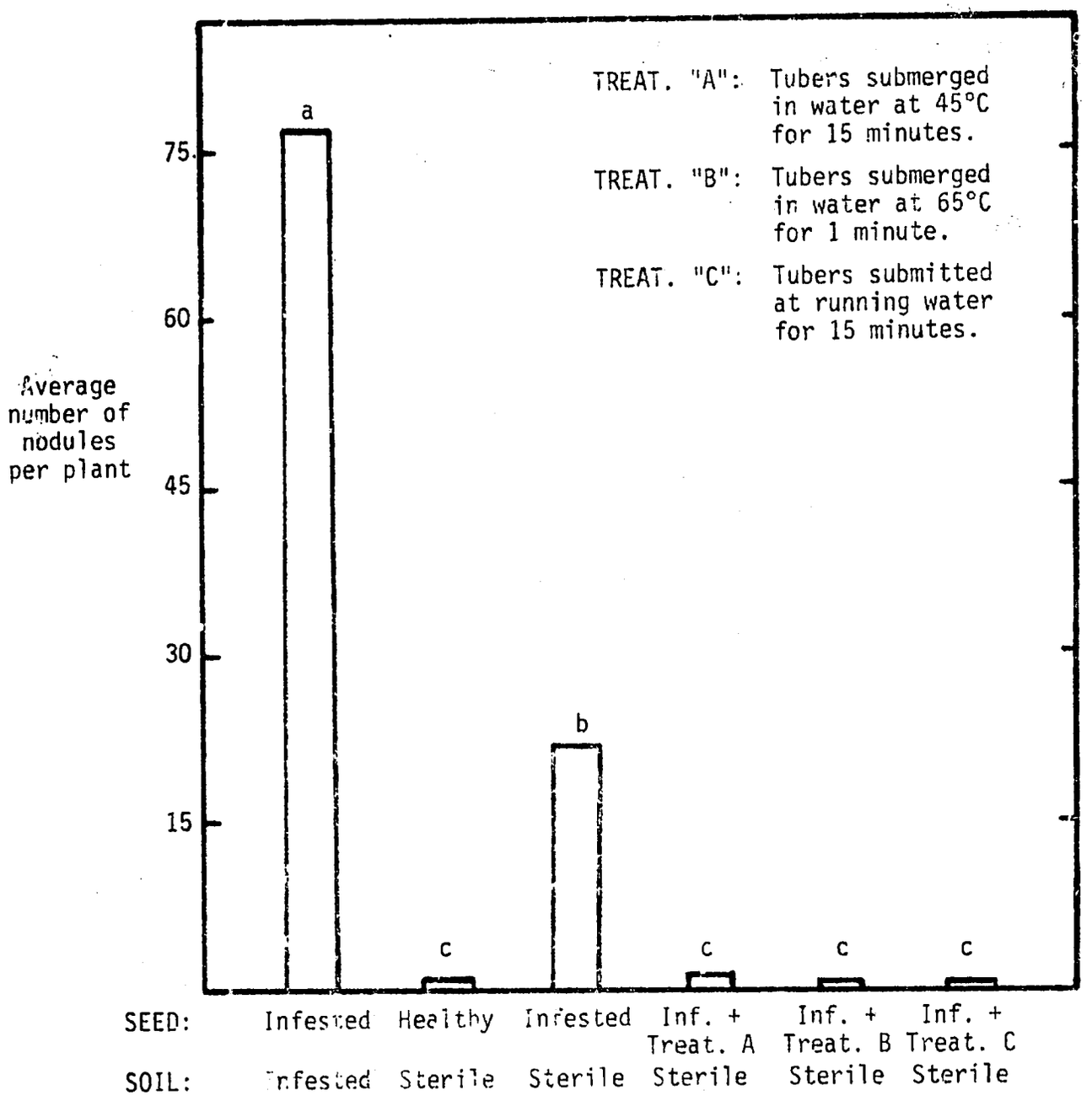

Fig. 6: Effect of various treatments to determine "rosario" incidence in nursery sterile soil. Different letters indicate significative differences (P=0.05).

- Chemical weed control is available which is economical and efficient against Spergula.
- Crop rotation practices are not effective against Nacobbus if the above weeds are present in the fields.
- The effect of Nacobbus on yield of larger tubers and total yields is significant.
- Seed tubers are important sources of contamination only for Nacobbus-free soils.

B.1 Project: National Diagnostic Clinic - San Benito Experiment Station

Leaders: Mery H. de Quitón, Victor Otazú

Activities: The clinic had an increase activity during this period over the previous six months. Distribution pre-addressed envelopes to extension agents for sending diseased specimens to the clinic gave good results. Most of the samples that arrived during this period were sent in these envelopes. The problem of time in transit must be solved so the clinic can be more efficient. Mailing time to Cochabamba is good, but to San Benito is very slow. The need for the clinic to be in Cochabamba city is emphasized again.

B.2 Project: Compilation of a New Plant Disease Index for Bolivia - San Benito

Several plant diseases, not previously reported in Bolivia, were identified in the clinic from 1979 to 1982. Also trips were made to La Paz and Santa Cruz to gather information especially from international institutions working in agriculture. As a result, we have compiled enough material to

publish a new plant disease index for Bolivia which should be useful for people working in agriculture in Bolivia.

B.3 Establishment of a Biological Control Program against Peach Crown Gall in San Benito

Leaders: M. Jaimes, W. M. Brown, M. de Quitón, V. Otazú

Introduction: This program started in 1980 with the visit of Dr. A. H. McCain from the University of California, Berkeley. He brought the strain "K-84" of *A. radiobacter*, a bacterium similar to the causal agent of crown gall but antagonistic to it. Mario Jaimes, now an IBTA technician at San Benito, made a thesis project to test this approach of control peach crown gall in Bolivia.

Results: Initially, there was no success due to some technical problems (see CID Working Paper 03/80). However, more isolates of "K-84" were sent that proved to be effective against crown gall. In a commercial nursery, over 2000 seedlings were treated with "K-84". A similar number of seedlings were planted untreated in a field adjacent. About 70% of untreated plants had crown gall, while less than 20% of treated plants were affected. The San Benito Experiment Station is now equipped to produce and sell crown gall-free plants to growers all over the country. During the CID/IBTA seminars there was much interest in this control approach, especially in Sucre, Tarija, and Santa Cruz.

B.4 Project: Determination of Etiology and Control of "Camanchaca" Disease in Onions in Bolivia - San Benito Experiment Station

Leaders: V. Otazú, E. Gallardo, M. de Quitón

Introduction: The "camanchaca" disease was thought to be a type of downy mildew. This disease causes lef spots and can completely dry the plant foliage. Due to the severity of this disease in the Cochabamba valley during the rainy season, a project was started in 1981-1982 with the following objectives·

- Properly identify the etiological agent of the disease.
- Determine a chemical product for satisfactory control of this disease.

Activities: The causal agent of this disease proved to be *Heterosporium allii* and not downy mildew. Fungicide trials supported this finding because Ridomil, a fungicide specifically effective against downy mildew, had little effect on "camanchaca." Table 4 shows the non-significant effect of the chemical products used to control this disease when two applications were performed at 2-week interval. However, with three applications (Table 5) at weekly intervals, a satisfactory control was obtained with Dithane M-45 (a dithiocarbomate of Zn and Mn). Some control was obtained with Ridomil MZ (a mixture of Metalaxyl and dithiocarbomates of Zn and Mn) apparently due to Ridomil MZ. Little response was obtained with Benomyl and pure Ridomil.

Table 4. Chemical control of "camanchaca" disease of onions with two applications at 2-week interval

Product	rate a.i. Kg/Ha	grs. of product per 20 lt tank of back-pack sprayer	% of dead foliar area/plant[1/]
Dithane M-45	4.2	60.0	20.0
Ridomil	1.4	64.0	24.0
Benlate	0.4	8.8	25.3
Water (check)	-	-	26.0
Ridomil MZ	1.3 (MZ)	32.0	30.3

[1/] There was no significant differences between treatments.

Table 5. Chemical control of "camanchaca" disease of onions with three applications at weekly intervals.1/

Product	Rate a.i. Kg/Ha	N° foliar lessions per plant	% dead foliar area per plant
Dithane M-45	4.2	7.9 a	12.1 a
Ridomil MZ	1.3 (MZ)	10.4 b	16.6 b
Benlate	0.4	15.2 bc	23.5 c
Ridomil	1.4	16.9 c	33.0 d
Water (check)	-	23.2 d	49.8 e

1/Different letters indicate significant differences between treatments (P=0.05) using Duncan's Multiple Range Test.

C.1 San Simón University - Becarios' Status

Manuel Echalar - "Chemical control of powdery mildew in peaches." He was in the process of writing his thesis before he was hired by Sanidad Vegetal - La Paz. He lost contact thereafter.

Eloy Sanabria - "Chemical control of barley yellow rust." This becario is in the process of writing his thesis. He still has subjects to complete at UMSS but will prepare the thesis in advance of his graduation.

Edwin Gallardo - "Chemical control of downy mildew of onions". He restarted his thesis work. Part of his results are presented in section B-4 of this sub-section. It seems that he will be able to complete his thesis now.

Mario Coca - "Erwinia related problems in potato storages." Part of his results are presented in A.1.2 of this sub-section. He has made considerable progress in his thesis writing and will be able to defend his thesis in the next two months.

Teófilo Villarroel - "Fungi related problems in potato storages." This becario finished his thesis work, but he did very little writing. He was hired as an extension agent in Oruro and it is doubtful if he will be able to finish his thesis writing.

Mario Jaimes - "Biological control of peach crown gall." This becario's thesis was approved by his committee members. His thesis is typed and bound, and he is ready to defend it.

D.1 Publications

1.1 Publicatons in press

- Otazú, V., W. M. Brown, and M. Herbas de Quitón. 1982. Plant Diseases in Bolivia. IBTA-CID Bulletin, 30 pp. (in Spanish).
- Otazú, V., G. Caero, and R. W. Hoopes. 1982. Late Blight of Potatoes and its Control. IBTA-CID Extension Bulletin (in Spanish).
- Otazú, V., R. W. Hoopes, and G. Caero. 1982. Nacobbus false root-knot of potatoes and its control. IBTA-CID Extension Bulletin (in Spanish).
- Quitón, M., and V. Otazú. 1982. Lupin (Lupinus mutabilis Sweet) diseases in Bolivia. III International Congress of Andean Crops. La Paz-Bolivia. Proceedings (Spanish).

1.2 Manuscripts in preparation

The following manuscripts are being prepared for publication in technical journals.

- The status of false root-knot nematode of potatoes in Bolivia.
- Etiology and control of an onion leaf blight occurring in Bolivia.

- *Fusarium* dry rot occurrence in Bolivian potato storages.
- Soft rotting-*Erwinia* occurrence in Bolivian potatoes.
- Biological control of peach crown gall in Bolivia.

SECTION V

TRAINING ACTIVITIES

CID/IBTA Training Seminars

The seminars were prepared by CID staff to be presented in five locations in Bolivia in accordance with the agreements reached with IBTA and USAID/B. IBTA organized the seminars as to location, participants, financial management, and advertisement. Four days for each location were planned with CID utilizing two full days for presentations and IBTA one and a half. Presentations were prepared with two objectives: (1) present the technical material and inform participants of the kinds of information that is available in the CID reports; (2) demonstrate to IBTA agronomists and technicians the best ways to make professional presentations of scientific information.

A CID published loose-leaf book with 145 pages of information about CID's activities was distributed to participants and interested individuals. The books were popular to the point of being stolen and a second and third printing were necessary.

The format of the presentations was basically the use of slides of pertinent material and comments by those making the presentation with a period of discussion, questions and answers following each talk. CID staff made the major presentations, but each CID counterpart and student advisee made one or more presentations on a pertinent research project.

Excellent press and radio coverage was received in all locations and television interviews were taped and telecasted in three of the five locations.

The topics presented over the four days were:

1. Inauguración Reseña Histórica del Contrato y Propósito de los Seminarios.
2. Actividades del Banco Nacional de Germoplasma de Papas.
3. Ensayos Fuera de la Estación en Cereales - Métodos. Resultados del CID/IBTA.
4. Entomología - Resultados del CID/IBTA.
5. Patología de Papas - Resultados del CID/IBTA.
6. Producción de la Papa - Fertilidad del Suelo - Resultados del CID/IBTA.
7. Utilización de Computadoras para Trabajos de Investigación y de Extensión.
8. Demostración de Análisis en Micro Computadoras con Procesador de Palabras.
9. Patología - Programa Nacional de Patología y Otras Actividades.
10. Entomología - Museo Nacional de Insectos y Programa Nacional de Entomología.
11. Mejoramiento Genético de la Papa - Resultados del CID/IBTA.
12. Discusión sobre Análisis de Computación y su Relación con Futuros Trabajos de Investigación.
13. Programa de Fertilidad y de Análisis de Muestras de Suelo.
14. Planificación y Coordinación de la Investigación.
15. Recomendaciones del CID y Discusión.
16. Concepto de Desarrollo. El IBTA - Su Función.
17. Instituciones Rurales. Reforma Agraria y su Papel Histórico en Bolivia. El IBTA - Su Función.

18. El Problema de la Desnutrición. Problema Multisectorial. Comercialización. Distribución. El IBTA - Su Función. Recursos Naturales-La Erosión.
19. Participación de la Comunidad. Factores Multiplicadores. Maestros Rurales, Líderes de Opinión.
20. Métodos de Extensión. Demostraciones de Resultado. Cursillos.
21. Juventud Rural. Su Problemática. Experiencias de Campo de los Técnicos. Juventud Canadá-Mundo.
22. Programas del IBTA, Planificación de Acciones (Metodología). Revisión. Reajuste Actualización para Arranque en 1982-83.
23. Informes y Acciones más Importantes; Mensuales, Trimestrales y Finales.
24. Seguimiento, Supervisión, Evaluación de los Programas del IBTA.
25. Parrillada (Cortesía del CID).

Pertinent information on the seminars

Location	Dates	Number of Participants	Books Distributed
Cochabamba	Mar. 29-Apr. 1	61	82
Sucre	April 19-22	54	67
Oruro	April 26-29	95	132
Tarija	May 3-6	33	36
Sta. Cruz	May 17-20	26	30
Total (five locations)		269	347

CID/IBTA Communications Workshop

Since the organization of IBTA in 1976, there has been an apparent lack of cooperation and communication between the Research and Extension divisions of the organization. This has greatly decreased the effectiveness of IBTA as a research-extension organization. Better cooperation in doing the research, publishing results, which could be adapted for extension use, printing the publications and providing the extension service is essential if IBTA is to survive and comply with its mandate.

CID sponsored and helped plan a workshop which was designed to allow Administrators, Researchers, Extension personnel and Communications specialists do a better job in their respective responsibilities and still work as a team. The theme of the workshop was on farming systems and it was used as a vehicle to show the process required. The Bolivian director of IICA, Ing. Antonio Saravia, gave the keynote address the first day on the "Concept of Farming Systems" and Dr. James Thomas, CID Chief of Party, gave the main talk the second day on "Research Alternatives for Bolivia." Both talks were published in the proceedings. (In Spanish only.).

The participants included all the national leaders of IBTA, the regional directors, and regional communications specialists as well as the regional directors of MACA. Other selected individuals were invited. A total of 57 persons attended the workshop which was held for two days on May 25 and 26, 1982.

CID also provided the services of Ing. Inés Ortiz, who was completing her TDY as the Communications Specialist. Ing. Ortiz helped the IBTA Communications Unit plan and organize the workshop and she gave one of the major presentations.

Student Scholarships

During the reporting period, a large number of students finished receiving their support from CID and several were able to terminate their thesis. The total number of students on scholarship through June 1982 was 32. The list is as follows:

Student	Location	Date Started	Anticipated Ending Date	CID Advisor
Fernando Rivas Arce	Cochabamba	7/15/80	7/14/81	Hoopes
Andrés Gregorio Mejía Escalera	Cochabamba	8/1/80	7/31/81	Kunkel
Edwin Fructuoso Gallardo Torrico*	Cochabamba	9/1/80	8/31/81	Stilwell
René Eduardo Andrew Cardozo	Cochabamba	10/1/80	9/30/81	Foster
Juan Humberto Arana Iriarte	Cochabamba	9/1/80	8/31/81	Thomas
Armando Ferrufino Coqueugniot	Cochabamba	10/1/80	9/30/81	Foster
Ignacio Huayta Colquehuanca	Cochabamba	10/1/80	9/30/81	Hoopes
Raúl Nuñez Cruz	Cochabamba	10/1/80	9/30/81	Stilwell
Gregorio Pinto Vega	Cochabamba	10/1/80	9/30/81	Stilwell
Eloy Sanabria Ortuño	Cochabamba	10/1/80	9/30/81	Stilwell
José Roberto Terceros Hermosa*	Cochabamba	8/1/80	7/31/81	Stilwell
Claudio Ticona Martinez**	Cochabamba	9/1/80	8/31/81	Thomas
Raúl Velásquez Arias	Cochabamba	10/15/80	10/14/81	Foster
José Luis Ríos Antezana	Cochabamba	10/1/80	9/30/81	Thomas
Rosario Medrano de Aparicio	Cochabamba	11/1/80	10/31/81	Stilwell
Eduardo Sarmiento Jaldín	Cochabamba	10/15/80	10/15/81	Kunkel
José Villarroel Coca	Cochabamba	11/1/80	10/31/81	Stilwell
Rubén Tito Aranibar Iriarte	Cochabamba	12/1/80	11/30/81	Kunkel
Juan Manuel Echalar Torricos	Cochabamba	12/1/80	11/30/81	Kunkel
Eybar Gorena Donoso	Cochabamba	12/1/80	11/30/81	Foster
Hortencia León Hurtado	Santa Cruz	8/15/80	8/15/81	BTAM
Nelson A. Rodriguez Méndez	Santa Cruz	8/15/80	8/15/81	BTAM
Rubén Herbas Canelas	Santa Cruz	10/15/80	10/15/81	Thomas
Elías Rojas Ricaldez	Santa Cruz	10/15/80	10/15/81	Thomas
Mario Coca Morante	Cochabamba	3/15/81	3/14/82	Otazú
Teófilo Villarroel	Cochabamba	5/1/81	4/30/82	Otazú
Filemón Iriarte Montaño	Cochabamba	6/1/81	5/31/82	Kunkel
José Prado Crespo	Cochabamba	6/1/81	5/31/82	Kunkel
Gustavo Franco Maldonado	Cochabamba	6/1/81	5/31/82	Kunkel
Carlos Padilla Irigoyen	Cochabamba	7/1/81	6/30/82	Thomas
Alberto López Valencia	Cochabamba	8/1/81	7/30/82	Kunkel
José Modestino Rojas Rojas	Cochabamba	9/1/81	8/30/82	Thomas

* Beca suspended.
**Beca suspended June 30, 1981. He will be under our beca program again starting February 1st, 1982.

Summary of advisees per staff member:

Dr. Robert W. Hoopes	2
Dr. Robert Kunkel	8
Dr. Thomas C. Stilwell	7
Dr. Donald R. Foster	4
Dr. James H. Thomas	7
Dr. Víctor Otazú	2
British Mission	2
Total	32 students

CID experienced increased difficulties in having project work and thesis accepted at the UMSS because the departmental administrators were changed again for political reasons. Numerous committee members, especially in Ag. Economics, were discharged and the students were left without recourse or had their drafts rejected by new committee members.

The total number of students sponsored by CID reached to 94 and about half will eventually receive their Ingeniero degree. The other half decided to leave the program, or took employment before finishing, or were terminated by CID staff for a variety of reasons.

Overall, the project was clearly a success in terms of excellence of training, placing of graduates, and low cost of the total program. Almost all of the graduates have had unusually good training by working on a daily basis with highly qualified scientists on research that has been well planned and was being properly executed. Techniques as well as theory were learned which in Bolivia is unusual. The graduates have found positions in MACA, IBTA, the regional development corporations, and private industry. The impact of even 40 of these graduates in the agricultural sector over the next ten years will be considerable.

The system has been extremely low cost in comparison to training outside Bolivia. Each student was entitled to receive a maximum of $b. 50,000 although not all did. Per student costs at the dollar exchange rate was US$ 2,000 or, if calculated on a per graduate basis, the total cost of the program was US$ 4,500.- Similar training outside Bolivia would be three to four times that amount and the students would not be trained on Bolivian problems.

SECTION VI

PUBLICATIONS

Administrative Reports

02/81 - Semiannual Progress Report for period July 1 - December 31, 1981.

01/82 - Semiannual Progress Report for period January 1 - June 30, 1982.

02/82 - End-of-Tour Report - Thomas C. Stilwell, June, 1982.

03/82 - End-of-Tour Report - Robert Kunkel, June, 1982.

04/82 - End-of-Tour Report - Robert W. Hoopes, June, 1982.

05/82 - End-of-Tour Report - Donald R. Foster, June, 1982.

06/82 - End-of-Tour Report - Víctor Otazú, June, 1982.

07/82 - End-of-Tour Report - James H. Thomas, June, 1982.

Working Papers

01/82 - Informe de Consultoría a Corto Plazo - Revisión de la Situación Actual de la Unidad de Comunicación-Extension del IBTA by Inés María Ortiz, May, 1982.

02/82 - Interacción entre Niveles de Humedad y Niveles de Fertilización en el Cultivo de Cebolla (Allium cepa) variedad Arequipeña by Esteban Antezana L., March, 1982.