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CONSORTIUM FOR INTERNATIONAL DEVELOPMENT

CID

Colorado State University
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University of California
University of Arizona
Utah State University

ADMINISTRATIVE REPORT No.
INFORME ADMINISTRATIVO No. 03/80

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, 1980

LA PAZ, BOLIVIA

PDAAN 774

03/80

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SECTION I

INTRODUCTION

This is the third semiannual report to be submitted since quarterly reporting was discontinued by an official amendment to the contract. Since much of the activity reported here has been in progress for several years, this report is basically a progress report and should not be viewed as definitive.

Readers, who also review the previous semiannual and quarterly reports, will note some significant trends and startling facts regarding the results of the research effort. These are referred to in the technical reports and summaries. However, it is strongly advised that the preliminary conclusions made not be used until further proof is accumulated and a responsible thesis is formulated.

Time and growing seasons permitting, the reports due at the end of the contract (1982) will be comprehensive and definitive.

SECTION II

ANNUAL HISTORICAL REVIEW

The contract has now completed the fifth year of a planned seven year effort which started in July of 1975. During the fifth year, several important changes were made in the contract effort, staff number, and composition. The events leading up to these changes have been chronicled by Dr. David James (CID Chief of Party from November 1, 1978 to July 15, 1980) in his end of tour report (CID Administrative Report 02/80), pages 43-48, and further discussion here is not required. The following section on personnel indicates the present make up of the team.

PERSONNEL

Due to the above mentioned changes in contract activities and priorities, the changes in personnel have been extensive during the reporting period. Additional significant changes are planned for the next period: July 1 - December 31, 1980.

The contract position and personnel are:

1. D. W. James, Ph.D., Soil Scientist, arrived in La Paz in July 11, 1977 and served as counterpart to the Executive Director of IBTA and Director of Research for CID until November of 1978

at which time he was re-assigned as Party Chief. (He was officially replaced by James H. Thomas, Ph.D., Crop Scientist, on July 15, 1980, and left Bolivia on July 20, 1980.

The agreement reached and incorporated into the contract by amendment was for the Party Chief to also be Director of Research for CID and advise IBTA at the Experiment Stations level in agronomic research.

2. W. M. Brown, Ph.D., Plant Pathologist-Agronomist, arrived at Cochabamba September 13, 1977, and worked through three growing seasons. He left Bolivia on July 1, 1980. Dr. Victor Otazu, Ph.D. Pathologist has been identified and approved as a replacement in this position.

3. D. C. Kidman, M.S., Irrigation-Agronomist, arrived at Santa Cruz December 17, 1977 and has worked through three winter seasons and two and a half summer seasons. It was agreed by MACA and CID that this position would be eliminated by September 30, 1980 due to lack of grant funds in USAID/B. With some changes in USAID/B priorities and a request by CIAT/MACA to continue the position, it is being considered that Mr. Kidman will continue at Santa Cruz to the end of the contract.

4. K. A. Adams, Ph.D., Agricultural Economist, arrived at Cochabamba December 26, 1977. It was agreed that Dr. Adams would be replaced by July 1, 1980 to allow his replacement to complete two years before the end of the contract. (Dr. Adams left Bolivia on July 15, 1980. A replacement has been identified but not approved.)

5. R. W. Hoopes, Ph.D., Plant Breeder-Potato Agronomist, arrived in Cochabamba September 22, 1978. He has worked through two complete growing seasons. It is anticipated that he will continue in this position until the contract ends.

6. J. A. Santaella, M.S., Extension Specialist, arrived in Cochabamba December 12, 1978. It was agreed that he would change locations in January of 1980 to allow him to work directly with the national leaders of IBTA-Extension. The February amendment stipulated that this position would be terminated on or before May 15, 1980 due to lack of funds from USAID/B. (MACA requested permission to hire Mr. Santaella on the 511-096 contract from June 1 to September 15, 1980. This was approved.)

7. T. C. Stilwell, Ph.D., Agronomist-Soil Scientist, arrived in Cochabamba December 12, 1978. He has worked through two summer seasons and plans to remain until the end of the contract.

8. R. R. Kunkel, Ph.D., Agronomist-Potato Research Specialist, arrived in Cochabamba January 11, 1979. He has worked through one and one half full growing seasons and plans to remain until the end of the contract.

9. D. R. Foster, Ph.D., Agronomist-Entomologist, arrived at Santa Cruz January 27, 1979. He has worked through two winter seasons and one and half summer season. The February 1980 amendment specifies that this position will be discontinued in Santa Cruz and will be moved to Cochabamba on or before September 1, 1980. Dr. Foster plans to remain until the end of the contract.

Summary: as of June 30, 1980

Contract Position Number	Position Name	Technician	Location
1*	Chief of Party	D. W. James a/	La Paz
2	Research Director - abolished	Amendment	# 4 (1/12/78)
3	Extension Specialist b/ -	" "	# 6 (5/2/80)
4	Ag. Economist -	" "	# 4 (1/12/78)
5*	Potato Agronomist	R. R. Kunkel	Cochabamba
6*	Cereals-Agronomist	T. C. Stilwell	Cochabamba
7*	Breeder-Potato Agronomist	R. W. Hoopes	Cochabamba
8*	Pathology-Agronomist	W. M. Brown c/	Cochabamba
9*	Ag. Economist	K. A. Adams d/	Cochabamba
10*	Agronomist-Entomologist	D. Foster	Santa Cruz e/
11*	Oilseeds-Irrigation-Soils f/	D. C. Kidman	Santa Cruz

a/to be replaced by James H. Thomas, July 1980.
b/discontinued May 15, 1980.
c/to be replaced by Victor Otazu, September, 1980.
d/to be replaced in August-September 1980.
e/to be moved to Cochabamba, September 1980.
f/to be abolished September 30, 1980.

* Currently active positions = 8
To be active after September 30, 1980 = 7

Local Staff

Contract Position Number	Position Name	Employee	Location
1	Administrative Asst.	Lydia de Novillo	La Paz
2	Bilingual Secretary	Norah López	La Paz
3	Bilingual Secretary*	María Nelly Avila	Santa Cruz
4	Chauffeur	Edmundo Sánchez	Cochabamba
5	Bilingual Secretary	Magda de Pacheco	La Paz
6	Bilingual Secretary	María Teresa Bernal	Cochabamba
7	Chauffeur	Luis Fernández	La Paz
8	Chauffeur	Carlos Tejada	Cochabamba
9	Bilingual Secretary	María Luisa Tejada	Cochabamba
10	Bilingual Secretary	Marisol Udaeta	Cochabamba
11	Bilingual Secretary	Margot López	La Paz
12	Chauffeur*	Gualberto Mojica	Santa Cruz
13	Chauffeur	Jorge Heredia	Cochabamba
14	Janitor-Watchman	Vitalio Alvarez	Cochabamba
15	Chauffeur*	Alcides Sabath	Santa Cruz

* To be terminated on August 15, 1980.

SECTION III

ACCOMPLISHMENTS

The format and numbering of the following technical reports follows the system previously established. (See page 3 of the CID Administrative Report 001/79 for explanation of authorship of reports.)

The due date of this report was extended to September 30, 1980 so CID technicians and IBTA counterparts could collaborate on the report contents. Since previous reports were due from CID much earlier than IBTA counterparts were to submit their reports, there was little or no collaboration or "training" in report writing accomplished. This report is, therefore, more of a cooperative effort than previous reports.

Where an analysis of the variance in an experiment showed there was no significant differences in results due to experimental treatments, or where treatments were significantly different but uncomplicated by interactions, the analysis of variance tables reported by technicians are left out. However, the level of significance and the coefficient of variation are still reported.

A. ADMINISTRATION

A.1 Chief of Party and Research Director

The current activities of the Chief of Party are reported in CID Administration Report 02/80. The emphasis of the activities of the Chief of Party will be changed somewhat to include advising the Directors of the IBTA experiment stations approximately one-third time.

The contract has been fortunate to have excellent and competent in-country support from the local staff.

B. AGRICULTURAL ECONOMICS

by

Kendall A. Adams - Agricultural Economist

B.1. **Title:** Agricultural Marketing and Farm Management

Justification: Costs of producing and distributing an item are ultimately reflected in the selling price of the item. The level of selling price is a fundamental factor in determining the demand for the item. If demand is reduced, it becomes difficult to make the item an economic success. If the item is not an economic success, the biological success of a particular agronomic practice is of little or no practical value. Therefore, it is important to determine the effects of biological practices on production costs and the effect of distribution practices on the consumer purchase price of the product.

Project title: Evaluation of marketing practices and distribution channels.

Objective: Transaction costs occur as a product moves forward in a distribution channel from producer to consumer. The first step in analyzing costs of distribution is to determine transaction costs at the various levels in a channel where title transfer takes place. The second step is to evaluate the transaction cost in terms of the productivity of the economic activity performed. In other words, transaction cost alone is not sufficient information to make an evaluation. A low transaction cost is as undesirable as a high transaction cost if the low cost has a low productivity associated with it and leads to a stagnation in demand. It is necessary to analyze transaction costs in terms of their productivity just as one analyzes investments in production in terms of productivity and not only in terms of whether the investment cost is high or low.

Status: With this analytical framework in mind, transaction costs were examined for potatoes and carrots. The test on potatoes was done on the Tiraque market. The results showed that middlemen buying on the Tiraque market and reselling usually in Cochabamba were showing a cost of transaction (gross margin) of approximately 15% while retailers buying and reselling these potatoes or their equivalent on the Cochabamba market were showing a transaction cost (gross margin charged the consumer) of approximately 33%.

The test on carrots was done in Capinota, an area popular for carrot production. The wholesaler margin was found to be about 30% and the retailer margin about 50%. Both the Tiraque and Capinota tests were done on the basis of observations for one day, so they should not be thought of as intensive test. However, the results indicate the probable existence of very high retail transaction costs for both carrots and potatoes, but quite low wholesale transaction costs for potatoes.

The indication is that retailing represents a distinctly in-efficient institution in both potato and carrot product movement. The retail margins cited here cannot be justified in terms of the investment in or demand creation efforts performed by the retailing institutions involved. Improvement in retailing is seen as necessary to improving farmers ability to increase their return on potatoes and carrots. The feasibility of potato pre-bagging was tested along with consumer preferences for different size grades of potatoes. By far the most popular pre-bagged size is 25 pounds, and a price preference of approximately $b. 10.- was shown for the same size unit of larger compared to medium size potatoes.

B.2. Project title: Evaluation of marketing practices - shipping containers.

Objective: Efficiency in marketing is affected by product handling and packaging. With this in mind, a series of tests were conducted involving five types of wooden crates built for tomatoes, green onions, lettuce and several other vegetables.

Status: Shipments were made by rail and truck from Cochabamba vicinity to Atocha (a mining center) and Santa Cruz and from Comarapa and Capinota to Cochabamba. The results for tomatoes were very good with the improved wooden crates in the 15 kg. size showing at least a 20% saving in product damage when compared to the traditional packaging method now in use.

Carrot breakage in transit was reduced to zero when the wooden crate was used, but very little effect could be noticed when green onions shipped in crates were compared to green onions shipped the traditional way. In the process of doing the shipping tests, a great deal of harvest damage has been identified along with what appears to be some inefficiencies in harvesting and packing practices. As a result, improved shipping containers appear to be only one part of a harvesting, packing, materials handling and transporting system in which every part must work together if an improved and higher value consumer product is to result. In other words, a good shipping container will not in itself be sufficient to overcome poor practices in other parts of the system.

A consumer test was performed on the green onions shipped by the wooden and traditional types of containers. The results showed consumers were unable to distinguish between the onions shipped in the different containers. However, it was shown that consumers do have product preferences and they would have been willing to pay a 20% premium for the onions being tested to satisfy these preferences. These results indicate the desirability of size grading for green onions and probably the desirability of grading when marketing potatoes and other vegetables.

B.3. Project title: Interrelationship between agronomic and socio-economic issues.

Objective: For many years the question has existed concerning why technological transfer is so slow. The indication is that there are complex motives behind small farmer decisions that are not completely understood. The objective of this project is to see what can be learned about farmer practices and motives from farm-family case studies that will guide our research in potatoes to produce information more readily adaptable to the present needs of small farmers.

Status: The relationship between socio-economic and agronomic issues were studied in the form of five case studies of potato farmers in the high valley region of Rodeo. These were studies of the whole farm and included an economic analysis of all enterprises on the farm in terms of returns to land, labor and capital for each enterprise. The results have been published in C.I.D. Working Paper number 022/79. The project required almost a year to complete. The results emphasize the importance of potatoes to these farmers and the importance of the inefficient use of their capital investment (made up mostly of labor costs) as a factor limiting expanded potato production. Also of value to potato research are the various agronomic practices actually used and the reasons why they are used.

B.4. Project title: Continuing evaluation of new technology.

Objective: New technology development is the primary goal of the CID research program. The purpose of economic evaluation

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is to give an estimate of the income possibilities represented by various biological experiments. As a general rule, test results must exceed the income results of traditional practice by at least 40 percent before the test results can be considered economically viable.

Status: New technology evaluation was accomplished in the form of an economic evaluation of the 1977-1978 phosphorous trials on potatoes. The trials consisted of six regional experiments with six to eight treatments in each experiment. The results demonstrate a market phosporous deficiency for potatoes in the regions where the trials were located and markedly high returns to fertilizer making the investment in fertilizer a very wise business decision given the environmental factors inherent in the time and location of the tests. The results have been published in C.I.D. Working Paper number 012/79.

The technique for technology testing now being used in the Santa Cruz region involves a new procedure. The plan identified a few farmers in the vicinity of each of two regional corn and rice trials in the Santa Cruz area. Using repeated callbacks, a fairly detailed history of agronomic practices was prepared for each farmer by field and crop and by different production methods within a given crop (such as chaqueado, barbecho, and mechanization). At harvest, samples of the crop were taken from fields on individual farms to determine production per ha rates. The actual per ha rates were compared to the experimental per ha rates. The production differences were applied to the farmer's actual variable costs to see what differences in income would have resulted from applying the experimental technology. The results of this study have been prepared and are awaiting publication as an experiment station circular.

Another project in the Santa Cruz region compared soil productivity with years of continuous cropping. An economic analysis showed that continuous cropping could be performed for at least six years and probably many more without suffering a loss in net benefit. The results of this study have been prepared and are awaiting publication as an experiment station circular.

An investigation of technology transfer to small farms was undertaken in the form of a treatise on agribusiness forms of vertical integration. Three successful agribusinesses in

Cochabamba were used as models. The results of this project have been published in the form of C.I.D. Working Paper number 011/80.

B.5. Project title: Case studies.

Objective: The case study technique is intended to complement survey technique by presenting more detailed information on farmer practices and motives.

Status: Case studies were completed for five potato farmers in the Rodeo region. The purpose of these studies was to find out why certain farming practices were performed and how these practices were learned. Why things are done and how they are learned gives direction concerning what research needs to be done regarding farm management practices and how the information should be communicated. The results of this study have been published in C.I.D. publication number 022/79.

Publications (since June 30):

1. Kendall A. Adams, Gonzalo Claure and David James, "The Economic Effects of Phosphorus Fertilization on Potatoes in the Cochabamba Region" (La Paz; The Consortium for International Development, Working Paper No. 012/79) July, 1979.

2. Kendall A. Adams, "Farm Family Case Studies, Rodeo Region" (La Paz; Consortium for International Development, Working Paper No. 022/79, n.d.)

3. Kendall A. Adams, "Agribusiness Integration as an Alternative Small Farm Strategy" (La Paz; Consortium for International Development, Working Paper No. 001/80, April, 1980).

4. Kendall A. Adams, "The Effect of Shipping Containers on Transportation Damage to Tomatoes" (La Paz; Consortium for International Development, Working Paper No. 05/80 in publication process).

5. Kendall A. Adams, Don C. Kidman, and others, "Productivity Comparisons between Average Farm Yield, Maximum Present Farm Yield, and Experimental Yield in the San Pedro and Yapacani Regions" (Saavedra; Experiment Station Circular, in publication process).

6. Don C. Kidman, Kendall A. Adams, and others, "The Effect of Continuous Cropping on Soil Fertility in the Colonization Areas of Santa Cruz" (Saavedra; Experiment Station Circular; in publication process).

7. Kendall A. Adams, "Consumer Preferences for Potatoes in Cochabamba" (Work in process, Cochabamba Potato Program).

Student Advisees:

1. Marco Lara, withdrew without plans for completion.
2. Allan Bojanic, withdrew with plans for completion later.
3. Daniel Sanchez, thesis completed and approved.

C. POTATO BREEDING

by

Dr. Robert Hoopes - Potato Breeder

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

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

Introduction: Bolivia is a center of diversity for the cultivated potato and also for wild, tuber-bearing species of Solanum. There is presently great interest, world-wide, in the conservation of germplasm which can be of use in the improvement of food crops. The success of improved varieties can accelerate the disappearance of native cultivars which may carry genetic material of considerable importance to breeders of the future. Deterioration of natural habitats leads to the loss of much germplasm in the form of wild species. The Toralapa Station maintains a collection of native cultivars of several species and ploidy levels. This material not only serves to maintain the germplasm of the country, but is often of immediate use in the national breeding program.

Objectives: 1) Expand the Bolivian Germplasm Bank with collections made by Toralapa technicians and by collaborating with international collecting teams. 2) Maintain the material which is now in the Germplasm Bank. 3) Continue the work of classification of the collection in terms of taxonomy, chromosome number, and resistance to certain diseases. 4) Identify varieties in the collection which can serve as parents in the breeding program.

Activities: 1) Expansion of the Germplasm Bank. A major international collection expedition was conducted in February, March, and April of 1980. Three teams spent two months collecting throughout the country. The teams involved scientists from England, Denmark, Germany, the Netherlands, Argentina, Peru and Bolivia. Concentrated effort was made to add to world collections of wild tuber-bearing Solanums from Bolivia, but some native cultivars were also collected. The expedition was highly succesful. IBTA technicians participated in all collection trips, which contributed to the expedition's success and provided valuable training opportunities to the technicians. The genetic material collected was made available to the Toralapa Station and the results of any investigations on the material will be made available to the Bolivian potato program. CID contributed to the expedition in the form of considerable logistical support: one vehicle for the entire time of the expedition, the use of our office complex and storage as headquarters, etc. The CID potato breeder accompanied the northern team on a week's trip in the altiplano area. 2) Maintenance of the present collection. This year, for the first time, the germplasm collection was maintained in two locations to minimize the losses that could be incurred in a single location in the event of something like a severe frost. Also, more of the varieties were put into the form of botanical seed to avoid their total loss through virus contamination. The maintenance of the collection is managed by Ing. Avilés. 3) Classification work. A CID beca student, Ruth Lopez, completed chromosome counts of about 75 previously unclassified native varieties in the collection. She also evaluated about 100 entries for resistance to the potato cyst nematode (Tiraque population believed to be Globodera rostochiensis). None of the 100 varieties, unfortunately, was resistant enough to be considered very useful in breeding for resistance. Another CID becario has begun a thesis project in which the rest of the germplasm bank, about 600 more clones, will be checked for resistance to this nematode. Freddy Caballero, a CID-sponsored becario, has initiated a thesis project to screen the germplasm collection for resistance to potato wart, Synchytrium endobioticum. Some of the entries in the germplasm collection will be screened for resistance to Potato Virus Y by Victor Alvarez, another CID becario. 4) Identification of parents in the collection. Interspecific crosses were made between the diploid species Solanum stenotomum and two tetraploid varieties, Imilla Blanca and Sani Imilla. The crosses were successful although seed set was low. The S. stenotomum varieties used are noted for high quality although their yields are low. In the tetraploid form, however, yields might be expected to increase.

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

Leaders: Ing. Israel Avilés with Robert Hoopes collaborating.

Introduction: Although much of the breeding program is centered on developing varieties resistant to diseases, good yield and good quality are always necessary characteristics. Most of the successful varieties in the world today, in fact, do not possess outstanding resistance to the majority of diseases and pests that attack potatoes, but retain their position because, given the necessary protection, they produce good yields of high quality potatoes.

Objectives: 1) Test introductions that were made in 1978-79 and given one year of selection in Bolivia. 2) Test progenies of crosses that were made with the object of obtaining good yield and quality. 3) Use the most promising material in further crossing.

Activities: 1) Introductions tested. Eleven Peruvian clones which had been tested previously at the Chinoli Station were tested. Of the eleven clones, three were retained for testing in the next growing season. Eight Cornell University clones were tested, of which three were retained for next year's evaluations. Two tuber families from Cornell were tested and sixteen single-plant selections were made on the basis of yield and tuber form. 2) Testing progenies of crosses. This material was tested by Ing. Aviles and the detailed results will appear in the Toralapa Station annual report. One result of interest was that several interspecific hybrids of S. phureja x local varieties produced extremely high yields as first-year seedlings. 3) Crosses made for yield and quality. One of the high-yielding Peruvian clones was crossed with Imilla Blanca and Sani Imilla, the standard local varieties. The varieties Huaicha Paceña and Puca Lunca were incorporated into the breeding program. Both of these are noted for very high quality and acceptable yields. More crosses were made between clones of S. phureja and the local varieties. As mentioned under activities associated with the Germplasm Bank, the diploid species S. stenotomum was used in some crosses to incorporate its high quality into tetraploid forms.

C.3. Project: To-1-P-1-d Breeding for Resistance to Phytophthora infestans (late blight)

Leaders: Israel Avilés and Robert Hoopes

Introduction: Late blight, caused by the fungus Phytophthora infestans, is a serious limiting factor in potato production where it occurs. It may be controlled by using fungicides if they are properly applied at the right time. An alternative to the use of fungicides is the planting of resistant varieties, a cheaper form of control. Varieties with a degree of resistance can also serve as a partial substitute for chemical controls, allowing the farmer to spray less chemicals, begin the program later, etc. A number of clones were received from CIP in Peru in 1976 and have received several years' testing under Bolivian conditions. Several of these clones have demonstrated outstanding resistance in all exposures to blight in the field, have produced good yields, and had acceptable quality. Eighteen new clones from CIP arrived in 1978-79, but too late to plant a good, replicated trial in the first season. In addition, we have received from the Cornell University program several tuber families segregating for late blight (and virus) resistance. The seedlings from which our tubers came had survived one exposure to blight in Ithaca, New York, so that we could expect a fairly high proportion of resistant material. This material was given one selection in Cochabamba during the winter, and only those individuals with reasonably good yield and tuber form were retained for a test in a blight-infested field in 1979-80. A further source of potentially blight-resistant material was a group of five clones received from Max-Planck Institute in Germany. These clones were reported to be resistant to at least some races of blight. Dr. Hermsen of Wageningen had sent botanical seed derived from parents with late blight resistance, and we had developed some tuber families from this seed. Finally, some progenies were available from crosses made at Toralapa between some of the best 1976 CIP introductions (resistant) and three local susceptible varieties--Imilla Blanca, Sani Imilla, and Runa.

Objectives: 1) Test 18 clones received from CIP in 1978 in a replicated trial in Escalante--where late blight is epidemic each year. 2) Verify the resistance, yielding ability, and quality of the best 1976 CIP introductions--720045, 720044, 720055, and 575031--and begin to multiply them in the field at Toralapa to develop a good source of seed. 3) Expose progenies of these clones crossed with local varieties in the field at Escalante and select the most resistant seedlings. 4) Test the following introduced material at Escalante: a) 9 tuber families and 57 clones from Cornell University, b) 7 families generated from botanical seed from Dr. Hermsen in Wageningen, c) 5 Max-Planck Institute clones. 5) Establish a blight resistance trial at Morochata, another area frequently affected by problems of late blight.

Activities: 1) Testing 18 newly received CIP clones. This trial was conducted by Israel Avilés and the data have not been provided, but the results should appear in detail in the Toralapa Station annual report. 2) Further testing of the clones 720045, 720055, 720044, and 575031. These clones again demonstrated a high degree of resistance at Escalante, being without damage when the local varieties were completely defoliated by the blight attack. Ing. Avilés has rated their flavor as good, although not quite so good as Imilla Blanca. Their specific gravities are about comparable to Imilla Blanca. Seed of these clones was produced on the Station, using roguing and selection practices. 3) Select the most resistant seedlings among the progenies of these clones crossed with local varieties. Ing. Avilés was able to select a good number of seedlings which survived one year's exposure in the field at Escalante. 4) Testing other introduced material at Escalante. a) Cornell material--thirty-one clones were selected at Escalante, having yielded well in spite of a severe blight attack. Several of these had resistance comparable to the best CIP clones, and produced good yields of well-formed tubers. Bulk pollen was collected from the most resistant plants of this material and was crossed with Imilla Blanca, Sani Imilla, Puca Lunka, and one clone with Nacobbus resistance. This material will also be expected to transmit immunity to Virus Y to a proportion of the progenies of these crosses. b) Sixteen seedlings were selected from the Wageningen material, based on their blight resistance at Escalante. c) None of the clones from Max-Planck Institute demonstrated good adaptation to any of the sites where they were grown. 5) Good growth and yields were obtained in the Morochata trial, although the onset of blight took place late in the season and did not have a strong influence on yields. This is made evident by the fact that the local variety Runa, known to be extremely susceptible to blight, was one of the higher yielding entries in this trial. It is noteworthy, however, that the two most popular varieties in the Morochata area, Imilla Blanca and Huaicha Paceña, were among the very lowest yielding in the trial, even in the absence of severe late blight.

TOTAL AND MARKETABLE YIELDS, MOROCHATA

Clone	Yield (kg/20 plants) Total	Marketable*	Clone	Yield (kg/20 plants) Total	Marketable
720045	14.77	10.58	720043	11.04	7.29
720044	13.35	10.67	720047	10.78	8.98
720055	13.23	6.02**	573270	10.32	7.88
720032	12.07	9.64	720054	10.28	7.60
Runa	12.00	9.05	Sani Imilla	10.22	8.62
575031	11.98	8.82	575049	9.86	7.04
606006	11.94	9.16	Huaicha Paceña	8.19	3.43
575048	11.46	9.49	720060	8.08	6.59
720051	11.43	4.66	Imilla Llanca	7.46	3.26

* Marketable yield as selected by the farmer-cooperator at harvest.

** This clone is very susceptible to powdery scab and suffers considerable superficial tuber disfiguration where this disease is a problem, accounting for the big difference between total and marketable yield.

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

Leaders: Dr. Nelson Estrada and Dr. Juan Landeo (International Potato Center, Lima-Peru), with Robert Hoopes, Luis Garvizu (Belen) and Israel Avilés collaborating.

Introduction: Frost is a severe hazard for the highest-elevation potato growing areas of Bolivia and an occasional hazard for slightly lower areas. Breeding for frost resistance is a very long-term, difficult process because the inheritance of resistance is extremely complex and because it is difficult to create exactly the right conditions for frost-resistance screening. The International Potato Center has a long-standing and large program of breeding for frost resistance and is willing to collaborate with the Bolivian national program in bringing its most promising material here to be tested under climatic conditions where there is likely to be frost during the growing season. Because of the difficulty of breeding for frost resistance and the existence of the CIP program, we have not been actively breeding for resistance, but rather working with CIP to test their introductions under Bolivian conditions. The Belén station has been used as one site for two years. Totoracocha, near Toralapa Station, was used in 1978-79, but was not a very suitable location. In 1979-80, the site of Koari, about 10 km. east of Toralapa, was substituted for Totoracocha.

Objectives: 1) Plant two trials at Belén Station--one observation trial with approximately 150 clones in two ten-plant replications of material which had not been observed in Bolivia before; and a three-rep. yield trial of 50 clones (including check varieties) which had performed well at Belén the previous year. 2) Plant essentially the same material at Koari, a location of about 3,800 meters elevation, 10 km. east of Toralapa Station.

Activities: The observation trial at Belén was planted November 21 and the yield trial on November 22. This was later than planned, but was delayed because of the political situation in Bolivia in the first part of November. The yield trial and one replication of the observation trial suffered from drought, severe weed competition, and considerable theft just before harvest. Excellent yields were obtained in the other section of the observation trial. The Koari yield and observation trials were planted on November 29. Good results were obtained here although the frost came very late in the season, making it hard to assess which clones had useful frost resistance. A brief summary of the results of the two trials follows:

Belén Yield Trial (49 clones)

	Tons/ha.
Sani Imilla (susceptible check)	5.1
Choquepitu (resistant check)	12.0
High yielding entries:	
376190-5	10.4
375512-24	9.8
375515-2	8.6
375512-10	8.4
Average of all clones	5.7

Koari Yield Trial (47 clones)

	Tons/ha.
Sani Imilla	15.6
Choquepitu	15.5
High yielding clones:	
375512-26	24.3
374067-2	21.6
375039-32	20.9
375514-3	20.6
375597-15	20.6
377413-7	20.6
Average of all clones	15.6

Belén Observation Trial (Rep. 1)

(148 clones)

	Tons/ha.
Sani Imilla	25.5
Choquepito	16.2
High yielding clones:	
374080-5	46.8
R214-5	40.7
375575-1	40.7
375030-17	38.3
375030-45	37.0
Average of all clones	22.5

Koari Observation Trial (103 clones)

	Tons/ha.
Sani Imilla	18.7
High yielding clones:	
375517-1	32.2
375512-26	29.6
375519-5	25.9
374066-4	25.3
Average of all clones	15.4

It is interesting to note that the resistant check, Choquepitu, tends to be one of the lower yielding varieties when conditions are very good, but one of the highest yielding varieties when conditions are bad. It is a pentaploid clone of the species S. curtilobum, tends to be quite bitter but can be consumed fresh, whereas some other frost resistant varieties are only suitable for making Chuño. Some of the improved varieties can produce far more than Choquepitu when conditions are favorable, but are not so stable in their yields when conditions are unfavorable. The very high yields of some of the CIP material make them quite promising apart from any frost resistance they might have. The next growing season, about five of the best clones from the yield trials will be put in demonstration plots on farmers' fields, while the best materials from the observation trials will be advanced into more replicated yield trials.

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

Leaders: Robert Hoopes and Ing. Arturo Moreira with Ings. Rómulo Claure and Israel Avilés collaborating.

Introduction: In all potato-growing areas of the world, virus diseases are either a major factor in reducing yields or they necessitate an expensive and well-organized seed production program to avoid problems of viruses. In the Andean region, Potato Virus Y (PVY) is of major importance and may be the most important virus disease of potatoes in this region (on a world-wide basis, leafroll virus is more important). Single-gene resistance is available from diploid species which conditions immunity to all strains of PVY which have been studied up to the present. More recently, a gene has been discovered in clones of S. tuberosum spp. andigena which also conditions immunity to PVY and is inherited in a simple, dominant fashion. Material with the PVY-resistance gene was made available to the Bolivian program from the Max-Planck Institute in Germany; from Dr. Hermsen's program at Wageningen, the Netherlands, and from Dr. Plaisted in Cornell. Some of this material should be of quite good adaptation to Bolivia, in terms of agronomic characteristics, and so would be ideal to use as parents to incorporate PVY resistance into potentially new varieties. PVY-resistant varieties could be an important factor in increasing the yields of Bolivian farmers if PVY infection causes yield losses as severe in Bolivia as it does in other parts of the world. No yield-loss studies have been made here as yet. The thesis study of Rosario Vargas indicated that PVY was extremely widespread in the production zones that she studied.

Objectives: 1) Verify the resistance or susceptibility to PVY of clones received last year from Max-Planck Institute and from Cornell. 2) Conduct mass inoculations of seedlings received from the above institutions and from Wageningen, separate the susceptible plants, and transplant apparently resistant plants to the field, where they can be evaluated for agronomic characteristics. 3) Screen for PVY resistance two progenies derived from crosses with Sani Imilla and Imilla Blanca and a German clone with PVY and PVX immunity. 4) Utilize in crosses those clones which have survived one year of selection for agronomic characteristics and which prove this year to be resistant to PVY.

Activities: 1) Verifying the resistance of supposedly PVY-resistant material. None of the clones supposed to be PVY resistant showed symptoms after an inoculation of a single plant of each in the greenhouse at Toralapa, although they were not checked with indicator plants or serology. Most of these clones were discarded for not having good adaptation to the Bolivian environment so that further checks were not performed. About 75 clones generated from tuber families from Cornell, having received one selection for agronomic characteristics, were inoculated with PVY. About 25% were discarded for showing symptoms, less than the 50% expected based on the genetics of resistance. A thesis student, Victor Alvarez, who is working full-time on PVY resistance, will re-check the surviving clones. 2) Mass inoculations of seedlings. About 7,000 seedlings from 30 segregating progenies were inoculated using PVY infected plant sap from tobacco. At the time of the inoculation, the project did not have available the proper equipment for mass inoculation (an air brush), or any facilities to modify the daylength or temperature, which are very important for good symptom development in seedlings. Symptom development was not as clear as desired. About 40% of the seedlings were eliminated for showing symptoms or unthriftiness. More than 50% should have been susceptible, so there are apparently a good number of "escapes" among the apparently resistant seedlings. The seedlings were transplanted to the field in Tiraque, Escalante, or Toralapa Station. Some were left in small pots to mature in the greenhouse. Quite severe losses took place after transplanting to Tiraque due to dry weather, weed competition, and severe damage from thrips. In all, about 1500 seedlings which had survived one screening for PVY and tuberized in the field, were harvested. 3) Screening progenies of crosses between a resistant German clone and Sani Imilla and Imilla Blanca. Twenty-nine apparently resistant seedlings were harvested from the cross between the resistant German clone and Sani Imilla. 4) Crosses. About 20 clones selected from the Cornell material for late blight resistance and good agronomic characteristics were used to bulk-pollinate eight Bolivian and CIP varieties. The twenty clones all have at least one PVY-resistant parent and so 50% of them should be resistant. They were not individually checked before using them as parents. Assuming 50% of them are resistant, about 25% of their progeny should be resistant if the other parent was susceptible. Victor Alvarez will conduct an improved mass inoculation on the seedlings of these progenies. 5) New introductions. Approximately 4000 tubers representing 8 families of S. tuberosum spp. tuberosum x S. tuberosum spp. andigena hybrids were received from Dr. Plaisted of Cornell and planted in Cochabamba in late May. This material will be harvested in mid-September, stored in a warm place, and planted again at Toralapa in late November. All of this material is segregating for PVY resistance. Clones that survive a screen for agronomic characteristics in Toralapa will be subjected to a PVY test. In addition, approximately 15000 botanical seeds, representing 12 families segregating for PVY resistance were received from Dr. Plaisted. Victor Alvarez will use this material as part of his thesis project and at the same time select several thousand PVY-resistant seedlings to enter the breeding program.

C.6. Student Advisory Activity of Robert Hoopes and IBTA technicians Carlos Alarcón, Israel Avilés, Gerardo Caero, and Arturo Moreira.

René Torrico: Species identification of populations of root-knot nematodes (Meloidogyne spp.) found in Bolivia, by means of differential host plants and morphology of females. Beca began February 1, 1979, ended Jan. 31, 1980. René has completed his thesis work and has written and revised the thesis. He worked closely with the University throughout the preparation of his material and assisted in teaching the laboratories for the nematology and entomology classes. We sent several hundred specimens, in the form of "perineal patterns" of rootknot nematode females, to the International Meloidogyne Project in North Carolina. The identifications René had made were confirmed or discussed by Dr. J. N. Sasser, head of the IMP group, who complemented René highly on his excellent preparation and work. Although the thesis is finished, it has not yet been possible to have it submitted to the University because the University is closed. René has been notified that he will be employed by IBTA, to fill a vacancy at the Toralapa Station, beginning in September of this year. René presented a paper at the Becario Symposium at La Tamborada in February of 1980. He also presented the paper "Identificación de Especies de Meloidogyne Mediante Hospederos Diferenciales", by René Torrico, Gerardo Caero, and Robert Hoopes, at the Symposium in Santa Cruz on March 14-16 of 1980.

Ruth López: Determination of chromosome numbers of clones in the Bolivian Germplasm Bank; testing of part of the Bolivian Germplasm Bank for reaction to the potato cyst nematode population of Tiraque (Globodera rostochiensis). Beca from May 15, 1979 to May 14, 1980.

Ruth completed the counting of chromosome numbers in approximately 75 entries in the Bolivian Germplasm Bank, classifying them as diploids, triploids, tetraploids, or pentaploids. She was very efficient and competent in the laboratory work associated with this project. She also screened about 100 entries in the Bank for resistance to the cyst nematode. This work, however, was excluded from the thesis itself after being partially written up. Her committee members thought that it was not desirable to have a two-part thesis with the two sections covering such diverse subject matter. She has written a first draft and a revision of her thesis. Her literature review covers in some depth the entire subject of chromosomes, ploidy levels, and the evolution of the various polyploid series of species in Solanum. Although some of her committee have informally reviewed and revised the thesis, it has not been possible to defend it because of the closure of the University. Ruth presented two papers on the two aspects of her thesis work at the Becario Symposium at La Tamborada in February of 1980.

Rosario Vargas: Determination of the incidence of several potato viruses in production zones of Cochabamba. Beca from February, 1979 to January, 1980.

Rosario travelled to the important potato production zones of the Cochabamba Department, making visual observations of virus infection incidence and later confirming these observations through the use of indicator plants and serology in the greenhouses and laboratory of Toralapa. The major objectives of this work were to identify which virus diseases were of the greatest importance in this area and to identify which production zones seemed to be reasonably free of virus diseases. This constitutes an important first step in the identification of potentially good seed production zones for the Department. Rosario has finished her work and has written and revised the thesis. Because of the closure of the University, it has not been submitted or defended. Rosario developed good skills in identifying plant viruses through visual observations and also through the techniques she used at the Station. She presented good, well-illustrated seminars on her work at meetings and at the University Becario Symposium in February.

Victor Alvarez: Screening Bolivian germplasm and segregating families for resistance to Potato Virus Y. Beca began June 1980.

Victor is in the early stages of a project which involves 1) screening some material in the Bolivian Germplasm Bank for resistance to PVY, 2) screening several thousand seedlings from botanical seed received from Dr. R. L. Plaisted of Cornell University for PVY resistance (they are in the form of segregating families with one or both parents resistant), and 3) adapting the mass inoculation and screening technique for use at the Toralapa Station. He has done a good portion of his literature review and has presented one seminar on the project proposal at the Toralapa Station. We have acquired for his work about 15,000 seeds of segregating families, plus 8 tuber families, from Cornell; an airbrush apparatus for mass inoculations; seed of several indicator plants for verifications of infection; insect cages; insulated chambers made from local materials to provide some control of light and temperature.

Freddy Caballero: Physiological Races of Potato Wart (Synchytrium endobioticum) present in the Cochabamba Department and Screening the Bolivian Germplasm Bank for Resistance. Beca began June, 1980.

Freddy will use differential potato varieties to attempt to identify the races of wart present in several areas of the Cochabamba department. The wart material was collected by Dr. William Brown and Ing. Hebert Torres of CIP. He will also screen as much as possible of the Bolivian Germplasm Bank, looking for sources of resistance to the race of wart prevalent near the Toralapa Station. He will plant the collection in at least one field location, do pot tests in the greenhouses at the Station, and if the technique functions well, use a rapid screening method which can be done in incubation chambers in the laboratory. Freddy has done some literature review, is working with the techniques of inoculation, and has presented a seminar on his project proposal at Toralapa.

Fernando Rivas: Screening the Bolivian Germplasm Bank for resistance to the potato cyst nematode (*Globodera rostochiensis*). Beca began August 1980.

Fernando will screen, if possible, all the remaining entries in the Bolivian Germplasm Bank for resistance to the Tiraque population of the potato cyst nematode. He will also screen material which was sent by Dr. Maria M. de Scurrah of CIP for resistance against this population. He has extracted thousands of cysts from the soil of infested fields in Tiraque and is presently ready to plant the first 100 clones from the germplasm and test them for resistance using a fairly simple pot test in the greenhouse.

D. POTATO AGRONOMY

by

Robert Kunkel, David James, and Gonzalo Claure

D.1. Subject: Soil fertility and plant nutritional relationships of potatoes produced in Bolivia.

Introduction: Past experiments in Bolivia have demonstrated a marked increase in potato yields due to applications of nitrogen and phosphorus fertilizers. In general, applications of potassium have not resulted in yield increases. However, statistically significant yield increases were obtained in some locations in 1979 from applications of potassium. It was thought that if the experimental precision could be increased, a general response to potassium might be demonstrated as well as obtained definitive data for the response to nitrogen and phosphorus. The coefficients of variability in past experiments have ranged from 12% to over 40% thus suggesting that even when statistical differences were obtained, they might be suspect if the differences "required" for significance were close to those obtained from the experiments.

Furthermore, the possibility of a three or more element deficiency cannot be ruled out. Thus indicating that if one element is defficient, there is not likely to be a large response to either of the other two. Seasonal differences and their effects necessitate conducting the studies for more than one year and in widly separated growing areas.

Because of the many small fields of potatoes that are grown and because of the ability to conduct experiments or demonstrations on only a very small portion of the potato fields, a method of rapidly estimating a fertilizer response is needed. Soil testing offers the most feasible approach toward a solution of this problem.

The potato problems of Bolivia are integrated problems and cannot be efficiently studied a segment at a time. There are diseases both above and below the soil surface that can reduce the potential response from fertilization. Insects above and below the soil surface can have a devastating effect on potato yields and tuber quality. The question of why do potato plants "die" a month to six weeks before the first killing frost, needs an answer. Total production in numerous studies has been positively correlated with the length of time the plants are alive and functioning as has also been the size of the potatoes. The larger the yield, the more numerous are the number of premium sized potatoes.

Methods:

1. Fertilizer applicator: The uniform application of fertilizers, ground applied insectides, etc., is essential for obtaining reliable experimental data. To make this possible, a continuous belt, ground-driven applicator was developed. The belt revolves 36 inches in a 10 meter row and has proven to be exact and dependable. Under most field conditions encountered, one man has little difficulty pushing the machine through the field. The fertilizer is delivered through a tube to the bottom of the premade furrow. The fertilizer band is about 6.0 cm. wide. Two deflectors cover the fertilizer with soil to a depth of from 1 to 1 1/2 cm. The rear wheel on the applicator presses the soil around the fertilizer. The fertilizers were premixed and the proper amount weighed into their respective prenumbered paper bags. In the field the fertilizers were distributed along the belt before actual application.

   The plots were 10 m. long with 0.7 m. between rows. Each plot was 3 rows wide but only the center row was harvested for data. Each treatment was replicated four times in a latin square design except as indicated in Table 1. Thirty -40 to 60 g. uncut seed tubers were planted by hand in each plot.

   A fertilizer hopper was constructed to fit over the belt for continuous demonstration fertilizer applications in long plots. The unit has been used for side dressing fertilizers in some trials after the plants were up. A furrow was made along the side of the plants into which the fertilizer was applied. Afterwards, the fertilizer was covered with soil.

2. Potato sizing equipment:

   A. A series of screens was developed to size potatoes into four sizes: Those over 5.5 cm. in diameter, those between 4.5 cm. and 5.5 cm., those between 3.5 cm. and 4.5 cm., and those less than 3.5 cm. in diameter. The unit was constructed to permit "nesting" of the screens to make them readily portable, in a minimum of space to the field.

B. An electric motor, pullies and a mercury safety switch were installed on the Toralapa potato sorter to expedite the grading of the Toralapa potato crop.

3. Potato specific gravity determination: These determinations were made with weight in air and weight in water measurements. From these weighings, the specific gravities of the potatoes were calculated. Most of the tuber samples were 3 to 4 kg. in weight.

4. Soil samples: Soil samples were taken with a soil sampling tube which was open along one side. Efforts were made to take the samples to a depth of 30 cm. but this was not always possible because of the hardness of the soil. All of the samples were taken between 15 and 30 cm. in depth. In each of the 11, 2 x 2 x 2 factorial experiments, there were 8 plots which received only nitrogen. Six cores of soil were taken directly from the center of the center row of each 3 row check plot in each experiment. The samples from each plot were kept separate. The results of the soil analysis were to be used for correlation studies to relate the soil test indices with the yield obtained from their respective rows. In two experiments, 28 soil core samples were taken from each block in the experiment for comparisons with the soil samples taken in the check rows.

5. Major elements N-P-K

a. Urea, 45% super phosphate and sulfate of potash were used in the 2 x 2 x 2 factorial experiments.

b. The fertilizers treatments used in the Iscayachi fertilizer experiment were composed of commercial formulations available on the market. Therefore, the amount of P and K varied among the treatments but the nitrogen levels were the same for all the respective comparisons. Three rates of nitrogen were used; 80, 100 and 120 kg. per hectare. The five commercial fertilizers used were 18-46-0, 15-15-15, 20-20-0 and 16-16-8. Later, it was discovered that the 16-16-8 was mislabeled and was in actuality muriate of potash. At about the time of plant emergence (December 20), N and P were side dressed on their respective plots at the rate of 80-80-0, 100-100-0 and 120-120-0 kg. per hectare. Urea and triple super phosphate were used to supply the nutrients for the side dressing.

6. Minor elements sprays: A commercial dry salt mixture containing iron, copper, zinc, molybdenum, manganese, boron, magnesium and cobalt was purchased from a Cochabamba fertilizer dealer. In addition to the minor elements, the mixture contained 20% nitrogen, 16% P_2O_5 and 12% K_2O. The trade name was stimufol and was recommended for use at 50 grams per 100 liters of solution. A check solution was made from urea and 15-15-15 fertilizer. This mixture supplied almost the same amount of N-P-K as stimufol. Enough spray was applied to wet the folliage. Plant leaf symptoms that resembled zinc deficiency were present to a limited extent at the two location where the sprays were applied. It was relatively late in the growing season when the sprays were applied.

7. The pertinent details of all the experiments except for the spray program, which consisted of a fungicide and an insecticide, are in Table 1.

8. November 23. A potato leaf-scorching frost occurred in the Tiraque, Toralapa and Candelaria areas, and about April 8, a ine killing frost occurred in the Toralapa, Chinoli and Iscayachi areas.

D.2. Results:

Experimental Design: One of the objectives of the work was to determine, if possible, why the coefficients of variation (C.V.) in past experiments were so large. It was thought that a latin square experimental design, which removed the effects of soil variability in two directions, would reduce the size of the mean square for error and thereby reduce the size of the C.V.s. The mean squares for error from nine latin square experiments and one randomized block experiment are in Table 2. Except for experiments 2 and experiment 10,

TABLE 1. Summary of the pertinent data of the various experiments conducted*

	Location	Planted	Variety & seed source of seed	Temik at planting	Exp. design	Date soil sampled	Date harvested	Specific gravity taken
1	Piscomayu	25 Oct.	Tor. Sani Imi.	15 Kg/ha	Latin square	block 25 Oct. plots 18 Feb.	12 May	26 May
2	Piscomayu	25 Oct.	" " "	No	" "	block 25 Oct. plots 18 Feb.	" "	none
3	Tiraque	30 Oct.	" " "	30 Kg/ha	" "	31 January	24 April	23 May
4	Tiraque	30 Oct.	" " "		" "	31 January	" "	20 May
5	Chulchucani	9 Nov.	" " "	20 Kg/ha	" "	8 February	13 May	28 May
6	Llachojmayu	9 Nov.	" " "	20 Kg/ha	" "	10 April	23 April	23 May
7	Chinoli	12 Nov.	Chin. Sani Imi.	20 Kg/ha	" "	Blocks 15 Nov.	20 May	21 May
8	Chinoli	12 Nov.	" " "	20 Kg/ha	Rand. Block	none	20 May	21 May
9	Iscayachi	15 Nov.	Runa Local	No	" "	none	28 April	21 May
10	Iscayachi	15 Nov.	Tor. Varieties	No	" "	20 February	9 April	8 May
11	Carreras	15 Nov.	" "	No	" "	8 February	9 April	none
12	Aguirre	23 Nov.	Tor. Sani Imi.	No	" "	12 February	16 May	none
13	Racay Pampa	28 Nov.	" " "	No	" "		17 April	29 May
14	Toralapa	20 Nov.	" " "	No	Latin Square		14 May	28 May

*1. The rows were 0.7 m. apart
2. The plots were 10.0 m. long
3. Each plot was 3 rows wide
4. Fertilizer was applied by machine into bottoms of furrows except in experiments 9-10-11 where in it was spread by hand except for the side dressed fertilizers which were machine applied.
5. 30, 40-60 g. seed tubers were planted per plot.

TABLE 2. A comparison between the mean squares for rows (blocks) and columns in nine latin square designed experiments.

Location		Mean squares		Significance of "F"		
	Rows	(blocks)	Column	Rows	Columns	C.V.
Piscomayu	1	6.69	9.49	.005	.005	18.9
Piscomayu	2	0.56	0.13	NS	NS	37.0
Tiraque	3	9.53	3.26	.005	.050	21.5
Tiraque	4	2.31	10.37	NS	.005	14.0
Chullchucani	5	5.29	10.06	.010	.005	15.0
Llachumayu	6	2.90	21.23	.100	.005	19.9
Chinoli	7	4.10	2.14	.025	NS	18.2
Chinoli	8	5.63	0.79	.100	NS	23.9
Aguirre	9	Data not used because of flooding				
Racay Pampa	10	5.45 (not a latin square)		.100	-	13.1
Toralapa	11	3.57	10.95	.050	.005	21.6

the C.V.s approximate 20%. Neither the row effect nor the column effect were significant in experiment 2. Experiment 10 was a randomized block experiment but contained the same treatment as the other experiments. The row effect in experiment 10 was of the same order of magnitude as that in experiments 5 and 8. In some experiments the mean squares for rows was larger than the mean squares for columns, but in others the reverse was true, whereas in others bi-directional variation existed in the experimental areas.

Without a prior knowledge of the existing heterogeneity of the experimental site, it would be difficult to design an experiment for maximum efficiency. In these experiments, the error mean square is composed largely of the interaction effects among treatment rows and columns. When the variabilities among the rows and columns are considered, it is understandable why the C.V.s are large and indicates that special consideration should be given to experimental designs if small real differences are to be proven statistically.

Total yields: The total yield data from the 10 experiments are summarized in Table 3. On the average, adding 120 Kg/ha of Phosphorous with 80 Kg/ha of Nitrogen increased the yield of potatoes about 100%.

Some percentage increases however were much larger. For example, the percentage increase in experiment N° 1 was about 300%; in experiment N° 2, about 360% but some were much less. For example, in experiments 3 and 4 the increase was only about 10 and 14% respectively. These increases were similar to those in experiment 7 and 8, but in both these areas there was an extreme shortage of water at least during part of the growing season.

The differences in potato productivity between experiments, even within relatively small geographical areas, is large. Soil samples were taken for chemical analysis at each experimental site, but the results need verification, which is now in progress. Hopefully these analyses will provide useful information to be used by the farmer or the researcher or both.

In all of these experiments the major increases in yield were the result of phosphorus. The effect of N-P-K are more clearly evident in Table 4. On the average increasing nitrogen from 80 to 160 Kg/ha tended to decrease the yield of

TABLE 3. Summary of Total Yields of Sani Imilla Potatoes in Various Locations in Bolivia (mean yields of four replications in Ton per Hectare).

(Experiments are in order of planting dates).

Mineral Nutrients Kg/ha N	P	K	Piscomayu 1	Piscomayu 2	Tiraque 3	Tiraque 4	Chullchu-cani 5	Llachu-mayu 6	Chinoli 7	Chinoli 8	Aguirre 9	Racay-pampa 10	Tora-lapa 11	Tons/ha Means
30	0	0	7.9	3.1	5.2	8.3	7.3	7.3	9.4	4.9	Severe water damage and not uniformly	6.5	7.4	7.4
80	0	120	8.9	2.3	5.1	9.1	12.7	7.8	9.2	5.4		6.3	8.0	7.5
80	120	0	26.9	8.4	6.1	12.9	23.9	12.2	11.1	6.1		14.8	24.4	14.7
80	120	120	29.1	9.1	6.5	13.5	21.7	12.3	11.4	6.2		15.4	25.1	15.0
160	0	0	5.2	2.7	4.9	7.7	11.5	8.0	7.9	4.4		6.6	6.1	6.5
160	0	120	6.0	4.7	5.1	9.5	12.2	6.9	9.3	4.1		5.0	6.2	6.[illegible]
160	120	0	20.1	8.0	8.3	12.7	17.6	11.1	9.6	5.9		14.5	16.9	12.5
160	120	120	20.5	8.0	9.4	15.4	16.1	12.2	11.0	6.6		12.8	17.9	13.0
Mean tons/ha			15.5	4.3	6.3	11.1	16.2	10.1	9.9	5.4		10.2	7.1	9.6

TABLE 4. Means of Main Effects of Fertilizer Treatments for Sani Imilla Potatoes in Various Locations in Bolivia.

Tons per Hectare 1/

	Piscomayu		Tiraque		Chullchu-cani	Llachu-mayu	Chincli		Agui-rre	Racay-pampa	Tora-lapa	Mean of means
	1	2	3	4	5	6	7	8	9	10	11	
N_1	18.15	5.73	5.73	10.95	18.35	13.15	10.28	5.65	-	9.30	16.20	11.35
N_2	12.95	5.83	6.93	11.33	14.35	13.80	9.45	5.25	-	9.01	11.78	10.07
P_1	7.00	3.20	5.09	8.65	12.63	11.73	8.95	4.70	-	6.10	6.93	7.50
P_2	24.10	8.35	7.58	13.63	20.08	15.23	10.78	6.20	-	14.30	21.05	14.13
K_1	15.00	5.55	6.13	10.40	16.73	13.33	9.50	5.33	-	10.68	13.70	10.64
K_2	16.00	6.00	6.53	11.88	15.93	13.63	10.23	5.58	-	9.73	14.28	10.98
N	***	NS	*	NS	***	NS	NS	NS	-	*	NS	
P	***	***	***	***	***	***	**	***	-	***	***	
K	NS	NS	NS	*	NS	NS	NS	NS	-	NS	NS	
NP	**	NS	NS	NS	*	NS	NS	NS	-	NS	NS	
NK	NS	NS	NS	NS	NS	NS	NS	NS	-	*	NS	
PK	NS	NS	NS	NS	NS	NS	NS	NS	-	NS	NS	
NPK	NS	NS	NS	NS	NS	NS	NS	NS	-	NS	NS	

1/ * sig. at. 5%
** sig. at. 1%
*** sig. at. 1/2%

D-9

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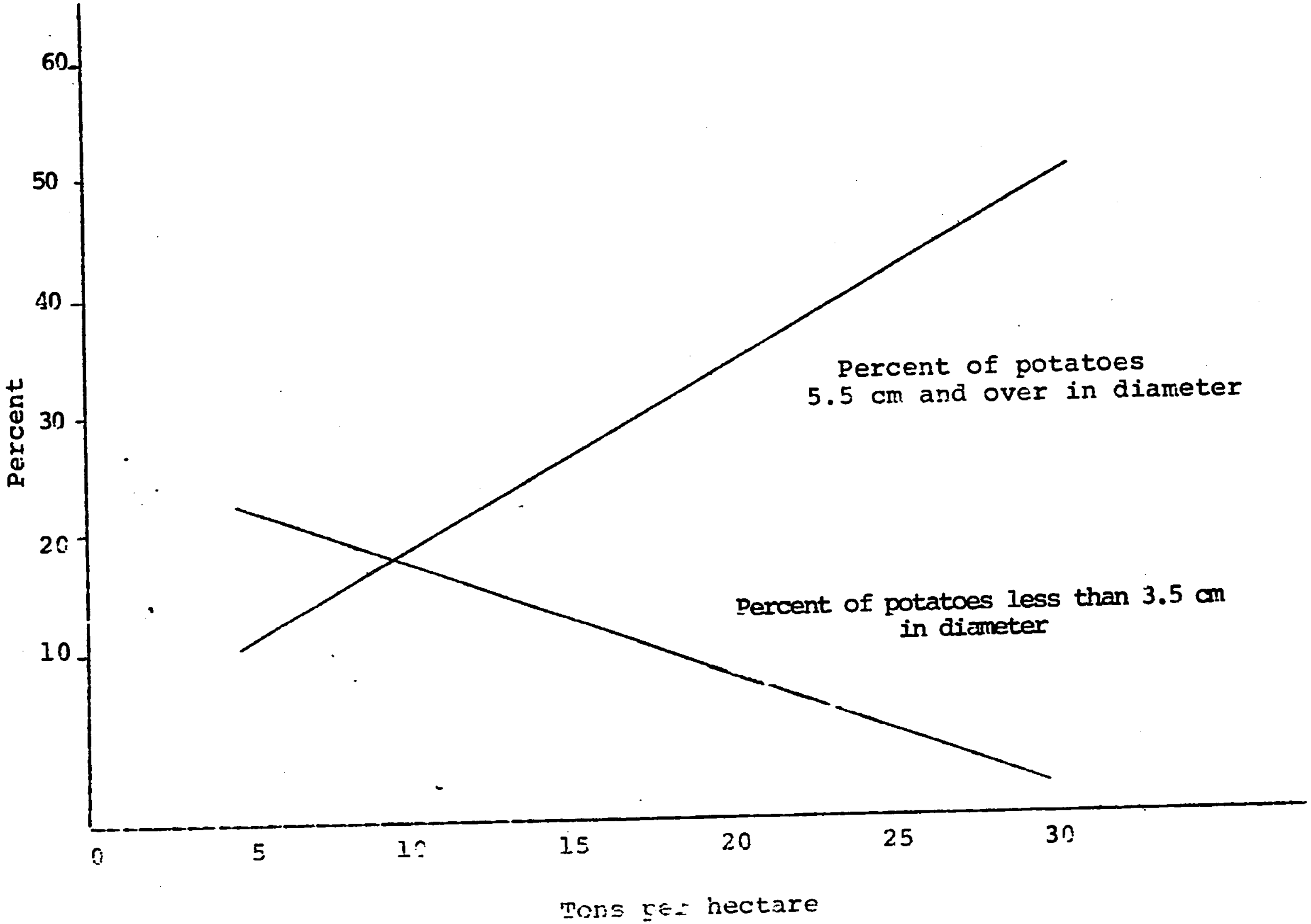
FIGURE 1. Regression lines showing the relationships between potato sizes and yield of potatoes. (Data are from Piscomayu experiment N° 1) The correlation coefficient squared for 5.5 cm potatoes was 77% The correlation coefficient squared for 3.5 cm potatoes was 64%



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potatoes. In experiments one and five, the yield decreases were significant statistically at the 1/2% level. In experiment 10, the decrease in yield was significant at only the 5% level. However, the increased amount of nitrogen resulted in a significant increase in yield in experiment 3. The increase in yield resulting from applying phosphorus was highly significant statistically at all locations. Only in experiment 3 did applying potassium significantly increase the yield, but an inspection of the data in Table 4 will show that in 9 out of 11 experiments the main effect of potassium was positive. It suggests that a combined statistical analysis should be made. In two experiments there was a significant interaction between nitrogen and phosphorus, and in one experiment there was a significant interaction between nitrogen and potassium. Probably the most noteworthy observations, however, is that without phosphorus, there was no increase in yield. Indicating that the level of phosphorus in the soil available to plants must be extremely low. The average yield for all experiments was about 9.6 tons per hectare, which is slightly above the average yield for Bolivia, Table 3. Nevertheless, in several experiments the highest yields approximated 25 tons per hectare, in a relatively dry and short growing season.

Percentage tuber size distributions: The detailed data for the effect of fertilizers and locations on tuber size distributions are in Tables 5, 6, 7, and 8. In general the higher the yield, the greater the percentage of large potatoes and the less the percentage of potatoes less than 3.5 cm in diameter. There is reason to believe that the larger potatoes are desired by potato consumers. The relationship between yield and tuber size were studied in detail by linear regression for the Piscomayu 1, and Chullchucani experiments. Both experiments provided almost identical information. Therefore, only the results of the Piscomayu study are presented. The most pronounced effects on size were on the tubers over 5.5 cm and less than 3.5 cm in diameter. The regression lines predict that if the yield of potatoes approaches 30 tons per hectare, the percentage of tubers less than 3.5 cm in diameter will almost disappear. The linear correlation coefficients relating yield to tuber size were high. When squared, in the case of the 5.5 cm size category, it was 77% leaving only 23% of the total possible variability ascribable to other causes.

Large potatoes may be desired by the housewife and, therefore, large yields may be advantages to the producer of consumption potatoes but the most desirable potatoes for seed purposes are between 40 - 60 grams, about 3.5 cm in diameter.

TABLE 5. Summary of Percentages of Tubers over 5.5 cm in diameter of Sani Imilla Potatoes in Various Locations in Bolivia.

Mineral Elements Kg/ha			Piscomayu		Tiraque		Chullchu-cani	Llojo-mayu	Chinoli		Agui-rre	Racay-pampa	Tora-lapa	Averages
N	P	K	1	2	3	4	5	6	7	8	9	10	11	
80	0	0	19.8	-	4.3	20.3	18.0	13	8.0	0.0	-	.0	.1	9.3
80	0	120	19.3	-	14.7	11.0	15.2	5	5.5	0.0	-	1.4	0.2	8.0
80	120	0	50.0	-	3.5	35.0	30.0	20	11.0	0.0	-	16.1	10.9	19.6
80	120	120	44.5	-	9.6	28.5	25.5	25	12.0	0.0	-	15.5	21.5	20.2
160	0	0	9.8	-	7.9	8.0	10.2	13	6.7	0.0	-	1.0	0.7	6.4
160	0	120	14.3	-	15.7	16.0	9.7	10	6.0	0.0	-	.0	1.1	8.1
160	120	0	39.8	-	11.5	22.8	24.2	23	6.5	0.0	-	16.9	20.3	18.3
160	120	120	40.8	-	6.1	30.0	25.0	32	9.7	0.0	-	11.3	18.5	19.3
Averages			29.8		9.2	22.6	19.8	17.6	8.2	0.0		7.8	9.2	13.8

TABLE 6. Summary of Percentages of Tubers Between 4.5 and 5.5 cm in diameter of Sani Imilla Potatoes in Various Locations in Bolivia.

Mineral Elements Kg/ha			Piscomayu		Tiraque		Chulchu-cani	Llojo-mayu	Chinoli		Agui-rre	Racay-pampa	Tora-lapa	Averages
N	P	K	1	2	3	4	5	6	7	8	9	10	11	
80	0	0	31.5	-	27.1	25.8	33.2	23	19.5	0.5	-	16.4	3.4	20.0
80	0	120	29.8	-	26.7	26.9	26.5	31	24.3	3.5	-	11.2	17.6	21.9
80	120	0	26.5	-	15.0	28.3	34.3	33	27.8	8.3	-	30.1	34.6	26.4
80	120	120	30.3	-	21.2	32.8	37.3	28	28.8	3.0	-	31.9	34.3	27.5
160	0	0	21.3	-	28.2	20.0	14.0	28	23.0	1.8	-	8.7	7.7	17.0
160	0	120	23.3	-	25.9	27.3	31.8	25	24.8	0.0	-	5.9	13.1	19.7
160	120	0	24.5	-	16.7	31.3	29.5	29	29.3	5.3	-	29.5	31.6	25.2
160	120	120	27.5	-	13.1	30.0	32.0	35	31.5	5.8	-	32.0	31.5	26.5
Averages			26.8		21.7	27.8	29.8	30.4	26.1	2.8		20.7	21.7	23.1

TABLE 7. Summary of Percentages of Tubers Between 3.5 and 4.5 cm in diameter of Sani Imilla Potatoes in Various Locations in Bolivia.

Mineral Elements Kg/ha N	P	K	Piscomayu 1	2	Tiraque 3	4	Chullchu-cani 5	Llojo-mayu 6	Chinoli 7	8	Agui-rre 9	Racay-pampa 10	Tora-lapa 11	Averages
80	0	0	33.0	-	40.1	37.3	35.5	42.7	48.5	27.3	-	44.0	51.6	40.0
80	0	120	32.8	-	35.4	32.0	38.5	42.5	46.8	37.5	-	39.3	46.3	39.0
80	120	0	18.5	-	48.8	24.0	28.7	33.3	42.3	39.5	-	38.1	41.2	34.9
80	120	120	19.3	-	41.2	28.8	28.2	34.8	40.5	37.5	-	33.6	32.8	32.9
160	0	0	35.3	-	38.9	47.3	48.5	38.3	41.8	21.3	-	43.5	48.7	40.4
160	0	120	35.3	-	36.1	37.3	39.5	43.0	45.3	28.5	-	39.4	41.1	38.4
160	120	0	25.5	-	45.8	32.5	33.0	36.5	44.3	24.3	-	35.5	33.0	34.5
160	120	120	23.5	-	42.6	29.8	31.3	22.8	41.3	35.0	-	37.9	34.4	33.2
Averages			27.9		41.1	35.2	35.4	34.2	43.9	31.4		38.9	41.1	36.6

TABLE 8. Summary of Percentages of Tubers Less than 3.5 cm in diameter of Sani Imilla Potatoes in Various Locations in Bolivia.

Mineral Elements Kg/ha			Piscomayu		Tiraque		Chullchu-cani	Llojo-mayu	Chinoli		Agui-rre	Racay-pampa	Tora-lapa	Averages
N	P	K	1	2	3	4	5	6	7	8	9	10	11	
80	0	0	15.8	-	28.4	16.8	13.8	21.0	23.5	75.0	-	39.7	44.9	31.0
80	0	120	18.3	-	23.2	17.3	19.3	21.2	23.5	58.5	-	48.1	36.0	29.5
80	120	0	5.0	-	32.7	12.8	7.7	13.2	18.5	54.7	-	15.9	13.3	19.3
80	120	120	6.0	-	28.1	10.0	9.0	13.0	19.3	59.5	-	19.1	11.4	19.5
160	0	0	33.8	-	25.2	24.8	19.5	20.5	28.8	77.0	-	46.8	43.0	35.5
160	0	120	26.0	-	22.4	19.5	19.0	21.2	24.0	71.5	-	53.7	44.7	33.6
160	120	0	10.3	-	26.0	13.5	13.0	11.5	20.0	70.5	-	17.3	15.1	21.9
160	120	120	8.5	-	38.1	10.3	11.7	12.7	17.8	63.7	-	18.6	15.7	21.9
Averages			11.8		28.0	15.7	14.1	16.8	21.9	66.3		32.4	23.6	25.6

Since the cost of the inputs for high yields is little more than the cost of the input for low yields, it behooves a grower to strive for maximum economic production.

Specific gravities: The specific gravity data have been summarized into Table 9. The largest differences occurred among the experiments. The differences resulting from the fertilizer treatments are quite unimportant considering the differences in the length of time the tubers were in a non temperature, and non humidity controlled storage between the time of harvest and the time of determining the specific gravities, Table 9. When the means of the main effects are considered, it would seem that on the average none of the mineral elements caused a major effect on the specific gravity of the tubers.

D.3. Iscayachi experiment: The data from this experiment are in Table 10. None of the treatments caused differences that were large enough and consistent enough to be statistically significant at the 5% level. A study of the data by groups indicated that whatever differences might prevail, that they were mostly due to the effects of levels of nitrogen and not due to either P or K. A study of the data listed under "Main effects of nitrogen" suggest some trends. For example increasing N suggest an increase in total yield of potatoes and also an increased percentage of large sized tubers. Conversely, there appears to be a decrease in the percentage of small sized potatoes.

D.4. Discussion of results from factorial fertilizer experiments: In all of the experiments with levels of Phosphorus there were highly significant statistical increases in yield. In most cases, the increase was double and at times triple that of the 0-P treatment. If the correlation between soil test Phosphorus and yield is high at all locations, soil test indices can be used to assess whether or not a given farmer's field is likely to produce higher potato yields than if no Phosphorus is added. If the correlation is very high, regression can be used to develop a guide indicating how much phosphorus should be applied for a given soil test. Such a program would require a routine soil testing laboratory wherein the soil samples can be analyzed and the results of the analysis returned to the grower or his agent in sufficient time to procure the needed fertilizer materials.

Obtaining a reliable soil sample could present a problem because many of the fields are small. Nevertheless, the variability of the soil as measured by the variability in potato yields in latin square designed experiments, indicates that there is often variability in two directions. If soil cores from are s low in phosphorus are mixed with cores from areas high in phosphorus, the average result of the chemical analysis could be very misleading. The extent of the sampling needed has not been determined. Special sampling procedures may be needed if the most efficient use is to be made of the phosphorus affordable by the grower.

Observational information obtained from viewing crops, suggests that there could be a phosphorus shortage for crops other than potatoes. Phosphorus is essential for all plants and animals. Thus the implications as to the essentialness of phosphorus in Bolivia, at this point in time, are tremendous, and are worthy of intensive study. To effectively study such a problem will require a well equipped laboratory for soil and plant analysis. Once a laboratory with adequate testing capacity has been developed, a soil survey of Bolivian soils should be made to determine the potential Bolivian phosphorus market. There are reports indicating that there are large deposits of low grade phosphate rock within Bolivia's borders. If these could be developed, it could lead to another Bolivian industry. But first the potential need for phosphorus must be solidly established.

Doubling or even tripling the average potato yield could have some important economic implications. For the farmer it would mean that he could grow the same amount of potatoes on half as much land. The other half could be used for a second cash crop. If he chose to plant the same acreage to potatoes as in the past, the price per unit of potatoes in the market, could be lowered, but since he would have twice as many potatoes to sell, his total income might still be increased since the cost per unit of production would be lower. Considering the nutritional value of potatoes a lower price in the consumer, might remove potatoes from the category of a luxury food item into that of a basic food item. The nutritive value of potatoes needs to be extolled.

Another possibility would be for a farmer to withhold the poorer quality potatoes from market, store them for sheep or cattle feed to be used during the dry season and thus quality marketing of potatoes would begin. This would benefit the producer of quality potatoes, the consumer of potatoes and families of the farmer indirectly by increasing milk and meat

TABLE 9. Summary of Specific Gravity Data for Sani Imilla Potatoes in Various Locations in Bolivia 1/

Mineral Elements Kg/ha N	P	K	Piscomayu 1	2	Tiraque 3	4	Chullchu-cani 5	Llojo-mayu 6	Chinoli 7	8	Agui-rre 9	Racay-pampa 10	Tora-lapa 11	Averages
80	0	0	.0930	-	.1143	.1053	.0910	.1015	.0875	.0787	-	.1040	.0950	.0978
80	0	120	.0940	-	.1066	.1055	.0930	.1000	.1000	.0816	-	.1030	.0940	.0878
80	120	0	.0980	-	.1154	.1054	.0910	.1000	.0969	.0833	-	.1180	.1070	.1017
80	120	120	.0950	-	.1109	.1068	.0890	.0974	.0977	.1066	-	.1140	.1070	.0949
160	0	0	.0900	-	.1092	.1010	.0920	.0976	.0945	.0734	-	.1030	.0930	.0848
160	0	120	.0870	-	.1062	.1031	.0930	.0995	.0968	.0726	-	.1010	.0890	.0994
160	120	0	.0960	-	.1156	.1059	.0910	.0964	.0957	.0800	-	.1140	.1000	.0881
160	120	120	.0900	-	.1138	.1043	.0920	.0991	.0965	.0802	-	.1110	.0940	
Averages			.0928		.1115	.1047	.0915	.0989	.0969	.0820		.1085	.0944	
							Main effects							Mean
N_1			.0950	-	.1118	.1058	.0910	.1078	.0980	.0875	-	.1097	.1007	.1008
N_2			.0908	-	.1112	.1035	.0920	.0981	.0958	.0765	-	.1072	.0940	.0966
P_1			.0910	-	.1091	.1038	.0922	.0996	.0972	.0765	-	.1027	.0927	.0961
P_2			.0947	-	.1139	.1056	.0907	.0982	.0967	.0875	-	.1090	.1020	.0998
K_1			.0942	-	.1136	.1091	.0912	.0989	.0961	.0788	-	.1097	.0987	.0989
K_2			.0915	-	.1093	.1049	.0917	.0990	.0977	.0852	-	.1072	.0960	.0981

1/ 1.0000 has been subtracted from all the values

TABLE 10. Data obtained from the Iscayachi fertilizer trial with Runa potatoes.

Mineral Nutrients Kg/ha				Percentages				Specific Gravity
N	P	K	Tons/ha	5.5+	4.5-5.5	3.4-4.5	3.5	
80	35	33	30.1	9.3	22.0	40.3	28.5	1.0900
100	44	42	27.0	7.3	26.0	41.7	25.2	1.0911
120	53	50	31.7	11.3	25.3	36.3	27.0	1.0911
80	35	0	30.4	8.2	24.7	36.7	30.7	1.0978
100	44	0	34.6	11.7	20.3	40.7	27.4	1.0978
120	53	0	36.5	11.7	21.3	37.3	26.0	1.0944
80	35	66	28.9	14.0	20.3	41.3	24.3	1.0966
100	44	83	40.5	14.5	26.7	37.7	18.7	1.0938
120	43	100	33.4	13.7	21.7	39.3	24.7	1.0926
80	88	0	25.0	7.0	26.7	33.0	35.7	1.0978
100	120	0	28.7	7.7	24.0	28.0	40.3	1.0978
120	140	0	35.5	8.8	21.0	39.7	29.0	1.0999
		Mean	31.9	10.2	23.3	37.7	28.1	1.0951
			NS	NS	NS	NS	NS	NS
			Main effect of nitrogen					
		N_1	28.6	9.6	23.4	37.8	29.8	1.0955
		N_2	32.7	10.3	24.3	17.0	27.9	1.0951
		N_3	34.3	11.4	22.3	38.1	26.7	1.0945

production on the farm.

The economies of investing enough capital to purchase sufficient phosphorous to produce maximum potato yields needs further study. If the cost of the phosphorous could be amortized over several potatoe crops, or other crops, the cost of phosphorus per year might be substantially reduced. Phosphorus does not leach from the soil nor does it become unavailable to plants, according to present knowledge of P fixation in Bolivian soils. If this is the case, large applications of phosphorus would be required only the first time and the necessity of adding such large quantities of phosphorus each year, would be eliminated. The response to phosphorus obtained this year, a relatively dry growing season, is believed to have been at least in part due to the concentrated band of fertilizer being placed deep in the soil where it remained plant available.

Fixation, rates, and placement of phosphorus fertilizer studies are needed. Preferably with the assistance of a state side, soil chemist who has had Bolivian experience.

In conclusion, the economic use of phosphorus under Bolivian conditions and the subsequent effect on the farmer needs to be thoroughly studied. The results obtained with phosphorus this year very substantially confirm results of past experiment, namely that phosphorus in the soil in many cases must be extremely deficient.

<u>Minor element sprays</u>: No changes in color of folliage or growth of vines was observed. Therefore, no tubers were harvested. The plots were about 40 meters long and should have crossed since deficient areas. In addition, the treatments were replicated. It is possible that the minor elements were applied too late in the life cycle of the plants to bring about any growth responses.

<u>Potato variety trials</u>: The data obtained from the Iscayachi variety trial are summarized in Table 11. The varieties are arranged in descending order according to total yield. Only two varieties seem worthy of further consideration, Runa, the old standard variety for the area and Alpha. Runa produced the highest total yields, produced a preponderance of medium sized potatoes and the specific gravity of the potatoes was well within the acceptable range. In addition, there was about 1/4 of the potatoes that were less than 3.5 cm in

TABLE 11. Summary of the data obtained from the Iscayachi Potato Variety Trial

Variety	Yield Ton/ha	Percentages diameter of potatoes in cm 5.5+	4.5-5.5	3.5-4.5	less than 3.5	Specific Gravity
Runa 1/	32.3	12.0	22.9	39.7	24.1	1.0850
Runa 2/	31.1	9.7	21.9	36.9	31.6	1.0881
Alpha	28.0	52.4	25.9	15.5	5.0	1.0921
Cardinal	24.9	31.3	35.7	28.1	5.0	1.0835
Radosa	22.4	48.9	32.3	15.2	3.6	1.0785
Spunta	21.6	43.2	28.2	22.1	6.5	1.0658
Estima	21.4	30.7	32.7	27.0	9.4	1.0664
Baraka	19.8	32.5	28.0	26.2	13.1	1.0762
Desiree	19.0	25.4	38.4	28.7	7.5	1.0721
Sirtema	16.9	36.3	31.5	29.9	9.6	1.0691
Bintje	16.9	4.6	15.6	50.9	17.1	1.0663
Jaerla	12.5	22.5	33.1	29.7	14.2	1.0664
Planka	12.5	22.5	28.1	38.7	10.5	1.0602
Dore	5.6	8.0	17.7	53.6	21.0	1.0708
	Means	27.4	28.8	31.2	12.7	

1/ Toralapa experiment station grown seed.
2/ Locally grown seed and generally smaller in size than the Toralapa seed.

diameter. Potatoes that are about 3.5 cm in diameter weigh about 50-60 grams, a very desirable size for seed purposes. The second variety Alpha produced a high percentage of large tubers-over 5.5 cm in diameter, but very few seed-size potatoes. The specific gravity of the potatoes would have ranked with the highest.

The variety experiment at Carreras was harvested and total weights of the potatoes in each plot were taken. The data have not been used however, because every potato, of every variety, in every plot was so badly riddled, with what appeared to be flea beetle damage, that the results were deemed to be unreliable.

D.5. Other activities:

1. Student activities: During the past year six students were assisted with becas toward an ingeniero degree. These students required considerable time, supplies and the use of equipment. Fortunately, the assistance of the faculty at Tamborada contributed much in the way of project supervision and laboratory facilities. All the students have written at least a rough draft of their project report, but only one has completed his ingeniero degree. Several reports have been reviewed by the respective thesis committees and changes in the thesis from minor to major revisions were recommended. It is anticipated that at least one additional student would now have completed his degree if it had not been for problems at Tamborada and changes in the faculty there. A tabulation of the students progress is given in Table 12.

2. Participation in Potato Conferences. Assistance was given in the preparation of two reports that were given at IBTA sponsored potato conferences.

3. I expressed an interest in an invitation to coauthor a chapter on potato diagnostic symptoms in a field manual being sponsored by the National Fertilizer Solution Association, but it was emphasized that being in Bolivia for the next two years would limit my access to library facilities and the pictures and information left in Pullman, Washington at the University.

4. Home leave was taken in Pullman, Washington from June 23 to July 21, 1980.

5. A serious epidemic of powdery mildew was discovered in the Tiraque and Candelaria areas. Routine applications of fungicides to control late blight in potatoes did not control the mildew.

6. A stem boring, tuber infesting worm, which was later identified as tuber moth larvae appears to be causing extensive reduction in potato yields because of premature dying of the plants. In addition, about 50% of the apparently healthy potatoes, taken at harvest time at Rakay Pampa for specific gravity measurements, were badly damaged by the worms while in storage.

TABLE 12. Status of Student Progress

Student's name	Title of project	Draft of thesis written	Ingeniero degrees granted	Months of beca
Luis Zapata	Types of phosphorous and calibration methods of analysis in soils with potato crops	yes	yes	12
Florencio Siles	Soil Preparation for Potato Crops	yes	no	12
Ginner Ledezma	Potassium Laboratory Methods of Calibration for Soils at the Toralapa Experiment Station	yes	no	12
Ramiro Blacutt	Phosphorous influence on Zinc availability	yes	no	12
Felipe Kantuta	The Agronomic value of Manure	yes	no	12
Nelson Rodríguez	Potato storage in some locations in Cochabamba	yes	no	12

E. CEREAL AGRONOMY

by

Dr. Thomas C. Stilwell - Cereal Agronomist

E.1. Summary of Wheat Production Experiments

Totora: Possible priorities for wheat production research are variety and weed control.

Under current economic conditions, the use of fertilizer is definitely not profitable.

The use of the herbicide 2,4-D is not profitable.

Use of new varieties is probably not profitable.

Valle Alto: The only possible priority for wheat production research is variety.

Under current economic conditions the use of fertilizer is definitely not profitable.

The use of the recommended variety is probably profitable.

E.1.1. Project: SB-I-Th-2-a Priorities of Production Research for Wheat.

Leaders: Eng. René Gómez Q. and Dr. Thomas Stilwell with Eng. Vidal Velazco collaborating.

Justification: As of this date, there exists no experimental data to permit the establishment of priorities of research in wheat. This experiment is designed to collect such data.

Objectives: (1) Identify practices of combinations of critical practices in the process of wheat production by wheat farmers and (2) establish the priorities of these practices.

Status: Because of unfavorable weather and political conditions, this experiment was planted in only two locations: Azul Kocha (Totora) and Mendez Mamata

(Valle Alto). Both locations were harvested. Because these two recommendation domains are quite different, the analysis were handled separately. This experiment was not planted in Santa Cruz due to lack of funds.

Results: Totora
The experiment in Totora suffered moderate drought similar to the local farmers. With respect to grain yield there were statistically significant increases due to fertilizer application. There were statistically significant differences in straw yield among varieties with criollo yielding more than Chinoli. Fertilizer also increased straw yield significantly more for the criollo variety. There was also a significant interaction between variety and weed control for straw yield with criollo straw yield showing much greater increase than Chinoli after weed control. The variety Chinoli was earlier maturing (lower grain moisture) and had a higher test weight (grain quality) than the crioll .

The partial economic analysis showed that the farmers practice was more profitable than any other practice or practices. Only variety and herbicide could possibly be improved to give greater cash profits over current farmers practices. For the next planting season, this type of experiment should continue with variety and weed control as factors but fertilizer should not be included.

Results: Valle Alto
The experiment in Mendez Mamata suffered severe drought but in general suffered slightly less damage than local farmers. Statistical analysis showed a significant grain yield increase due to use of the recommended variety. Use of fertilizer increased both grain yield and straw yield. Weed control increased straw yield only. The partial economic analysis follows:

Treatment	Grain yield T/ha	Straw yield T/ha	Var. cost $b/ha	Net benefit $b/ha
FP + Jaral	0.55	0.75	0	1676
Farmers Practice (FP)	0.51	0.79	0	1616
FP + Weed Cont.	0.49	0.70	577	936
FP + Fertilizer	0.86	1.11	2793	-214

Only use of Jaral showed economic returns potentially greater than normal farmers practice. Use of fertilizer had a definite negative effect on economic returns. Use of herbicide is probably not an economically profitable input. With these results it is possible to consider only variety as a priority in production research. Because this is the result of only one experiment in one location in one very dry year, these results cannot be considered final. This experiment should be repeated in several locations during the next planting season.

E.1.2. Project: SB-I-Th-2-b Evaluation of Variety, Lime and Fertilizer on Production of Wheat.

Leaders: Eng. René Gomez Q. and Dr. Thomas C. Stilwell with Eng. Vidal Velasco collaborating.

Justification: Greenhouse research indicates that there is a good wheat yield response to lime application. This experiment will test to see if the same response can be obtained under farmers conditions.

Objectives: (1) determine the optimum combination of lime, fertilizer and variety in terms of wheat yield under farmers conditions, (2) determine the optimum combination of lime, fertilizer and variety in economic terms, and (3) develop an agronomic recommendation for use of lime and fertilizer with existing varieties.

Status: Because of unfavorable weather and political conditions, this experiment was planted in only two locations: Azul Kocha (Totora) and Mendez Mamata (Valle Alto). Due to a shortage of suitable lime at planting, this factor was not included in the experiment. Both locations were harvested. Because these two recommendation domains are quite different, the analyses were handled separately.

Results: Totora

This experiment suffered moderate drought similar to local farmers. The statistical analysis showed that each level of fertilizer application increased grain and straw yield significantly. The variety Chinoli 70 had significantly higher grain yields than either Criolla or Jaral.

The economic marginal returns analysis showed very poor returns for fertilizer application. Part of the analysis is included here:

Treatment	Grain T/ha	Straw T/ha	Var. cost $b/ha	Net benefit $b/ha	Marg. incr. N B	Marg. incr. V C	Marg. rate return
FP + Jaral	1.08	1.06	56	2435	654	56	1168%
FP + Chinoli	1.06	1.15	56	2411	-	dominated	
Farmers practice (FP)	0.94	1.62	0	1781	-	-	
FP + Chinoli + 40-40-0	1.80	1.83	2849	1315	-	dominated	
FP + Jaral + 40-40-0	1.26	1.44	2849	97	-	dominated	

These results indicate that fertilizer is not a profitable input for wheat in Totora. It is possible that use of Chinoli without fertilizer gives greater economic returns than criollo. Because this experiment was not repeated over several locations and has only one year of data, a farmer recommendation is not possible. This experiment should be repeated in the next planting season with more locations in Totora, possibly eliminating the highest rate of application (120-120-0).

<u>Results:</u> Valle Alto
This experiment suffered severe drought but slightly less than local farmers. Statistical analysis showed that increasing rates of fertilizer application resulted in increased grain yield, straw yield and weed growth. There were no differences in grain yield among varieties, but Chinoli yielded more straw than criollo or Jaral. There were no interactions between variety and fertilizer application.

An economic analysis of the data showed that application of fertilizer lowered economic net benefits and in no case gave greater returns than no fertilizer application. Both recommended varieties yielded more than the local variety without fertilizer. The results of this experiment cannot be used for recommendations because the data are from only one location in one very dry year. This experiment should be repeated in several locations during the next planting season.

E.1.3. <u>Project</u>: SB-I-Th-1-a General Weed Control in Wheat

<u>Leaders</u>: Eng. René Gomez Q. and Dr. Thomas C. Stilwell with Eng. Francisco Checa collaborating.

<u>Justification</u>: Because of a lack of data, it is not possible to determine the economic benefits of recommended weed control in wheat under farmers conditions. This experiment is designed to supply these data.

<u>Objectives</u>: (1) determine the most efficient method of weed control in wheat under farmers conditions, (2) determine the optimum weed control under farmers conditions, and (3) develop a farmer recommendation for weed control in wheat.

<u>Status</u>: Because of unfavorable weather and political conditions, this experiment was planted in only two locations: Azul Kocha (Totora) and Mendez Mamata (Valle Alto). Due to a harvesting errors, the experiments in both locations were lost. This experiment was not planted in Santa Cruz due to lack of funds.

E.1.4. <u>Project</u>: SB-I-Th-1-b Post emergent Chemical Weed Control in Wheat

<u>Leaders</u>: Eng. Francisco Checa with Dr. Thomas Stilwell collaborating.

<u>Justification</u>: The strong infestations of weeds in wheat reduce the yield and grain quality of wheat, increase harvesting labor and cause other problems in large plantings of wheat. The use of post emergence herbicides has the potential to reduce these problems.

<u>Objectives</u>: To determine the proper rate of application of selected preemergence herbicides for weed control in wheat.

<u>Status</u>: One experiment was planted on the San Benito experiment station.

<u>Results</u>: San Benito
Three variables were tested: herbicides, date of application and rate of application. Among herbicides

Agren controlled Eragrostis sp. better than another herbicide. The earliest applications gave best control of Fragrostis sp. The best control of Eragrostis was with the combination of Agren, early application with minimum dosage.

The yields of straw and grain tended to be the reverse of the results of weed control. The best yields were with either 2,4 - D or no application of herbicide. There were definite phytotoxic effects of herbicides with the greatest effect being from early application and Dicamba.

No economic analysis was done since the experiment was done under experiment station conditions; i.e. row planting, fertilizer, irrigation, non-criollo variety and unusual weed population. This experiment should be repeated under farmers conditions in farmers fields during the next planting season. Dicamba should be replaced with another herbicide since it seems too easy to cause phytotoxic effects.

E.1.5. Project: SF-I-Th-1-a Preemergent Chemical Weed Control in Wheat

Leaders: Eng. Francisco Checa with Dr. Thomas C. Stilwell collaborating.

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

Objectives: To determine the proper rate of application of selected preemergence herbicides for weed control in wheat.

Status: This experiment was planted in only two locations: Azul Kocha (Totora) and San Benito (Valle Alto).

Results: Totora
This experiment had a moderate weed infestation similar to most farmers fields. All types of control methods (manual, different herbicides and different application rates) did control the weeds present. There were

no significant differences in grain or straw yield among treatments. Because there were no significant differences, the cheapest treatment (no control) would be economically best. Since this experiment was done using experiment station techniques (row planting, fertilizer application, non-criollo variety), these results cannot be used to make farmer recommendations.

Results: San Benito
This experiment was planted on the experiment station and had an average infestation of Eragrostis sp. All types of control methods (manual, different herbicides and different application rates) did control the weeds present. There were no significant differences in straw yield among treatments. For grain yield, all herbicide treatments yielded more than manual control or no control. No economic analysis was performed since this experiment was done under experiment station conditions; i.e. row planting, fertilizer, irrigation, non-criollo variety. Also the predominant weed, Eragrostis sp., is not a problem in farmers fields.

E.1.6. Project: SB-I-Th-4-a Verification of Wheat Varieties and Technology

Leaders: Eng. René Gomez, Dr. Thomas C. Stilwell, and Eng. Jaime Salamanca with Eng. Vidal Velasco R. collaborating.

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

Objectives: (1) verify that the recommended wheat production practices perform as well as in the previous experiments and (2) demonstrate to the farmers in their own fields that the recommended practices are profitable.

Status: Because of unfavorable weather and political conditions, this experiment was planted in only two locations: Azul Kocha (Totora) and Mendez Mamata

(Valle Alto). Both locations were harvested. Because these two recommendation domains are quite different, the analyses were handled separately. This experiment was not planted in Santa Cruz due to lack of funds.

Results: Totora
This experiment suffered moderate drought similar to local farmers. Since there was only one location, a combined statistical analysis was not possible. The economic marginal returns analysis is shown below:

Treatment	Grain T/ha	Straw T/ha	Var. Cost $b/ha	Net Benefit $b/ha	Marg. Incr. N	P	Marg. Incr. V C	Marg. rate return
Farmers practice (FP)	0.84	1.54	0	2080	-		-	-
FP + Chinoli 70	0.72	1.22	56	1707	-		dominated	-
FP + Chinoli + 2,4-D	0.81	1.03	571	1344	-		dominated	-
FP + 2,4-D	0.76	1.19	515	1327	-		dominated	-
FP + Chinoli + 2,4-D + fertilizer	1.30	1.46	3364	-329	-		dominated	-
FP + 2,4-D + fertilizer	1.03	1.36	3308	-863	-		dominated	-

These data suggest not to use fertilizer, herbicide nor the variety Chinoli. Because this is not based on several years experiments in many locations, no final conclusion should be made this year. This experiment should be repeated in the next season with more locations in Totora.

Results: Valle Alto
This experiment suffered severe drought similar to local farmers. Because there was only one location, a combined statistical analysis was not possible. Because of a harvest error, the straw weight was not recorded and a complete economic analysis is not possible. The yields of grain are shown below:

	Grain yield
Farmers practice (FP)	0.61 t/ha
FP + Jaral	0.49
FP + 2,4-D	0.30
FP + Jaral + 2,4-D	0.42
FP + 2,4-D + Fertilizer	0.62
FP + Jaral + 2,4-D + Fertilizer	0.65

These results indicate that only use of fertilizer has hopes of increasing yield over that of the local farmers practices in a very dry year. Unfortunately the price of fertilizer makes its use very uneconomic. The results of this trial indicate that there are no practices that can improve farmer income in a dry year. Because this experiment was planted in only one location this year, no conclusion or recommendation is possible. This experiment should be planted in more locations during the next planting season.

E.2. Summary of Barley Production Experiments

Tiraque: Possible priorities for barley production research are variety and chemical control of yellow rust. Under moderate infestations of S. arvensis, it is not economically profitable to apply Sencor.

Economically profitable chemical control of yellow rust is possible.

In response to yellow rust, a farmer's first step should be to use the variety Promesa and then application of Bayleton to control yellow rust.

E.2.1. Project: SB-I-C-2-b Weed Control in Barley

Leaders: Eng. Alberto Cordova and Dr. Thomas C. Stilwell with Eng. Francisco Checa collaborating.

Justification: Due to a lack of experimental data, it is impossible to determine the profitability of control of Spergula arvensis under farmers conditions. This experiment will supply these data.

Objectives: (1) determine the optimum date and rate of application of Sencor for control of S. arvensis in barley, (2) determine the economic optimum date and rate of application for Sencor for control of S. arvensis in barley and (3) develop agronomic recommendations for the control of S. arvensis under farmers conditions.

Status: Because of unfavorable weather and political conditions, this experiment was planted only in Plano Base (Tiraque).

Results: Tiraque
This experiment showed a moderate to heavy infestation of Spergula arvensis. There was nearly complete control of S. arvensis with all rates and dates of application of Sencor. Control of S. arvensis did not affect grain yield, straw yield or grain test weight.

The economic marginal returns analysis showed the best economic returns with no application of herbicide.

The tentative recommendation is to not apply Sencor for control of S. arvensis. This single experiment is not adequate for making a recommendation in Tiraque and should be repeated in more locations over several years. Sencor should be replaced with Tribunil.

E.2.2. Project: SB-I-C-2-d Verification of Barley Varieties and Technology

Leaders: Eng. Alberto Cordova, Eng. Vidal Velazco and Dr. Thomas C. Stilwell.

Justification: There exist few data on the profitability of recommended barley production practices under farmers conditions. This experiment will compare the profitability of the recommended practices with those used by the farmers.

Objectives: (1) Verify that the recommended barley production practices perform as well under farmers conditions as under experimental conditions, and (2) demonstrate to farmers on their own land the benefits of the recommended practices.

Status: Because of unfavorable weather and political conditions, this experiment was planted only in Plano Base (Tiraque) and two locations in Totora. The two locations in Totora suffered severe drought and were not harvested.

Results: Tiraque
Because only one location was planted in Tiraque, only the economic marginal returns analysis was done.

Treatment	Grain T/ha	Straw T/ha	Var. cost $b/ha	Net ben. $b./ha	M I N B	M I V C	M R Ret
FP + Promesa + Bayleton	2.42	3.68	1130	9287	737	903	82%
FP + Promesa	2.05	3.05	227	8550	6093	227	2684%
FP + Bayleton	1.43	2.12	903	3784	- dominated		-
Farmers Practice (FP)	0.55	1.75	0	2457	-	-	-

This analysis indicates that it is better to use Promesa than apply Bayleton on criollo, and even better to apply Bayleton to Promesa.

Because these are results from only one experiment, no final recommendations should be made. This experiment should be repeated in several locations in Tiraque during the next planting season.

E.2.3. <u>Project</u>: SB-I-C-2-f Chemical Control of Yellow Rust in Barley

<u>Leaders</u>: Eng. Vidal Velazco, Eng. Alberto Cordova, Dr. W. Brown and Dr. Thomas C. Stilwell.

<u>Justification</u>: The recent appearance of yellow rust fungus disease threatens a large part of Bolivia's barley production. This experiment is needed to verify the most profitable combination of chemical control practices for this disease.

<u>Objectives</u>: (1) identify the practices or combination of practices most effective for the control of yellow rust in barley under farmers conditions, (2) evaluate the economic returns of these practices for control of yellow rust under farmers conditions, and (3) develop an agronomic recommendation for the control of yellow rust for barley production by farmers.

<u>Status</u>: Because of unfavorable weather and political conditions, this experiment was planted only in Plano Base (Tiraque) and two locations in Totora. Because of severe drought in Totora, there was little infection of yellow rust and no fungicide applications were made. Only the experiment in Tiraque is reported here.

Results: Tiraque

Seed treatment with Baytan gave no differences in yield of grain or straw but did slightly reduce infection in early stages and gave a slight increase in seed test weight, compared with no seed treatment. Increased rates of application of Bayleton resulted in increased grain, straw yields and grain test weight. The increase in grain yield and test weight occurred when two applications of Bayleton were made. The amount of infection of the leaf and grain head near harvest time was reduced primarily by increased rates of Bayleton.

A summary of the economic marginal returns analysis is shown below:

Treatment	Grain T/ha	Straw T/ha	Var. Cost $b/ha	Net Ben $b/ha	M I NI	M I VC	M R Ret.
FP + 2 aplic. Bayleton 500 gm/ha	1.45	2.28	1806	3038	213	606	35%
FP + 2 aplic. Bayleton 250 gm/ha	1.25	1.75	1200	2825	794	1200	66%
Farmers Practice (FP)	0.61	0.95	0	2031	-	-	

The economic analysis indicates that a minimum rate of 250 gm Bayleton/ha may be profitable if two applications are made. Revision of other experimental results indicate that two applications of 250 gm each is a safe recommendation. Recognizing that this is only one experiment in one location in one year, the very tentative recommendation would be to make 2 applications of Bayleton each being either 250 or 500 gm/ha of commercial product.

E.2.4. **Project:** SI-I-C-2-g Priorities of Production research for Barley

Leaders: Eng. Alberto Cordova, Eng. Vidal Velazco R. and Dr. Thomas C. Stilwell

Justification: At present, there are no experimental data to establish priorities in the research program of barley. This experiment is designed to supply this data.

Objectives: (1) identify practices or combinations of practices which are critical in the production of barley under farmers conditions, and (2) establish the ranking of these critical factors.

Status: Because of unfavorable weather and political conditions, this experiment was planted in only three locations: Plano Base (Tiraque) and two additional locations in Totora. The two locations in Totora suffered severe drought and were not harvested.

Results: Tiraque
This experiment showed a severe infection of barley yellow rust. In general, the variety Promesa yielded more grain and straw, had a higher test weight and showed greater tolerance to yellow rust than the criollo. The application of Sencor for weed control resulted in slightly higher grain yields. The application of fungicide (Bayleton) resulted in higher grain yield, better test weight and less yellow rust than no application. The combination of Promesa variety plus application of Bayleton resulted in higher grain yields and test weight than other combinations of these factors. Seed treatment with Baytan did not affect yield.

A partial economic analysis of these data showed the following results:

Treatment	Grain T/ha	Straw T/ha	Var. cost $b/ha	Net benefit $b/ha
FP + Promesa + Bayleton	2.95	4.55	1130	11613
FP + Promesa	1.75	1.90	227	6773
Farmers Practice (FP)	0.85	1.90	0	3234

Using the results of this experiment combined with experience in other experiments, the following factors were determined to have priority in barley production research in Tiraque:

1. Variety - use of Promesa variety.
2. Fungicide - application of Bayleton to control yellow rust in Promesa.

1.3. Summary of Oats Production Experiments

Tiraque: Possible priorities for oats forage production research are variety and weed control.

Possible priorities for oats grain production research are also use of the variety Litoral plus weed control.

The use of either the variety Litoral or Texas resulted in higher economic profits than the Criollo.

Colomi: With good soil fertility and adequate water, few improvements are needed in oats grain or forage production.

Under normal soil fertility and water supply possible priorities for oats grain production research are the use of the variety Litoral with weed control. A possible priority for oats forage production research is use of the variety Litoral.

The best economic returns for oats grain production came from the combination of the variety Litoral planted at 60-80 Kg/ha.

E.3.1. Project: SF-I-Av-2-a Priorities of Production Research for Oats

Leaders: Eng. Alberto Cordova and Dr. Thomas C. Stilwell with Eng. Vidal Velasco collaborating.

Justification: As of this date, there is no experimental data available to establish priorities for research in the oats research program. This experiment is designed to supply this data.

Objectives: (1) identify the practices or combinations of practices most critical in the production of oats forage and grain under farmers conditions, and (2) determine the ranking of these critical practices.

Status: A total of three experiments were planted and harvested: Paico Mayo (Tiraque), Toncoli and Pucara (Colomi).

Results: Tiraque
This experiment had a normal to heavy infestation of Spergula arvensis. Both grain and forage were harvested in this experiment. The results for the forage harvest are given first.

The use of the variety Litoral gave higher forage yield than the criollo. The use of fertilizer resulted in higher forage yield than no fertilizer. Control of weeds with Sencor also gave higher yields, especially when combined with fertilizer application. The partial economic analysis of the data follows:

Treatment	Yield T/ha	Var. Cost $b/ha	Net Benefit $b/ha
FP + Litoral	1.85	320	1030
Farmers Practice	0.15	0	110

The results indicate that only the use of the variety Litoral gave obvious economic benefits. Both fertilizer and weed control gave less profit. Only weed control could possibly be modified to give positive results. Based on these data, the priorities for production research for oats forage in Tiraque should be:

1. Variety and 2. Weed control

The results of the grain harvest showed that the variety Litoral yielded significantly more grain than the criollo, especially when combined with weed control by Sencor. The variety Litoral yielded more grain than criollo without fertilizer. Weed control with Sencor in general resulted in higher grain yields. The partial economic analysis of the data follows:

Treatment	Yield T/ha	Var. Cost $b/ha	Net Benefit $b/ha
FP + Litoral + Sencor	1.14	517	832
FP + Litoral	0.76	0	555
Farmers Practice	0.39	0	285

This analysis showed that fertilizer did not give an increase in economic net benefits. Only the use of Litoral or Litoral + Sencor gave greater economic returns than the farmers practice. Based on this analysis, the priorities for production research for oats grain in Tiraque should be:

1. Variety 2. Variety + weed control.

This experiment should be repeated in more locations during the next planting season, and fertilizer should be eliminated as a factor. Sencor should be replaced with Tribunil since its initial cost is lower and may give more positive economic benefits.

Results: Colomi

The results of the two experiments in Colomi are so different that separate analysis is required. In Pucara, there were no significant differences in forage yields among treatments and so the cheapest treatment (farmers practice) was the best. The lack of yield response to the treatments was probably due to the obviously high fertility and soil moisture of the location.

The experiment location in Toncoli was less fertile and showed more treatment differences. There were significant differences among varieties in grain yields with Litoral yielding more than Criollo. Weed control with Sencor gave higher yields than no control, and the combination of weed control with Litoral variety gave higher grain yields than other combinations of these factors.

The following economic analysis was done for grain yield:

Treatment	Yield T/ha	Var. Cost $b/ha	Net Benefit $b/ha
FP + Litoral + Sencor	3.07	905	1336
FP + Litoral	1.95	320	1103
Farmers Practice (FP)	0.30	0	219

This analysis indicates that for increasing grain yields under farmer conditions, the most important factor is use of the variety Litoral followed by weed control with Sencor. Use of fertilizer is not economically possible. For forage production, the priorities change a bit.

The criollo variety yielded significantly more oats forage than Litoral, and weed control with Sencor gave higher yields than no control. However, when the yield of both oats and weeds (total forage yield) is considered, the variety differences disappear and weed control results in less total forage yield. The partial economic analysis for total forage yield follows:

Treatment	Yield T/ha	Var. Cost $b/ha	Net Benefit $b/ha
Farmers Practice	7.63	0	3205
FP + Litoral	7.85	320	2977
FP + Fert.	7.87	1135	2170
FP + Weed Control	6.33	585	2074
FP + Litoral + Weed control	5.81	1455	985

Economically no treatment was better than the farmers practice. The use of the variety Litoral was close to the farmers net benefits and results from the Variety X Density experiment suggest that it could give higher forage yields than the criollo with different planting rates. Therefore, the use of the variety Litoral can be listed as a tentative priority only if not combined with weed control. The use of weed control and fertilizer offer little or no hope for improving total forage yields.

For the Colomi area, the following priorities are indicated for grain production only:

1. Use of variety Litoral.
2. Weed control with Sencor in plantings of Litoral.

The following priorities are indicated for total forage production (oats + weeds)

1. Possible use of variety Litoral

For plantings of oats having the dual purpose of grain and forage production, only use of the variety Litoral shows promise of increasing profits for both grain and forage. This experiment should be repeated in more locations during the next planting season.

E.3.2. Project: SF-I-Av-2-b Variety x Plant Density Trial for Oats

Leaders: Dr. Thomas C. Stilwell and Eng. Alberto Cordova

Justification: Because of the lack of data about the interaction between variety and seeding rates, it is not possible to make a confident recommendation for these factors under farmers conditions. This experiment is designed to supply this data.

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

Status: Because of unfavorable weather and political conditions, only three experiments were planted: Toncoli and Chulpani Chico (Colomi) and Paico Mayo (Tiraque). The experiment in Chulpani Chico was lost due to very large soil fertility differences within the area of the experiment. The two remaining experiments were located in different recommendation domains and the analyses were done separately.

Results: Colomi
This experiment had a normal weed infestation and the highest densities appeared to represent local farmer practices. For grain production, the optimum planting density was between 60-100 Kg/ha. Both varieties Texas and Litoral yielded more grain than the Criollo, but there were no statistical differences among these two varieties. The criollo variety was significantly later maturing than either Texas or Litoral. A partial economic analysis of the grain production data follows:

Treatment	Yield T/ha	Var. Cost $b/ha	Net Benefit $b/ha	M I V C	M I N B	M R Return
Den 3 + Litoral	4.30	128	3007	64	574	897%
Den 2 + Litoral	3.42	64	2433	64	263	411%
Den 1 + Texas	2.97	0	2165	-	-	

This analysis indicates that the best economic returns for grain production under farmers conditions result from using the variety Litoral planted at 60-80 Kg/ha.

Analysis of the total forage yield (oats + weeds) showed no significant differences among varieties or planting rates. There was a trend of increasing yield with increasing planting rate but this could not be statistically confirmed. In this case,we would chose the cheapest treatment (lowest planting density) as the preferred treatment.

Because these data represent only one experiment done in one location in one year,no recommendations can be made at this time. This experiment should be planted at several locations during the next planting season to give a set of data which better represents the variability of the area.

Results: Tiraque
This experiment suffered very heavy weed infestation and at one point was considered lost. The forage yields are reported first. In general the Criollo variety was later maturing than either Litoral or Texas. The yield of oats forage and total forage (oats + weeds) were significantly lower for criollo than for either Litoral or Texas. In general,the yields were quite low and represent results under worse than average farmers conditions. The partial economic analysis follows:

Treatment	Yield T/ha	Var. Cost $b/ha	Net Benefit $b/ha	M I V C	M I N B	M R R
Den 2 + Texas	2.80	64	1112	64	612	10[illegible]%
Den 1 + Litoral	1.19	0	500	-	-	-

In this experiment,the use of either variety Texas or Litoral gave greater profit than the criollo.

The grain harvest from this experiment was quite low (average 600 Kg/ha). Statistical analysis showed no significant differences among the treatments. With these results,the economic analysis can be bypassed and the cheapest treatment selected. In this case, this would be any variety at the minimum planting density (40 Kg/ha).

Because these data are from only one experiment in one location in one year, no recommendation can be made. However,it does demonstrate that under worse than average conditions,improvements can be made on local farmer practices in Tiraque. This experiment should be repeated in more locations during the next planting season.

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E.4. Project SB-I-(Th-C-Av)-4-b Agro-Economic Factors of Small Grain production

Leaders: Dr. Thomas Stilwell and Eng. René Gomez Q. with Eng. Gerardo Ramirez and Dr. Edgardo Moscardi collaborating.

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

Objectives: (1) describe the problems of farmers in the production of wheat, barley and oats for the purpose of establishing the priorities of research in these crops; (2) define farmer practices so that on-farm experiments can be done in a similar manner; (3) estimate costs of production to be used in estimating profitability of new practices; and (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 survey field work, data tabulation and preliminary analysis has been completed. A data summary has been published as a special report of San Benito (Resúmen de Datos de la Encuesta de Factores de Producción en Trigo, Cebada y Avena).

Results: A total of 324 farmers were formally interviewed. These were distributed among 5 valleys: Valle Alto, Sacaba, Colomi, Tiraque and Totora. The survey included data divided into the following general sections: Basic descriptive information, Planting, Fertilizer use, Weed Control, Insect Control, Disease Control, Harvest, Storage and Marketing, Miscellaneous.

There are too many detailed results to be presented here and only a few will be mentioned. In the case of all three crops, it was found that there is a tremendous lack of technical information. This has given increased importance to the distribution of printed extension sheets, pamphlets, bulletins, etc. In the case of barley, it was confirmed that yellow rust is a major problem. Oats producers were found to use the crop primarily for forage with little grain being produced. The oats program of San Benito has subsequently initiated a dual testing program where each oats experiment in farmers fields is evaluated for both grain and forage production. All on-farm trials are now planted in fields having the predominant crop rotation in that area. Since no farmers were found who planted in rows, all on-farm agronomic experiments are now broadcast planted. The economic data collected has been used in analysis of agronomic experiments and the results agree with farmer practices described in the survey.

Further analysis and publication of specific results are in progress.

E.5. Project: General Analysis of Experimental Results.

Leaders: Dr. Thomas C. Stilwell

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

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

Status: To facilitate IBTA computer work, an arrangement was made for CID-USAID to donate two computer terminals to IBTA. In turn, IBTA then presented this equipment to UBMSS as payment in advance for computer services. This arrangement will permit about two years of free computer use by IBTA after which services will be provided at nomimal rates.

As of this writing, one set of programs has been completed for analysis of Randomized Complete Block experiments. A computer programmer (Sr. Antonio Stambuk) has been contracted by CID to write additional programs for all common experimental designs. The programming is being done on the UBMSS computer under the IBTA-UBMSS agreement. Because of irregular computer malfunctions and illness of Mr. Stambuk, the development of these programs has been slow. Because of recent political problems, the university has been closed and all programming work has stopped. Work will resume when the UBMSS computer center reopens.

E.6. Project: Survey of Systems of Crop Production

Leaders: Eng. Julio Vargas and Eng. José Amurrio with Dr. Thomas C. Stilwell, Dr. Edgardo Moscardi and Dr. Gonzalo Avila collaborating.

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

Objectives: (1) define the principal systems of production being used by small farmers in Valle Alto, (2) describe in detail representative systems of production, and (3) form priorities for research programs of UMSS faculty of agronomy on the basis of these results.

Status: Because of delays in the planning stages, the actual field work was not started till May. National elections and political instability seriously disrupted field work. Field work still continues with two student supervisors and two becarios.

E.7. Project: Seminar - Methodology for On-Farm Production Research

Leaders: Eng. Julio Rea, Dr. Thomas C. Stilwell and Dr. Edgardo Moscardi.

Justification: Many IBTA experiment stations maintain or are starting active on-farm production research programs. There are very few personnel currently trained to conduct and evaluate experiments done in farmers fields. This seminar is designed to provide a brief exposure to the methodology involved in successful on-farm experiments.

Objectives: (1) describe the methods and uses of classifications of farm systems, (2) describe the types of experiments appropriate to on-farm testing programs, (3) observe an on-farm testing program in the field, (4) describe the logic and interpretation of statistical and economic results, and (5) describe the presentation and dissemination of experimental results.

Status: The seminar took place on May 5-9, 1980, with most presentations being given in the auditorium of Banco Agrícola in Cochabamba. Approximately 30-40 people participated in each day including IBTA personnel, students and representatives of various local agencies and businesses interested in promoting agricultural research. The major topics covered were: Classification of Agricultural systems, Recommendation Domains, Definition of Production Systems and Information Collection, Experimental Design, Experimental Variables, Interpretation of Statistical Analyses, Interpretation of Economic Analyses, Reports and Field Days. One day was spent visiting on-farm oats experiments in Colomi to demonstrate actual production research.

E.8. Project: UBMSS Student Seminar

Leaders: Eng. José Amurrio with Dr. Thomas C. Stilwell and Dr. William M. Brown collaborating.

Justification: A large amount of applied research is being accomplished through various beca programs within the UBMSS faculty of agronomy. This seminar will present these results and show cause for increased support of such programs.

Objectives: (1) demonstrate the volume and utility of research currently being done under becas at UBMSS Facultad de Agronomía, and (2) demonstrate the catalytic role of UBMSS in the beca programs of research.

Status: The seminar took place on Feb. 28, 1980 at the Facultad de Agronomía, UBMSS. A total of 26 students presented results of their thesis work. Each student presented a half page abstract which was reproduced and copies given to persons in attendance. Attendance in all sessions ranged from 100-200 throughout the day.

General comments were quite favorable and it is planned repeat this again next year.

E.9. Project: Publication of Research Results

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

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

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

Status: At the present, approximately 18 titles have been prepared by the staff of San Benito in the form of leaflets (hojas divulgativas). Most have been printed at least once and a second printing is being started. Emphasis has been placed on materials with very narrow subject matter content appropriate to solve a very specific farmer problem.

Production time for a single leaflet is approximately two weeks from the delivery of a final draft to delivery of the completed copies. Cost of production is approximately $b. 600.- per 1000 copies. As of this date, the following titles have been reprinted:

Hoja Divulgativa N° 4:	Control Químico de la Roya Amarilla en Cebada, 3000 copies
Hoja Divulgativa N° 7:	Ideas para Mejor Uso de Pesticidas, 1000 copies
Hoja Divulgativa N° 8:	Cómo Tomar Muestras de Suelos para un Análisis Químico, 500 copies

E.10. Publications, Papers, Reports, etc.

During the past year, several reports, papers or publications were prepared, printed and distributed. These included:

Resumen de Datos de la Encuesta de Factores de Producción en Trigo, Cebada y Avena. 1980. 114 p. Thomas C. Stilwell, René Gómez. Technical Report, E.E. San Benito.

Control Químico de la Roya Amarilla en Cebada. Nov. 1979. Hoja Divulgativa N° 4, Vidal Velazco, Thomas C. Stilwell. Estación Experimental San Benito.

La Roya Amarilla en Cebada. Nov. 1979, Hoja Divulgativa N° 3 Vidal Velazco, Thomas C. Stilwell. Estación Experimental San Benito.

Determinación de Prioridades para la Investigación, April 1980 44 p. Thomas C. Stilwell, Paper presented in Symposium on Methodology for On-Farm Research

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Sistemas de Investigación Aplicada. Oct. 1979. 10 p.
Thomas C. Stilwell, Paper presented in Symposium on Methodology for on-Farm Research

F.11. Student Advisees

Roberto Bernal

"Quantitative Determination of Recommendation Domains for Wheat in Valle Alto and Pilancho". At the termination of the Beca, Roberto had started a rough draft of his thesis. He is presently working for CORDEPO and has not progressed in his thesis.

Orlando Claros

"Correlation Between Risk Perception by Farmers and Adoption of New Practices for Wheat in Valle Alto, Pilancho, and Sacaba" Orlando is presently a co-supervisor of the UBMSS Systems of Production Survey. He now has a thesis in draft form. Review and revision must await reopening of the university.

Oscar Omonte

"Correlation Between Agro-Economic Factors and Technology adopted by Wheat Farmers" Oscar is presently a co-supervisor of the UBMSS Systems of Production Survey. He now has a thesis in draft form. Review and revision must await reopening of the university.

Gregorio Quilo

"Determination of Factors that influence the Date of Planting for Wheat and Barley". At the termination of the beca, Gregorio had not started his rough draft nor completed analysis of data. There has been no progress since March.

Freddy Corrales

"Sources and levels of Organic fertilization for Drumhead Cabbage (*Brassica oleracea*)".

Esteban Antezana

"Effects of Moisture levels and Fertilization on Onion (*Allium cepa*) Var. Arequipeña".

Luis Pedrazas

"Effects of Different Levels of Soil Moisture on Maiz (*Zea mays*) Grown for Sweet Corn Consumption in the Valle Central of Cochabamba".

The above three students had originally prepared projects and materials for wheat experiments in Santa Cruz. At the last minute, the Santa Cruz wheat program was cancelled due to lack of funds. These students subsequently changed to horticulture projects and are now involved in the field work.

Emilio Ormachea

"Factors influencing wheat production in Santa Cruz". Emilio is currently involved in background research leading up to field work. He is being actively supervised by Simon Maxwell, economist in the British Mission in Santa Cruz.

Mario Altamirano

"Factors which Influence the Election of Wheat Varieties in Valle Alto in Cochabamba". As of this writing, Mario has completed the field work of the survey and is in the process of data screening and analysis. This thesis is part of the UMSS Systems of Production survey.

Alejandro Merida

"Factors which Influence the Election of Maize Varieties in the System of Production in Valle Alto of Cochabamba". Similar to Mario Altamirano has completed the field work of the survey and is in the process of data screening and analysis.

F. ENTOMOLOGY, PEST CONTROL, AND NATIONAL MUSEUM

by

Dr. Donald R. Foster - Entomologist
Nelson Reyes - IBTA

F.1. Insect Control Studies - Levels of Artificial Infestation, Damage, and Chemical Control of Tibraca Limbatriventris - Dr. Donald Foster-CID Entomologist-agronomist. Nelson Reyes-IBTA Entomologist.
This section involves two studies. In the first study Tibraca Limbatriventris (Hemiptera: Pentatomidae) was caged over rice plants in the field to determine if they could effect yield. In the second study, insecticides were tested for their ability to control the grasshopper population in rice.

F.1.1. SECTION I. Levels of artificial infestation and damages by Tibraca Limbatriventris

Studies in Argentina have indicated that T. limbatriventris can cause considerable loss of yield in rice by injecting a toxic saliva into the base of stems and killing them. The purpose of this study was to determine if this insect actually can cause yield losses in the rice growing region near Santa Cruz and if so, what population causes economic losses. To determine the amount of yield reduction, three population levels of insects were placed in rice plots at the Portachuelo sub-station and enclosed in screen cages which were 1 m long, 1 m high and 1/2 m wide. Insect populations were 4, 10 and 20 per m^2 or 2, 5, and 10 per cage. Test plots contained no insects. The treatments were replicated 10 times and placed in a randomized complete block design. Insect numbers were checked weekly to remove eggs and replace dead adults. Plots were harvested on the same day and yield was converted to 14% moisture.

F.1.1.1. Results are given in Tables 1 - 8. Small numbers of insects can cause significant decline in yields. The economics of when it will pay the farmer to spray for control of this insect based on this yield data, have not been completed at this time. Other data

TABLE 1. YIELD OF RICE IN KG/HA AT 14% MOISTURE

Treatment	Replications										Total	Ave. ± S
	I	II	III	IV	V	VI	VII	VIII	IX	X		
0 insects/m^2	1790	2560	2410	2660	2020	3260	4180	2180	1590	1800	24450	2445.0±786.1c
4 insects/m^2	960	1172	1110	1270	1700	3580	2620	2520	2240	1240	18412	1841.2±863.8b
10 insects/m^2	790	560	1166	1360	480	1200	1300	800	1370	320	9346	934.6±393.2a
20 insects/m^2	604	460	1260	1060	700	546	600	290	400	230	6150	615.0±324.9a

$S\bar{x} = 201.53$ $F = 17.29^{**}$

TABLE 2. TOTAL NUMBER OF TILLERS PER CAGE PLOT OF 0.5 m^2. ARTIFICIAL INFESTATION TRIAL OF THE STINK BUG. "*TIBRACA LIMBATIVENTRIS*".

Treatment	Replications										Total	Ave. ± S
	I	II	III	IV	V	VI	VII	VIII	IX	X		
0 insects/m^2	172	138	160	167	193	183	205	179	112	181	1690	169.00 ± 27.10
4 insects/m^2	235	205	141	175	171	132	189	163	213	164	1788	178.80 ± [illegible]2.11
10 insects/m^2	216	202	142	157	104	151	116	154	191	182	1615	161.50 ± 36.28
20 insects/m^2	196	206	191	108	211	154	105	192	136	214	1713	171.30 ± 42.13

$S\bar{x} = 11.02$ $F = 0.42NS$

TABLE 3. TOTAL NUMBER OF INFESTED TILLERS WHERE THE BUG <u>TIBRACA</u> <u>LIMBATIVENTRIS</u> ATTACKS IN 0.5 m^2 OF LAND.

Treatments	Replications I	II	III	IV	V	VI	VII	VIII	IX	X	Total	Ave. ± S
0 insects/m^2	0	0	1	29	35	33	2	2	1	1	104	10.4 ± 15.2a
4 insects/m^2	23	27	55	99	34	14	52	34	47	31	416	41.6 ± 23.9a
10 insects/m^2	154	152	38	98	54	38	37	53	94	78	796	79.6 ± 44.6b
20 insects/m^2	34	140	139	63	151	73	17	137	98	162	1019	101.9 ± 51.6b

$S\bar{x} = 11.69$ $F = 12.02^{**}$

TABLE 4. TOTAL NUMBER OF PANICLES PER CAGE IN 0.5 m^2 - AN ARTIFICIAL INFESTATION TRIAL OF *TIBRACA LIMBATIVENTRIS*.

Treatments	Replications										Total	Ave. ± S
	I	II	III	IV	V	VI	VII	VIII	IX	X		
0 insects/m^2	153	123	140	119	125	147	173	114	78	92	1264	126.4 ± 28.4a
4 insects/m^2	149	150	95	107	139	134	157	103	134	124	1292	129.2 ± 21.4a
10 insects/m^2	92	159	136	96	91	96	101	72	107	57	1007	100.7 ± 29.1b
20 insects/m^2	65	111	95	93	107	89	75	46	33	46	760	76.0 ± 27.4c

$S\bar{x} = 8.46$ $F = 8.69^{**}$

TABLE 5. TOTAL NUMBER OF EMERGED STEMS PER CAGE (0.5 m^2)

Treatment	Replications										Total	Ave. ± S
	I	II	III	IV	V	VI	VII	VIII	IX	X		
0 insects/m^2	8	0	10	5	10	10	0	0	1	3	57	5.7 ± 4.5a
4 insects/m^2	25	12	12	9	22	8	9	7	35	22	161	16.1 ± 9.3b
10 insects/m^2	26	0	11	13	12	8	30	13	14	22	149	14.9 ± 8.8b
20 insects/m^2	28	28	22	5	32	41	24	28	13	25	246	24.6 ± 9.9c

$S\bar{x} = 2.66$ $F = 9.37^{**}$

TABLE 6. AVERAGE HEIGHT IN CM OF THE DAMAGED CAUSED BY RICE STINK BUG (<u>TIBRACA LIMBATIVENTRIS</u>) IN 0.5 m^2

Treatment	Replications										Total	Ave. ± S
	I	II	III	IV	V	VI	VII	VIII	IX	X		
0 insects/m^2	0	0	0	2.3	3.0	9.6	0	0	0	0	14.9	1.5±3.1a
4 insects/m^2	12.3	21.3	18.0	20.0	18.7	15.7	10.0	32.7	26.0	20.0	194.7	19.5±6.5c
10 insects/m^2	16.7	8.7	11.0	9.0	9.0	21.0	16.0	21.0	16.7	21.7	145.8	14.6±5.3b
20 insects/m^2	22.0	21.0	10.0	14.6	13.3	5.0	13.0	15.7	19.7	6.0	140.3	19.0±5.9b

$S\bar{x}$ = 1.69 F = 20.90**

TABLE 7. (PLANT LENGTH) HEIGHT IN CM OF RICE PLANTS

Treatments	Replications										Total	Ave. ± S
	I	II	III	IV	V	VI	VII	VIII	IX	X		
0 insects/m^2	74.0	75.7	65.7	76.0	59.4	72.0	81.0	83.6	66.7	74.0	728.1	72.81 ± 7.25
4 insects/m^2	56.4	72.0	75.4	71.4	53.7	75.4	64.0	72.0	75.0	66.0	681.3	68.21 ± 7.89
10 insects/m^2	69.0	73.0	74.7	73.7	66.0	76.7	77.5	73.4	73.7	73.7	731.4	73.2 ± 3.39
20 insects/m^2	75.7	79.7	83.4	75.7	55.0	75.4	76.4	69.4	72.7	71.7	734.7	73.5 ± 7.61

$S\bar{x} = 2.15$ $F = 1.39NS$

TABLE 8. (PANICLE LENGTH) LENGTH OF THE PANICLE EXPRESSED IN CM.

Treatment	Replications										Total	Ave. ± S	
	I	II	III	IV	V	VI	VII	VIII	IX	X			
0 insects/m^2	17.0	18.7	17.4	16.7	18.4	18.4	19.0	18.0	19.0	19.0	181.6	18.2 ±	0.86
4 insects/m^2	14.5	18.4	17.4	19.7	14.4	19.7	17.4	19.4	19.0	18.0	177.9	17.8 ±	1.95
10 insects/m^2	17.0	18.7	19.0	18.4	19.0	18.4	19.7	19.0	18.4	19.7	187.3	18.7 ±	0.78
20 insects/m^2	18.4	18.0	19.7	18.0	17.4	17.7	17.0	19.4	18.7	18.7	183.00	18.3 ±	

$F = 1.03NS$

collected from the study shows that attack by different populations of T. limbatriventris do not effect the number of tillers developed by the plants (Table 2) as might be expected if the plant were compensating for damage by this insect. The number of infested stems does differ significantly with the pest population (Table 3). Plots with higher pest populations had significantly fewer flowering heads (Table 4) and higher numbers of "espigas rebrotes" (Table 5). The average height at which feeding damage could be found on the stems varied significantly with the population density (Table 6). In 3 of the control plots, a very small amount of feeding was observed at a very low level. With higher populations feeding damage can be observed higher on the stem. Two factors found not to differ with intensity of attack were plant height (Table 7) and length of the panicle (Table 8). An attempt was made to count natural populations in farmers fields near the Portachuelo Sub-station, but each farm visited had already applied an insecticide (Endrin or Nuvacron) to control the population of T. limbatriventris. Some rice was only 10 cm tall, but no fields could be found that were insecticide free.

F.1.2. Based on the above data it definitely appears that insecticide applications for control of T. limbatriventris are justified in Bolivia, but many questions remain to be answered. The nature of the population growth is not known. It may be possible that initially high population will be brought down to low, non-economic, levels by beneficial insects and the crop will have time to compensate for early damage. The biology of the pest, is still poorly understood. Considering the above data, it is recommended that this study be repeated for two more years to insure that the data is reliable under different weather patterns. It is also recommended that an intensive study be initiated on the seasonal population trends of this insect so that economically damaging populations can be predicted with some degree of accuracy and insecticides can be applied at the proper times. Studies begun this year on the biology of this pest should continue so that the life cycle will be well understood.

F.1.3. SECTION II. Chemical control of insects on rice

The second part of this section of rice studies examined the effect of 9 chemicals on the control of grasshopper populations in rice at Portachuelo. Grasshoppers often occur on rice in numbers large enough to cause severe foliage loss. To determine if infestation at Portachuelo were economically damaging, a study was conducted using nine different insecticides commonly available on the local market.

Plots were planted at the Portachuelo Sub-Station with the variety CICA-6. Before application, the number of grasshoppers per m^2 were counted in each plot and on the following day insecticides were applied to the test plots. Plots were arranged in the randomized complete block design. Counts of grasshoppers per m^2 were made at 3 days, 7 days, and 12 days after insecticide application and plots were harvested when the plants matured. Yields were determined by removing the center portion of each plot and yields were adjusted to 14% moisture.

Analysis of Variance was used to determine if significant differences in yield or grasshopper population were detected.

There were no significant differences in the population of grasshoppers in the plots at the times counts were made (Tables 9, 10, 11 and 12) and the populations were quite stable during this period. Yields (Table 13) did show significant differences. Plots sprayed with Nuvacron, Dipterex, Sevin, Belmark and Endrin had significantly higher yields than the control plots (Testigo). These differences in yield were probably due to the reduction of other pest populations which were not counted and apparently the grasshopper population of between 0.5 and 1.0 grasshoppers per m^2 is not economically damaging to rice. While it is definitely recommended that studies on insecticide control of rice pests be continued, it is not recommended that these studies be carried out on such low population as those in the present study.

TABLE 9. CHEMICAL CONTROL OF INSECTS ON RICE. 24 HOURS LECTURE BEFORE APPLICATION.

Treatments	Average Number/m^2 of grasshoppers					
	Replications					
	I	II	III	IV	TOTAL	$\bar{X}$
Nuvacron 40	0.42	0.42	1.42	0.67	2.93	0.73
Ekatin 25	0.67	0.42	1.00	0.18	2.27	0.57
Thionex 35	0.67	0.75	0.58	0.75	2.75	0.69
Dipterex 80	0.50	0.92	0.67	1.00	3.09	0.77
Sevin 80	0.67	0.75	1.08	1.08	3.58	0.89
Belmark 30	0.58	0.58	1.08	1.00	3.24	0.81
Dimecron 50	0.58	0.42	0.48	0.42	1.84	0.46
Parathion 25	1.08	0.75	1.08	0.58	3.49	0.87
Endrin 19.5	0.42	1.08	1.08	1.00	3.58	0.89
Testigo	0.58	0.92	0.67	0.67	2.84	0.71

C.V. = 33.90% M.S. Treatments = 629.77 NS

TABLE 10. CHEMICAL CONTROL OF INSECTS ON RICE. 3 DAYS LECTURE AFTER APPLICATION.

	Average Number/m² of grasshoppers					
	Replications					
Treatment	I	II	III	IV	TOTAL	$\bar{X}$
Nuvacron 40	0.25	0.33	0.67	0.42	1.67	0.42
Ekatin 25	0.17	0.67	0.5	0.17	1.51	0.38
Thionex 35	0.42	1.33	0.25	0.5	2.50	0.63
Dipterex 80	0.92	0.58	0.17	1.00	2.67	0.67
Sevin 80	0.33	0.75	0.67	1.17	2.92	0.73
Belmark 30	0.25	0.5	0.75	1.25	2.75	0.69
Dimecron 30	0.75	0.42	1.17	0.42	2.76	0.69
Parathion 25	0.5	0.75	1.42	1.42	4.09	1.02
Endrin 19.5	0.33	0.42	0.75	0.83	2.33	0.58
Testigo	0.75	0.42	0.92	1.33	3.42	0.85

C.V. = 51.47%   M.S. Treatments = 1173.55 NS

TABLE 11. CHEMICAL CONTROL OF INSECTS ON RICE. 7 DAYS LECTURE AFTER APPLICATION

	Average number/m² of grasshoppers					
	Replications					
Treatments	I	II	III	IV	TOTAL	$\bar{X}$
Nuvacron 40	0.17	0.67	1.17	0.55	2.59	0.65
Ekatin 25	0.5	1.00	0.83	1.33	3.66	0.91
Thionex 35	0.17	0.67	1.08	1.25	3.17	0.79
Dipterex 80	1.17	0.92	1.17	0.42	3.68	0.92
Sevin 80	0.33	0.75	1.25	1.17	3.50	0.88
Belmark 30	0.42	1.33	1.08	0.75	3.58	0.89
Dimecron 50	0.33	0.75	0.83	0.58	2.49	0.62
Parathion 25	0.58	0.92	0.58	1.17	3.25	0.81
Endrin 19.5	0.83	1.25	1.33	2.17	5.58	1.39
Testigo	0.67	0.5	1.08	1.17	3.42	0.85

C.V. = 36.23% M.S. Treatments = 1000.70 NS

TABLE 12. CHEMICAL CONTROL OF INSECTS ON RICE. 12 DAYS LECTURE AFTER APPLICATION.

Treatments	Average Number/m^2 of grasshoppers					
	Replications					
	I	II	III	IV	TOTAL	$\bar{X}$
Nuvacron 40	0.5	0.33	1.08	0.33	2.24	0.56
Ekatin 25	0.5	0.5	0.5	0.33	1.83	0.46
Thionex 35	0.33	2.08	2.08	0.25	4.74	1.19
Dipterex 80	0.58	1.75	0.92	0.33	3.58	0.89
Sevin 80	0.33	0.5	0.42	1.08	2.33	0.58
Belmark 30	0.5	1.08	0.92	1.75	4.25	1.06
Dimecron 50	0.25	0.83	0.58	0.42	2.08	0.52
Parathion 25	0.42	0.58	1.83	0.42	3.25	0.81
Endrin 19.5	0.33	0.75	0.83	0.58	2.49	0.62
Testigo	0.25	0.42	1.5	1.17	3.34	0.83

C.V. = 63.78% M.S. Treatments = 2308.79 NS

TABLE 13. CHEMICAL CONTROL OF INSECTS ON RICE (PORTACHUELO), YIELD IN KG/HA OF CICA-6 VARIETY. ADJUSTED AT 14% HUMIDITY.

Treatments	I	II	III	IV	$\bar{X}$ kg/ha		ma/ha
Nuvacron 40	6296	4748	5589	6033	5667	a	0.75 E/ha
Ekatin 25	5933	5226	5533	4415	5277	ab	1.0 E/ha
Thionex 35	4624	4224	4289	4748	4471	bc	1.5 E/ha
Dipterex 80	5030	5694	5343	5754	5455	a	0.4 Kg/ha
Sevin 80	5530	5306	5063	5461	5340	a	1.5 Kg/ha
Belmark 30	6356	5289	4413	5706	5441	a	0.2 E/ha
Dimecron 50	5496	5656	5502	4335	5247	ab	1.0 E/ha
Parathion 25	4436	5035	4102	5583	4789	abc	1.0 Kg/ha
Endrin 19.5	5819	5533	5524	5167	5511	a	1.0 E/ha
Testigo	4178	4569	3757	3783	4072	c	----------

F = 3.93*

F.2. Soy Insects

Insects were sampled from soybeans at the Saavedra Experiment Station using a standard 15" sweep net. Three replications of 100 sweeps each were made on each sampling date. The insects were placed in alcohol and returned to the laboratory. Insects were separated into their orders and counted (Table 14). At the present time, the insects are locked in the university at Santa Cruz. When work resumes there the insects will be identified to species and classified as pest, beneficial or of non-effect in the crop and the population of each of these will be analyzed statistically. The data for the various orders shows some fluctuations. It is not known if this represents changes in species composition.

TABLE 14. SOYBEAN CROP - SAAVEDRA SITE

ORDER	8/II/80	22/II/80	18/III/80	10/IV/80
Coleoptera	36.67	15.00	21.67	8.33
Dermaptera	0.00	0.67	0.00	0.00
Diptero	29.00	22.67	15.33	3.67
Himenoptera	6.33	6.00	7.33	5.00
Homoptera	65.67	9.33	23.67	12.33
Hemiptero	188.33	16.00	50.00	10.33
Lepidoptera	4.67	2.33	2.33	0.33
Orthoptera	12.33	2.00	1.33	4.00
Total population	343.00	74.00	121.66	43.99

F.3. Insect Control - Collection and Identification

Donald Foster, CID Entomologist-Agronomist
Nelson Reyes, IBTA Entomologist
Eduardo Zambrana, IBTA Technician

Insects were collected at regular intervals using a sweep net during the growing season at Portachuelo and Saavedra. They were returned to the laboratory and each order present was counted separately. The numbers of each order are given in Tables 15 y 16. These insects were then prepared for identification by mounting them on pens and labeling the specimens. The representatives of homoptera were taken to Ohio State University by Dr. Dwight Delong after his visit here. Some of these have been identified and returned by Dr. Delong (Table 17). The other homoptera have been identified and are ready for return. Insects of the other orders were in the University when it was closed and we have not been able to obtain these specimens for further work. The insects are being photographed as they are identified; when complete, it will be presented as a manual of rice insects.

TABLE 15: MEAN NUMBER OF INSECTS PER 100 SWEEPS IN RICE AT PORTACHUELO BY DATE.

Order	Date				
	11/I/80	8/II/80	22/II/80	13/III/80	10/IV/80
Homoptera	35	93	47	23	3
Hymenoptera	19	10	13	4	5
Coleoptera	58	28	60	40	3
Lepidoptera	0	6	0	13	1
Orthoptera	14	40	48	45	9
Odonata	0	0	0	0	0
Hemiptera	3	12	5	11	1
Dermaptera	0	6	0	13	1
Diptera	14	13	1	4	12
Total population	143	208	174	153	35

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TABLE 16: MEAN NUMBER OF INSECTS PER 100 SWEEPS IN RICE AT SAAVEDRA BY DATE.

Order	Date				
	11/I/80	8/II/80	22/II/80	13/III/80	10/IV/80
Homoptera		90	82	32	4
Hymenoptera		13	5	6	6
Coleoptera		20	47	45	7
Lepidoptera		0	0	15	4
Orthoptera		50	55	40	12
Odomata		0	0	0	0
Hemiptera		10	15	8	1
Dermaptero		7	0	8	0
Diptero		15	6	6	9
Total population		205	210	160	43

TABLE 17: INSECTS (HOMOPTERA) OF RICE IDENTIFIED AND RETURNED BY Dr. DELONG.

Family	Genus & Species
Cercopidae	Thomaspis sp.
Cicadellidae	Plesiomnata mollicella (Fowler)
	Balclutha hebe (Kirk)
	Agallia dorsata Oman
	Stirellus picinus (Berg)
	Dalbulus maidis Del. & Wolc
	Helochara communis Fitch
	Scaphytopius marginalineata (Stal)
	Chlorotettix sp.

F.4. Chemical Control of Rednecked worm (*Stegasta bosquella*, Chambers), other Leaf Feeding, Insects and the Effect on Beneficial in Peanuts

Dr. Donald Foster, CID Entomologist-Agronomist
Nelson Reyes, IBTA Entomologist

F.4.1. Summary

The effect of nine insecticides was studied in the chemical control of the rednecked peanut worm, *Stegasta bosquella* (CH.), other leaf feeding insects and the beneficial fauna. The majority of the chemicals showed immediate effects. That is to say, effectiveness up to the 2 or 3 first days, decreasing its nocious effect on the following days.

Thionex 35, 1.3 l/ha; Parathion 25, 1.18 kg/ha Dipterex 80, 1.08 kg/ha; Methion 48.2, 0.57 l/ha and Sevin 80, 2.24 kg/ha showed the best effect on the pest. All of them as well as Metasystox 25, 0.79 l/ha and Belmark 30, 0.17 l/ha had good control on Anticarsia sp. Loxostege sp., Mocis sp., and Plusia sp. Yields did not show significant differences, obtaining an average of 1731 kg/ha (shelled) which ranged between 1630 and 1828 kg/ha.

F.4.2. Methods and materials

Location: Saavedra Experiment Station.
Experiment design: Randomized blocks with 4 replications.
Plot size: 3.6 x 6.0 m (21.0 m^2).
Seeding date: November 13, 1979.
Spacing: 0.6 m between rows and 0.1 m between plants.
Seed quantity: 100-120 kg/ha.
Seeding: Manual.
Variety: Tainang-Selección 9.
Weed control: One hoeing and one hand weeding.
Disease control: One application of Benlate 0,4 kg/ha.
Fertility, irrigation: None.
Insect control: The insecticides were applied with a Tecnoma manual sprayer of 4 liters capacity, joined to an iron bar of 2.0 m long with 5 nozzles. The application pressure was 30 lb/inch^2, water equivalent to 80 l/ha.
Harvest: February 29, 1980, manual from 2 central rows.
Data taken: The following data was taken from 6 plants/plot at random: No. of insects/plant, No. of beneficial

insects/plant, some agronomic characteristics and yield. The percentages of control were calculated by the formula of Henderson and Tilton:

$$\% \text{ control} = 1 - \frac{(Ta \times Cb)}{(Tb \times Ca)} \times 100$$

where:

Ta: No. of insects after treatment
Cb: No. of insects in the check before treatment
Tb: No. of insects before treatment
Ca: No. of insects in the check after treatment.

F.4.3. Results and discussion

Due to high infestations and low percent control of the insecticides, it was necessary to make three applications in this trial, the results are shown in tables 18, 19, 20 and 22. Table 21 shows the effect of the insecticides on Anticarsia sp., Plusia sp. Loxostege sp. and Mocis sp. larvae.

Readings made previous to the first and second application did not show significant differences, but did for the third application. The readings made after applications showed high significant differences (tables 18, 19 and 20).

The percent control was in general low. The following insecticides had good effect 2 days after the applications: in the first application, Thionex 35, Parathion 25, Dipterex 80, Methion 48.2 and Sevin 80 with 82, 78, 68 and 54% of control respectively, at the first count after application; nevertheless, in the following readings, none of the insecticides was able to control this pest. For the second and third application, the percent control at the first reading, was almost null, increasing slowly in the later counts, but not getting a desirable level of control (Table 22).

Thionex 35, although it is an insecticide that acts as a contact or ingestion poison had a null residual effect at 5, 10 and 15 days after application.

Belmark 35, a pyretroid insecticide that acts as a contact poison, had a longer residual effect than the Thionex 35, but did not give adequate control. It reached 51, 24 and 46% control at 2, 5 and 10 days from the application.

TABLE 18: YIELD IN kg/ha, INSECTICIDES AND DOSES USED IN THE FIRST APPLICATION FOR CHEMICAL CONTROL OF REDNECKED WORM (*STEGASTA BOSQUELLA*, CHAMBERS). EXPERIMENTAL STATION OF SAAVEDRA, 1979-80.

Treatments: Commercial Name	Treatments: Technical Name	Concentration %	Actual Doses mc/ha, l o kg	Yield without the hull kg/ha	Average Number of Worms per Plant, Days Before and after the First Application: Before 1	After 2	After 5	After 10	After 15
Check	—	--	--	1.630	1.29	2.17 d	0.71	0.53 abc	4.71
Metasystox	Oxidemeton metil	25	0.70 l	1.722	1.08	1.25 bc	1.21	0.50 ab	4.08
Nuvacron	Monocrotofos	40	1.23 l	1.788	1.50	1.25 bc	0.87	0.96 c	4.46
Thionex	Endosulfan	35	1.35 l	1.755	1.12	0.33 a	0.79	0.83 bc	4.42
Dipterex	Triclorfon	80	1.02 kg	1.828	1.54	0.83 abc	0.87	0.42 a	4.62
Belmark	Fenvalerate	30	0.48 l	1.753	1.00	0.83 abc	0.42	0.25 a	4.25
Sevin	Carbaryl	80	2.18 kg	1.654	1.08	0.83 abc	0.58	0.21 a	4.17
Lannate	Methomyl	90	0.54 kg	1.693	0.91	1.50 cd	0.83	0.33 a	4.25
Parathion	Etil parathion	25	1.15 kg	1.775	1.13	0.42 a	0.46	0.59 abc	4.54
Methion	Metil parathion	48.2	0.58 l	1.712	0.87	0.58 ab	0.91	0.37 a	4.38
						** CV = 46.9%		** CV = 49.6%	

** = Highly significant at 0.01% of probability

The amounts followed by the same letter are not significantly different at the 0.01% of probability level of probability (Duncan's range test).

TABLE 19: EFFECT OF THE INSECTICIDES USED IN THE CHEMICAL CONTROL OF STEGASTA BOSQUELLA (H), IN PEANUT. EXPERIMENTAL STATION OF SAAVEDRA, 1979-80.

Treatments	Actual Doses mc/ha	Average number of Stegasta bosquella (H) per Plant, Days before and After the Second Application			
		Before	After		
		1	3	10	15
Check	---	4.71	2.50	2.50 c	2.69 b
Metasystox 25	0.85 l	4.08	2.13	1.50 a	1.81 a
Nuvacron 40	1.35 l	4.46	2.58	1.79 ab	1.31 a
Thionex 35	1.29 l	4.42	2.41	1.63 a	1.56 a
Dipterex 80	1.12 kg	4.62	2.25	1.71 a	1.37 a
Belmark 30	0.47 l	4.25	3.25	1.96 abc	1.56 a
Sevin 80	2.33 kg	4.17	2.63	2.33 bc	1.56 a
Lannate 90	0.52 kg	4.25	2.91	1.87 ab	1.69 a
Parathion 25	1.20 kg	4.54	2.21	1.67 a	1.75 a
Methion 48.2	0.55 l	4.38	2.46	1.75 ab	1.75 a
				* CV = 20.20	** CV = 21.3%

* Significant at 0.05% of probability
** Highly significant at 0.01% of probability

The amounts followed by the same letter are not significantly different at the 0.05% level of probability (Duncan's range test).

TABLE 20: EFFECT OF THE INSECTICIDES USED IN THE CHEMICAL CONTROL OF STEGASTA BOSQUELLA (H), IN PEANUT. EXPERIMENTAL STATION OF SAAVEDRA, 1979-80.

Treatments	Actual Doses mc/ha	Average Number of Worms, Stegasta bosquella (H), per Plant, Days Before and After the Third Application		
		Before	After	
		1	2	10
Check	--	2.69	1.19	0.75
Metasystox 25	0.82 1	1.81 a	0.93	0.68
Nuvacron 40	1.33 1	1.31 a	0.87	1.06
Thionex 35	1.25 1	1.56 a	0.69	0.18
Dipterex 80	1.10 kg	1.37 a	1.12	0.37
Belmark 30	0.45 1	1.56 a	0.75	0.50
Sevin 80	2.20 kg	1.56 a	0.63	0.50
Lannate 90	0.50 kg	1.69 a	0.81	0.81
Parathion 25	1.20 kg	1.75 a	0.75	1.06
Methion 48.2	0.58 1	1.75 a	0.63	0.81
		** CV = 21.3%		

** = Highly significant at 0.01% of probability

The amounts followed by the same letter are not significantly different at the 0.01% of probability (Duncan's range test).

TABLE 21: EFFECT OF CHEMICAL PRODUCTS USED IN THE CONTROL OF REDNECKED WORM, STEGASTA BOSQUELLA (H) IN PEANUT. EXPERIMENTAL STATION OF SAAVEDRA, 1979-80.

Treatments	Actual Doses mc/ha	Average number of Worms of Anticarsia sp., Plusia sp., Loxostege sp. y Mocis sp., Days before and after the application			
		Before	After		
		1	3	10	15
Check	--	0.00	0.17	0.21	0.17
Metasystox 25	0.70 l	0.17	0.08	0.41	0.00
Nuvacron 40	1.23 l	0.13	0.09	0.65	0.21
Thionex 35	1.35 l	0.39	0.13	0.41	0.33
Dipterex 80	1.02 kg	0.08	0.04	0.27	0.13
Belmark 30	0.48 l	0.25	0.04	0.45	0.17
Sevin 80	2.18 kg	0.19	0.00	0.54	0.25
Lannate 90	0.54 kg	0.24	0.17	0.41	0.13
Parathion 25	1.15 kg	0.33	0.13	0.46	0.00
Methion 48.2	0.58 l	0.04	0.00	0.23	0.09

TABLE 22: PERCENT CONTROL OF THE INSECTICIDES USED IN THE CHEMICAL CONTROL OF REDNECKED WORM, STEGASTA BOSQUELLA (H) IN PEANUT. EXPERIMENTAL STATION OF SAAVEDRA, 1979-80.

Treatments	Doses mc/ha Average 3 applicat.	First Application Days after the application				Second Application Days after the application			Third Application Days after the application	
		2	5	10	15	3	10	15	2	10
Check	—									
Metasystox 25	0.79 l	31	0	0	0	2	31	22	0	0
Nuvacron 40	1.32 l	50	5	0	19	0	24	49	0	0
Thionex 35	1.30 l	82	0	0	0	0	31	32	0	59
Dipterex 80	1.08 kg	68	0	39	18	10	30	48	0	3
Belmark 30	0.47 l	51	24	44	0	0	13	36	0	0
Sevin 80	2.24 kg	54	2	57	0	0	0	34	9	0
Lannate 90	0.52 kg	3	0	19	0	0	17	30	0	0
Parathion 25	1.18 kg	78	26	0	0	8	31	36	3	0
Methion 48.2	0.57 l	60	0	5	0	0	25	30	19	0

The effect of Parathion 25 was satisfactory only until 2 days after application, with 78% control, decreasing to 26% at 5 days, then becoming null at 10 days. A similar result occurred with Methion 48.2 with 50% control at 2 days and 0.5 and 0% control at 5, 10, 15 days.

Sevin 80, reached 54, 2 and 57% of control at 2, 5 and 10 days, dropping to 0% at 15 days of the application. The percent control with insecticides could not be determined on the Anticarsia, Plusia, Loxostege and Mocis larvae due to the total absence of these in the testigo nevertheless, as shown in Table 21, we can say that Methion 48.2, Dipterex 80, Metasystox 25, Parathion 25 and Belmark 30 controlled the mentioned pests with more efficiency.

The effect on beneficial fauna showed that Sevin 80, Thionex 35 and Parathion 25 were insecticides that caused less damage.

Taking into consideration the results obtained in the present study, it can be said:

- it is necessary the study of the biological cycle of Stegasta bosquella (CH.)
- to determine the economic level of the damage caused by this pest.
- to determine, based on life cycle and population change data, the best timing for insecticide application.

F.5. Chemical Control of Leaf Feeding Insects and Effect on Beneficial Fauna in Soybeans

Dr. Donald Foster, CID Entomologist-Agronomist
Nelson Reyes, IBTA Entomologist

F.5.1. Summary

To be able to determine the best insecticides to control leaf feeding insects in soybean, a study was done at the Saavedra Experiment Station where 11 chemical products were tested compared to a check treatment without application. The effect was variable, outstanding Ambush 50, 0.09 l/ha; Dipterex 80, 0.41 kg/ha and Parathion 25, 0.7 kg/ha. The grain average

yield was 1705 kg/ha, with a range variation between 1501 and 2002. There was no significant difference in yield. The effect on beneficial fauna was variable.

F.5.2. Methods and materials

Location: Saavedra Experiment Station.
Experiment design: Randomized blocks with 4 replications.
Seeding date: December 11, 1979.
Variety: Pelicano.
Seed quantity: 60 kg/ha.
Weed control: one hoeing.
Disease control: None.
Fertilization: None.
Insect control: The different insecticides were applied with a Tecnoma manual sprayer of 4 liters capacity joined to an iron bar of 2.0 m long with 5 nozzles. The application pressure was 30 $lb/inch^2$. water equivalent to 80 l/ha.
Harvest: February 29, 1980, manual, from 3 central rows.
Data taken: In 6 plants/plot, at random, the following data was taken: No. of insect/pest per plant, No. of beneficial insects per plant, some agronomic characteristics and finally yield.

The percentages of control were calculated by the Henderson and Tilton formula:

$$\% \text{ control} = 1 - \frac{(Ta \times Cb)}{(Tb \times Ca)} \times 100$$

where:

Ta: No. of insects after treatment
Cb: No. of insects of the check before treatment
Tb: No. of insects before treatment
Ca: No. of insects in the check after treatment.

F.5.3. Results and discussion

The results obtained in the study of chemical control of leaf feeding insects and effect on beneficial fauna in soybean are shown in tables 23, 24, 25, 26 and 27. According to importance, the insect pests *Ceratoma* sp., *Anticarsia* sp., *Loxostege* sp. and *Diabrotica* sp. were of higher incidence in the crop.

Table 28 shows the percentages of control with chemical products in relation to the different pests.

TABLE 23. YIELD, INSECTICIDES AND DOSES USED IN THE CHEMICAL CONTROL OF CHEWING INSECTS IN SOYBEAN AND AVERAGE NUMBER OF WORMS OF ANTICARSIA SP. PER PLANT, DAYS BEFORE AND AFTER THE APPLICATION. EXPERIMENTAL STATION OF SAAVEDRA, 1979-80

Treatments		Concentra-tion	Actual Doses	Yield	Average number of Anticarsia sp. per plant, days before and after the application				
Commercial Name	Technical Name	%	mc/ha 1 o kg.	kg/ha	Before	After			
					1	3	6	10	16
Thionex	Endosulfan	35	0.38 1	2,002	0.54	0.13	0.00	0.17	0.13
Thionex	Endosulfan	35	1.04 1	1,691	0.54	0.09	0.00	0.25	0.04
Lannate	Methomyl	90	0.19 kg	1,732	0.45	0.09	0.06	0.04	0.04
Nuvacron	Monocrotofos	40	0.35 1	1,726	0.33	0.04	0.06	0.09	0.06
Sevin	Carbaryl	80	0.85 kg	1,597	0.33	0.00	0.06	0.17	0.13
Dipterex	Triclorfon	80	0.41 kg	1,703	0.29	0.00	0.06	0.00	0.27
Dimecron	Fosfamidon	100	0.24	1,651	0.40	0.00	0.19	0.09	0.15
Decis	Decametrin	2.5	0.35	1,673	0.46	0.17	0.00	0.04	0.04
Ambusch	Permetrin	50	0.09 1	1,624	0.46	0.04	0.00	0.04	0.00
Belmark	Fenvalerate	30	0.15 1	1,729	0.46	0.09	0.00	0.00	0.06
Parathion	Etil parathion	25	0.70 kg	1,834	0.29	0.04	0.19	0.04	0.10
Check	---			1,501	0.37	0.17	0.13	0.09	0.44
					CV=55.5%	CV=163.4%	CV=179.8%	CV=166.1%	CV=152.5%

TABLE 24: EFFECT OF THE INSECTICIDES USED IN THE CONTROL OF CHEWING INSECTS IN SOYBEAN. EXPERIMENTAL STATION OF SAAVEDRA, 1979-80.

Treatments	Average number of Ceratoma sp. per plant, days before and after the application				
	Before	After			
	1	3	6*	10	16
Thionex	0.57	0.12	0.29 ab	0.21	0.37
Thionex	0.54	0.16	0.29 ab	0.29	0.21
Lannate	0.58	0.17	0.17 ab	0.29	0.33
Nuvacron	0.39	0.29	0.09 a	0.17	0.48
Sevin	0.75	0.45	0.17 ab	0.29	0.29
Dipterex	0.83	0.41	0.13 a	0.50	0.25
Dimecron	0.86	0.16	0.25 ab	0.29	0.33
Decis	0.75	0.20	0.37 b	0.33	0.21
Ambusch	0.70	0.29	0.09 a	0.33	0.27
Belmark	0.67	0.33	0.30 ab	0.38	0.15
Parathion	0.99	0.20	0.37 b	0.29	0.15
Check	0.87	0.20	0.29 ab	0.29	0.37
	CV=53.3%	CV=68.1%	CV=55.7%	CV=46.6%	CV=68.9%

* = Significant at 0.05% of probability.

The amounts followed by the same letter, are not significantly different at the 0.05% of probability (Duncan's range test).

TABLE 25: EFFECT OF THE INSECTICIDES USED IN THE CONTROL OF CHEWING INSECTS IN SOYBEAN. EXPERIMENTAL STATION OF SAAVEDRA, 1979-80.

Treatments	Average number of Diabrotica sp. per plant, days before and after the application				
	Before	After			
	1	3*	6	10	16
Thionex 35	0.17	0.00 a	0.00	0.17	0.25
Thionex 35	0.21	0.00 a	0.04	0.13	0.21
Lannate 90	0.29	0.00 a	0.04	0.13	0.21
Nuvacron 40	0.13	0.00 a	0.00	0.25	0.21
Sevin 80	0.37	0.00 a	0.00	0.13	0.13
Dipterex 80	0.33	0.00 a	0.00	0.25	0.09
Dimecron 100	0.17	0.00 a	0.00	0.21	0.17
Decis 2.5	0.25	0.00 a	0.00	0.29	0.13
Ambusch 50	0.25	0.00 a	0.00	0.17	0.21
Belmark 30	0.29	0.00 a	0.00	0.17	0.17
Parathion 25	0.29	0.00 a	0.00	0.25	0.21
Check	0.25	0.13 b	0.13	0.25	0.25
	CV=73.9%	CV=439.8%	CV=319.1%	CV=116.7%	CV=97.3%

* = Significant at 0.05% of probability.

The amounts followed by the same letter, are not significantly different at the 0.05% of probability (Duncan's range test).

TABLE 26: EFFECT OF THE INSECTICIDES USED IN THE CONTROL OF CHEWING INSECTS IN SOYBEAN. EXPERIMENTAL STATION OF SAAVEDRA, 1979-80.

Treatments	Average number of *Loxostege* sp. per plant, days before and after the application				
	Before	After			
	1	3	6	10	16
Thionex 35	0.33	0.17 b	0.06 ab	0.13	0.31
Thionex 35	0.29	0.09 ab	0.00 a	0.13	0.19
Lannate 90	0.21	0.09 ab	0.00 a	0.09	0.31
Nuvacron 40	0.33	0.09 ab	0.13 ab	0.13	0.00
Sevin 80	0.25	0.21 b	0.00 a	0.13	0.19
Dipterex 80	0.25	0.04 a	0.00 a	0.17	0.37
Dimecron 100	0.25	0.00 a	0.13 ab	0.09	0.25
Decis 2.5	0.25	0.00 a	0.08 ab	0.13	0.25
Ambusch 50	0.33	0.00 a	0.06 ab	0.13	0.19
Belmark 30	0.25	0.04 a	0.19 b	0.00	0.37
Parathion 25	0.21	0.00 a	0.00 a	0.13	0.31
Check	0.33	0.41 c	0.41 c	0.21	0.13
	CV=82.13%	CV=153.05%	CV=148.86%	CV=101.04%	CV=95.14%

* = Significant at 0.05% of probability.

** = Significant at 0.01% of probability.

The amounts followed by the same letter, are not significantly different at the o.05% and 0.01% of probability (Duncan's range test).

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TABLE 27: EFFECT OF THE INSECTICIDES USED IN THE CONTROL OF CHEWING INSECTS IN SOYBEAN. EXPERIMENTAL STATION OF SAAVEDRA, 1979-80.

Treatments	Average number of beneficial insects, arachnids, orius, coccinélidos, and calosomas per plant, days before and after the application.				
	Before	After			
	1	3	6	10	16
Thionex 35	0.25	0.13	0.19	0.17	0.25
Thionex 35	0.25	0.21	0.06	0.17	0.31
Lannate 90	0.21	0.17	0.06	0.13	0.13
Nuvacron 40	0.25	0.21	0.00	0.21	0.25
Sevin 80	0.21	0.13	0.19	0.13	2.06
Dipterex 80	0.33	0.00	0.06	0.04	0.25
Dimecron 100	0.37	0.09	0.13	0.09	0.06
Decis 2.5	0.45	0.13	0.19	0.13	0.19
Ambusch 50	0.21	0.04	0.13	0.13	1.69
Belmark 30	0.41	0.09	0.19	0.13	0.31
Parathion 25	0.29	0.09	0.19	0.13	0.19
Check	0.33	0.17	0.13	0.13	0.31
	CV=79.9%	CV=83.3%	CV=48.5%	CV=99.3%	CV=276.6%

TABLE 28: PERCENT CONTROL OF ELEVEN INSECTICIDES USED IN THE CHEMICAL CONTROL OF CHEWING INSECTS IN SOYBEAN. ESPERIMENTAL STATION OF SAAVEDRA, 1979-80.

Treatments	Ceratoma				Anticarsia				Loxostege				Diabrotica				Beneficials			
	3	6	10	16	3	6	10	16	3	6	10	16	3	6	10	16	3	6	10	16
Thionex	8	0	0	0	48	100	0	80	59	85	38	0	100	100	99	0	0	0	0	0
Thionex 35	0	0	0	10	64	100	0	94	75	100	30	0	100	63	38	99	0	39	0	0
Lannate 90	28	12	0	0	56	62	63	93	65	100	33	0	100	73	55	38	0	27	0	34
Nuvacron 40	0	31	0	0	74	48	0	85	78	68	38	100	100	100	0	0	0	100	0	0
Sevin 80	0	32	0	0	100	48	0	62	32	100	18	0	100	100	65	65	0	0	0	0
Dipterex 80	0	53	0	10	100	41	100	22	87	100	0	0	100	100	24	73	100	54	69	19
Dimecron 100	19	13	0	0	100	0	0	69	100	58	43	0	100	100	0	99	53	11	38	83
Decis 2.5	0	0	0	0	20	100	64	93	100	74	18	0	100	100	0	48	0	0	27	55
Ambusch 50	0	61	0	0	81	100	64	100	100	85	18	0	100	100	32	16	63	0	0	0
Belmark 30	0	0	0	0	54	100	100	89	87	39	100	0	100	100	41	41	57	0	20	20
Parathion 25	12	0	0	64	70	0	43	71	100	100	0	0	100	100	14	28	30	0	0	30

Readings previous to application, statistically did not show significant difference, so the distribution of the insect was random. Readings after application showed significant differences in some and highly significant in others (tables 24, 25 and 26).

In relation to the most important pest, Ceratoma sp. (Table 24) the insecticides Parathion 25, Ambush 50 and Dipterex 80 showed the best effect with 64, 51 and 53% of control, respectively, between the 6 and 16 days after application. These same products applied to other insects showed different effects (table 28).

All the insecticides had satisfactory control on Diabrotica sp. mainly between 3 and 6 days after application (table 25).

Loxostege sp. larvae were highly resistant to all insecticides (table 26).

Thionex 35 and Sevin 80 did not affect the beneficial fauna, contrasting with Dipterex 80 and Dimecron 100 that were the most severe for that fauna. (table 27).

F.6. Potato Entomology

Dr. Donald Foster, CID Entomologist-Agronomist
Ing. Gerardo Caero

F.6.1. Thrips

One of the most serious pests of leaves in potatoes are thrips. These are tiny insects which remove all but the upper epidermis of the leaf and, when they occur in large enough numbers, remove large amounts of leaf tissue. It was originally planned to find a field infested with thrips, spray certain blocks to remove the thrips and leave other blocks infested so that a comparison of yield loss due to thrips damage could be made. This was not possible because fields infested with thrips were also infested with other potato pests. The contribution of thrips to yield loss will probably have to be done in the greenhouse where competing insects can be eliminated.

Populations of thrips were counted in heavily infested fields and in an insecticide treated field adjacent to one infested field. The results of these counts are given in Table 29.

TABLE 29: THRIPS POPULATIONS IN POTATOES.

Five leaves were removed from one potato plant and placed in alcohol for later counting. Yields for the different locations were not available.

	AGUIRRE UNTREATED		AGUIRRE TREATED		DESAGUADERO	
Repl. #	Nymphs	Adults	Nymphs	Adults	Nymphs	Adults
1	3	242	0	0	48	28
2	0	185	0	0	151	70
3	6	196	0	1	67	40
4	3	101	0	0	111	79
5	1	162	0	0	98	59

Analysis of variance shows that there is a significantly larger number of nymphs at the Desaguadero location than the Aguirre site. This must be due to a climatic difference in location since the thrips appear to be the same species (as yet not positively identified) and the samples were collected one week apart (Desaguadero, March 20; Aguirre, March 27). The treated site at Aguirre received applications Meta-Systox and Perfection applied on a schedule. Obviously, these heavy insecticide applications will control the thrips population.

The populations in the untreated fields were large enough to cause death of leaves and apparently death of entire plant, although other pest insects also present probably contributed to the death of the plant. Although Desaguadero has a significantly higher number of nymphs, there was no significant difference between the two populations when nymphs and adults were added together. It has been reported that with potato leafhopper, Empoasca fabae, the nymphs are more destructive than adults. We do not yet have data on relative damage between nymphs and adults of thrips on potatoes, but it may be an important factor in determining economically damaging populations.

F.6.2. Aphid water traps

TABLE 30: APHIDS (HOMOPTERA) AND OTHER INSECTS COLLECTED AT THE TORALAPA EXPERIMENT STATION IN WATER PLAN TRAPS PLACED IN POTATO PLOTS.

ORDER	TRAP No. 1	2	3	4	5
Homoptera	2	9	2	2	0
Coleoptera	1	1	0	0	1
Hymenoptera	6	6	11	2	14
Diptera	64	58	153	77	263
Thysanoptera	0	0	1	0	1

Yellow water pan aphid traps were placed in separate potato fields at the Toralapa Experiment Station on December 15, 1979 and removed at harvest time in March. Insects were collected weekly and accumulated for later counting and identification.

The results of the preliminary count of orders represented is given in table 30. The Homoptera appear to be Myzus persicae. One of the primary purposes of the water traps is to measure the population of this aphid. The numbers trapped indicate that the aphid population for Toralapa is very low. These low population numbers have been confirmed by a visual search of leaves in two of the fields.

Almost all of the other insects in the traps were flies (Diptera) and wasps (Hymenoptera). The flies were the group with by far the largest population. This has been observed also when collections were made with nets both in Toralapa and other potato growing areas. The wasps were primarily parasitic wasps but there were a few sawflies which have been recorded as a pest on potatoes.

F.7. Other Activities:

Dr. Donald Foster, CID Entomologist-Agronomist

F.7.1. Khapra Beetle

In March it was reported that beetles resembling khapra beetle, *Trogoderma granarum* Everts., a serious product pest were discovered in rice which had been imported to Bolivia from Pakistan. The Ministry of Agriculture requested my help in determining if this was indeed the Khapra beetle. I flew to La Paz and on March 17 met with Ministry officials who expressed the seriousness of the situation. I looked at the early instar larva which the identification was based on and confirmed that it was in the family Dermestidae, but for aditional work, adults would be needed. We went to a rice storage area in La Paz and, after 2 hours of looking through bags of rice, found no dermestids. At my suggestion, Sanidad Vegetal personnell returned to the site of the original collection, Cochabamba, to find more specimens and if possible adults.

A week later we examined newly collected adults and larvae and determined that there was a good possibility that the insects were Khapra beetle but that, with the laboratory equipment available and lack of identified specimens in a collection, a positive identification was impossible.

At this point, two suggestions were made: 1) the specimens could be taken to insect identification laboratories in either California or Maryland or 2) FAO could be asked to send one of its experts on stored grain insects to Bolivia.

About a week later, Dr. Ernesto de las Casas from FAO-Rome arrived in Bolivia to work on the problem. I spent two days with Dr. de las Casas and Sanidad Vegetal personnell looking for these beetles in Cochabamba. We found specimens in several rice mills. Dr. de las Casas took these specimens to the United States for identification.

I have received a letter from Dr. Lloyd Knutson of the USDA insects identification laboratory saying that these insects were not the Khapra beetle but the actual identification has not been made yet as far as I know. I have seen no report by Dr. de las Casas nor by Sanidad Vegetal.

F.7.2. Short Term Contract - Oscar Bacon (Don Foster)

One of the most important factors in developing a pest management system for any pest insect is the development of a method for determining the population levels of the pest in a crop at any given time. When one can reliablycount the numbers of pest insects,he can determine when to apply controls for economically damaging populations and he can enumerate the decline in the pest population caused by an effective chemical.

The potato tuberworm moth (PTW) is one of the most damaging insects in potatoes in Bolivia and to learn how to control it we must be able to count the populations of this pest. A new and powerful technique developed for counting PTW populations is the pheromone trap. This method uses a chemical similar to the sex attractant of the female PTW to attract male PTW moths to a trap where they can be counted.

One of the world experts in the use of this method is Dr. Oscar Bacon of the University of California in Davis. Dr. Bacon came to Bolivia from June 13 to July 8 on a CID short term contract to work with me for the purpose of determining the feasibility of using this pheromone trap technique in Bolivia. We also surveyed fields and stored potatoes for insects associated with potatoes at this time of the year. To make sure he had every chance for success, I spent the week before Dr. Bacon's visit making arrangements for locations to visit, served as guide and translator during his stay,and pinned and prepared for identification the insects we collected from potatoes (this alone required a week).

The data collected in this month are reported in Dr. Bacon's report CID Working Paper No. 04/80. In my opinion the visit was a very successful. We trapped PTW in the areas of Melga, Sacaba, Morochata and Comarapa. Traps were also employed in potato fields near Santa Cruz but no moths were trapped due to rain and very cold weather. We collected from stored potatoes in Vallegrande and Huarina but did not utilize pheromone traps because no potatoes where being grown in these locations during the winter. In all over 1,000 insects were collected and mounted for identification and approximately 1,500 PTW parasites of the genus Copidosoma, were collected from potatoes grown near Aguirre and shipped alive to Dr. Leo Caltagirone, University of California, Berkeley for special study.

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Dr. Bacon did not have the opportunity to bring PTW parasites from California but he did bring references describing these parasites which can be obtained when our laboratories are equipped for rearing insects. He also brought an extensive set of papers on PTW pheromone trapping. These were photocopied and will be very useful as the pheromone trapping program develops. The help and advice given by Dr. Bacon in this short visit will certainly enhance our chances for developing a system for counting PTW in Bolivia.

F.7.3. Visit to International Potato Center in Lima (Don Foster)

Since the major emphasis of the entomological program is being shifted to potatoes in the upcoming year, it was decided that a visit to the International Potato Center (CIP) in Lima would be beneficial to learn of ongoing potato insect projects, to explore possibilities for cooperation between CIP and the Bolivian National Potato Program and to review literature of Potato insects in the CIP library.

I arrived in Lima on July 8 with Dr. Oscar Bacon, and on July 9 we toured the CIP facilities. The following day after seeing Dr. Bacon safely off on his return to California, I consulted with Dr. K. V. Raman on projects which we could develop cooperatively. We discussed potato insect problems which both Peru and Bolivia share. I also had an opportunity to discuss techniques with several of Dr. Raman's assistants and feel that this was very beneficial. Several of the major Peruvian potato pests were being maintained in field plots and the tour of this area was very interesting.

In addition to Dr. Raman and his staff, I had the opportunity to visit with Dr. O.T. Page, Director of Research, Dr. K.J. Brown, Director of Regional Research and Training, and Dr. Bruce Parker, visiting professor from the University of Vermont.

The remainder of my time was spent reviewing literature in the CIP library and copying as many of the important references as possible. Of special usefulness was the Commonwealth Agricultural Bibliography (Abstracts, 1900-1969) of articles on insects associated with potatoes. Many new references were found in this four volume publication and these were transferred to bibliography cards.

In summary: I was very well received by the staff at CIP and feel that groundwork has been laid to develop a program of cooperation with CIP which should be very beneficial to the Bolivian National Potato Program.

F.7.4. <u>National Insect Museum</u>

Ing. Jaime Silva - Museum Entomologist
Dr. Donald Foster - CID Entomologist-Agronomist

Work planned for the National Insect Museum for this year included collecting trips to each of the agricultural producing regions of Bolivia. Because of time limitation, this was not possible. Two trips were made in the area of La Paz and the experiment stations at Belen and Patacamaya. In addition, insects have been collected in the following locations: Morochata, Sorata, Sacaba, Melga, Santa Cruz, Warnes, Saavedra, Portachuelo, Buena Vista, Yapacaní, Chapare, and San Lorenzo. In all about 15.000 insects have been collected. Many of these have been mounted and are ready to be mailed to various experts for identification. Many representatives of the family CICADELLIDAE were taken to the U.S. by Dr. Dwight DeLong. He is mounting and identifying these specimens. He also has four publications in manuscript describing new species found during his visit to Santa Cruz.

Table 31 shows insects returned with identifications from Dr. DeLong and other taxonomic specialists. This list should become much longer now that we have received special shipping boxes for sending larger numbers of insects for identification.

The museum has made some changes to increase its ability to be of service to others and to be more efficient. An insect identification card has been produced and distributed so that persons wishing to have insects identified will know what kind of data should be sent with the specimen. A second change is the development of an information card to be filled out for each species identified in the museum. The use of this card will improve the organization of the museum and relieve the time consuming process of filling out a card on each individual specimen collected.

TABLE 31. INSECT IDENTIFICATIONS MADE FOR THE NATIONAL INSECT MUSEUM IN THE PAST YEAR.

Family	Genus & Species	Location
Myrmeleontidae	Dimates elegans (Perty)	Santa Cruz
	Brachynemuns dispar (Banks)	Santa Cruz
Cicadellidae	Presiomnata mollicella (Fowler)	Santa Cruz
	Falclutha hebe (Kirk)	Santa Cruz
	Agallia albidula Uhler	Santa Cruz
	Agallia dorsata Oman	Santa Cruz
	Mendezellus sp.	Santa Cruz
	Decalidia sp.	Santa Cruz
	Exitanus obscurivervis (Stal)	Santa Cruz
	Scaphytopius marginalineata (Stal)	Santa Cruz
	Stirellus picinus (Berg)	Santa Cruz
	Chlorotettix sp.	Santa Cruz
	Dalbulus maidis Del. & Wolc.	Santa Cruz
	Helochara communis Fitch	Santa Cruz
Melyridae	Astylus atromaculatus Blanchard	Mairana
Cryptophagidae	Cryptophagus sp.	Toralapa
Chrysomelidae	Stolas sp. nr. decempustulata Boheman	Mairana
	Megascelis sp.	Yapacaní
	Cerotoma sp. nr. tingomariana Bechyne	Yapacaní
Curculionidae	Boliviana variabilis Hust	Santa Cruz
	Trichocyphus formosus Erichson	La Paz
	Conotrachelus vicinus Hust	Santa Cruz
	Conotrachelus histrio Boh	Santa Cruz
	Conotrachelus denieri Hustache	Santa Cruz
	Neobaridia amplitarsis csy	Santa Cruz
	Metamasius anceps (Gyll.)	Santa Cruz
	Entimus granulatus (Linne)	Santa Cruz
	Ericydeus sedecimpunctatus Linne	Santa Cruz
	Polydinus coelestinus Perty	Santa Cruz
	Naupactus tarsalis Boh	Santa Cruz
	Naupactus sp.	Cochabamba
	Naupactus condecoratus Boh	Yapacaní
	Naupactus crenateiventris Hust	Santa Cruz
	Naupactus tuberculatus Hust	Santa Cruz
	Parapantomorus sharpi Keller	Santa Cruz
	Merocnemus horni Faust	Santa Cruz
Sciaridae	Bradysia sp.	Toralapa

F.8. Publications

Foster Don, Cleto Siles, and Nelson Reyes. 1980. Ideas para el mejor uso de insecticidas. Bol. Div. N° 8. CIAT.

Foster Don, Cleto Siles, Nelson Reyes, and Fernando Córdova. 1980. Control de la petilla del arroz (Tibraca limbatriventris). Bol. Div. N° 9. CIAT.

Foster Don, and Larry Crowder. 1980. Diapause of the pink bollworm, Pectinophora gossypiella, related to dietary lipids. Comp. Biochem. Physiol. 65 (4): 723-725.

Silva Jaime, and Don Foster. In ms. Creación y función del Museo Entomológico Boliviano. Hoja Div.

Foster Don, and Jaime Silva. In ms. Studying Bolivian Insects.

G. PLANT PATHOLOGY

by

William M. Brown, Jr.

This section will be submitted as supplementary to this report.

H. OILSEEDS, SOILS, IRRIGATION

by

Don C. Kidman - Agronomist

H.1. Regional Adoption and Comparison of Soybean Varieties

Responsible for the program: Hebert Zurita

Responsible for the experiment: Hebert Zurita and Alejandro Tejerina

Program Advisor: Don Kidman

H.1.1 Introduction and Objectives

Soybean production in the Santa Cruz area during the 1979-80 season was approximately 35,000 ha. The principal varieties were U.F.B., Pelicano, and Mandarin. The regions within the soybean production area of Santa Cruz vary considerably in mean annual rainfall from 900 mm in the south of Santa Cruz to 1,800 mm in Yapacaní and Antofagasta. Rainfall and climatic differences between regions affect yields (Saavedra Experiment Station data). Soybean variety selections are presently being made from previous variety introduction studies conducted at the Saavedra Experiment Station using varieties introduced from other major soybean producing countries. The objectives of this project were:

(1) To study the adoption of soybean varieties to different summer environments.

(2) To provide information to allow selection of varieties of superior performance on a regional level.

H.1.2 Materials and Methods

Three regions were selected for regional trials, i.e., Okinawa, Zanja Honda (south zone) and Aquai (San Pedro). The trials consisted of twelve varieties, which originally came from Brazil, Colombia, and United States, seeded in individual plots $14.4 m^2$ with 4 rows 6 m in length, spaced at 60 cm with a plant spacing in rows at 7.5 cm in a randomized complete block design.

Planting dates were as follows: Okinawa - January 9, 1980; Zanja Honda - December 18, 1979; Aquai - January 16, 1980.

Soil analysis at each site showed the soil to be of medium texture, near natural in pH reaction, and both phosphorus and potassium were available in ample quantities so no fertilizers were applied.

Weeds were controlled using one application of the herbicide Lasso at 3 l/ha, plus one hand hoeing. Insects were controlled at Zanja Honda and Okinawa with one application of Nuvacron (4) at 1 l/ha, and at Aquai, insecticide Thionex was used at the rate of 1 l/ha.

No plant disease control measures were necessary.

The harvest dates were: Okinawa - May 2-10, 1980; Zanja Honda - April 15 to May 8, 1980; and Aquai - May 15, 1980.

The yield data was taken from a harvest plot area of 6 m^2 and reported in tons/ha of grain at 13% moisture content.

H.1.3 Results and Discussion

Table 1, 2, and 3 contain the complete yield data of the experiments at Okinawa, Zanja Honda and Aquai, respectively. Variety Rillito was eliminated from each experiment because of very low germination. The varieties Davis, ICA-L-109 and V. Biloxi were eliminated from the Aquai experiment.

The experiment at Okinawa had the lowest average yield of 2.15 ton/ha. Yields ranged from 1.40 to 2.71 ton/ha. The respective varieties were Pelicano (testigo) and Santa Rosa.

The variety yields at Zanja Honda were highest of the three experiments with an average yield of 3.54 ton/ha. Variety yield average ranged from 2.46 to 4.13 ton/ha. The respective varieties were Pelicano (testigo) and Davis.

The variety yields at the Aquai regional experiment (Table 3) ranged from 2.21 to 4.78 ton/ha with an average yield of 3.07 ton/ha.

The five highest yielding varieties at Zanja Honda were Davis, F-86, Visoja, Santa Rosa, and Andrews with respective yields of 4.13, 4.05, 4.05, 4.03, and 3.65 ton/ha.

The five highest yielding varieties at Okinawa were Santa Rosa, UF V-1, V-1, Davis, and F86 with respective yields of 2.71, 2.42, 2.40, 2.33, and 2.28 ton/ha.

At Aquai, the five highest yielding varieties were V-1, Santa Rosa, UF V-1, Andrews, and Bossier with respective yields of 4.78, 3.53, 3.39, 3.11, and 2.80 ton/ha. The variety mean yields of V-1 and Andrews were significantly different from each other and the other three varieties.

Table 4 shows the yields of the varieties averaged through the three regions. The three highest yielding varieties were V-1, Santa Rosa, and UF V-1. Their respective average yields were 3.45, 3.42, and 3.13 ton/ha. Santa Rosa was the only variety that was among the five highest yielding varieties at each region. Pelicano, the check variety, was the lowest yielding variety in each regional test.

H.1.4 Summary and Conclusions

A soybean variety comparison experiment was conducted in the regions of Zanja Honda, Okinawa, and Aquai. The varieties compared were selected from previous variety introduction experiments. Some varieties were repeated from immediate past years regional tests.

The varieties Santa Rosa, V-1 and UF V-1 were outstanding in each region.

Table 1. Regional soybean variety comparison experiment. Okinawa 1979/80. Yield data.

Varieties	Replications ton/ha 1	2	3	4	Total	Ave.	Duncan multiple range test
Santa Rosa	2.73	2.40	2.87	2.85	10.85	2.71	a
UF V-1	2.18	2.72	2.09	2.68	9.67	2.42	b
V-1	2.14	2.50	2.29	2.68	9.61	2.40	
Davis	1.67	2.12	2.82	2.69	9.30	2.33	
F-86	1.49	2.87	2.10	2.66	9.12	2.28	
Andrews	2.18	1.73	2.56	2.53	9.00	2.25	
Visoja	2.11	2.33	2.60	1.91	8.95	2.24	
Bossier	1.75	1.76	1.96	2.28	7.75	1.94	
Y. Biloxi	1.46	2.12	2.07	2.11	7.76	1.94	c
ICA-L-109	1.62	1.81	1.64	1.80	6.87	1.72	d
Pelicano	1.58	1.39	1.32	1.30	5.59	1.40	
	20.91	23.75	24.32	25.49	94.47	2.15	

C.V. = 14% M.S. varieties = 5.65**

Table 2. Regional soybean variety comparison experiments. Zanja Honda 1979/80. Yield data.

Varieties	Replications ton/ha 1	2	3	4	Total	Ave.	Duncan multiple range test
Davis	3.75	3.32	4.93	4.53	16.53	4.13	a
F-86	4.13	4.43	3.47	4.15	16.18	4.05	
Visoja	3.13	4.36	4.06	4.63	16.18	4.05	
Santa Rosa	3.59	4.05	3.93	4.53	16.10	4.03	b
Andrews	4.00	3.53	3.50	3.57	14.60	3.65	
UF V-1	3.78	3.60	3.43	3.49	14.30	3.58	
Y. Biloxi	3.10	3.32	3.49	3.82	13.73	3.43	
Bossier	2.96	3.47	3.52	3.73	13.68	3.42	
V-1	2.77	3.16	3.64	3.06	12.63	3.16	c
ICA-L-109	2.64	2.49	3.76	3.28	12.17	3.04	
Pelicano	2.81	1.84	2.72	2.48	9.85	2.46	
	36.64	37.57	40.45	41.27	155.95	3.54	

C.V. = 12.0% M.S. varieties = 6.06**

Table 3. Regional soybean variety comparison experiment. Aquai, 1979/80. Yield data.

Varieties	Replications ton/ha 1	2	3	4	Total	Ave.	Duncan multiple range test
V-1	5.04	4.47	5.07	4.53	19.11	4.78	a
Santa Rosa	3.19	3.73	3.65	3.56	14.13	3.53	
UF V-1	2.71	4.09	3.92	2.84	13.56	3.39	b
Andrews	3.32	2.63	3.54	2.95	12.44	3.11	c
Bossier	2.91	2.60	3.19	2.48	11.18	2.80	d
Visoja	2.14	2.67	2.21	3.11	10.13	2.53	
F-86	1.80	1.75	2.47	2.81	8.83	2.21	
Pelicano	1.82	2.35	1.96	2.69	8.82	2.21	
	22.93	24.29	26.01	24.97	98.20	3.07	

C.V. = 14.2% M.S. varieties 15.02**

Table 4. Regional soybean variety comparison experiment. Regional yield averages. 1979/80.

Variety	Regions ton/ha			Total	Average
	Aquai	Okinawa	Zanja Honda		
V-1	4.78	2.40	3.16	10.34	3.45
Santa Rosa	3.53	2.71	4.03	10.27	3.42
UF V-1	3.39	2.42	3.58	9.39	3.13
Visoja	2.53	2.24	4.05	8.82	2.94
F-86	2.21	2.28	4.05	8.54	2.85
Bossier	2.80	1.94	3.42	8.16	2.72
Pelicano	2.21	1.40	2.46	6.07	2.02

H.2 Regional Rice Fertilizer Experiments

Responsible for the Program: Francisco Paz

Responsible for Fertilizer Project: Erwin Ortiz, Don Kidman and Julio Calancha

H.2.1 Introduction and Objectives

Santa Cruz produces 56% of the national rice production. Much of the rice is produced by the small farmer in the frontier areas. It is his principal food crop and produces well under his system of farming called "chaqueado." This system involves the clearing of a small area of forest land of the brush and small trees by cutting and burning. The crop is then planted between tree stumps and felled unburned trunks. The farmer can produce rice with this system without weed or insect control or fertilization.

Current trends are for farmers to try to maintain their land clear and continue to prepare it for mechanized farming. Therefore, fertilizers will be important to maintain soil fertility, weeding, insect control, improved varieties and various other management practices will be needed to continue to produce rice and other crops on a profitable basis.

This was a study to help identify soil fertility limitations in rice culture. There are three areas included in the study: San Pedro, Portachuelo and Yapacaní.

The objectives were: (1) to determine maximum potential yields of rice, using an improved variety selected for the region, (2) to determine optimum levels of fertilizer for highest economic yields, and (3) to determine soil fertility limitations as they relate to soil chemical analysis.

H.2.2 Materials and Methods

The experiment was established at the following regional locations: San Pedro, Portachuelo and Yapacaní. The methods and materials pertain to all locations. Composite soil samples were taken at each experiment site for chemical and textural analysis. The experiments were designed as complete randomized block with 4 replications and 12 treatments.

The plot size was 3 x 5 meters (15 m^2) and was planted in rows 30 cm wide, and 5 meters long with approximately 150 seeds/meter. They were planted using a Planet Jr.

The fertilizers were applied in two applications. The first was made at planting time as follows: Nitrogen (N), all of the N for the N-40 treatment plus 1/2 of the N for the other N treatments; all of phosphorus (P) was applied for all P treatments; the potassium (K) was applied complete to the K-75 plots and all other plots received K at the rate of 100 kg/ha (all of the K would have been applied at the first application time had it been available). All applications of all fertilizers, less the micro elements (ME), were applied in bands about 10 cm deep and 15 cm to the side of the row. MEE was applied foliar about 60 days after planting. They consisted of B, Fe, Mn, Cu, S, and Zn. The fertilizer treatments at each location were as follows:

Treatment	N	P (kg/ha)	K
1	0	0	0
2	0	30	150
3	40	30	150
4	80	30	150
5	160	30	150
6	80	0	150
7	80	15	150
8	80	60	150
9	80	30	150
10	80	30	75
11	80	30	300
12	80	30	150+ME

Agronomic observations were taken at flowering and harvest time of: length of panicle, height of plants; % lodging, and number of days to flowering. and tillering.

Harvested area for yield measurements was 6 rows by 3 meters. Plot yields were calculated to tons/ha of grain adjusted to 14% moisture content.

Location	Variety	Planted	Harvested	No. Days
San Pedro	Cica 8	October 17	March 24	158
Portachuelo	Cica 8	November 28	April 24	147
Yapacaní	IR 1529-430-3	October 24	April 1	158

H.2.3 Results and Discussion

San Pedro

No differences between treatments were observed which would indicate fertilizer limitations of N, P, or K. The yield results are contained in Table 1. Average treatment yields range from 5.67 tons to 6.92 tons/ha, with an average of 6.26 tons/ha. Analysis of variance showed no significant differences due to fertilizer treatments.

Table 2 is the soil analysis which shows the soil to be a clay loam with an organic matter content of 3.4%. The field in which the experiment was located had been cultivated for five continuous years since clearing. The organic matter content plus residual plant refuse was sufficient to supply the N requirements. Table 2 also shows the available P and K to be well above expected critical levels for these plant food elements and, therefore, no yield responses to added fertilizers of P or K was expected or obtained (the critical level for P is between 8 and 10 ppm, and for K between 80 and 100 ppm according to experience in other areas).

Table 3 contains the agronomic observations of tillering per square meter, the length of the panicle, percent lodging, and number of days to flowering. None of these observations appear to be related to fertilizer treatment yields and most observations have only normal variation. Lodging was heavy due to excessive rain and wind accompanied by substantial panicle development.

Portachuelo

During the growing season, visual differences were obvious between the 0-N treatments and all other N treatments. The 0-N plots were a lighter green color than the other plots. Also, the rice on the plot borders next to the pathways between replications showed N border effect with the exception of the N-160. As the crop reached

Table No. 1. Rice fertilizer experiment yield data. San Pedro. 1979-1980.

Treatment	Replications (ton/ha)				Total	Average
	I	II	III	IV		
0-0-0	7.46	6.62	7.06	6.52	27.66	6.92
0-30-150	6.54	7.86	4.99	5.17	24.56	6.14
40-30-150	7.18	6.62	5.74	5.09	25.63	6.41
80-30-150	6.54	8.02	6.22	5.78	26.56	6.64
160-30-150	6.22	6.90	6.62	4.31	24.05	6.01
80-0-150	7.48	9.10	5.31	4.99	26.88	6.72
80-15-150	6.58	7.02	6.26	5.55	25.41	6.35
80-60-150	6.08	6.98	7.66	5.86	26.58	6.65
80-30-0	6.08	5.70	5.29	5.62	22.69	5.67
80-30-75	5.82	6.62	4.67	6.30	23.41	5.85
80-30-300	6.18	6.90	5.90	4.67	23.65	5.91
80-30-150+ME	6.62	6.90	4.89	5.11	23.52	5.88
TOTAL	78.78	85.24	70.61	64.47	300.6	6.26

C.V. = 11.74% M.S. Treatments = 0.66 N.S.

Table No. 2. Soil Analysis Data. San Pedro. 1979-1980.

pH	E.C.	P ppm	K ppm	O.M. %	Sand %	Silt %	Clay %	Texture
8.0-7.3	185	9.0	231	3.4	1	57	42	silty clay

Table No. 3. Agronomic characteristics. Rice experiment. San Pedro. 1979-80.

Treatments	Tillering total (m^2)	Length of panicle (cm)	Plant height (cm)	Lodging %	Days to flowering
0-0-0	450	22	91	65	130
0-30-150	444	22	92	50	129
40-30-150	528	21	93	80	131
80-30-150	516	21	94	82	130
160-30-150	516	21	96	60	133
80-0-150	522	22	94	68	132
80-15-150	492	22	93	85	131
80-60-150	546	22	94	82	131
80-30-0	450	22	93	75	132
80-30-75	480	22	92	65	131
80-30-300	492	22	93	60	131
80-30-150+ME	522	22	94	82	132

the seed development stage, most of the border effect disappeared due to a return of darker green color to the entire experiment. This coloring effect change from normal green to a lighter green, and then back in the latter growth stage to a darker green again was perhaps due to the position of N in the root zone. The earlier rains during January could have moved the N to a soil depth at which much of it was positionally unavailable to the rice plant roots. During the latter plant growth stage, the roots could have grown to sufficient depth to reach some of the N previously unavailable.

The yield results are shown in Table 4 and range from 6.18 to 8.26 ton/ha, with an average of all treatment yield of 7.16 ton/ha. The highest yield was obtained on the highest N application plots (160 kg of N/ha); therefore, it is unknown as to whether additional N would increase yields. It is highly probable that N losses did occur by leaching from excess rain. The analysis of variance shows the differences in yields due to fertilizer treatments to be significant to the 5% level. All treatment yields are fairly high and differences between treatment yield averages are not clearly defined. The differences appear to be due to the low yield of the treatment containing ME. Without this treatment, there is no significant differences shown by analysis of variance. Both P and K are not available in more than borderline quantities according to Table 5, which contains the soil analysis, and additions of these plant food elements did not produce higher yields.

Agronomic observation data contained in Table 6 are not too helpful in supporting treatment yield results. It is observed, however, that the tillering/m^2 and height of plants observations had the highest values in the 160-30-150 treatment.

Yapacaní

During the growing season, N deficiency symptoms were observed in the plots with 0-N and 40 kg of N/ha. At flowering time, the rice crop was attacked by rice blast, which reduced yields to less than one-third of that expected. The yields by treatment are shown in Table 7 and range from 2.03 to 2.57 ton/ha with an average of 2.32 tons. Analysis of variance of the yield data showed treatment mean differences to be nonsignificant.

The analysis of the composite soil sample taken at planting time is contained in Table 8. Organic matter is shown to be 2.6%. P and K are both shown to be low in Table 8, and increased yields from the addition of these nutrients in the experiment might have been obtained if the disease rice blast had not damaged the rice crop. Table 9 contains some agronomic observations taken during the growing period of the crop. The tillering/m^2 is highest in the highest N treatment, which is 160 kg N/ha. The other observations have slight variation and do not appear to have any correlation with fertilizer treatments.

H.2.4 Recommendations and Summary

Regional fertilizer studies should be continued on the basis of selecting sites within individual regions according to soil fertility levels indicated by soil test analysis. These studies would be highly important because the longevity of the original soil fertility could be fairly well defined as it is affected by soil type and years of continuous cropping. Soil test indices now in use could be verified as to their application to this area.

Fertilizer experiments designed to study the limitations of N, P, K and ME in the soil under rice culture were established on a regional basis at San Pedro, Portachuelo, and Yapacaní. Soil fertility was determined from soil samples taken at each site at time of planting. They showed, according to soil test indices now in use for P and K, that all sites were near or above the critical levels for these elements with the exception of Yapacaní, which was low in available P. None of the locations showed average yields due fertilizer treatments to be significantly different. Nitrogen deficiency symptoms were observed in the experiments at Portachuelo and Yapacaní during the growing period of the rice crop. Average yields were 6.26, 7.16, and 2.32 ton/ha for the regions of San Pedro, Portachuelo and Yapacaní, respectively. The rice crop at Yapacaní was attacked by the disease rice blast(Piricularia orizae) and Helminthosporium orizae. This disease caused an estimated yield reductions of two-thirds or more.

Table No. 4. Rice fertilizer experiment yield data. Portachuelo. 1979-1980.

Treatment	Replications (ton/ha) I	II	III	IV	Total	Average
0-0-0	6.07	6.84	8.04	6.84	27.79	6.95
0-30-150	8.15	8.38	7.45	6.20	30.18	7.55
40-30-150	7.20	7.20	6.77	4.99	26.16	6.54
80-30-150	7.66	8.22	8.49	7.17	31.48	7.87
160-30-150	7.66	8.41	8.89	8.07	33.03	8.26
80-0-150	7.47	7.79	6.92	6.20	28.38	7.10
80-15-150	7.39	7.98	6.47	8.00	29.84	7.46
80-60-150	7.41	6.73	8.02	7.35	29.51	7.38
80-30-0	6.77	6.50	7.83	6.50	27.60	6.90
80-30-75	6.84	6.33	5.73	7.64	26.54	6.64
80-30-300	6.45	7.75	7.56	6.77	28.53	7.13
80-30-150+ME	7.09	5.48	6.09	6.05	24.71	6.18
TOTAL	86.10	87.61	88.26	81.78	343.75	7.16

C.V. = 10.26% M.S. Treatments = 1.36 N.S.

Table No. 5. Soil Analysis Data. Portachuelo. 1979-1980.

pH	E.C.	P ppm	K ppm	O.M. %	sand %	silt %	clay %	Texture
5.6-4.6	50	8.8	121	2.2	29	30	41	sandy clay loam

Table No. 6. Agronomic characteristics. Rice Experiment. Portachuelo. 1979/80

Treatments	Tillering total (m^2)	Length of panicle (cm)	Plant height (cm)	Lodging %	Days of flowering
0-0-0	308	17	81	5	116
0-30-150	306	19	84	2.5	117
40-30-150	312	20	83	12.5	118
80-30-150	420	19	93	22.5	113
160-30-150	465	20	98	36.85	118
80-0-150	444	19	88	2.5	116
80-15-150	342	20	93	22.5	116
80-60-150	396	21	94	1.25	115
80-30-0	330	20	93	32.5	118
80-30-75	357	19	93	2.5	116
80-30-300	422	19	89	6.25	116
80-30-150+ME	339	19	92	28.75	116

Table No. 7. Rice fertilizer experiment yield data. Yapacaní. 1979-1980.

Treatments	Replications (ton/ha) I	II	III	IV	Total	Average
0-0-0	2.54	1.56	1.87	2.13	8.10	2.03
0-30-150	2.46	2.25	2.08	2.08	8.87	2.22
40-30-150	2.32	2.12	2.39	1.98	8.81	2.20
80-30-150	2.38	2.21	2.52	2.48	9.59	2.40
160-30-150	2.18	2.48	2.87	2.16	9.69	2.42
80-0-150	2.43	2.05	2.10	3.28	9.86	2.47
80-15-150	2.29	2.51	2.18	2.81	9.79	2.45
80-60-150	2.02	2.01	2.39	3.00	9.42	2.36
80-30-0	2.36	2.35	2.18	2.38	9.27	2.32
80-30-75	1.91	1.64	2.59	2.89	9.03	2.26
80-30-300	3.19	3.08	2.46	2.53	10.26	2.57
80-30-150+ME	2.38	2.35	2.10	1.98	8.81	2.20
TOTAL	28.46	25.61	27.73	29.7	111.50	2.32

C.V. = 14.93% M.S. Treatments = .089 N.S.

Table No. 8. Soil Analysis Data. Yapacaní. 1979-1980.

pH	E.C.	P ppm	K ppm	O.M. %	Sand %	Silt %	Clay %	Texture
6-4.8	61	3.4	98	2.6	15	46	39	silty clay loam

Table No. 9. Agronomic characteristics. Rice experiment. Yapacaní. 1979/80.

Treatment	Tillering total (m^2)	Length of panicle	Plant height	Days to flowering
0-0-0	332	18	68	122
0-30-150	212	18	63	121
40-30-150	308	18	64	122
80-30-150	284	18	68	124
160-30-150	356	19	68	125
80-0-150	284	17	66	125
80-15-150	308	18	67	124
80-60-150	284	17	67	123
80-30-0	284	17	67	122
80-30-75	308	19	67	123
80-30-300	260	18	68	123
80-30-150+ME	332	17	69	124

H.3 Regional Studies of Comparison and Adaption of Corn Varieties

Head of Corn Program: Erwin Ortiz

Project Leaders: Erwin Ortiz, Diógenes Chávez and Don Kidman

H.3.1 Introduction and Objectives

The 1979-1980 regional studies of adaption and comparison of corn varieties were composed of varieties that were outstanding performers in the introduction trials, and varieties that have repeatedly performed well in previous years' tests. Performance of varieties is rated on desirable agronomic characteristics as well as yield. Selections of varieties will be made from this season's trials considering past performance as well as yield for the seed increase program.

The objectives were: (1) to compare the performance of new improved varieties with varieties now produced in different localities, and (2) to select varieties on a regional basis for the seed increase program.

H.3.2 Materials and Methods

Thirteen varieties were planted at Saavedra Experiment Station, Villa Busch (Yapacaní), San Pedro, Piray (Zanja Honda), and Mairana, in a randomized block design.

Planting was done by hand in plots 4 rows wide and 5 meters long. The distance between rows was 75 cm, with 50 cm between hills and 2 seeds per hill. Planting dates for the various regions were: Saavedra Experiment Station, October 17, 1979; Yapacaní (Villa Busch), October 25, 1979; San Pedro, October 10, 1979; Piray (Zanja Honda) December 18, 1979; and Mairana, January 16, 1980.

Weeds were controlled by hand as necessary. Insects were controlled using Nuvacron 40 at 1 liter per hectare rate.

Data taken included yields, calculated in tons per hectare of grain at 14% moisture content, and various other agronomic characteristics pertaining to variety performance.

The performance of varieties in relation to each other varied with regional locations, and all of the experiments were completed without any specific problems except the Mairana experiment. The area of Mairana suffered extreme drought conditions during the growing season, and the experiment was not evaluated.

The soil analysis of each experimental site are shown in Table 1. All of the soils are a clay type in texture, with a pH that is near neutral and an organic matter content ranging from 2.6 to 3.4%. During the growing season, no symptoms of nitrogen deficiency appeared on any of the corn plants at any of the sites. Both phosphorus and potassium seemed to be adequate for good yield response although soil test phosphorus is indicated to be near the critical level at Yapacaní and perhaps a little low at San Pedro.

Table 1. Soil Analysis of Regional Experimental Sites

Experimental Site	pH	O.M. %	P ppm	K ppm	Soil textural class.
Piray	6.8	2.6	17.0	121	Sandy clay loam
Saavedra	6.2	3.4	9.0	227	Clay
Yapacaní	6.4	3.3	7.4	195	Silty clay loam
San Pedro	7.7	2.9	5.6	152	Silty clay

H.3.3 Results

Piray-Zanja Honda

The highest variety yields were obtained at Piray-Zanja Honda as shown in Table 2, with an average of all varieties of 7.90 ton/ha. The three highest yields were obtained with varieties Amarillo Portachuelo, Suwan C-4 and Suwan 7528. The yields were 9.11, 8.98 and 8.95 ton/ha, respectively. Table 2 also gives the regional analysis, and shows that there is a significant difference among yield means at the 99% level of confidence. Table 3, which contains the Duncan Multiple Range, indicates no significant differences among the first eight top yielding varieties. Table 4 shows the days of flowering, height of plants and height of corn ear. The check varieties are Amarillo Portachuelo, Cubano Amarillo, and Sintético 10 líneas.

Saavedra

The Saavedra experiment grew well and without any problems except for a strong attack of armyworms (Spodoptera frugiperda). The average yield of all varieties was 5.81 ton/ha. The three highest yielding varieties were Poza Rica 7528, Ludiana 7528, and Suwan 7528, with average yields of 6.90, 6.53, and 6.33 ton/ha. The complete yield data are shown in Table 5. Analysis of variance showed the yield means of the varieties to be nonsignificant. The check varieties as indicated in Table 5 were Sintético 10 líneas, Amarillo Portachuelo, and Cubano Amarillo. Agronomic characteristics are found in Table 6.

Yapacaní

The Yapacaní experiment matured very well and without any serious problems being observed. Table 7 shows the complete yield data. The three top yielding varieties were Ludiana 7528, San Ramón 7528, and Suwan C-1, with yields of 5.59, 5.56, and 5.52 ton/ha, respectively. The average yield of all varieties was 5.14 tons per ha.

Table No. 2. Regional corn variety comparison trials (summary)

	Variety Location Means				All		
	Piray	Saavedra	Yapacaní	San Pedro	Locations Total	Ave.	Yield Rank
Amarillo Portachuelo	9.11	5.78	4.63	6.32	25.84	6.46	3
Suwan C-4	8.98	5.76	4.69	5.41	24.84	6.21	7
Suwan 7528	8.95	6.33	4.82	5.80	25.90	6.48	2
Ludiana 7528	8.48	6.53	5.59	5.72	26.32	6.58	1
Amarillo Cristalino	8.41	5.89	5.48	5.09	24.87	6.22	6
Suwan Saavedra	8.34	5.44	4.81	---	18.59	6.20	8
San Ramón 7528	8.32	5.58	5.56	6.30	25.76	6.44	4
Poza Rica 7528	8.06	6.04	5.42	6.18	25.70	6.43	5
Suwan C-1	7.97	5.53	5.52	4.70	23.72	5.93	9
Amarillo Dentado	7.70	5.34	5.36	3.37	21.77	5.44	10
Cubano Sel	7.28	5.17	5.31	2.69	20.45	5.11	12
Dehli 7635	6.20	5.36	5.18	3.94	20.69	5.17	11
Sintético 10 líneas	4.89	5.87	4.49	3.59	18.84	4.71	13
Average	7.90	5.74	5.14	4.92		5.93	
Significance	**	N.S.	N.S.	*		**	

Table No. 3. Regional corn variety comparison experiment. Complete yield data. Piray-Zanja Honda. 1979-1980.

Varieties	Replications (ton/ha) I	II	III	IV	Total	Ave.	Duncan Multiple Range Test
Amarillo Portachuelo*	9.68	9.78	8.10	8.89	36.45	9.11	a
Suwan C-4	8.69	9.47	8.98	8.78	35.92	8.98	a b
Suwan 7528	8.87	8.48	9.17	9.27	35.79	8.95	a b
Ludiana 7528	9.19	8.40	7.72	8.60	33.91	8.48	a b c
Amarillo Cristalino	7.51	8.48	8.48	9.17	33.64	8.41	a b c
Suwan Saavedra	8.48	8.39	9.17	7.31	33.35	8.34	a b c
San Ramón 7528	7.81	8.98	7.52	8.98	33.29	8.32	a b c
Poza Rica 7528	9.08	6.64	7.52	8.98	32.22	8.06	a b c
Suwan C-1	7.43	8.11	8.31	8.01	31.86	7.97	a b c
Amarillo dentado	8.33	7.65	7.46	7.36	30.80	7.70	b c d
Cubano Sel.*	7.13	7.72	6.55	7.72	29.12	7.28	c d
Delhi 7635	5.54	5.93	7.11	6.22	24.80	6.20	d
Sintético 10 líneas*	3.66	6.52	3.56	5.83	19.57	4.89	d
	101.40	104.55	99.65	105.12	410.72	7.90	

C.V. = 9.72%   M.S. Treatments 9.66**

* Check varieties

Table No. 4. Regional corn variety comparison experiment. Agronomic characteristics. Piray-Zanja Honda. 1979-1980.

Varieties	Days to flowering	Height of (m)	
		plant	corn ear
Saavedra V-103 (Amarillo Portachuelo)*	54	2.78	1.55
Suwan	51	2.33	1.35
Suwan 7528	54	2.58	1.40
Ludiana	54	2.45	1.33
Amarillo Cristalino	54	2.60	1.38
Suwan Saavedra	53	2.18	1.33
San Ramón 7528	52	2.43	1.40
Poza Rica	54	2.48	1.38
Suwan C-1	51	2.18	1.23
Amarillo Dentado	55	2.43	1.38
Saavedra V-101 (Cubano Amarillo)*	55	2.90	1.65
Delhi 7635	52	1.95	1.05
Saavedra V-102 (Sintético 10 líneas)*	54	2.38	1.35

* Check varieties.

Table No. 5. Regional corn variety comparison experiment. Complete yield data. Saavedra. 1979-1980.

Varieties	Replications (ton/ha)				Total	Average
	I	II	III	IV		
Ludiana 7528	7.31	6.24	6.92	5.66	26.13	6.53
Suwan 7528	7.37	6.59	6.01	5.33	25.30	6.33
Poza Rica 7528	7.78	5.82	5.81	4.73	24.14	6.04
Amarillo Cristalino	6.14	6.43	5.25	5.74	23.56	5.89
Sintético 10 líneas*	6.77	5.66	5.47	5.56	23.46	5.87
Amarillo Portachuelo*	5.42	5.31	6.54	5.93	23.11	5.78
Suwan C-4	7.06	4.80	5.78	5.39	23.03	5.76
San Ramón 7528	6.50	4.95	6.30	4.56	22.31	5.58
Suwan C-1	6.87	4.95	4.85	5.46	22.13	5.53
Suwan Saavedra	5.67	5.37	5.87	4.86	21.77	5.44
Delhi 7635	5.49	4.89	6.08	4.99	21.45	5.36
Amarillo Dentado	6.04	5.44	4.93	4.93	21.34	5.34
Cubano Sel.*	4.67	5.26	5.48	5.26	20.67	5.17
	83.09	71.71	75.20	68.40	298.40	5.74

C.V. = 10.45%   M.S. Treatment 0.63 N.S.

* Check varieties

Table No. 6. Regional corn variety comparison experiment. Agronomic characteristics. Saavedra. 1979-1980.

Varieties	Days to flowering	Height of (m)	
		Plant	Corn ear
Poza Rica 7528	55	2.15	1.13
Ludiana 7528	54	2.08	1.13
Suwan 7528	55	2.00	1.18
Amarillo Cristalino	54	2.10	1.10
Saavedra V-102 (Sintético 10 líneas)*	57	2.15	1.15
Saavedra V-103 (Amarillo Portachuelo)*	56	2.20	1.23
Suwan C-4	54	2.00	1.13
San Ramón 7528	55	2.08	1.10
Suwan C-1	54	1.90	1.00
Suwan Saavedra	52	1.95	1.15
Delhi 7635	53	1.80	0.88
Amarillo Dentado	55	2.05	1.15
Saavedra V-101 (Cubano Amarillo)*	59	2.40	1.30

* Check varieties

Table No. 7. Regional corn variety comparison experiment. Complete yield data. Yapacaní. 1979-1980.

Varieties	Replications (ton/ha)				Total	Average
	I	II	III	IV		
Ludiana	5.11	5.89	5.75	5.62	22.37	5.59
San Ramón 7528	3.67	5.50	5.57	7.51	22.25	5.56
Suwan C-1	5.62	5.77	5.84	4.85	22.08	5.52
Amarillo Cristalino	5.07	5.87	4.72	6.24	21.90	5.48
Poza Rica 7528	5.04	5.86	5.63	5.16	21.69	5.42
Amarillo Dentado	5.27	5.33	6.13	4.69	21.42	5.36
Cubano Sel.*	4.46	5.38	5.16	6.25	21.25	5.31
Delhi 7635	4.40	5.82	5.00	5.49	20.71	5.18
Suwan 7528	4.37	4.43	5.98	4.51	19.29	4.82
Suwan Saavedra	5.42	5.22	4.86	3.73	19.23	4.81
Suwan C-4	4.95	3.52	4.58	5.69	18.74	4.69
Amarillo Portachuelo*	4.81	5.35	5.00	3.35	18.51	4.63
Sintético 10 líneas*	3.77	5.69	3.77	4.73	17.96	4.49
	61.96	69.63	67.99	67.82	267.40	5.14

M.S. Treatments 0.63 N.S.

* Check varieties

The analysis of variance showed no significance among the average yields of the varieties. Table 8 contains the observations of the agronomic characteristics of the varieties. It was observed that check variety Cubano Amarillo has a tendency toward lodging. Table 8 shows this variety to be the tallest among all varieties (2.6 meters) and to the ear development at a point of greater height of all varieties (1.46 meters).

San Pedro

The San Pedro experiment developed to maturity without any problems of management or weather. However, people problems were beyond management and various plants had been robbed of the corn ears. As a result, one replication was eliminated from the experiment. The harvest yield data are contained in Table 9, which shows the three highest yielding varieties to be Amarillo Portachuelo, San Ramón 7528, and Poza Rica 7528. Their respective yields were 6.32, 6.30, and 6.18 ton/ha. The average yield of all varieties was 4.72 ton/ha. The analysis of variance showed the differences among variety average yields to be above the 95% level of confidence. The Duncan multiple range tests (Table 9) indicates that there are no statistical difference among the top eight varieties. One of the check varieties, Amarillo Portachuelo, was the highest yielding variety. Table 10 contains the agronomic observations that were recorded.

H.3.4 Discussion

Table 11 shows the average variety yields by regional location. The average variety yields of all locations are also shown. The 5 top yielding varieties according to yields averaged through regional location were: (1) Poza Rica, (2) Ludiana 7528, (3) Suwan 7528, (4) Amarillo Portachuelo, and (5) San Ramón 7528. Their respective yields were 6.64, 6.58, 6.48, 6.47, and 6.44 ton/ha. The average yield of varieties through all locations was 4.72 tons of shelled corn at 14% moisture content per hectare.

The analysis of variance of the corn variety average yields by regional location showed significance among variety yield at the 99% level of confidence. The Duncan multiple range test indicates no significant differences among the average yields of the top nine yielding varieties. Among the 5 outstanding varieties in yield and with good agronomic characteristics were 3 new additions to the comparative experiments. They were Poza Rica 7528, Ludiana 7528, and San Ramón.

Check variety Amarillo Portachuelo was one of the outstanding varieties. The check varieties Cubano Amarillo and Sintético 10 líneas were the two lowest yielding varieties averaged through locations. Nevertheless, they yielded above normal production (farmer) levels.

The agronomic characteristic observations indicated that the varieties were well adapted to all of the regional locations, with the exception of variety Cubano Amarillo. This variety grew taller than any of the other varieties in the two regional locations of highest rainfall. The height of corn ear development on the stalk was also greatest at these two locations and contributed to a much greater lodging problem. This variety performed very well in the other locations.

H.3.5 Summary and Recommendations

The regional performance of promising varieties should be a continuous study. This provides a basis of selection of varieties of corn that are well adapted to regional location and which can be used with confidence for commercial production.

Accordingly, the new varieties in this year's studies that have been outstanding should be continued in the next season's regional trials. These are: Poza Rica 7528, Ludiana 7528, San Ramón 7528, and perhaps Amarillo Cristalino. Because of consistent good performance over previous years, the varieties Amarillo Portachuelo, Cubano Amarillo, Suwan (a mixture of C-1 and C-4), and Sintético 10 líneas are recommened to the seed increase program for use in commercial production.

Table No. 8. Regional corn variety comparison experiment. Agronomic characteristics. Yapacaní (Villa Busch). 1979-1980.

Varieties	Days to flowering	Height of (m) Plant	Corn ear
Ludiana 7528	52	2.30	1.18
San Ramón 7528	54	2.25	1.20
Suwan C-1	50	2.13	1.10
Amarillo Cristalino	56	2.31	1.29
Poza Rica 7528	56	2.23	1.14
Amarillo Dentado	54	2.26	1.23
Saavedra V-101 (Cubano Amarillo)*	56	2.60	1.46
Delhi 7635	48	2.00	1.04
Suwan 7528	55	2.43	1.30
Suwan Saavedra	51	2.03	1.16
Suwan C-4	52	2.20	1.13
Saavedra V-103 (Amarillo Portachuelo)*	58	2.38	1.28
Saavedra V-102 (Sintético 10 líneas)*	55	2.43	1.31

* Check varieties

Table No. 9. Regional corn variety comparison experiment. Complete yield data. San Pedro. 1979-1980.

Varieties	Replications (ton/ha) I	II	III	Total	Ave.	Duncan Multiple Range Test
Amarillo Portachuelo*	5.49	8.08	5.39	18.76	6.32	a
San Ramón 7528	4.73	6.13	7.74	18.60	6.30	a
Poza Rica 7528	4.27	7.34	6.94	18.55	6.18	a
Suwan 7528	3.64	6.28	7.47	17.39	5.80	ab
Ludiana 7528	5.99	6.70	4.46	17.15	5.72	ab
Suwan C-4	6.16	5.34	4.73	16.23	5.41	ab
Amarillo Cristalino	3.18	7.48	4.61	15.27	5.09	abc
Suwan C-1	6.28	5.46	2.37	14.11	4.70	abcd
Delhi 7635	3.26	4.69	3.88	11.83	3.94	bcd
Sintético 10 líneas*	2.87	3.56	4.35	10.78	3.59	bcd
Amarillo Dentado	2.92	3.11	4.09	10.12	3.37	cd
Cubano Sel.*	1.28	4.42	2.36	8.06	2.69	d
	50.07	68.59	58.39	177.05	4.92	

M.S. Treatments 4.64*

* Check varieties

Table No. 10. Regional corn variety comparison experiment. Agronomic characteristics. San Pedro. 1979-1980.

Varieties	Days to flowering	Height of (m) Plant	Corn ear
Poza Rica 7528	61	2.23	1.14
Saavedra V-103 (Amarillo POrtachuelo)*	62	2.38	1.28
San Ramón 7528	60	2.25	1.30
Ludiana 7528	59	2.26	1.18
Amarillo Cristalino	59	2.31	1.29
Suwan 7528	62	2.43	1.31
Suwan C-1	54	2.13	1.14
Suwan C-4	58	2.13	1.10
Amarillo Dentado	60	2.21	1.16
Saavedra V-102 (Sintético 10 líneas)*	59	2.45	1.38
Saavedra V-102 (Cubano Amarillo)*	61	2.60	1.48
Delhi 7635	55	2.03	1.01

* Check varieties

Table No. 11. Regional corn variety comparison experiment. Average yield data of regional locations. 1979-1980.

Varieties	Replications (ton/ha) Piray	Saavedra	Yapacaní	San Pedro	Total	Ave.	Duncan Multiple Range Test
Poza Rica 7528	8.06	6.90	5.42	6.18	26.56	6.64	a
Ludiana 7528	8.48	6.53	5.59	5.72	26.32	6.58	
Suwan 7528	8.95	6.33	4.82	5.80	25.90	6.48	b
Saav. V-103(Amr. Port.)*	9.11	5.80	4.63	6.32	25.86	6.47	
San Ramón 7528	8.32	5.58	5.56	6.30	25.76	6.44	
Amarillo Cristalino	8.41	5.89	5.48	5.09	24.87	6.22	c
Suwan C-4	8.98	5.76	4.69	5.41	24.84	6.21	
Suwan C-1	7.97	5.53	5.52	4.70	23.72	5.93	d
Amarillo Dentado	7.70	5.34	5.36	3.37	21.77	5.44	
Delhi 7635	6.20	5.36	5.18	3.94	20.68	5.17	
Saav. V-101(Cubano Amar.)*	7.28	5.17	5.31	2.36	20.12	5.03	
Saav. V-102(Sintético)*	4.89	5.87	4.49	3.59	18.84	4.71	
Average	7.90	5.81	5.14	4.72			

M.S. Treatments 1.83**

* Check varieties

H.4 Regional Corn Experiments--Fertilizer Studies

Responsible for the Program: Erwin Ortiz
Responsible for Fertilizer Program: Don Kidman, Erwin Ortiz, Walter Guzmán
Assessor: Don Kidman

H.4.1 Introduction and Objectives

In Latin America, more corn (Zea mays L.) is produced than any other cereal. The demand for this cereal in regional and national markets is increasing for use in balanced feeds, principally, for poultry. Human consumption of corn is also increasing.

In Bolivia, corn occupies about 230.000 ha, which corresponds to around 23% of the total cultivated area (Avila, 1977). It is estimated that about 90% of the corn planted in Santa Cruz is of the variety Cubano Amarillo, which was introduced in 1953 (Torrico, 1968). The average yield of corn in Santa Cruz for the year 1979 was about 1.78 tons/ha (Cámara Agrícola del Oriente).

One of the factors affecting corn yields in Santa Cruz is fertility of the soil. Corn is being grown under mechanization on soils that have been depleted by rice, cotton, and sugar cane crops as well as in new areas. Fertilizer experiments in different locations and environments can give information about crop behaviour and yield, and permit estimation of fertility needs, economic returns, and production techniques.

In this experimental work, corn yields and some related agronomic characteristics were studied on a regional basis. The regions were San Pedro, Saavedra, Yapacaní, Piray, and Mairana.

This study will be used as the basis for the student thesis of Walter Guzmán.

The objectives were: (1) to determine the maximum potential production of the corn variety Cubano Amarillo on a regional basis, (2) to find an optimum level of soil fertility, (3) to determine those major plant food elements limiting yields.

H.4.2 Materials and Methods

The experiment was established at the following locations: San Pedro, Saavedra, Yapacaní, Zanja Honda (Piray) and Mairana. The methods and materials pertain to all experiments. Soils ranged in texture from sandy clay loam to silty clay. Soil samples were taken at each experimental site as a composite sample for chemical and textural analysis. All experiments were of randomized block design with 4 replications and 12 treatments. Spacing was 1 m between rows, 3 seeds per hill spaced 50 cm between hills. Desired plant density was 50.000 plants/ha. Plot size was 4 x 6 meters.

Location	Planted	Harvested	Number of Days
Piray	Dec. 18	April 29	132
Saavedra	Oct. 19	Feb. 22	126
Yapacaní	Nov. 15	Mar. 11	116
San Pedro	Oct. 10	Feb. 15	128
Mairana	Jan. 7	Failed	-

The fertilizers were applied in two applications. The first application was made at planting times as follows: Nitrogen (N), all of the N for the N-80 treatments plus 1/2 of the N for the N-160 and 240 treatments. Phosphorus (P), all treatments. Potassium (K), the K-75 plus 100 kg/ha for the K-150 and K-300 treatments (all of the K would have been applied, but sufficient quantities were not available). The remaining needed fertilizer was applied as a second application. All applications, except the minor elements (ME), were applied in bands 10 cm deep and about 15 cm to the size of the planted row. ME was applied foliar just prior to flowering stage and contained B, Fe, Mn, Cu, S, and Zn by regions.

Weeds were controlled by hand. Insects were controlled when necessary with Nuvacròn 1.51/ha.

The treatments at each location were as follows:

Treatment No.	N kg/ha N	P	K	Treatment No.	kg/ha N	P	K
1	0	0	0	7	160	15	150
2	0	30	150	8	160	60	150
3	80	30	150	9	160	30	0
4	160	30	150	10	160	30	75
5	240	30	150	11	160	30.	300
6	160	0	150	12	160	30	150+ME

Agronomic observations were made at time of harvest by experimental treatment of: height of plants, lodging originating from the roots or at some point in the stalk, and the number of plants harvest within the harvested area of two rows by 6 meters.

H.4.3 Results and Discussion

Piray

The overall yield results are reported in Table 1. Treatment yield averages varied from 8.04 tons/ha, which was the lowest N treatment (240-30-150) to 8.96 tons/ha for treatment (160-60-150). This is mentioned from the interest standpoint that excessive applications of N fertilizer often show yield reduction trends. The average of all treatment was 8.54 ton/ha. Analysis of variance showed no significant yield differences that were due to fertilizer treatments. Table 2 shows the soil to be near neutral in reaction, potassium to be borderline in availability, phosphorus more than ample and an organic matter percentage of 2.6. No plant deficiency symptoms of any nutrient were observed during the growth period and since no stem borer insects (Diatraea sp, Metamasius bilobus H.) were found during the growing cycle, lodging was assumed to be directly associated with local weather conditions.

The measured comparisons by treatment of the height of plants and lodging at harvest time are shown in Table 3. These differences are negligible. The organic matter contained in the soil at this site (2.6%) is apparently sufficient after 7 years of cultivation to supply the corn crop with its nitrogen requirement. No previous applications of fertilizers, organic or inorganic have been applied to soil at this site. The average number of plants harvested per plot treatment also differ very little. The average overall plant density was 50,278 plants/ha.

The results of this experiment indicate that the soil at this site has sufficient fertility to meet the corn crops fertility requirements. Soil test analysis support the yield data in which no response was obtained from fertilizer treatments.

The results of this experiment were important and the objectives were fulfilled in the following manner: (1) the yield results conformed with the finding of the analysis of the soil, which

Table No. 1. Corn fertilizer experiment yield data. Zanja Honda (Piray). 1979-1980.

Treatments	Replications (ton/ha) I	II	III	IV	Total	Average
0-0-0	9.53	8.56	8.36	7.99	34.44	8.61
0-30-150	7.84	8.75	8.35	8.05	32.99	8.25
80-30-150	8.77	8.36	8.55	8.99	34.67	8.67
160-30-150	7.53	9.59	7.91	8.33	33.36	8.34
240-30-150	7.60	8.50	8.21	7.86	32.17	8.04
160-0-150	8.98	8.93	9.26	8.08	32.25	8.81
160-15-150	8.83	8.30	8.77	9.01	34.91	8.73
160-60-150	9.31	8.90	9.42	8.21	35.84	8.96
160-30-0	8.70	8.00	9.00	7.69	33.39	8.35
160-30-75	8.30	8.46	9.17	8.24	34.17	8.54
160-30-300	8.14	8.59	7.91	8.77	33.41	8.35
160-30-150+ME	8.19	9.71	8.41	8.78	35.09	8.77
TOTAL	101.72	104.65	103.65	100.00	409.68	8.54

C.V. = 6.2% M.S. Treatments 0.29 N.S.

Table No. 2. Soil analysis data. Corn fertilizer experiments 1979-1980.

Location	pH	E.C.	Kppm	Pppm	O.M.	Percent Sand	Silt	Clay	Texture
Zanja Honda	6.8	67	121	17.0	2.6	61	19	20	S.C.L.
Saavedra	6.2	74	227	9.0		1	37	62	C.
Yapacaní	6.4	70	195	7.4	3.3	9	52	39	S.C.L.
San Pedro	7.7	44	152	5.6	2.9	1	57	42	S.C.

Table No. 3. Agronomic characteristics, corn experiment data are averages of 4 replications. Zanja Honda (Piray). 1979-1980.

Treatment	Plant height (m)	Lodging from roots %	Lodging from stalks %	No. of plants harvested per plot
0-0-0	3.00	13.1	4.4	63
0-30-150	2.98	7.2	3.4	59
80-30-150	3.10	10.7	3.7	61
160-30-150	3.08	11.2	5.2	58
240-30-150	3.03	17.6	5.3	61
160-0-150	3.05	11.4	5.1	59
160-15-150	3.05	10.1	4.8	62
160-60-150	3.10	15.5	4.8	63
160-30-0	3.00	12.1	6.5	58
160-30-75	3.00	8.9	5.9	59
160-30-300	3.08	13.9	4.9	61
160-30-150+ME	3.10	11.3	5.4	60
TOTAL	36.57	133.1	59.4	734
AVERAGE	3.05	11.1	5.0	60.33

indicated that there should be no yield response to P or K because they were available in sufficient quantities, (2) the percentage of organic matter in the soil plus plant residues was sufficient to provide the N requirement for the corn yields obtained. Only one crop per year has been grown continuously for 7 years on this sandy clay loam soil. The organic matter content of 2.6% is of significant importance in providing nutrient, (3) these findings can be helpful in the area of Piray in developing cropping practices for the conservation of soil fertility over a prolonged period of time.

Saavedra

Table 4 shows the yield data by fertilizer treatment which ranged from 4.68 to 5.67 ton/ha with an average of 5.24 ton/ha. The analysis of variance showed that there was no statistical significant differences in yield due to fertilizer treatments.

Table No. 4. Corn fertilizer experiment yield data. Saavedra. 1979-1980.

Treatments	Replications (ton/ha) I	II	III	IV	Total	Average
0-0-0	4.99	5.26	5.72	4.86	20.83	5.21
0-30-150	5.03	5.85	4.61	4.65	20.14	5.04
80-30-150	4.40	5.85	4.86	4.65	19.76	4.94
160-30-150	4.43	4.75	5.41	5.72	20.31	5.08
240-30-150	6.00	6.03	4.99	5.20	22.22	5.56
160-0-150	4.65	5.41	6.76	5.64	22.46	5.62
160-15-150	4.12	6.55	6.38	5.62	22.67	5.67
160-60-150	4.71	5.65	6.51	4.65	21.52	5.38
160-30-0	4.29	5.58	5.26	5.24	20.37	5.09
160-30-75	5.03	5.30	6.03	4.92	21.28	5.32
160-30-300	5.54	5.13	5.24	5.51	21.42	5.36
160-30-150+ME	4.78	4.67	4.88	4.40	18.73	4.68
Total	57.97	66.03	66.65	61.06	251.71	5.24

C.V. = 10.8% M.S. Treatments 0.35 N.S.

Table 2, soil analysis, shows the soil texture to be clay with an organic matter percentage of 3.4. The field in which the experimental site is located is in its 7th year of continuous cropping. There is no record of previously applied fertilizers of any kind. Organic matter percentage of 3.4 plus added plant residues was apparently sufficient to supply the N requirement for the corn yields obtained. Table 2 shows that available phosphorus was sufficient and that available potassium was more than adequate. Therefore, no yield response would be expected from additional quantities of these fertilizer elements.

Table 5 shows the averages by fertilizer treatment of height of plant, lodging caused by weakened stalks or roots and the number of plants harvested. These data show little variation and no relationship to fertilizer treatment. The number of plants harvested correspond to about 35,000 plant/ha.

Table No. 5. Agronomic characteristics, corn experiment. Data averages of four replications. Saavedra. 1979-1980.

Treatment	Plant height (m)	Lodging from roots %	Lodging from stalk %	No. of plants harvested
0-0-0	2.30	5.0	3.9	45
0-30-150	2.37	3.0	5.5	41
80-30-150	2.37	1.9	5.4	42
160-30-150	2.35	2.8	5.0	45
240-30-150	2.27	1.2	3.7	41
160-0-150	2.37	1.2	6.0	42
160-15-150	2.40	1.9	8.1	40
160-60-150	2.32	3.8	4.5	39
260-30-0	2.40	1.7	3.5	43
160-30-75	2.35	3.7	4.9	41
160-30-300	2.30	2.4	4.9	41
160-30-150+EM	2.40	2.4	6.0	42
TOTAL	28.2	31.0	60.5	502
AVERAGE	2.35	2.6	5.0	41

It is apparent from the results of this experiment that soil fertility was not a limiting factor at this experimental site. Phosphorus and potassium are plentiful at this time as a result of the natural parental materials. The nitrogen is derived principally from the mineralization of the organic matter and plant residues. In time, without replenishment, these mineral elements will be depleted to the point that they will become limiting growth factors.

Yapacaní (Villa Busch)

The yield results of the experiment are contained in Table 6. Fertilizer treatment yields varied between 4.15 and 5.53 ton/ha, with an overall average of 4.89 ton/ha. The statistical analysis shows no significant difference in yields due to fertilizer treatment.

Table No. 6. Corn experiment yield data. Yapacaní. 1979-1980.

Treatments	Replications (ton/ha)				Total	Average
	I	II	III	IV		
0-0-0	5.34	2.91	3.78	5.83	17.86	4.47
0-30-150	2.70	5.79	6.59	5.79	20.87	5.22
80-30-150	5.89	4.16	5.54	5.30	20.89	5.22
160-30-150	3.64	5.72	4.65	4.50	18.51	4.63
240-30-150	3.88	3.02	6.48	3.23	16.61	4.15
160-0-150	6.27	5.44	4.88	4.26	20.85	5.21
160-15-150	6.93	4.95	5.54	4.71	22.13	5.53
160-60-150	3.88	6.24	4.12	3.02	17.26	4.32
160-30-0	4.47	3.78	6.62	5.41	20.28	5.07
160-30-75	6.59	5.62	3.74	4.23	20.18	5.05
160-30-300	5.83	5.16	5.20	5.03	21.22	5.31
160-30-150+ME	4.47	5.75	3.57	4.37	18.16	4.54
TOTAL	59.89	58.54	60.71	55.68	234.82	4.89
	C.V. 25%		M.S. Treatment 0.8 N.S.			

The texture is a silty clay loam, slightly acid (pH 6.4 - Table 2). Phosphorus is borderline (7.4 ppm) in availability so differences in yield due to this element would hardly be expected. Likewise potassium is above the critical point in availability. The organic content of the soil was relatively high, 3.3%. The field was in its 4th year of continuous production. The soil N was sufficient to maintain good yields without the addition of fertilizer.

Table 7 shows the agronomic characteristics that were measured. They demonstrate the limitations of corn variety Cubano Amarillo in this region. The average height of the corn was 3.13 meters. The corn ear height averaged near 2 meters. This caused a high 74% lodging. The plant population harvested averaged about 30,000 plants/ha, well below the established population during the growing cycle.

Table No. 7. Agronomic characteristics of corn variety Cubano Amarillo at harvest. Data are averages of four replications. Yapacaní. 1979-1980.

Treatment	Plant height (m)	Lodging from roots (%)	Lodging from stalk (%)	No. of plants harvested
0-0-0	3.00	51.0	24.3	36
0-30-150	3.20	48.7	24.4	39
80-30-150	3.00	51.3	23.0	38
160-30-150	3.12	44.3	26.4	35
240-30-150	2.97	58.1	28.7	34
160-0-150	3.20	46.1	21.1	38
160-15-150	3.35	42.5	23.8	40
160-60-150	3.25	55.9	23.5	34
160-30-0	3.22	55.6	26.4	35
160-30-75	3.00	48.6	25.0	36
160-30-300	3.10	47.2	21.5	36
160-30-150+EM	3.12	49.3	25.0	36
TOTAL	37.53	597.8	293.1	437
AVERAGE	3.13	49.8	24.4	36.42

San Pedro

Yields varied from 4.77 to 6.23 ton/ha with an average of 5.6 ton/ha as reported in Table 8. The analysis of variance indicates that the treatment averages are not significantly different. This silty clay soil had an available phosphorus content of 5.6 ppm. This would seem below the critical P level; however, the treatments yield averages were very good and do not indicate deficiency of this plant nutrient. The soil analysis shows the available K (152 ppm) to be above the expected critical level; therefore, no yield increases would be expected from additions of fertilizer K. The organic matter content is shown to be 2.9%, and the experiment is the 6th cropping year. There were no visible symptoms of N deficiency during the growing period. It is apparent that there was sufficient N release from mineralization of organic materials to satisfy the N requirements of the corn crop at the yield levels obtained.

Table 9 contains data from some agronomic observations at harvest. The variations in average height of plant and average number of plants harvested are small. Plant lodging averaged about 70%.

Table No. 8. Corn fertilizer experiment yield data. San Pedro. 1979-1980.

Treatment	Replications (ton/ha) I	II	III	IV	Total	Average
0-0-0	5.14	6.73	5.91	5.96	23.74	5.94
0-30-150	4.60	4.14	5.96	4.36	19.06	4.77
80-30-150	4.25	6.16	6.16	5.25	21.82	5.46
160-30-150	5.32	5.88	5.96	4.57	21.73	5.43
240-30-150	6.10	5.88	5.46	4.39	21.83	5.46
160-0-150	4.25	6.23	7.93	6.51	24.92	6.23
160-15-150	4.82	5.17	4.28	6.42	20.29	5.07
160-60-150	6.16	7.43	5.17	4.47	23.23	5.81
160-30-0	6.51	5.60	7.26	5.52	24.89	6.22
160-30-75	5.28	5.46	6.23	6.38	23.35	5.84
160-30-300	6.45	4.57	7.01	5.60	23.63	5.91
160-30-150+ME	6.66	4.00	4.89	4.96	20.51	5.13
	65.54	67.25	72.22	63.99	269.00	5.60

C.V. = 16.8% M.S. Treatments 0.86 N.S.

Table No. 9. Agronomic characteristics of corn experiment at time of harvest. Data are averages of four replications. San Pedro. 1979-1980.

Treatment	Plant height (m)	Lodging from roots (%)	Lodging from stalk (%)	Plants harvested/ plot
0-0-0	2.82	4.2	6.0	42
0-30-150	2.82	4.5	9.0	39
80-30-150	2.87	1.3	8.2	40
160-30-150	2.82	3.1	6.9	40
240-30-150	2.82	4.7	7.0	48
160-0-150	2.85	1.8	9.8	41
160-15-150	2.82	2.5	6.9	40
160-60-150	2.87	3.6	7.7	42
160-30-0	2.77	2.9	5.8	43
160-30-75	2.80	3.0	6.1	41
160-30-300	2.75	6.7	5.5	41
160-30-150+ME	2.80	5.1	8.3	39
TOTAL	33.81	43.4	87.2	521
AVERAGE	2.82	3.6	7.3	43.42

H.4.4 Summary and Recommendations

Regional corn fertilizer experiments were established at Piray, Saavedra, Yapacaní, San Pedro, and Mairana, using corn variety Cubano Amarillo with 12 fertilizer treatments. These were prepared to identify the limitations of N, P and K, and some minor elements (Cu, Fe, S, Mn, B, and Zn). Soil samples were taken at the sites at planting time to establish the availability of P and K, and to determine the organic matter percentage. The yield result differences by fertilizer treatment were not statistically different at any location. The soil analysis confirmed that no yield increase should be expected from P or K fertilizers, with the possible exception of San Pedro, where P was below an expected level. There was no yield response to applied fertilizer N. This indicates that there was sufficient release of N from the mineralization of organic matter and plant residues to satisfy the corn crop requirements for maximum yields. The regional sites represented continuous cropping from 5 to 7 years without additions of inorganic fertilizers. Mairana was an exception with continuous cropping estimated to be 26 years.

A greater effort should be made in identifying soil fertility limitations on a broader regional basis. This effort should be made on a basis of soil type and the number of years by crop in continuous cropping selecting sites after soil fertility states has been determined by soil analysis. To have information of soil fertility, reserves and limitations on a regional basis is of great economic importance to the grower.

H.5 Regional Oilseed Crops Fertilizer Experiments, 1979-80.

Project leader: Hebert Zurita
Cooperators and Counterparts: Hebert Zurita, Alejandro Tejerina, and Don Kidman

H.5.1 Introduction and Objectives

Oilseed crops are increasing in economic importance in the Santa Cruz area, and although variety studies have been extensive, there is no data available at Saavedra Experiment Station pertaining to oilseeds crops response to applied fertilizers for this area. Lower than average yields were commonly observed in the older farming areas, especially on some of the sandy soils. It was decided, therefore, to begin some preliminary studies during the cropping year 1979-80, with the option of expanding the program in the following years as resources would permit.

The objectives were to: (1) determine potential crop yields by measuring yield response to various levels of applied fertilizer nutrients, and (2) identify critical nutrient levels by means of yield response and soil analysis.

H.5.2 Materials and Methods

Two experiments were established with soybeans and one with peanuts. The soybean experiments were located at the Saavedra Experiment Station and Piray (south zone), and seeded with the variety Pelicano. The peanut experiment was established at the Saavedra Experiment Station with variety Taiwan Sel. No. 9.

A randomized block design was used with an incomplete factorial.

The plot size was 2.4 m x 6 m (14.4 m^2). It consisted of 4 rows each 6 m in length with a row spacing of 60 cm and a plant spacing of 7.5 cm for soybeans, and 10 cm for peanuts. Fertilizer treatments were applied at date of planting by banding at a depth of 5 cm to one side of the seeded row. Minor elements, which were applied foliar about 45 days after planting. The soybeans were planted at Saavedra, December 7, 1979, and Piray, December 19, 1979. Peanuts were planted November 10, 1979.

Required soil analysis was performed and results are contained in Table 1.

Weeds were controlled at Saavedra by hoe. At Piray, the herbicide Lasso was used at a rate of 3 liters/ha plus hoeing.

Insects were controlled using Nuvacron 40 at 1 l/ha; and/or Thionex at 1 l/ha. No disease control measures were used in the soybean experiments; however, in the peanut experiments, one application of Benlate at 300 gms/ha plus an application of Dethane M-45 at 3 kg/ha was used for the control of leaf spot (Cercospora sp.)

Soybeans were harvested April 25 and May 8, 1980 at Saavedra and Piray, respectively. Peanuts were harvested March 3, 1980. The plot area harvested was 6 square meters and excluded border rows. Yield data are reported in ton/ha of soybeans at 13% moisture content, and in ton/ha of peanuts at 8% moisture content.

Table 1. Soil analysis data at experimental sites.

Location	pH	K ppm	P ppm	O.M. %	Texture
Soybean					
Saavedra	6.5	86	11.0	3.1	Medium
Piray	6.4	125	27.0	2.1	Medium
Peanut					
Saavedra	6.2	90	7.4	2.1	Medium

H.5.3 Results and Discussion

Complete experimental yield data are contained in the tables. Table 2 (Saavedra soybean experiment) shows that average yields due to fertilizer treatments varied from 1.49 to 1.78 ton/ha, with an overall average of 1.59 ton/ha. The analysis of variance of the yield data contained shows there were no significance differences among fertilizer treatment means. The coefficient of variation (CV) of 12.6% indicate that the experiment was well managed. These results correlate positively with the soil analysis data of Table 1, which indicates that both available phosphorus and potassium were above critical levels for these elements (8-10 ppm for P, and 80-100 ppm for K). There is no indication from the soil analysis that yield increases from applied fertilizer treatments should have been obtained.

The average fertilizer treatment yield from the soybean experiment located at Piray are shown in Table 3. The yields range from 2.19 to 2.93 ton/ha, with an average of 2.74 ton/ha. The analysis of variance shows no significant differences among the treatment yield means. Table 4, soil analysis, shows that available P and K are high, and therefore yield increases would not be expected from additions of these fertilizer elements.

Table No. 2. Regional fertilizer experiment in soybeans. Yield data. Saavedra. 1979/80.

Treatment	Replications (ton/ha)				Total	Average
	I	II	III	IV		
0-0-0	1.44	1.53	1.64	1.52	6.13	1.53
0-0-150	1.46	1.60	1.34	1.67	6.07	1.52
0-150-150	1.71	2.00	1.74	1.65	7.10	1.78
0-30-150	1.27	1.65	1.64	1.40	5.96	1.49
0-60-150	1.78	1.58	1.58	1.68	6.62	1.66
0-30-0	1.57	1.77	1.96	1.45	6.75	1.69
0-30-75	1.88	1.08	1.56	1.58	6.10	1.53
0-30-150+ME*	1.19	1.80	1.58	1.48	6.05	1.51
0-30-225	1.33	1.81	1.79	1.42	6.35	1.59
0-30-225+ME	1.74	1.57	1.76	1.77	6.84	1.71
25-30-150	1.64	1.65	1.57	1.18	6.04	1.51
25-30-150+ME	1.57	1.86	1.49	1.16	6.08	1.52
	18.58	19.90	19.65	17.96	76.09	1.59
		C.V. = 12.6%		M.S. Varieties	0.04 N.S.	

* ME consisted of a mixture of B, Fe, Mn, Cu, S, and Zn.

Table 3. Regional fertilizer experiment in soybeans, yield data. Zanja Honda (Piray). 1979/80.

Treatment	Replications (ton/ha) I	II	III	IV	Total	Average
0-0-0	2.37	2.51	2.31	3.02	10.21	2.55
0-0-150	2.84	2.69	2.87	2.76	11.16	2.79
0-15-150	2.33	1.53	2.89	2.92	9.67	2.42
0-30-150	3.57	2.68	2.98	2.35	11.58	2.90
0-60-150	2.28	3.34	2.66	3.12	11.40	2.85
0-30-0	2.05	2.18	2.03	2.13	8.39	2.10
0-30-75	2.08	2.47	2.75	3.80	11.10	2.78
0-30-150+ME	1.48	2.38	2.00	2.95	8.81	2.20
0-30-225	2.37	3.22	2.72	2.78	11.09	2.77
0-30-225+ME	3.08	2.79	2.81	2.41	11.09	2.77
25-30-150	2.71	3.15	2.66	3.19	11.71	2.93
25-30-150+ME	2.66	2.38	2.88	2.64	10.56	2.64
	29.82	31.32	31.56	34.07	126.77	2.64

C.V. 16.1% M.S. Varieties 0.29 N.S.

The yield results of the peanut experiment are contained in Table 4, and show average yields of treatments to vary from 1.60 to 2.03 ton/ha with an overall average of 1.83 ton/ha. The CV of 10.9% indicating factors is fairly well controlled.

The analysis of variance showed no significant differences among fertilizer treatment means. As is shown in Table 1, P is near borderline in availability (7.4 ppm), but still was ample. K is shown to be in sufficient available quantity.

Minor elements, as applied, gave no indication of crop yield response at either site.

There was no response to applied nitrogen fertilizer from any of the three experiments.

Table 4. Regional fertilizer experiment of peanuts. Saavedra. 1979/80. Yield data.

Treatment	Replications (ton/ha)				Total	Average
	I	II	III	IV		
0-0-0	2.02	1.87	1.50	2.03	7.42	1.86
0-0-150	1.45	1.92	2.03	1.95	7.35	1.84
0-15-150	1.80	2.09	1.67	1.94	7.50	1.88
0-30-150	1.74	2.03	1.76	1.71	7.24	1.81
0-60-150	1.55	1.71	1.86	1.58	6.70	1.68
0-30-0	1.35	1.94	1.52	1.60	6.41	1.60
0-30-75	1.94	2.02	2.23	1.74	7.93	1.98
0-30-150+ME	2.09	1.65	2.21	1.70	7.65	1.91
0-30-225	1.54	1.78	1.88	1.52	6.72	1.68
0-30-225+ME	1.82	2.24	1.88	2.17	8.11	2.03
25-30-150	1.96	1.79	2.20	1.73	7.68	1.92
25-30-150+ME	1.68	1.94	1.81	1.81	7.24	1.81
	20.94	22.98	22.55	21.48	87.95	1.83

C.V. = 10.9%   M.S. Treatments 0.07 N.S.

H.5.4 <u>Summary</u>

Regional fertilizer experiments were established at Saavedra with crops of soybeans and peanuts, and at Piray, with soybeans. The fertilizer elements used as variables in the experiments were N, P, K, and ME. Soil analysis were obtained from soil samples taken at each experimental site to verify the availability of P and K. No significant differences among yield means due to fertilizers treatments were obtained at either location. These yield results were in agreement with the soil sample analysis for P and K, which showed that they were available at near or above critical levels.

H.6 Studies of Time of Planting and Row Width of Soybean Variety Pelicano During Winter in the Area of Yapacaní.

Alejandro Tejerina, Hebert Zurita, Don Kidman, and Angel Cordero*

H.6.1 Introduction

About 4,500 ha of soybean are produced during the winter season, in the humid regions of the Santa Cruz area (Yapacaní, San Pedro, and border of the Rio Grande), usually in rotation with rice.

Winter soybean production is generally used as seed for the summer planting, although a part finds use in the oil industry. Since previous studies show soybean yield is directly affected by planting date and density, it was necessary to determine the most appropriate planting date and density for the Santa Cruz region. The soybean variety Pelicano was used and the study was conducted in Yapacaní.

H.6.2 Bibliography Review

F. Sainz (1974) reports that all soybean varieties flower more rapidly with periods of darkness of from 14 to 16 hours, however some varieties require 10 hours of darkness. According to these differences of sensibility to photoperiod, varieties are adapted to determined latitudes.

Previous work at Saavedra (H. Zurita, 1974-75), showed that the optimum plant population density of soybean variety Pelicano during summer seeding in Santa Cruz was 60 to 90 cm between rows, and 7.5 to 12.5 cm within rows.

J. Alson Aldunate (1976) found the optimum plant population densities in summer in Santa Cruz corresponded to a distance of 60 to 90 cm row spacing, and 2.5 to 7.5 cm in row spacing. He also found that with this row spacing, the height of plants increased by an average of 10 cm over the height of plants in row widths of 80 to 90 cm with in-row plant spacing of 10 to 15 cm. The experiment was designed to elucidate these characteristics.

H.6.3 Materials and Methods

The experiment was established on the farm of Sr. Asano, located in the colony of San Juan de Yapacaní, province Ichilo, Department of

*This work is a contribution of the Saavedra Experiment Station of CIAT, also it is part of a thesis. The authors are: Graduate Student in Agric. Science of UBGRM; Head of the Oilseeds Program at the Saavedra Experiment Station; Research Agronomist, CID; and professor of Agriculture Science, UBGRM, respectively.

Santa Cruz, in the winter of 1979. The zone is subtropical and humid; mean temperature, 26.6°C; mean low temperature, 16.4°C during the summer, and 22.5°C and 8.0°C, respectively, during winter. The precipitation was 1061 mm during summer, and 434 mm during winter of 1979. The soil texture was clay, with a pH of 5.4; the organic matter content was 3.1%; phosphorus very low and potassium 0.33 me/100 g of soil, this corresponds to a medium fertility, with a phosphorus deficiency.

The experimental design was a randomized block with a split plot. There were four replications (blocks). There were planting dates (whole plots) at 15 days intervals, starting with the first of May and continuing until the first of August, 1979. Row width constituted the split plot with four row widths of 20, 30, 40, and 50 cm. The size of the split plot was four rows by six meters of length. Plant spacing within the rows was uniform at 7.5 cm.

The variety Pelicano was used which corresponds to maturity group VIII. It is an indeterminate growth type, susceptible to lodging, indehescent, and has cream colored seed. Maturity period of Pelicano is 98 days in Santa Cruz. Average height is 110 cm; cutting height of 16 cm (lowest seed pod); and average yield at Saavedra has been 2,088.5 kg/ha.

The seed was inoculated, planted using a Planet Junior, and irrigated "up". The soybeans were thinned after 15 days from date of planting to 7.5 cm. Weeds were controlled by hand.

Insect pest, Empoasca sp., Thrips sp., Ceratoma sp., Diabrotica sp., and other species were controlled with two applications of Nuvacron 40, at rates of 0.6 l/ha.

The following data were taken: days to flowering, days to maturity, height of plant, cutting height, number of pods per plant, number of seeds per pod, lodging, weight of 100 seeds, quality of the seeds, and yield.

H.6.4 Results and Discussion

A review of the results are contained in Tables 1 and 2. The average number of days to maturity was 119, and increase of 21 days over summer planting.

The average height of plant was 33.2 cm, only 30% of that obtained during summer. The planting of May and August were superior to those of June and July in height of plant by 16 cm average. There was no difference in height of plant due to row spacing of 20 to 50 cm. Time of planting or row spacing did not affect lodging.

Table 1. The effect of time of seeding in relation to agronomic characteristics of soybean variety Pelicano seeded during the winter season at Yapacaní. 1979.

Time of seeding	Days to maturity	Height of plant cm	Height of cutting cm	No. pods/ plants	Weight of 100 seeds	Quality of seed (*)	Yield kg/ha
1/V/79	121	36.6	11.1	19.6	9.2	1.6	1.104
15/V/79	120	38.1	11.6	18.7	10.8	1.7	1.231
1/VI/79	118	28.6	7.6	15.2	8.6	1.8	960
15/VI/79	112	26.7	8.6	10.9	7.9	1.5	739
1/VII/79	116	25.1	9.8	10.8	13.8	1.6	1.046
15/VII/79	114	24.8	7.5	14.7	10.6	3.5	1.333
1/VIII/79	132	52.2	15.0	14.2	11.7	4.7	1.107
AVERAGE	119	33.2	10.2	14.9	10.4	2.3	1.074

* Scale: (1) very good; (2) good; (3) regular; (4) poor; and (5) very poor.

Table 2. The effect of row spacing in relation to agronomic characteristics of soybean variety Pelicano seeded during winter at Yapacaní. 1979.

Distance between rows cm	Plant height cm	Cutting height cm	Stalk width mm	No. pods/ plant	Weight of 100 seeds	Quality of seed (*)	Yield kg/ha
20	33.3	10.9	2.6	11.6	10.3	2.4	1.203
30	33.9	10.3	2.9	14.0	10.2	2.4	1.108
40	32.9	9.9	2.9	15.9	10.2	2.3	1.008
50	32.2	9.5	3.0	18.1	10.6	2.3	977
Average	33.1	10.2	2.8	14.9	10.3	2.4	1.074

* Scale: (1) very good; (2) good; (3) regular; (4) poor; and (5) very poor.

The cutting height in winter was 10.2 cm, which is 5.8 cm lower than in summer. The height of cutting was 4.2 cm higher for the seedings of May and August in comparison to June and July. The average cutting height was 0.9 cm higher for row widths 20 and 30 cm in comparison to row widths 40 and 50 cm.

The quality of seed was good in those plantings from the first of May through the 15th of July, but was of lesser quality for all other plantings because of the damage from excess rainfall during the maturing periods.

The average yield in this experiment was 1.074 kg/ha, which is only 49% of average summer yields. Only the yield of the crop growth period beginning on the 15th of June was significantly inferior to those of the other crop growth periods; this was due to extreme drought stress. The average yield due to row widths of 20 and 30 cm was 14% higher than those of 40 and 50 cm due to the lower height of plants during winter.

Figure 1 shows graphically the effect of planting date and density on soybean yields in the Yapacaní area.

H.6.5 Conclusions

The results of the experiment indicate: (1) the time of planting best suited for soybean variety Pelicano during the winter in Yapacaní is the middle of May, and (2) the distance between rows of from 20 to 30 cm is best suited for soybean variety Pelicano during winter in Yapacaní.

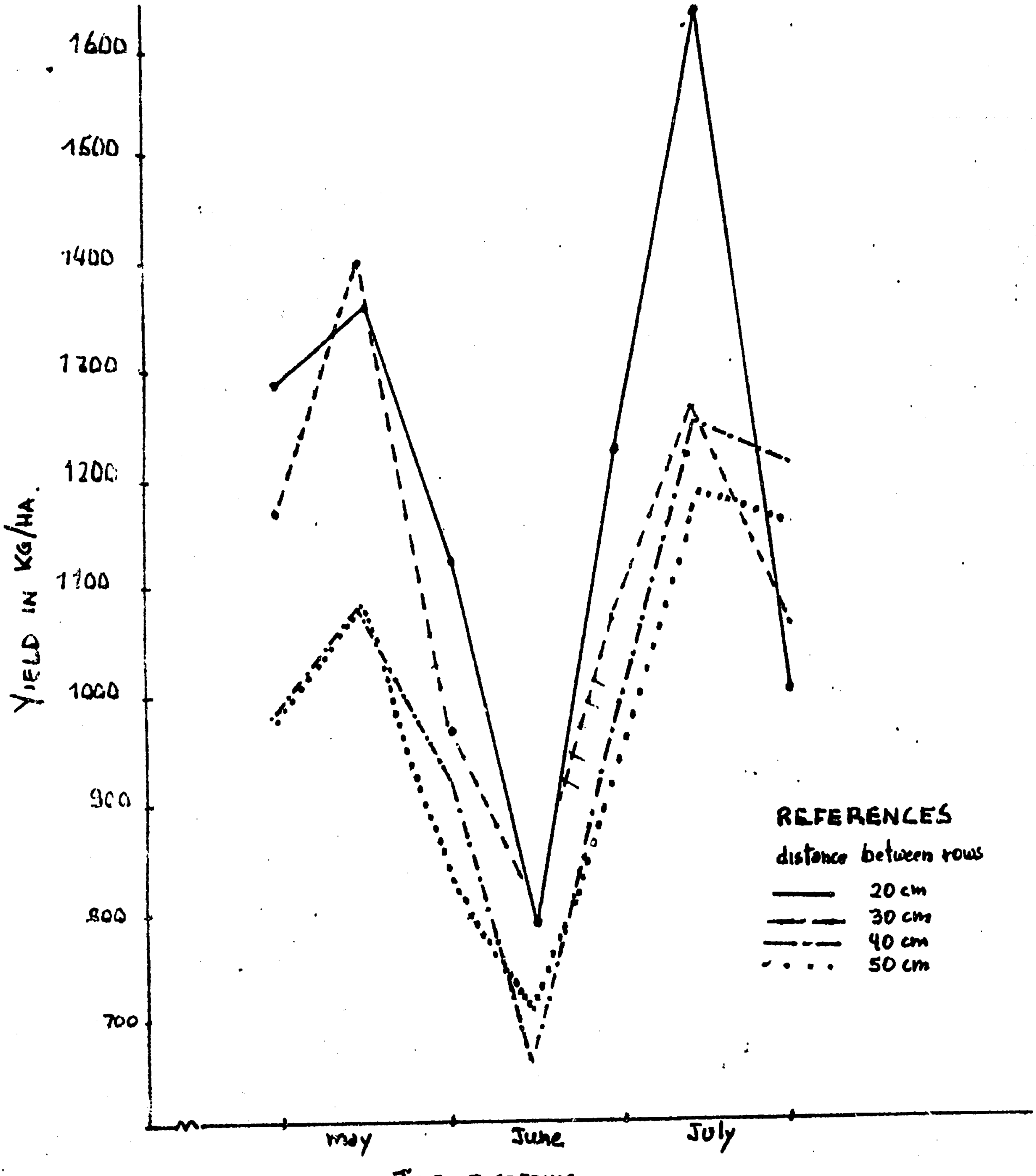

FIGURE 1. The effect of time of seeding and distance between rows on yields of Soybean variety Pelicano during winter. 1979.

I. GENERAL EXTENSION

by

José Santaella P. - Extension Specialist

I.1 Beginning with the reporting period (January 1, 1980), the position of Extension Specialist was moved to La Paz to work directly with the IBTA Director of Extension and the Extension Administrative office.

An in-depth evaluation of the administrative was started under the Director of Extension, Ing. Alfredo Ballerstaedt. Several descriptive papers were prepared and submitted to IBTA by the CID advisor. These reviews and evaluations were performed to determine the changes that would be required when the new extension program, funded by USAID/B, would be initiated in mid to late 1980.

The reduction in total CID manpower from 10 to 7 agreed upon by MACA/USAID/CID in February (to be effective in May) required the Extension position to be cancelled. A revision of the goals and objectives for the extension specialist was made to include only short range activities. Subsequently in March and April activities were confined to short range objectives of advising on personnel actions and completing the Extension program plan.

The position was terminated May 15, 1980.

SECTION IV

TRAINING ACTIVITIES

Student Scholarships

CID has been managing a scholarship fund provided by MACA from GOB counterpart funds. The scholarships have allowed students who have completed their class work and have certificates as Egresados to perform appropriate research, write a thesis, and obtain their Ingeniero Agrónomo degree with the financial support of fund and the technical and academic support of the CID staff scientists.

The program has been very successful and is highly praised: by MACA who will be hiring the graduates; by the Universities who have, in the past, often dispaired of finding suitable advisors and/or projects for their students; by CID who have been able to maintain contact with the Universities and carry on a larger research program because of the added personnel engaged in the research; and by the students who often fail to complete their degrees because of lack of financial resources or languish in the absence of a truly scientific atmosphere.

A CID staff scientist has been a member of almost every thesis committee and helped to direct the work. They have further reviewed each thesis and helped the students write professionally in a competent manner.

The following is a summary of the students currently in the program.

LIST OF BECARIOS - JANUARY TO JUNE, 1980

NAME	Jan.	Feb.	Mar.	Apr.	May	June	Contract Final Date
La Paz							
Monica Cecilia Lora Vacher	xxxx	xxxx	xxxx	xxxx	1/2		May 15, 1980
Cochabamba							
Rosario Vargas de Claure	xxxx						January 31, 1980
René G. Torrico Marañón	xxxx						January 31, 1980
Ramiro Blacutt Blacutt	xxxx	xxxx					February 29,1980
Roberto J. Bernal	xxxx	xxxx					February 29,1980
Freddy O. Claros Rivero	xxxx	xxxx					February 29,1980
Oscar V. Omonte	xxxx	xxxx					February 29,1980
Gregorio Quilo Lima	xxxx	xxxx					February 29,1980
Mario Jaimes Villarroel	xxxx	xxxx	xxxx				March 31, 1980
Ponciano Camacho Ovando			xxxx				March 31, 1980
Tito José Revollo Quiroga			xxxx				March 31, 1980
Simón Jesús Ricaldez Sejas		xxxx	xxxx	xxxx			April, 30, 1980
Ruth Mery de Rodriguez	xxxx	xxxx	xxxx	xxxx	1/2		Mayo 15, 1980
Nelson Rodriguez Lizárraga	xxxx	xxxx	xxxx	xxxx	1/2		Mayo 15, 1980
Raúl Gregorio Morales Molina	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	October 15, 1980
Daniel Sánchez Chávez	xxxx	xxxx	xxxx	xxxx	xxxx	1/2	Junio 15, 1980
Julio Mancilla Lafuente	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	June 30, 1980
Felipe Cantuta Mamani	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	June 30, 1980
Pablo España Vargas		xxxx	xxxx	xxxx	xxxx	xxxx	July 31, 1980
Esteban Augusto Antezana					xxxx	xxxx	October 31, 1980
Luis Pedrazas Arandia					xxxx	xxxx	October 31, 1980

N A M E	Jan.	Feb.	Mar.	Apr.	May	June	Contract Final Date
Cochabamba (Cont.)							
Freddy Corrales Melendres					xxxx	xxxx	October 31, 1980
Eddy Victor Alvarez Mejia					1/2	xxxx	November 14, 1980
Mario Altamirano Orosco						xxxx	November 30, 1980
Alejandro Mérida Villarroel						xxxx	November 30, 1980
Freddy Caballero Ledezma						1/2	December 14, 1980
<u>Santa Cruz</u>							
Judith Dorado	xxxx	xxxx	xxxx				April 30, 1980
Alejandro Tejerina	xxxx	xxxx	xxxx				March 31, 1980
Ivonne Silvia Rivera	xxxx	xxxx	xxxx	xxxx			April 30, 1980
Miguel Ramiro Aguilera	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	July 31, 1980
Alberto Aguilera Soruco	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	July 31, 1980
Luis Fernando Cardona V.	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	July 31, 1980
Freddy Aranibar	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	June 30, 1980
Walter Guzmán	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	October 31, 1980
Julio Calancha Siles	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	September 30,1980
Norberto Orosco	1/2	xxxx	xxxx	xxxx	xxxx	xxxx	July 15, 1980
Eduardo Zambrana		xxxx	xxxx	xxxx	xxxx	xxxx	July 31, 1980
Róger Velez			xxxx				March 31, 1980
Rodolfo Aguilar			xxxx				March 31, 1980
Leonor Castro			xxxx	xxxx	xxxx	xxxx	August 31, 1980

SECTION V

PUBLICATIONS

Working Papers

01/80 - Agribusiness Integration as an Alternative Small Farm Strategy by Kendall A. Adams, April 1980.

02/80 - Evaluación del Programa de Entrenamiento del Préstamo 511-T-053, Sector Agrícola I by Alejandro Pierront and Sonia Aranibar, May 1980.

03/80 - Short Term Consultant Report--Control of Crown Gall in Cochabamba by Arthur H. McCain, May 1980.

04/80 - Short Term Consultant Report--Insects Affecting Potatoes in Bolivia by Oscar G. Bacon, June 1980.

05/80 - The Effect of Shipping Containers on Transportation Damage to Tomatoes, Green Onions, and Carrots by Kendall A. Adams, April 1980.

06/80 - Informe de Consultoría a Corto Plazo by Samuel Vélez, June 1980.

Administrative Reports

02/80 - End of Tour Report with CID Contract--The First Five Years and a Critique of USAID/Bolivia by David W. James, June 30, 1980.

SECTION VI

GENERAL

CID/USAID-B Working Relationships

CID/USAID working relationships have improved markedly over the past several months. During the first 3-4 years of the Contract, CID was often required to justify its activities, not in reference to the contract terms, but in relation to perceived USAID requirements and/or philosophy which was not included in the "Host Contry Contract," but which was implied as binding on the contractor. This "rear guard" action often detracted CID administration and staff in Bolivia and in the U. S. from more meaningful use of time. Further, apparently arbitrary financial decisions were made by USAID that affected both MACA and CID without recourse except contract cancellation.*

Fortunately, these problems have been resolved and it appears that, if funding is available, the better working relations will allow CID to maximize their efforts during the final two years of the contract and realize most of the original goals.

Special Purchase Account T-053

During the budget negotiations held in February, it became evident that grant funds were not available for scientific supplies and instruments. Permission was requested and granted by MACA and USAID/B to utilize $40,000 from T-053 loan funds to supplement the CID contract activities. Purchases were to be made by September 22, the termination date of T-053. Approximately $20,000 was to be spent in the U.S., through Utah State University purchasing services, and $10,000 was to be used in Bolivia for supplies. The remaining $10,000 would cover transportation costs of the supplies and equipment from the U.S. to Bolivia.

This fund has been extremely helpful to the contract. The instruments, equipment, and tools it has purchased will almost completely satisfy the needs of the contract to termination and will serve IBTA for many years if properly maintained.

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* Detailed information available in CID Administrative Report 02/80 by David W. James, pp. 44-48.

T-053 Irrigation Equipment Purchase

In September of 1978, Dr. Richard Griffin was contracted under the 511-06 contract to design an irrigation system for the experimental areas of the Saavedra Experiment Station (CID Working Paper 022/78). In previous years, many experiments have been lost to drought conditions. A supplemental system of irrigation would also permit experimentation with irrigation which earlier reports indicated was necessary if maximum production was to be realized in the Santa Cruz area.

Dr. Griffin's design was approved and funds were earmarked from T-053 to purchase the equipment through Utah State University. The equipment was purchased and sent to Bolivia to be installed by Don C. Kidman, CID staff member in Santa Cruz.

The equipment cost $29,000, and the transportation cost $30,000.

When it is installed and functional (November 1980), the system will provide a quantum increase in effective research capability of the station.

Counterpart Relationships

As reported in all previous quarterly and semiannual reports, CID continues to experience difficulty and frustration over the CID/IBTA counterparts issue. A counterpart survey (CID Administrative Report 02/80, page 28) indicates that CID has never had a complete set of counterparts for the team since inception. Each CID technician should have had one (or more!) full time counterpart(s) who he could train and who could work exclusively with the CID scientist. Our experience has been one or all of the following at one time or another with each position.

1) Counterparts are shared by more than one CID scientist.

2) Counterparts are responsible to CID and one or more other donor or contract groups.

3) Counterparts are changed by IBTA Administrators before meaningful training can take place.

4) Counterparts have a full research or administration load in IBTA in addition to CID responsibilities.

5) Counterparts are assigned who do not have sufficient academic background to take advantage of CID training.

It is, of course, recognized that personnel changes are necessary and counterparts will have differing degrees of capability, but it is evident that IBTA personnel are not receiving the in-depth training that would be possible from the experienced CID scientists.

Contract 511-06 for Short Term Consultants

Readers are referred to the last semiannual report (CID Administrative Report 001/79, page 163) for a discussion of the function of this contract which is an appendage contract originally designed to facilitate this contract (511-101). Contract 511-06 is scheduled to terminate in September of 1980. (T-053 is the source of the loan funds).

It has proven very useful to the CID contract. Five consultants were contracted during the reporting period for help on the CID contract and one consultant was contracted for USAID/B. The five consultants are listed below.

A final comprehensive report will be available after the contract terminates in September of 1980.

CID Report Number	
03/80	Arthur McCain. "Crown Gall in the Cochabamba Region of Bolivia," (a review of incidence, recommendations for control, laboratory procedures, and recommendations for future activities.
--	Antonio Stambuk Vargas. Consultant to provide computer program services in our effort to standardize IBTA station reports and facilitate timely reporting by IBTA technicians.
06/80	Samuel Vélez. Instruction of three groups of 15 persons each in extension and communication; review the production, preparation and publication of bulletins; prepare a manual or guide for the production and publication of scientific and extension bulletins.
04/80	Oscar G. Bacon. Insects Affecting Potatoes in Bolivia. A review of the insects found on and affecting potato production. Recommendations for study and determining control procedures.
--	Benjamín Garnica. Attorney. 511-06 funds were paid to Mr. Garnica by agreement from MACA and USAID/B. CID had no responsibility for this service.

-- Ing. José Santaella P. Short term services for agricultural extension from June 1st to September 15. CID had no responsibility for this consulting service. Contract approval was received from MACA and USAID/B.

02/80 Alejandro Pierront H. Evaluation of the training provided by 511-T-053. USAID/B requested contract. Approved by MACA and USAID/B. CID had no responsibility for this contract.

Computer Services

Dr. T. Stilwell has been working with IBTA counterparts, MACA officials, Experiment Station Directors, the University of San Simón Computer Center, and students to develop a series of computer programs that would allow experimental results to be analyzed by computer. Dr. Stilwell and programmers from a local computing firm, under contract with CID, have developed a number of these programs and are working on more.

These programs will allow virtually all the experimental results from all the experiment stations in Bolivia to be analyzed using a standard format. They will provide speedy results with which more timely and more meaningful station reports can be written. The programs will be designed to be run on the nation's university computers or easily adapted to run on most microcomputers.

The programs are also designed to be operated by the "near novice" as well as experienced operators. The computer is programmed to "ask for" the information it needs in order to process the data and give the desired information.

One facet of the training and advising to be done by the CID technicians at the Experiment Station level will be to instruct in the use of these computer programs as a tool for research.

A complete list of programs available to IBTA will be available for the next semiannual report.

SECTION VII

SUMMARY OF CONTRACT STATUS AND ACCOMPLISHMENTS

General

The last semiannual report described the changes made during July 1 - December 31, 1979 and their effect on the contract. It also reported the preliminary effects of the November 1979 revolution in Bolivia and the subsequent problems in renegotiating an extension of the contract. Drastic cuts in program and personnel demanded by USAID precipitated a visit to Bolivia by Dr. Doyle Matthews, Dean, College of Agriculture, USU, and responsible official at USU for the CID/Bolivia Lead University. A reduction in staff of 30% from 10 to 7 was finally agreed upon as a compromise and an extension with budget was signed. The team was then at full strength until the end of the reporting period.

The individual project sections in this semiannual report show that a great deal of valuable information has been accumulated during the past year. Relatively more information on the agricultural production of Bolivia in Ag. Sector I will be forthcoming next year. Recommendations for new practices, if followed, would dramatically increase production in potatoes, cereals including corn, and oilseeds.

The extension effort was dissipated considerably by change of location and was eventually discontinued.

Toralapa Summary (CID)

CID/IBTA technicians added significant amounts of germplasm to the Bolivia Germplasm Bank by cooperating with three collection teams representing six countries. The material will add to the Bolivian potato breeding program.

Germplasm from the regular germplasm bank was maintained in two locations this season instead of one. More varieties were converted to botanical seed to avoid loss from virus contamination.

Through becarios, 75 previously unclassified varieties were classified as to chromosome count and resistance to potato cyst nematode. Further work in this area is planned.

Interspecific crosses were made to determine parentage of Imilla Blanca and Sani Imilla varieties.

Breeding for yield and quality continues. More introductions have been tested as well as hybrids (crosses) made for yield and quality. A number of elite breeding lines have potential as future varieties.

Breeding for resistance to late blight disease continues. New clones and other elite lines were tested in two or more locations. Blight incidence was low, but the resistant clones yielded much higher quantities of marketable potatoes than the checks Sani Imilla and Imilla Blanca.

Frost resistant trials were planted at Belen and Koari. Yields of test clones consistently exceeded yields of the susceptible check Sani Imilla, and the resistant check Choquepitu. Where condition were very bad (Belen yield trial), Choquepitu yielded more than the test clones.

Breeding for resistance to viruses continues with tests to verify PVY-resistance of clones. Seventy-five clones introduced from the U.S. were inoculated with PVY; 25 showed symptoms and were discarded.

Seven thousand seedings from 30 progenies are being evaluated by a becario for PVY resistance. Progenies from crosses of resistant clones are being evaluated.

Four thousand new tubers were received from U.S. crosses for evaluation. These were planted in May. Additionally, 15,000 botanical seeds from segregating PVY resistant material will be evaluated by a becario.

Toralapa Potato Agronomy Summary (CID)

CID technicians have been successful in building from local materials two plot fertilizer applicators which have increased precision and reliability of results. The past year's results of using the equipment are very encouraging. Potato sizing equipment has also been developed. This will aid in marketing and classification studies.

Continued experimentation re-emphasizes the urgent need for a soils laboratory to do routine soils analysis in a reliable inexpensive way.

In addition to on station testing, regional fertilizer trials were conducted in 14 experments in 10 locations. Trials included major and minor fertilizer elements and information was also gathered on seed treatment, specific gravity. Results show that the element phosphorus is critically lacking for high yields. Where phosphorus was applied, yields increased by 2-4 times in the same location. Increases in yield also increased the number of medium size potatoes for the market.

The implication of doubling or tripling potato yields on a national or regional basis needs to be studied.

San Benito Cereals Summary (CID)

Wheat experiments for this year (1979-80) showed that under present conditions, high technology inputs into wheat production are probably a losing proposition with the exception of utilizing a high yielding adapted variety of seed. Grain yields are very low compared to other world wheat producing areas, but the cost of required fertilizers, herbicides and insecticides to produce higher yields is prohibitive. Using normal farmer practices but substituting an improved variety gave the best net return, but the highest yields were produced with fertilizer. Only one year of data is available and recommendations must be viewed as preliminary. Experiments were conducted with location, fertilizer, lime,pre-emergent and post-emergent weed control, varieties and technology of production.

Barley and oat experiments showed that further research in barley will be most effective in variety and chemical control of yellow rust. Experiments were conducted in weed control, varieties, technology, rust control, and forage production.

A survey was conducted to provide base information in cereal production. The survey results will be used to identify needed areas of research.

Computer programs have been and are being prepared "for use by IBTA and CID technicians without previous computer experience," which will allow reports from all stations to be standardized. The time (2-3 months) now being required for analysis of results and writing reports will be dramatically reduced and useable information will be available for distribution much quicker.

Saavedra Agronomy Summary (CID)

Investigative work this year has been confined to research on corn, soybean, rice, and peanuts.

The best varieties from the soybean variety trials exceeded the check variety Pelicano by 80-100%. Two or three varieties are now ready for seed increase.

The best varieties from the corn variety trials were significantly better than the check Cubano Amarillo and two have been selected for seed increase based on this and past year's performance.

Variety experiments were conducted with corn, peanuts, and soybeans, and fertilizer trials were conducted on rice, corn, and oilseeds. In the Santa Cruz area, studies show that soil fertility levels are usually adequate for rice, corn, peanuts, and soybeans. No significant responses to fertilizer were recorded in the 1979-80 season.

Other studies on continuous cropping vs. "barbecho" system were conducted. Preliminary results show that a continuous cropping system can be profitable, but more studies are required. There is good evidence that soil fertility decline under continuous cropping is slow or negligible with good management and previous data showing significant yield decline is probably due to lack of weed control in subsequent years.

Time of planting studies indicate that mid-May is optimum planting date for soybeans in the Yapacaní region.

Saavedra-Entomology Summary (CID)

Entomological studies on T. limbatriventris were started this year. Artificial populations were grown on rice in variety densities and results show that increasing numbers of insects cause increasing damage. Economic levels of damage are not defineable at present.

Grasshopper populations control with the use of chemicals in rice is being studied. Plots sprayed with 9 chemicals had varying degrees of control as expressed in yield.

Chemical controls are being investigated for insects in soybeans, and peanuts. These were preliminary studies and further work is required.

Insects are continuously being collected, prepared, identified, and placed in the National Insect Museum in Cochabamba.

Agricultural Economics Summary (CID)

Marketing studies were continued in vegetables (including potatoes). Observations and data show that the retailing operation in the market is very inefficient. Retail margins of 33 - 50% are common. Improvement in the retailing operation, such as pre-bagging in 25 lb. bags, which is the most popular size, would reduce consumer price significantly.

Transportation systems for vegetables were studied. Containerized shipment reduced damage; 20% in tomatoes; to zero in carrots; and had no effect on onions. Consumer preferences were identified and it was shown that in some cases consumers were willing to pay a premium of 20% for top quality, or size.

Economic analysis of new technology was conducted in Cochabamba and Santa Cruz, and a study on continuous cropping was made. Results will appear in CID working papers or bulletins.