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INTERNATIONAL POTATO CENTER

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DEVELOPMENT OF CIP

In 1971 an agreement was ratified with the Government of Peru making the establishment of the International Potato Center the fifth autonomous international center sponsored by the Consultative Group of International Agricultural Research, CGIAR. The first funding though the CGIAR was received in 1972, since then the Center has made rapid progress in establishing its research, regional research and contractual research programs.

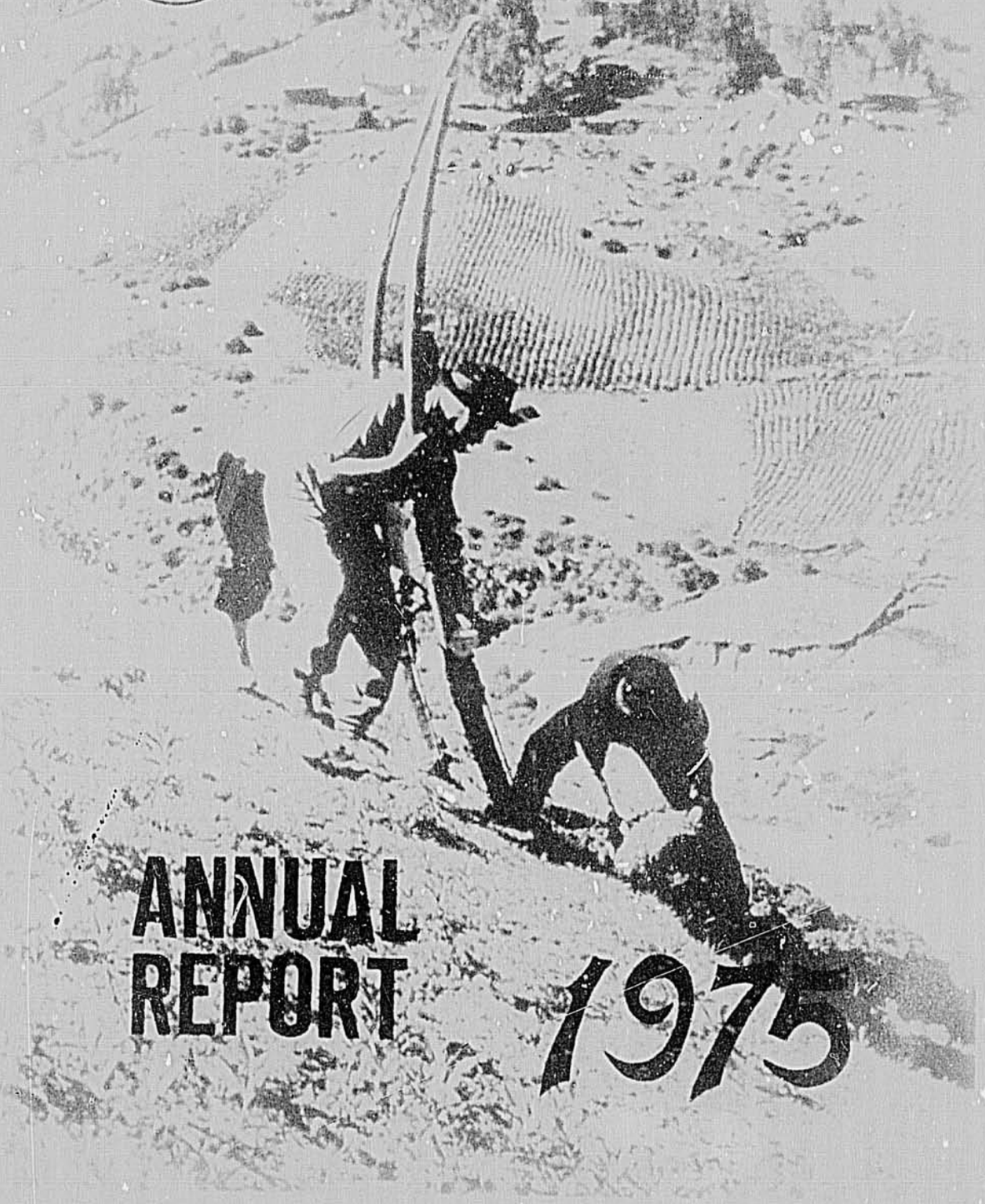
The forebearers of the International Potato Center, known also as CIP the acronym for the Spanish equivalent, were the Rockefeller Foundation's International Potato Program in Mexico and the North Carolina State University's potato research program in Peru. The latter funded by USAID was in collaboration with the Peruvian National Potato Program. The legacy provided CIP with research information, trained personnel, and basic germplasm which has been integrated into a strategic plan of action now functioning.

The emblem of the International Potato Center is derived from a Pre-Colombian weaving of Nazca Culture.

THIS ANNUAL REPORT OF THE INTERNATIONAL POTATO CENTER FOR 1975

IS AVAILABLE FREE OF CHARGE IN ENGLISH AND SPANISH

INTERNATIONAL POTATO CENTER
APARTADO 5969 LIMA-PERU CABLE:CIPAPA



ANNUAL REPORT 1975

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COVER PHOTOGRAPH:
Farmers in the Andes mountains still use the foot plow or "Chaquitaclla" to turn the soil on the steep hillsides to plant potatoes.

The International Potato Center, also known as Centro Internacional de la Papa (CIP), is a Scientific Institution, autonomous and non-profit making, established by means of an agreement with the Government of Peru with the purpose of developing and disseminating knowledge for greater utilization of the potato as a basic food. International funding sources for technical assistance in agriculture are financing the center.

STATEMENT BY DIRECTOR GENERAL, CIP

This is CIP's third Annual Report. During the past three years CIP has become one of the senior members of the group of Centers sponsored by the Consultative Group on International Agricultural Research. Achieving the institutional maturity indicated in this report in such a short period depended greatly on the following:

- The faith and backstopping of donors who were willing to invest in a new approach to the establishment of a Center.

- Scientists of international caliber who were willing to leave secure comfortable positions in established institutions to join such a venture.

- A Board of Trustees, everyone of whom was a working member, giving several weeks a year of their time to CIP management without pay.

- Contracts with established institutions for a portion of CIP's Core Program which provided a quick access to on-going programs working on developing country problems.

- A recognition by developing countries of the need for an international center concentrating on the tuber-bearing Solanums.

The hard part of growth is behind. The interesting part of research breakthroughs with potatoes for developing countries is now here. Just ahead in developing countries are the increases in production, production efficiency and production stability due to CIP's involvement. My personal thanks to everyone who was involved in the Chapter of the "CIP Story" encompassed in this third Annual Report.

CIP DONORS - 1975

Starting from a group of three donors in 1972, the following donors have also contributed to the financial support of the International Potato Center:

	Core Budget	Special Projects Budget
- Banco Interamericano de Desarrollo (BID)	X	X
- Canadian International Development Agency (CIDA)	X	
- Danish International Development Agency (DANIDA)	X	
- Ford Foundation		X
- Government of Germany	X	X
- Government of Switzerland	X	
- Institut Mondial du Phosphate		X
- International Minerals & Chemical Corporation (IMC)		X
- Rockefeller Foundation	X	
- Sweden International Development Agency (SIDA)	X	
- United Kingdom Overseas Development Ministry (UKODM)	X	
- United States Agency for International Development (USAID)	X	

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IN MEMORIAM

IT IS WITH DEEP REGRET THAT WE REPORT THE DEATH OF DR. BØRGE JACOBSEN ON MARCH 4, 1976 IN VANDEL, DENMARK. DR. JACOBSEN HAD BEEN A MEMBER OF THE CIP BOARD OF TRUSTEES FOR TWO TERMS AND HAD TAKEN AN ACTIVE PART IN THE ANNUAL INTERNAL REVIEW OF OUR PROGRAM. HIS INVOLVEMENT IN THE ACTIVITIES OF CIP WILL BE GREATLY MISSED.

THE STATUS OF CIP STATE THAT TO FULFILL ITS OBJECTIVES THE CENTER WILL:

I Conduct research programs for the improvement of potato production and other tuberous roots, both nationally and internationally;

II Collect, maintain and distribute germ plasm in order that it may be used nationally and internationally;

III Provide assistance in the development of related institutions which might be established in Peru or headquartered elsewhere;

IV Train potato technicians under the leadership of high-level scientists;

V Publish and distribute research results;

VI Establish an information center and organize a specialized library, as well as an herbarium;

VII Organize conferences, forums, round tables and seminars, both nationally and internationally concerning potato improvement activities;

VIII Participate in all other activities related to the goals of the Center.

STATEMENT BY THE DIRECTOR OF RESEARCH

The organization of CIP's research is presented elsewhere in this Annual Report. Basically, 9 Thrusts focus on broad research objectives while Projects within Thrusts provide the flexible and dynamic action to solve specific production constraints.

The philosophical strategy guiding CIP's research can be succinctly stated: to rapidly develop, adapt, and expand the research necessary for the technology to solve priority problems limiting production in developing countries. This implies adapting the collective knowledge that has contributed to the step-wise increase in potato production in developed countries. But, at the same time, the exploitation of hitherto unavailable genetic resources now in CIP's World Potato Collection, coupled with the challenge to respond to the urgent world demand for more food, provides abundant incentive to seek "breakthroughs" in production.

CIP has an awareness of the unsolved technical problems that limit production in developing countries. The need to breed and select potatoes resistant to persistent pathogens and pests, and adapted to produce adequate yields under the stress of drought, heat and cold, imposes a practical bias on CIP's research. In recognition of the many unsolved technical problems, it has been a part of CIP's philosophy to sponsor Planning Conferences to obtain expert guidance in identifying priority problems and in recommending appropriate action. Limited resources and urgency dictate the need to contract research to solve basic or background problems restricting applied research progress.

STAFF

on December 31, 1975

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Luis Valencia, Ing. Agr.	Entomologist

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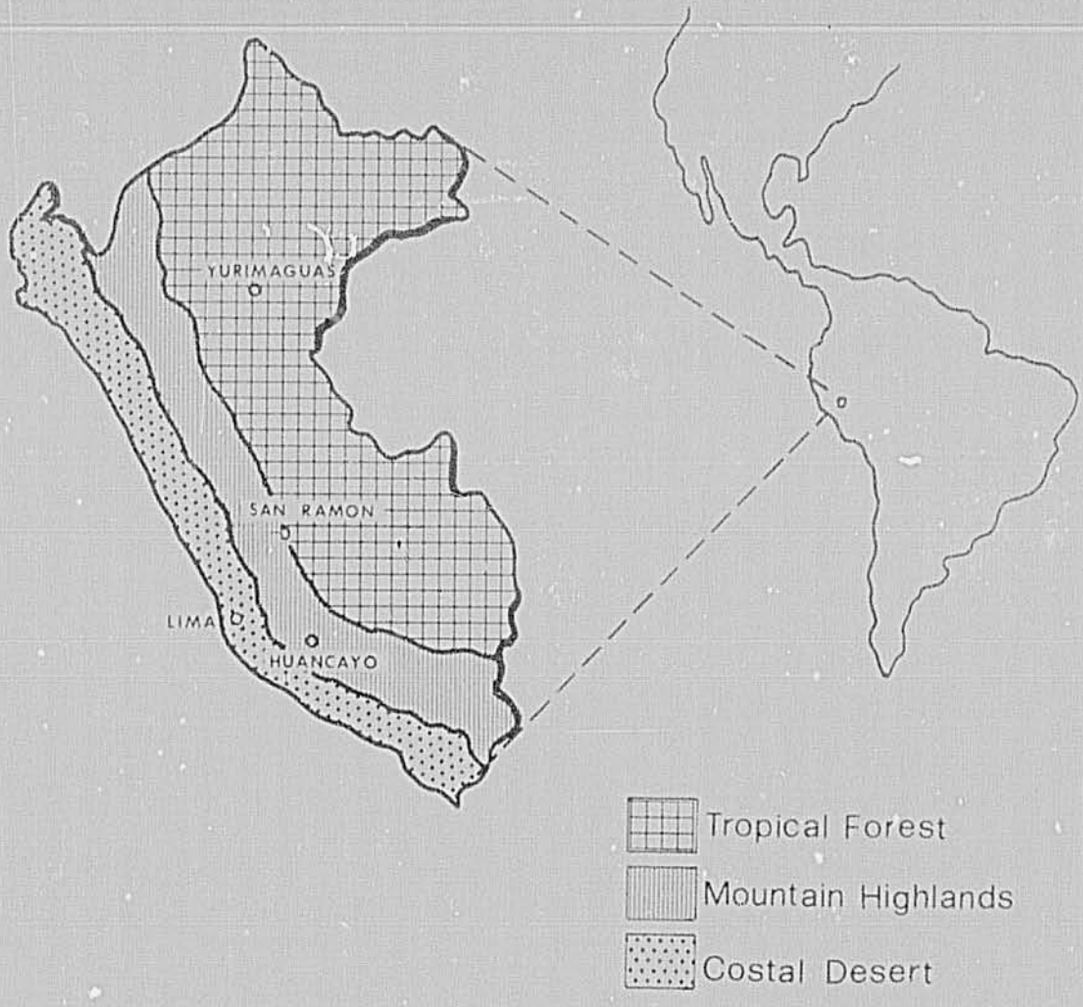
Rosa Méndez, Ing. Agr.	Physiology
Donald Berrios, Ing. Agr.	Physiology (Huancayo)
Amparo de Siveroni, Q.F.	Physiology
Rosario de Roca	Physiology

FUNDING OF THE INTERNATIONAL POTATO CENTER

The International Potato Center is one of a family of international agricultural research centers in various strategic locations around the world. These agricultural research centers are funded by the Consultative Group on International Agricultural Research (CGIAR), a co-operative organization comprised of 29 governments, assistance agencies and foundations which seek a solution to the urgent need for food production in developing countries. The centers are charged with specific areas of research responsibility. The International Potato Center is a one-crop institute working to improve potato cultivation in developing areas of the world.



Geographical and Environmental Data for 5 Year Period for Growing Periods*

	La Molina	Huancayo	San Ramon		Yurimaguas
Altitude	238	3,380	800		175
Latitude	12	12	11		6
Growing period	Dec.-Feb.	Nov.-Apr.	May-Jul.	Dec.-Feb.	May-Jul.
Length of growing period (days)	75	150	90	90	60
Rainfall (mm)	0	496	264	673	375
Air t (max.abs.)	31 C	26 C	33 C	34 C	36 C
Air t (min.abs.)	14 C	-2.0 C	10 C	15 C	19 C

* Environmental Data is only for the length of the growing period.

EXPERIMENTAL DEVELOPMENT

The location of the International Potato Center in Peru provides within practical traveling distance three unique climatic areas suited to plant research. While the yearly difference in length of day with light intensity above 1 foot candle does not vary more than one half hour, other climatic factors vary greatly.

*The headquarters site at La Molina, a short distance to the east of Lima, is located in a subtropical coastal desert. The annual precipitation cannot be expected to exceed seven millimeters per year and food production can only be possible with irrigation. The air temperature range in this site varies between 14 and 31° C.

*In contrast to the site at La Molina, the research area at Huancayo is at an elevation of 3,300 meters and frost can be predicted from April to September and air temperatures as low as -5° C. The climate of the Huancayo area is considered to be typical of the climate of the Andean potato producing area.

*The experimental area of San Ramon is located in what is known as the "high jungle" area of the Amazon Basin. The elevation is slightly above 800 meters and tropical conditions exist. It is considered only as an advance base of operations to be used as experiments move to areas lower in the humid tropics. No buildings exist at the San Ramon site.

*During 1975 another area was established in the amazon jungle, the Yurimaguas area. The elevation of this experimental area is 175 meters above sea level. The fields are located on the Huallaga river in the low tropical region of the jungle, and minimum nighttime temperatures are not known to drop below 19° C and the day temperatures may reach as high as 36° C. An airstrip is located nearby and the flight from Tarapoto, Peru, requires 15 minutes. There are no permanent structures at the Yurimaguas facility.

HEADQUARTERS, LA MOLINA, PERU

The central headquarters of the International Potato Center is located in the Agricultural Institutes complex at La Molina, a short distance to the east of Lima. Located close by are the National Agricultural Experiment Station, the National Industrial Agricultural Research Center, and the National Agrarian University. Students working toward advanced degrees at the National Agrarian University are able to work under the direction of CIP scientists doing research with potatoes.

The central headquarters complex includes a main building where laboratories and administration offices are located. Field areas, greenhouses, storage structures, screenhouses, and support areas complete the facility. There is a small cattle ranch where animals are kept for the production of antisera used in virus research. The recently completed building to house the germplasm bank is described elsewhere in the support area.

HUANCAYO FACILITY

Greenhouses under construction in Huancayo

CO-OPERATING INSTITUTIONS

The International Potato Center has been able to expand its research base by contracting institutions in other areas of the world. By these contractual arrangements, the facilities of CIP as a research institution are expanded to include resources and facilities not available in Peru.

* Cornell University, USA
* North Carolina State University, USA
* University of Wisconsin, USA
* University of Minnesota, USA
* Agricultural University, Wageningen, The Netherlands
* University of Birmingham, United Kingdom
* Foundation for Agricultural Plant Breeding, Wageningen, The Netherlands
* Research Station for Arable Farming, Lelystad, The Netherlands
* I.A.C., Wageningen, The Netherlands
* Ministerio de Agricultura, Peru
* Swedish Seed Association, Svalov, Sweden

SIGNIFICANCE OF THE POTATO

The Potato, a tuber-bearing species of "Solanum" – the native food for centuries in the Andean highlands, the staff of life for the Irish, and a common sight on many tables throughout the world – is more than an ordinary vegetable. In the shadow of the growing food crisis, a spotlight now is cast upon the potato. Rich in carbohydrates, the potato has long been recognized as a source of energy; but this tuber also offers a superior source of protein and ascorbic acid, further complimented with useful amounts of thiamine, niacin, iron, and phosphorus.

MAJOR CROPS RANKED ACCORDING TO CALORIE AND PROTEIN PRODUCTION (*)

	Calories		Protein	
RANK	Production per Unit Area	Production per Unit Area per Day	Production per Unit Area	Production per Unit Area per Day
1	Sugar cane	White potatoes	Soybeans	Soybeans
2	White potatoes	Corn	White potatoes	Beans
3	Sugar beet	Sugar cane	Corn	Peas
4	Corn	Rice	Peanuts	White Potatoes
5	Rice	Sugar beets	Sorghum	Corn
6	Sorghum	Sorghum	Peas	Sorghum
7	Sweet potatoes	Barley	Beans	Peanuts
8	Barley	Sweet potatoes	Rice	Spring wheat
9	Peanuts	Beans	Barley	Barley
10	Winter wheat	Soybeans	Winter wheat	Rice

* Data from Feds Staff paper, October 2, 1970 "Agronomic Potential of US Crops for Production of Calories and Protein".

Suited to Small Farmers in Developing Countries

In addition to the benefits to public health, the labor intensive cultivation process for the potato is better suited to the needs of the small farmer in developing countries than the cereal crops. The comparatively short growing period gives the farmer an opportunity to use the potato in a system where more than one crop is possible on the same land each growing season.

Genetic Potential

Although the potato is a principal food crop of the industrialized countries of the northern temperate zones, the full genetic potential of the potato for developing countries of the world remains unexploited. In tropical climates, diseases and pests are still major drawbacks, especially when chemical protectants are too expensive for the farmer and storage conditions are difficult to arrange. In-country production of healthy tuber seed potatoes and their distribution to farmers for planting each year presents technical problems in countries without the necessary infrastructure or the technical expertise. The importation of vegetatively multiplied crops such as the potato is limited in most countries by quarantine laws. Easy country-to-country transfer of newly improved varieties takes place readily with the cereal crops such as wheat and rice, but not with the potato. To help overcome these limitations and others, the International Potato Center was created.

RESEARCH ORGANIZATION

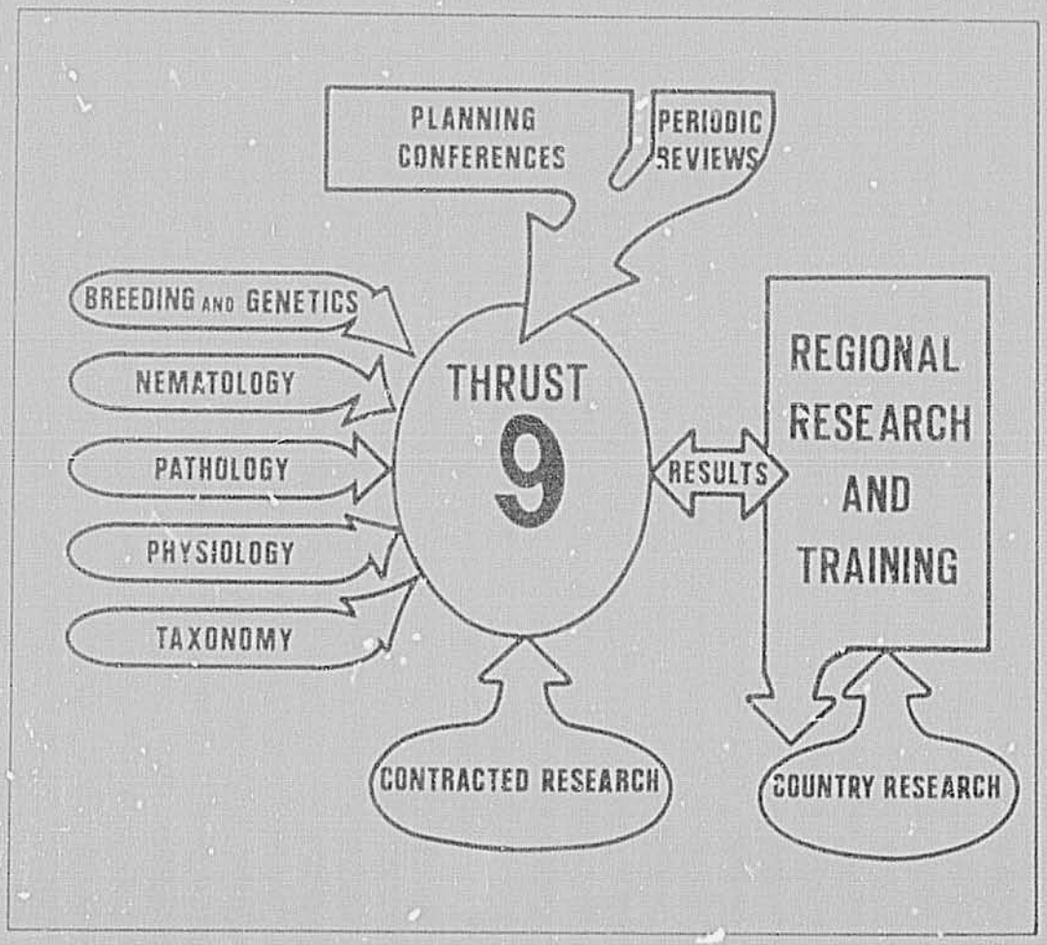
For administrative efficiency CIP source research is organized into five Departments: Breeding and Genetics, Nematology, Pathology, Physiology and Taxonomy. These Departments facilitate the vertical integration of scientists according to discipline, the budgeting of research, funding of research contracts, and the allocation of technical and stenographic assistance. Through Departmental co-operation source research scientists contribute to Regional Research and Training activities. The Departments are the first order of research organization, the weft of CIP's research fabric.

It would be difficult for CIP to achieve its goals without dynamic research Thrusts that provide the horizontal cohesive unification among Departments - the warp of CIP's research fabric. The nine research Thrusts, each with a Thrust co-ordinator, serve to integrate research activity aimed at broad problem areas. In this 1975 Annual Report research progress is outlined under Thrust titles.

Within a broadly defined Thrust there are a number of specific research Projects, about 40 in total, each with a leader and one or more co-operators. A Project is clearly defined with respect to the justification for initiating the research, background knowledge, objectives, experimental procedures, expected duration and funding estimate. Progress within a Project as well as the collective progress within a Thrust is monitored from time to time culminating in annual Project Progress Reports.

The source of research effort of CIP is substantially augmented through Contact Research carried out at universities and institutions in Europe, England and North and South America. Contract Projects have defined objectives and are funded through CIP Departments for three-year periods with annual review of progress. More than a dozen outstanding research teams are involved under contract in solving specific priority potato problems of significance to developing countries. Through Contracts CIP is able to gain access to research expertise, instrumentation, and research facilities at substantial savings in capital outlay and costs for the personal services of competent scientists and their essential technical support. Scientists under contract also contribute to CIP's Regional Research and Training programs.

Through Planning Conferences, 86 international experts from 23 countries have been convened at three year periods to overview the objectives research Thrusts. Recommendations and priorities have been established to guide CIP projects development during the next five years. In addition to the direct usefulness of an open external review, participants also commonly identify problems of interest to their own areas of work. On return to their respective institutions, the fortuitous encounter with a CIP problem has frequently resulted in the initiation of a project in free support of a CIP Thrust or objective.



DEVELOPING THE WORLD POTATO COLLECTION
(Thrust No. 1)

The objectives of this thrust are:

1. To explore and collect all primitive cultivated forms and wild species of potatoes in the Western Hemisphere.
2. To save from extinction the gene reservoir which is actually in danger of loss due to erosion pressures.
3. To find new living genetic sources for potato breeding purposes.
4. To classify the collected germ plasm.
5. To put classified material at the disposal of potato scientists.
6. To maintain in a usable form, all collected species of potatoes.

POTATO EXPLORATIONS AND COLLECTIONS FOR 1975

During 1975 the search for potato germ plasm was continued into areas of the Central Mountains of Bolivia, Southern Peru, the Andean area of Ecuador, and the Archipelago regions of Chiloe in Chile. Some complementary regions of Colombia were also searched. The potatoes of the Chiloe region of Chile are considered to be primitive plants which are on the route to extinction.

More than 3500 accessions of cultivated potatoes have been collected, usually in the fields during harvest. At times, scientists were able to locate materials in storage areas and in native markets. The expeditions into the departments of Ayacucho, Apurimac, Cuzco and part of Puno found the area extensive and difficult.

The explorations which have been completed so far in 1975 leave the areas of Venezuela and the mountainous areas of Mexico to be searched. However, work of this nature is continuous and we expect to continue to locate new materials for the collection for some time on a reduced scale. The planned work of searching for potato germ plasm has progressed rapidly and it is almost two years in advance of the projected timetable for completion.

MATERIAL INTRODUCED INTO CIP GERM PLASM COLLECTION - 1975

	Donor	Collector	Origin	No. Accts.
Native cultivars	Est. Exp. de Labor	C. Ochoa	Guatemala	29
New collections introduced into CIP in 1975	Ovalle, Quetzaltenango	C. Ochoa	Guatemala	44
		C. Ochoa	Sur Peru	3,000
		C. Ochoa	Ecuador	231
		C. Ochoa	Colombia	19
	O.J. Santos		Inst. Agronom. Campinas, Sao Paulo, Brazil	1
	Dr. H. Kishore		Wisconsin, USA	3
			Central Potato Res. Inst. Simla, India	35
	Dr. H.W. Howard		Breeding Program Cambridge, England	4
Hybrids	Dr. Huijsman		Breeding Program Wageningen, Holland	4
	Dr. T.T. Sekioka		University of Hawai College of Tropical Agriculture	2
		C. Ochoa	Guatemala	22
Wild Species		J. Hawkes M. Jackson J. Landeo	Central Peru	16

EVALUATION OF GERM PLASM

Over 2,000 clones were evaluated, mostly by CIP scientists, in 1975. Recorded were reactions to late blight, nematodes, viruses, and freezing temperatures. Data were obtained also on yielding ability and nutritional quality. Clones with useful traits will form the genetic base for future breeding work.

TAXONOMICAL STUDIES OF THE GERM PLASM BANK

The classification of potato germ plasm materials contained in the CIP collection has progressed steadily in 1975. The large mass of living material from many regions of South America has produced a great number of duplicates. Lists of this synonymous material have been compiled and a check is being planned to be made with chemotaxonomical methods to verify duplicates.

For the present time, the following classified groupings by species of the collection have been made.

Species	Number of Accessions
S. stenotomum Juz. et Buk	853
S. goniocalyx Juz. et Buk	239
S. phureja Juz. et Buk	225
S. ajanhuiri Juz. et Buk	56
S. tuberosum L. (ssp. *andigena*)	5,171
3 x natural hybrids (S. x *chaucha*)	557
S. x juzepezukii Buk	134
S. x curtilobum Juz. et Buk	149
Total of native cultivars treated	7,384
Hybrids of TXA	29
TOTAL ACCESSIONS	7,413

A planning conference is being scheduled for March of 1976 for the purpose of reviewing progress in explorations cultivated potatoes and determining priorities for continuing work in the coming years of 1976 to 1981. In the coming planning conference, participants from at least eight countries will meet to present opinions and suggestions for continuation of the work underway.

DISTRIBUTION OF GERM PLASM

The number of requests for material from the CIP Germ Plasm Collection has increased each year. Because of quarantine regulations, distribution outside of Peru is made primarily in the form of botanical seed. In most instances open-pollinated seed of clones with known resistance is distributed in response to specific requests. Improved genetic stocks in the form of hybrid seed or as tubers are distributed from the various research programs of CIP-Lima, as well as from the CIP Regional Base in Mexico, Contract Projects, and co-operating institutions. All of these sources are combined to meet the increasing need for genetic resources.

The planned work of searching for potato germ plasm has progressed rapidly and it is almost two years in advance of the projected timetable for completion.

Ing. Juan Landeo in the process of artificially pollinating a potato flower.

UTILIZATION OF THE TUBER-BEARING SOLANUMS TO PROVIDE BETTER ADAPTED POTATOES FOR DEVELOPING COUNTRIES
(Thrust No. 2)

The objectives of this thrust are threefold:

1. To improve the adaptation of tetraploid and diploid Andean *Solanum* species.
2. To create superior populations in performance and stability for use in the highlands and lowland tropics.
3. To evaluate breeding procedures for utilizing the germplasm resources in the cultivated forms of *S. tuberosum*.

During the summer of 1975, 15,000 clones of *neo-tuberosum* were evaluated. From these, a sample of 1,500 high-yielding and early maturing clones were selected and planted in La Molina and Huancayo. This was done to develop genetic materials for crossing to sources of resistance to pests.

During the summer of 1975, a 2,500 *phureja* population was evaluated. Superior families and clones were crossed during the Fall to initiate a new selection cycle. Some tuber bearing wild *Solanum* species have been incorporated to widen genetic base and introduce some pest resistance. A sample of 1,000 clones was evaluated in December, 1975 for resistance to late blight, bacterial wilt, root knot nematode, and viruses X and Y.

An 8,000 clone tuberosum population was evaluated in the summer of 1975 and a sample selection of 300 clones was cross pollinated. A seedling population is in preparation for evaluation next Summer.

The breeding work for adaptation of the potato to the lowland tropics was continued in 1975. Forty superior clones were selected and planted at Yurimaguas. Four of these clones yielded 0.5 Kg. of potatoes per plant in a 60 days growing period. Parents of these plants were used to obtain 40 tuber families (3,000 clones) which will be replanted in the hot lowland.

In the over-all approach to this thrust, a number of research contracts with other institutions are integrated into the program.

GROWTH CHAMBERS

Dr. Kenneth Sayre, Physiologist, checking plants in growth chamber.

Modern controlled environment equipment has been installed, tested, and is presently being used in research. Four large "Conviron" walk-in type growth chambers provide scientists with 36 ft2 of area in each. One chamber is equipped to lower growth temperature to -7 C, and it permits studies of cold adaptability of the potato. There are six smaller reach-in chambers, each one with 9 ft2 of growing area. Two of the smaller chambers will provide controlled growing conditions down to -5 C with full illumination.

With the equipment installed, it is possible to program 24 temperature changes each day with a minimum time of five minutes between changes.

Adaptation to the Lowland Tropics

Three testing sites in Peru were used in these experiments. La Molina, an arid area under irrigation that represents a hot lowland tropic. San Ramon, a high jungle location where the common crops are cassava, fruit trees, coffee and corn. Yurimaguas, a low jungle site in the Amazonian basin where the agriculture is a shifting system that uses cassava, rice, bananas and tropical forages.

About 6 000 clones from various diploid and tetraploid taxonomic groups as well as their intercrosses were evaluated at the San Ramon location during the period June-October, 1974. From these 36 tetraploid clones were chosen for their earliness and yield potential and were grown in replicated trials during December to February 1975 at San Ramon and La Molina. The same set of clones was grown later at Yurimaguas. The following indicates the taxonomic groups in the pedigrees of the clones utilized in the experiments:

Tuberosum x Tuberosum	4 clones
Tuberosum x Phureja	16 clones
Tuberosum x Neo-Tuberosum (Andigena)	5 clones
Neo-Tuberosum x Neo-Tuberosum	6 clones
Tuberosum x native Andigena	2 clones
Native Andigena	1 clone

The experimental design at each location was a completely randomized block with two replications. Each plot had ten plants.

There was a great deal of variability in yield among clones within each location. Each environment represented a different level of stress as measured by differences in overall mean. The growing periods of 60, 75 and 90 days for the testing sites were not purposely chosen but were the length of time at which most of the clones were either mature or dead as a consequence of weather stress, insect and disease damage or the combined effects of them.

Temperature-wise the two jungle locations placed more stress on the plants than did La Molina. At Yurimaguas temperatures were high and uniform, while at San Ramon it was somewhat cool during the night. However, in these two sites rainfall supplied moisture on a rather regular basis. Despite the fact that at La Molina both the maximum and the minimum temperatures were lower, the yield of most individual clones as well as the overall mean was lower than at San Ramon. Since the crop at La Molina was under surface irrigation, the moisture availability was not uniform, and this appears to have had a stress effect on yield.

Potato tubers from hybrids, Tuberosum x Phureja, produced in the tropical area of the Yurimaguas, Peru, in 60 days.

At La Molina the principal problem was the attack by tuber moths, *Scrobipalpuloa absoluta* and *Phthorimaea operculella*, which caused considerable damage in the foliage and later on in the tubers. Spraying with insecticides every seven days did not provide an adequate control. An attack of *Rhizoctonia solani* also affected about 20 per cent of the plants.

At San Ramon, the two major problems were *Rhizoctonia solani* which attacked about 50 per cent of the plants, and late blight, *Phytophthora infestans*. The damage of late blight was relatively well controlled by fungicides.

At Yuracmaguas, a heavy attack of leaf hoppers (*Empoasca* spp.) was recorded and isolated plants were affected by *Pseudomonas solanacearum*. The major disease problem was a leaf blight caused by a *Phycomycete*, the identification of which is in process. The disease affected the plants at an early stage of growth and killed many of them. Differences in susceptibility were noticeable. Foliage of the most severely affected individuals was practically covered by the mycelium of the fungus. It is interesting to note that no attack whatsoever of late blight was detected during the growing period. The reason could be that the high temperatures limits the survival of the fungus. Later experiments were also free from attack by *P. infestans*.

Three Tuberosum cultivars at San Ramon and La Molina yielded significantly better than the Peruvian cultivars used as checks. The failure of the local cultivars was expected because they were all selected under highland conditions (short-day and cool temperatures). On the other hand, *Tuberosum* cultivars normally short-day types have a higher critical day length than Andean potatoes. Also their adaptation to higher temperatures is a consequence of the conditions under which they were selected in the summers of the northern hemisphere. However, the level of tolerance to high temperatures appears to be limited and the conditions present at Yuracmaguas seemed to be beyond the threshold of adaptation for them.

The NT x NT hybrids at San Ramon and Yuracmaguas had a similar behaviour to the T x T cultivars but at La Molina they were slightly inferior. For further selection for adaptation to lowland tropics, the *Neo-Tuberosum* material may be more responsive than *Tuberosum* because it has a broader genetic base.

The performance of some of the "wider" hybrids, T x NT and T x P is encouraging because it shows that the existing potential for adaptation to the lowland tropics might be capitalized upon under a carefully designed breeding scheme. Some clones under the severe environmental conditions of Yurimaguas yielded about .5 Kg. per plant in 60 days. This yield is approximately equivalent to 15 Ton/Ha which for a short growing period constitutes a remarkable performance. Some of the same hybrid clones also performed very well, in relationship to the rest of the materials tested, in the other two locations.

From the results presented, it appears that the most promising materials for the lowland tropics, at least at present, have as one parent a *Tuberosum* cultivar which provides earliness and relative heat tolerance. To obtain highly heterotic hybrids a *neo-Tuberosum* or a *Phureja-Stenotomum* hybrid that produces 2n gametes by first division restitution would be suitable as the other parent. To realize the maximum gain from each source of germ plasm, it would be necessary to perform some previous selection for adaptation to tropical conditions. In addition to the widening of the genetic diversity obtained by such combinations of germ plasm, also an adequate level of resistance to diseases must be achieved.

Early maturity is an essential requirement for tropical adaptation. However, this earliness does not necessarily need to be in the absolute sense of time from planting to senescene. A medium maturity cultivar with an early tuber initiation and fast bulking may also be suitable even if the vines do not reach maturity rapidly. A great deal of genetic variability for tuber initiation has been found and this trait may be rapidly improved under selection. The earliness obtained by genetic means may be increased at some extent using some pre-conditioning of tubers before planting. Presprouting of tubers and a proper physiological age may help to hasten the crop.

There are some additional problems such as disease resistance, mainly to bacterial wilt and late blight which have to be solved by breeding to make the potato an economically competitive crop. The impact of introducing the potato to these new areas of cultivation in developing countries could be tremendous since the high nutritive value of this crop is well known.

Breeding and Selection of Potatoes for Cold Tolerance

In January 1975, as part of the effort to develop adapted potatoes for cold conditions of the highland tropics, approximately 93 clones which had been screened previously for resistance to -4°C laboratory tests, were planted at high altitude locations in Huancayo and Casablanca. In the high and dry areas frosts did not occur during the growing season, preventing the possible selection of clones which possessed acceptable tuber characteristics and which yielded at least 0.5 Kg. per plant. The cooking quality of some of these clones was very good.

In 1975 two new groups of hybrids were planted in the greenhouse at La Molina. In the first planting 4,300 seedlings from 117 families were used. This experimental group of plants included 16 *Solanum* species in their genetic heritage. Upon exposure to low temperature, approximately 100 seedlings survived -3° C tests in the cold cabinet and -4° C in the cold bath. These survivors are now undergoing tests in the field at two locations at 3,200 meters and 2,800 meters above sea level.

The second group of 8,500 seedlings was planted in November and 2,250 survived after the cold cabinet test of two hours exposures at -3° C. The survivors will be transplanted to the Huancayo fields at 3,200 meters in January of 1976.

Seeds obtained from the crosses made in 1974 and from introductions were planted in La Molina greenhouses in April 1975. The seedlings had a first screening in the cold cabinet of 3 hours at minus -3° C and a second screening in the low temperature bath at minus -4° C.

Data on Work Done	Number of Results
1. Species included in crosses	16
2. Families obtained	117
3. Seeds planted	10,370
4. Seedlings obtained	4,300
5. Seedlings eliminated after cold cabinet test	3,950
6. Seedlings tested in low temperature bath	1,040
7. Seedlings resistant after two different tests (No. 5 and No. 6) Approx.	100
8. Percentage of resistant seedlings Approx.	2%

International Potato Center scientist explaining his work to two visiting review team members about research to develop genetic adaptability to cold. Large numbers of genetic crosses are used to select those which may provide the needed adaptation to cold climates. (L-R) Dr. Fabio Cisneros, Dr. Nelson Estrada, Dr. Orville Page, Dr. Richard Webster, Dr. Humberto Mendoza, Dr. Hugo Li[illegible]

CONTROL OF SELECTED FUNGAL PATHOGENS
(Thrust No. 3)

Late blight (*Phytophthora infestans*) is considered to be the disease that causes the greatest losses in potato production. CIP's blight program is far reaching with research work at its four sites (La Molina, Huancayo and San Ramon in Peru, Toluca in Mexico), with three important contracts (Swedish Seed Association, Cornell University and University of Wisconsin) and testing being conducted by our Regional Research and Training teams throughout the world.

The program in Mexico is in part a continuation of the Rockefeller Foundation Potato Program which was transferred to CIP. After a careful evaluation of the collection for resistance to late blight, derived principally from *Solanum demissum*, certain cultivars were increased and distributed around the world. During 1975 a 30 cultivar set having good agronomic qualities was sent for testing in Algeria, Costa Rica, Honduras, Korea and Panama. The performance of some of these has resulted in their selection by national programs, for increase as potential varieties. Another cultivar bred principally for bacterial wilt resistance has been named "Caxamarca" by the Peruvian program and is prized equally for its blight resistance, high culinary quality and earliness.

A search for a readily utilizable resistance source without the major genes of *S. demissum* was begun by both the Cornell University-CIP contract team in New York State and by CIP core scientists in Peru using *S. andigenum* (and other species in the latter case). The Cornell scientists early success using their *Neo-tuberosum* breeding materials was confirmed by tests in Toluca, Mexico. The Huancayo-La Molina fields screening work was slow because of the lack of adequate natural infection in the field. Nevertheless, by selecting on the basis of lesion type about 400 clones were identified. These and about 500 seedlings selected at La Molina from 50 families of the North Carolina State University diploid program (*S. phureja x S. tuberosum*) were tested in the high jungle CIP plots at San Ramon (800 m. elevation) where it has been found that this disease occurs throughout the year and is severe during the heavy rainfall period, November through June. Three consecutive tests showed that 15 *andigena* and five *phureja* clones have a very good level of field resistance (up to 35 per cent affected foliage at the end of the vegetative period), another 45

clones had good resistance (up to 55 per cent blight) and 97 were moderately resistant.

The selected resistant clones have been crossed with many clones having other superior qualities. These have resulted in the screening so far of about 7500 seedlings in screenhouses at La Molina by inoculation with *P. infestans* zoospore suspensions during the cool humid winter. Thirty to 60 per cent were discarded as susceptible. When some of the cultivars from the Mexican collection were used as parents many seedlings were immune due to the presence of major genes, which complicated the selection for field resistance at La Molina. However, these and other selected crosses have been screened in Mexico where the "demissum" races occur; about half of them demonstrated moderate to high field resistance. This was the second year of seedling screening at La Molina, and the first during which selected seedlings, screened for agronomic qualities, were tested for blight and adaptation at San Ramon. The best of these will be tested again at San Ramon and a highland location, and the outstanding ones will be freed of disease for shipment to our Mexican test site, and to CIP's other regions for eventual distribution to national programs.

At San Ramon tuber blight was practically nil at harvest, but a low percentage developed in stored potatoes, suggesting the possibility of infection at harvest time. So far no late blight has developed during five growing cycles under hot, humid tropical conditions at Yurimaguas.

The possibility of gaining even more useful information by applying different means to interpret the work at Toluca, Mexico, and by improving experimental design was assessed with the help of a visiting epidemiologist. Arrangements were made to computerize the last five years of accumulated data on observations of the collection for resistance in Mexico. A different rating scale for blight incidence was tried. The effect of interference between resistant and susceptible plots (interplot interference) in the development of blight was investigated in an extensive experiment using remote sensing techniques and ground observations, the results of which are still being processed.

An R-gene differential set of clones and a standard set for field resistance under long day conditions were grown in Mexico

CONTROL OF SELECTED BACTERIAL DISEASES
(Thrust No. 4)

An international trial for resistance to bacterial wilt (*Pseudomonas solanacearum*) in Peru, Brazil and Colombia indicated that the Phureja resistance being utilized by CIP is not general. Screenhouse studies with bacterial isolates of world-wide distribution indicate that this resistance can lead to selections for most situations, not being adequate when temperatures are very high. Studies on the inheritance of resistance conducted by the Wisconsin contract, show specific host-pathogen resistance is developed in the selection process according to the isolate used in screening. These results led to the decisions at the second planning conference on bacterial wilt and adaptation to the lowland tropics) during September 1975 to utilize several isolates in future screening work at Wisconsin, to seek non-specific resistance for the long term work and to evaluate resistant selections in all of CIP's regions as fast becomes feasible. During 1975 more than 200 clones were shipped by the Wisconsin contract to requesting national programs in Colombia, Egypt, Kenya, Mexico, Nepal, Nigeria, Puerto Rico, Sri Lanka and Taiwan. The screening process at Wisconsin now includes resistance for wilt, late blight and virus Y.

Progress towards release of a resistant variety by national programs has been slow, with a maintenance setback in Nigeria, but in Peru the final tests for defining the best among six selections were completed and a variety will be named for release in 1976. In both cases resistance is to both bacterial wilt and late blight.

A field test site at La Molina facilities was established where an insect proof cloth screenhouse provides adequate sanitation safeguards. Previously, the nearest naturally infested field required two days of travel to reach. In this, studies are being conducted on survival in soil, host range including symtomless hosts and interaction with the root-knot nematode (since greenhouse tests indicated a higher incidence and severity when the bacterium and nematode are together).

Soil survival studies at different sites in Peru showed the highland soils sustain a population of *P. solanacearum* from year to year, but that the use of infected seed is by far the greater means of perpetuating the wilt disease. A coastal field in Northern Peru did not permit enough survival to perpetuate the

disease. The coastal site at La Molina sustained a low disease potential. Soil samples from 2 highlands sites , Cajamarca and Huancayo, one jungle site, San Ramon, and two coastal sites, Viru and La Molina, were placed in pots, sown to potatoes and infested with bacteria. La Molina was used as a reference to the known level of disease perpetuation potential. Different soils showed different disease potentials of respectively 87 per cent, 100 per cent, 100 per cent, 87 per cent and 28 per cent.

A soil factor, as yet unknown, adds yet another variable to tuber incidence of bacterial wilt. It was already known or assumed to be affected by temperature, soil moisture, host resistance, host adaptation, pathogen virulence and, aggressivity, inoculum potential, and root or stolon damage by such things as nematodes and cultural practices. Hence it is concluded that research is needed for each situation to determine the best combination of control measures.

Field plot in tent house where clones are being screened for resistance to Pseudomonas solanacearum, and the interaction of this disease with the nematode, Meloidogyne sp. Dr. Carlos Martin, CIP scientist, examines tubers after harvest.

Fundamental studies on the nature of resistance conducted by the research contract with Wisconsin have uncovered a mechanism of agglutination of cells when the resistant host is invaded. Further information on this work is to be found in this report under the review of selected contract results.

At the planning conference held in September, it was recommended that CIP begin research on soft rot caused by *Erwinia carotovora*. Among the initial 179 clones screened for resistance to soft rot, 44 had up to one per cent rot and 58 had up to five per cent rot. The 44 most resistant clones are being increased to re-confirm the preliminary results.

Potato plant with symptoms of Pseudomonas solanacearum showing on one-half of the plant.

Dr. Roger Kurtbaoui, Post Doctoral Scientist, examining the results of centrifuge treatment in the laboratory

CONTROL OF SELECTED VIRUS AND INSECT VECTORS (Thrust No. 5)

At CIP the dual approach to work on control of potato viruses and vectors is through (a) resistance and (b) measures during seed production. Priority continues to be given to selection for resistance for which the work is concentrated on two aphid transmitted viruses, potato leaf roll (PLRV) and potato virus Y (PVY); evaluation of aphid resistance is also underway. PLRV and PVY are the most important viruses affecting the potato in developing countries and cause the most serious losses. For this work a complete collection of breeding lines which show resistance has been assembled at CIP from breeding programs in different countries. The main aim of this research is toward improving the production of the small farmer who saves his own seed. A common practice observed by such farmers is the annual selection of their smallest tubers for seed, which results in rapid degeneration because such tubers tend to come from infected plants. As an aid to seed programs, antisera to some of the commonest potato viruses have been produced at CIP in large amounts and are being distributed to national programs. Work continued in assessing the importance of PLRV in andean countries and on the characterization of some little known or new viruses which present potential hazards to seed production in specific regions.

PLRV Resistance

The search to locate resistance to PLRV in the germ plasm collection continued. Tubers harvested from 285 clones exposed to infection in the field at La Molina in 1974 were planted in 1975 but secondary PLRV symptoms developed in only 60 clones. The remaining 225 were re-planted in a further field exposure trial and the tubers harvested for planting in 1976. However, as in 1974, the aphid population in the field at La Molina was too low for a thorough test. A study of alternative procedures which permit efficient screening of large amounts of material and decrease the time needed for exposure and detection was initiated. A large cage containing PLRV infected plants heavily colonized by aphids was used to expose seedlings. Within several weeks, many developed secondary symptoms of the virus. This method is also being tested with rooted cuttings and sprouted tubers. It will be used for the development of PLRV resistant populations at CIP, and for future screening of germ plasm.

A general regional program for testing segregating populations from crosses between PLRV resistant parents has been activated in, initially, Argentina, Brazil and Chile. It involves exposure of seedlings to the virus under field conditions in which a high degree of spread occurs, and recording the proportion of plants in each family which develop symptoms. The advantages of this program are that it 1) enables evaluation of a uniform group of material in different countries under widely different conditions, 2) serves as a vehicle for moving genetic materials to national programs and 3) has the potential of growing into a combined test for evaluation of other factors, e.g. resistances to other pests and diseases. From the information obtained, CIP will be in a position to send out an improved set of PLRV resistant crosses each year. Regional evaluation of actual breeding lines is also envisaged and for these tubers of lines also present at CIP have been sent from Europe to the national programs of Brazil, Chile, Mexico, Egypt, Lebanon and Turkey.

Importance of PLRV in Peru and Colombia

A survey of over 200 fields in five different localities confirmed that PLRV is widespread in Peru. The cultivar Mariva seems resistant to the virus because very few infected plants occur. Lack of knowledge of PLRV symptoms in Andigena potatoes has meant that the importance of the virus in Peru and other andean countries has been underestimated in the past. In Colombia the symptoms caused by PLRV in *Andigena* are common and have been known for many years under the name "enanismo amarillo" without knowledge of the causal agent.

PVY Resistance

Seedlings grown from seed collected from 20 of 40 potentially PVY resistant germ plasm clones selected in 1974 were inoculated mechanically with PVY. Eleven of them segregated for resistance to this virus. These clones will be used for further tests.

For the development of PVY resistant populations mass screening by mechanical inoculation of seedlings with PVY will be used. Precise conditions for efficient functioning of this test are being established.

Virus X Resistance

Tubers harvested from 560 germ plasm clones leaf-inoculated with two strains of PVX in the field in 1974 were tested for PVX by inoculating sap from sprouts to *Gomphrena globosa*. Neither PVX strain was detected in 188 of the clones so these can be considered as potential sources of PVX resistance. There are no plans at present to continue this work.

Antiserum Production

Good progress has been made and antisera to PVX, PVY, potato virus S, andean potato latent virus (APLV) and the andean potato calico strain of tobacco ringspot virus have been prepared in co-operation with the Agrarian University, Lima. Increasing numbers of requests for antisera from national potato programs of different countries were received but large stocks are still available for distribution and these will be replenished when necessary by preparing further sera.

New or Little Known Viruses

Work on APLV has continued. The virus was shown to be common in Peru and was detected in germ plasm received from Ecuador. In the CIP germ plasm collection about 15 per cent of plants are infected. The virus is not necessarily latent and, depending upon the isolate and cultivar in question, can cause mosaics, chlorosis of minor leaf veins, etc. Transmission of APLV by the flea beetle *Epitrix* occurs only at low efficiency, but the virus is readily transmitted by contact. Low level transmission through potato true seed was also detected. Trials to determine effects on yield are in progress.

Study of the characteristics of three other viruses which appear to be new in potato are underway.

(L-R) Dr. Ana María de Tokeshi and Mr. José Rocha prepare inoculum and rabbit with materials to produce sera for use in potato virus research.

The leafhoppers which attack potatoes in the areas of Huancayo and San Ramon have been identified by Dr. Rauno Linnavouri of Finland, and two of the leafhoppers were described for the first time as new ones for the science of Entomology. Seen in the drawing at the right is *Bergallia huancayoensis* Lv. 1975 and below is *Copididonus ramonensis* Lv. 1975

In the Ica valley of Peru, a red biotype of the potato aphid *Macrosiphum euphorbiae*, was collected in 1975

With regard to work on the "Andean weevil complex", the biological material collected in 1975 in the peruvian central highlands and identified as *Adioristus* ssp. belongs to a new species for science. Dr. Charles Obrien from Florida University, was able to verify the differences in the types when studying in Europe

CONTROL OF SELECTED NEMATODES PESTS
(Thrust No. 6)

Nematodes are one of the common obstacles to the production of potatoes in several countries of the world, although only a few species are considered as major problems.

"The potato cyst nematode" *Heterodera* species, "root-knot nematodes" *Meloidogyne* species, "root-lesion nematodes" *Pratylenchus* species, and the "false root-knot nematodes", *Nacobbus* species, are among the most important pests of potatoes.

Following the nematode control strategy developed for CIP at a Planning Conference held in February 1974, active research on screening and breeding for resistance to the potato cyst nematode and the root-knot nematodes is being conducted. Also active research is being conducted to study the distribution, biology and importance of the "false root-knot nematode" as pests of potatoes.

Dr. Parviz Jatala, Nematologist, in the process of examining roots damaged by nematodes.

POTATO CYST NEMATODES
HETERODERA ROSTOCHIENSIS; H PALLIDA

Potato cyst nematodes are the most important nematode pests of potatoes. They occur in many potato producing areas of the world and once established in an area, it is impossible to eradicate them. Chemical control of these nematodes is costly and it is difficult to keep the soil population below damaging levels. Plants grown in an infested area show unthrifty top growth, general symptoms of poor root development and the yield may drastically be reduced.

A pre-requisite to screening and breeding for resistance to a particular nematode is thorough understanding of biology as well as identification of species and races of the nematode in question. In order to achieve this, an extensive collection was necessary to obtain a wide cross section of species and races of nematode pests of potatoes. Collection from England, Japan, Germany, Mexico, Panama and USA were obtained from scientists in the respective countries.

Argentina, Chile as well as some Central American Countries have not been adequately sampled.

Species and Race Distribution

Three nematode populations from Colombia, four from Bolivia and 40 from Peru were examined for speciation through studying female color change. Results confirmed that *H rostochiensis* types are confined to Southern Peru and Bolivia while the *H pallida* types mostly occur in areas North of Lake Titicaca. Five different races or pathotypes were identified by the use of European host differentials.

Screening Test for Resistance

One hundred and twenty-four clones from the CIP germ plasm collection were tested against four *Heterodera* populations (Cuzco, Huancayo, Otuzco and Puno). Of these, 18 clones showed some degree of resistance to at least one population. Eight clones exhibited a certain degree of resistance to two of the populations while three clones showed resistance to three of the four mentioned populations. In addition to the germ plasm collection, 150 clones sent from Mexico and five clones obtained from the Max Planck Institute were

tested against the Huancayo and Otuzco populations of the potato cyst nematode *Hezerodera pallida*. Of the 150 clones tested, 36 showed some degree of resistance to at least one of the populations, while all the clones from the Max Planck Institute exhibited various degrees of resistance to both populations. Resistant clones will be tested again to confirm the information obtained in 1975.

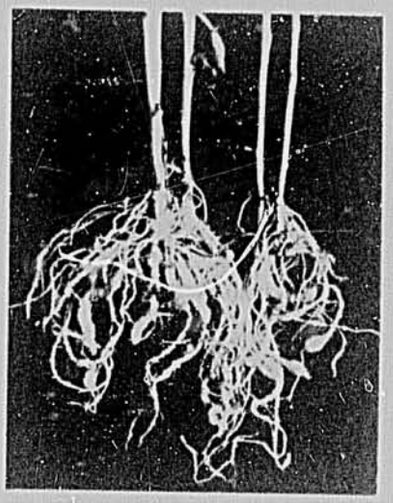
Breeding for Resistance to the Potato Cyst Nematode

Two different sets of crosses were made during 1975. The first set was intercrosses among 20 *S. andigena* selections from CIP germ plasm collection. These clones were selected during the previous two years of screening. They had exhibited various degrees of resistance by limiting the nematode reproduction rate. Of these clones 15 were resistant to the nematode population from Otuzco while only three were moderately resistant to Huancayo and two to Cuzco populations. The objectives were to discard weak parents and increase the level of resistance through selection as well as combining specific resistances. Sixty five families were obtained and tested.

Cuttings were used to test one genotype against more than one population. Although results of the test against the Otuzco population were equivocal, a parallel test conducted in Huancayo against the other three populations was more reliable, ten percent of the progenies exhibited resistance.

The second test involved intercrosses between *S. andigena* selections and resistant sources obtained from the Cornell University and the Max Planck Institute. This provided an opportunity to hibridize *S. tuberosum* back crosses with wild resistant sources to *S. andigena* clones. Thirty-five families were obtained in this group and the seeds will be tested during 1976.

ROOT-KNOT NEMATODES, *MELOIDOGYNE SPECIES*



Root-knot nematodes are considered as one of the most important nematode pests of plants affecting production of adequate food supplies in the developing nations. They are cosmopolitan in distribution being found on both tropical and temperate environments.

Most *Meloidogyne* species have relatively high temperature requirements for a rapid and highly reproductive life cycle. Since at present potatoes are predominantly grown in cool temperature regions of the world, they are not worldwide economic problem. However, extension of the range of potato culture into tropical climates will drastically change this situation.

A limited collection of these nematodes has been made. At present time there are 20 populations of *Meloidogyne* species maintained at CIP (Table I). However, screenings for resistance are made primarily against the La Molina field population.

STATUS OF NEMATODE COLLECTION AT CIP

TABLE I. Nematode Collection Made in 1975*

Country	Total Number of Samples Collected	Heterodera	Meloidogyne	Nacobbus
Peru	45	6	1	9
Ecuador	45	7	7	1
Bolivia	10	10	–	10
Colombia	6	4	–	–
Argentina	4	3	–	4
Panama	–	–	–	–
Mexico	3	3	–	–
U.S.A.	–	–	–	–
England	–	–	–	–
Germany	–	–	–	–
Japan	1	1	–	–
TOTAL	114	34	8	24

* Including some duplications

TABLE NO. 2

Total Nematode Collection Available at CIP up to 1976*

	Heterodera	Meloidogyne	Nacobbus
	77	15	5
	14	3	1
	35	2	15
	3	–	–
	3	–	2
	4	–	–
	3	–	–
	3	–	–
	4	–	–
	2	–	–
	1	–	–
Total	149	20	23

* Some of the numbers indicated are less than in Table No. 1 because of duplications.

Screening Test for Resistance

Major emphasis in screening for resistance to root-knot nematodes has been placed on screening cultivated potatoes of the CIP Germ Plasm Collection. Four to six tubers of each of 948 clones from the CIP Germ Plasm Collection, nine local commercial cultivars and five clones from the Cornell University were planted in a *Meloidogyne* infested field in La Molina. Prior to their maturity, plants were removed from the soil and their roots were examined for nematode infection. Tubers were collected and stored for two months prior to examination. After this period, tubers were examined for galling and deformation caused by the nematode infection. Those with no apparent surface deformation and galls were sliced and examined for the presence of the nematode inside.

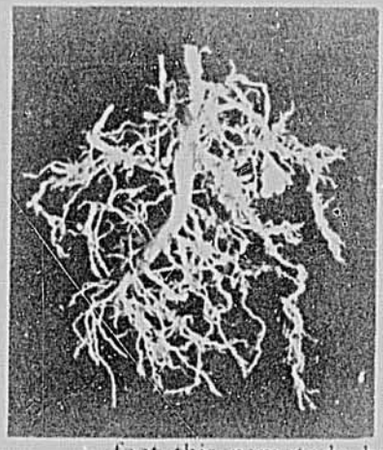
Of all the clones examined, nine exhibited some degree of root resistance and had no tuber infection. These clones are presently being retested.

Data indicate that roots of some clones were severely infected by the nematodes but their tubers were not and vice-versa. This indicated that the resistance of roots and tubers to the root-knot nematodes may be independent of one another.

Importance of the root-knot nematodes on the infection and wilt development by *Pseudomonas solanacearum* race three was investigated. A preliminary report of the study was presented last year.

Pseudomonas resistant cultivar "BR-73-40" (*Solanum phureja x S. tuberosum* subsp *tuberosum*) and susceptible cultivar "Renacimiento" (*S. tuberosum* sbsp *andigena*) were inoculated with various combinations and times sequences of inoculation by *M. incognita acrita* and *P. solanacearum*. Control plants did not receive either of the two organisms. Data on wilting were collected periodically. Results indicate that infection and wilt development *P. solanacearum* is enhanced in the presence of *M. incognita acrita* in both resistant and susceptible cultivars. Resistance of "BR-73-40" to bacterial wilt was broken when the root-knot nematodes were present. Mechanism of the synergism is believed to be that of mechanical wounding as well as physiological changes in the plants caused by infection of the root-knot nematodes. Further studies in the field condition warrants attention.

The False Root-Knot Nematode, *Naccobbus* ssp.



The false root-knot nematodes are considered one of the most important nematodes pests of potatoes in some andean regions of Southern Peru and all the potato growing areas of Bolivia. The symptom caused by the invading larvae and the young females is in the form of galls on the root-knot system. Because of its extreme similarity to the root-knot nematodes, as far as the root symptomatology is concerned, for many years it was mistakenly called "root-knot nematode". Later it was determined that in fact this nematode belongs to a different genus and was given the common name of the "false root-knot nematode".

Little is known about the distribution of this nematode in the world. Similarly, there is no report of the biology, life cycle and behaviour of these nematodes on potatoes.

In order to determine the importance of these nematodes as pests of potatoes, it is imperative to collect and identify the species attacking potatoes as well as the range of its distribution. Similarly, extensive laboratory and greenhouse experimentation is needed for studying the life cycle and behaviour of these nematodes on potatoes.

Distribution of *Nacobbus* ssp.

Potato growing areas of Bolivia, Northern Argentina (partly), Southern Peru (Department of Puno), Ecuador and Southern Colombia (partly) were surveyed to determine the presence of *Nacobbus* ssp.

It was found that practically all the potato growing areas of Bolivia and most of the fields in the Southern Highlands of Peru were heavily infested with these nematodes.

In Peru, *Nacobbus* ssp. is also distributed in certain areas of central and northern highlands. Only a certain potato growing area of Northern Argentina was examined and was found to be infested with this nematode. In Ecuador, *Nacobbus* ssp. was found only in one field infecting tomatoes. No *Nacobbus* ssp. was found in the fields visited in Southern Colombia. In addition to these countries there are reports of the presence of these nematodes in Chile, England, Holland, India, Mexico (unpublished report) and the United States.

Greenhouse studies indicate that *Nacobbus* ssp. have a wide temperature adaptability and can be a threat in the warmer climates. Species determination and studies on the host range and biology of these nematodes are in progress.

DEVELOPMENT OF POTATOES WITH WIDER ADAPTATION TO ENVIRONMENTAL STRESS AND RESISTANCE TO INSECTS
(Thrust No. 7)

The principles of this thrust are to develop potatoes adapted to the hot-humid tropics and to the cold highland tropics. Problems of production under high jungle and arid coastal conditions are also being studied.

Characterization of Frost Resistance

In research to develop rapid methods to screen for frost resistance in potatoes and to determine effects of different environmental conditions and plant factors, progress can be reported.

This research involved three clones with different levels of resistance to freezing. Rensselmiento, USA Nevada, a Colombian variety with moderate resistance, and CIP 700265, a native variety of *S. curtilobum* with a high level of resistance. These clones were planted at La Molina, and weekly samples were taken from the plants starting one month after planting and continuing until the crop was four months old.

Samples were taken of leaflets from the upper (small leaflets), middle (medium size), and lower (large leaflets) levels for comparisons.

The following parameters were analyzed:

1) Resistance to low temperatures of -2° C to -5° C.
2) Water and dry matter content.
3) Leaflet size as expressed by leaflet area.
4) Plant age.

Results of this experiment may be summarized as follows:

1. At any stage in the growth cycle, leaflets sampled from lower nodes (older leaflets) demonstrated a lesser degree of damage from temperatures below 0° C but above the killing temperature.

2) The actual temperature at which the leaflets were killed was the same for all leaflets from any given genotype regardless of their size, position on the plant, or age.

The lack of a significant interaction between plant age and killing temperatures now allows scientists an extended period of working time when screening large numbers of genotypes.

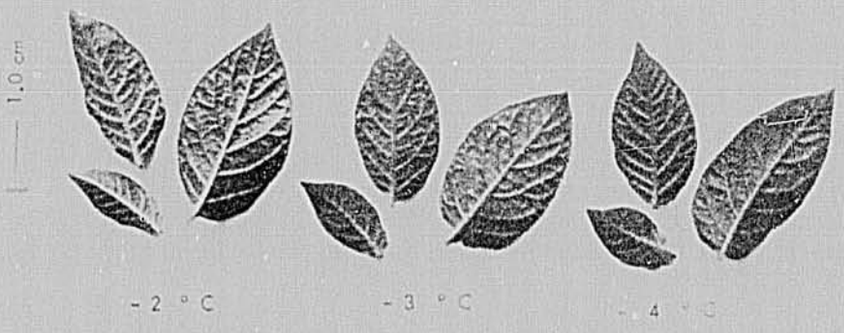
In the experiment it was possible to process 30 samples a day using the system developed by the University of Minnesota. A faster method was sought and the following modification was developed:

1. After the treatment at a given test temperature is completed, the leaflets are transferred directly to a humid chamber equilibrated at 0° C. thus eliminating the shaking of leaflets and the leachate reading.

2. After overnight treatment under these conditions, the leaflets are moved to room temperature and visually scored on the color and turgidity of the tissues.

3. Elimination of the shaking of leaflets and leachate reading makes it possible to evaluate up to 100 samples a day in contrast to the 30 samples a day being processed previously. Accuracy is adequate to clearly distinguished viable, intermediate, and dead leaflets. This technique is being used extensively in the breeding program to rapidly screen for frost resistance.

The appearance of leaflets of the variety, Nevada, after being exposed to varying degrees of freezing temperatures.



NEVADA

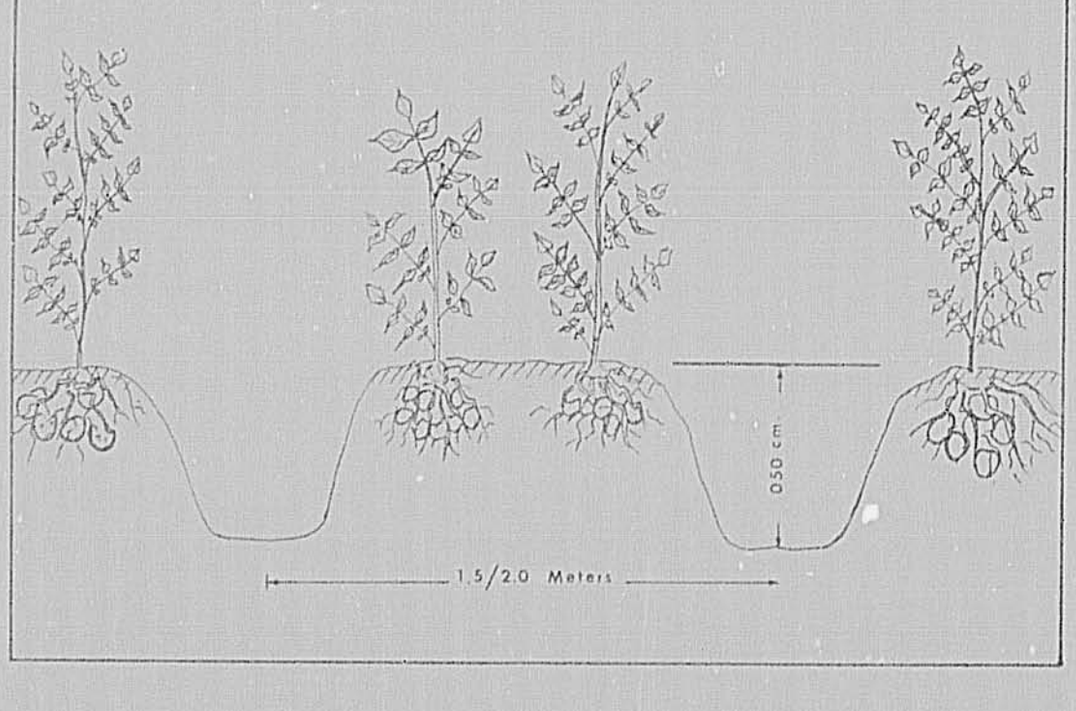
Agronomic Systems for Potato Production

Several studies were initiated in San Ramon in June of 1975 to find practices and cropping systems which would permit continual and long-term commercial production in semi-tropical and tropical regions.

These studies included experiments in the use of elevated beds, mulching with straw or with polyethylene plastic sheets, intercropping systems and trials with spacing and populations.

Preliminary results in the use of elevated beds indicate that when tuber size and total production is considered, the beds which are 1.5 and 2.0 meters wide, have excellent commercial application for production.

When potatoes were planted in elevated beds it was found that hilling of the plants was not necessary and there were fewer weeds. Yields of 25 tons per hectare obtained with some varieties.



Diagramatic representation of the elevated beds used in testing various ways of planting potatoes in the tropics.

Intercropping

In the trials with different crops interplanted with the potato in elevated beds, the lowest production of potato was encountered when inter-planted with corn. The yield was between 32 and 60 per cent of that in the control beds. The corn was able to grow rapidly and take advantage of the plant nutrients and sunlight. In trials with the other crops, the combination of peanuts and potato varieties produced no significant reduction in potato yield. Four of the six potatoes produced more than the control plots.

When one considers the total production per unit of area, credit must be given to the corn and potato combination. In this case one must also consider the quantity of crop residue which remain in the field. This increase in plant materials will require soil nitrogen in the decomposition process.

The lower potato poduction encountered with the potato and legume combinations is strongly compensated for by the long-range fertility level of the soils, and the consequent possible increase in yields of the following crops.

Yield of Potatoes in Beds with other Crops
Locality of San Ramon (Peru) - Winter 1975

YIELD (Tn/Ha)

VARIETIES	Potato	Potato-Maize	Potato-Beans	Potato-Peanut	Potato Soybean
Revolución	24.49	14.47	26.09	20.06	27.06
Cuzco	20.52	11.87	23.51	24.52	23.60
Antarqui	20.19	6.52	24.79	19.32	15.18
Mariva	18.29	6.17	13.42	18.78	18.96
Yungay	17.07	6.50	15.67	21.92	16.46
Ranrahirca	18.04	6.08	14.50	18.92	17.06
Average	19.76	8.59	19.66	22.07	19.72

Mulch trials

Trials involving polyethylene and straw mulches indicated that several advantages were obtained. The elimination of the hilling requirement to prevent greening and the reduction of weeds were the most obvious benefits. Acceptable yields were also obtained with the treatment. The use of mulches without hilling produced yields of 29 to 30 tons per hectare accompanied by an increase in the percentage of commercial sized tubers. It was further determined that mulches provide better water relations for growth.

It is interesting to note that the resulting higher soil temperatures with the black polyethylene plastic (26° to 29° C) did not appear to be extremely limiting.

Effect of Soil Coverings on Total Yield of Tubers
Locality of San Ramon (Peru) - Winter 1975

Varieties	YIELD (Tn/Ha)				
	Control A	Control B*	Straw Mulch	Black Polyethylene Mulch	Average
Revolución	15.87	27.25	28.55	20.88	22.96
Ranrahirca	6.72	16.53	17.19	9.23	12.41
Mariva	9.81	19.10	17.47	9.33	13.92
Antarqui	11.57	18.10	15.85	10.81	14.08
Yungay	4.86	14.39	12.38	7.96	9.89
Cuzco	10.49	22.27	21.15	14.36	17.06
Average	9.77	19.60	18.76	12.09	

* Control with application of herbicide Sencor.

In the spacing trials it did not appear that the use of equidistant spacing had any particular benefits with the clones studied. One clone yielded 40 tons per hectare with a population of 60,000 plants per hectare; 70 per cent of the tubers in this trial were larger than five centimeters in diameter. This indicates there was tolerance to crowding and denser populations.

Fertility Trials

Fertility relationship, varietal responses to fertility levels, efficiency of fertilizer use, rotations as means of maintaining productivity, and erosion problems are being investigated in the hot and humid regions.

Trials are being conducted by contractual arrangements with the local university and some of the experiments are conducted by CIP scientists. Preliminary first season results, however, have indicated that there is a considerable range of response to fertility levels between varieties. There were a number of varieties and clones which yielded very well (30 tons per hectare) without addition of fertilizers. In these trials the soils were not extremely low in fertility, the responses were wide, and ranging from 10 per cent to 300 per cent increase. In view of the results found, it may be possible to select varieties which will produce well for farmers who are unable to use commercial fertilizers, and also for others who are able to obtain adequate fertilizers inputs.

The final results of the trials by contractual work with the university, are not available at this time as the experiments are of a long duration. Preliminary indications are that the use of unprocessed rock phosphate can be used for 50 per cent of the phospahte requirements of potatoes without affecting a loss in productivity on certain soils. Research is continuing in this area.

IMPROVEMENT OF GENERAL NUTRITIONAL QUALITY PROTEIN YIELD AND CARBOHYDRATE-PROTEIN BALANCE IN POTATOES
(Thrust No. 8)

Analysis of freeze-dried samples of potatoes for crude protein by the semi-micro Kjeldahl method was continued in 1975. A new multiple block digester will increase the potential of the laboratory to about five hundred nitrogen analyses per week.

Protein quality was assayed biologically using *Streptococcus zymagenes* after enzymatic digestion. It is possible to process one hundred and fifty samples per week with the present equipment.

Potential for Increase of Total Protein

The percentage of protein in potato tubers varies between cultivars, treatments and locations. One sample of the *Phureja* group in the breeding program exceeded 20 per cent crude protein, but contained only 13 per cent solids. The negative correlation between per cent crude protein and per cent total solids is usual. However, a few clones with both a high percentage of total solids and a high percentage of crude proteins are being identified.

With respect to total food production this relationship does not hold. The cultivars producing the highest yields with the high total solids generally produce the maximum yields of protein and carbohydrates per hectare.

Proportionally, the potato contributes more protein than calories to the daily requirements of man, and should never be categorized solely as a carbohydrate food. Only with added fats; cooking aids; butter, saucer cream; etc., does the potato approximate a balance of protein and calories. On the other hand, the production of potato protein and carbohydrate/hectare is high. In current trials, cultivars have yielded 50-60,000 k cal. and 600-800 k. of useable protein per hectare.

Environment has a marked effect on total solids and crude protein accumulation. Under the high temperatures and high rainfall of San Ramon the per cent total solids of the tubers is much lower than that of the same clones grown in Huancayo when temperatures are lower and rainfall is moderate.

The crude protein in the tubers increases in direct proportion to increasing applications of nitrogen fertilizers. If desired, higher levels of crude protein in the tubers can be attained by nitrogen application.

SAMPLES ANALYZED FOR CRUDE PROTEIN CONTENT*

Source of the Sample	Number of Samples Analyzed
Germ plasm collection	138
Breeding Programs	376
Environmental Effects on Protein Accumulation	214
Fertility Trials	66
Cultivation System Trials	75
TOTAL	869

*-- Dry matter of the tubers was determined in every sample.
-- About 25 per cent of the samples were analyzed for both the soluble and insoluble nitrogen fractions.
-- Approximately 200 samples were submitted to the microbiological determinations of their protein quality.

Mrs. Amparo Siveroni, Chemical Pharmacist, working at a spectrophotometer in the CIP Physiology Laboratory

SEED PRODUCTION TECHNOLOGY FOR DEVELOPING COUNTRIES
(Thrust No. 9)

The principal objectives of the Seed Thrust are:

1. To maintain the more important clones in a pathogen-free state, and when necessary, to free these clones of virus using the meristem/heat therapy technique.

2. To multiply these clones in a pathogen-free state for distribution to co-operating countries.

2. To investigate new methods of rapid increase of valuable clonal materials that can be adapted by co-operating countries.

4. To provide CIP scientists with low virus content seed for research purposes.

5. To develop inexpensive methods for both short and long-term storage of potato clones.

For the past year, major emphasis continued on improving the "multi-meristem" techniques for short-term storage and distribution of genetic material. All virus-free clones are being placed in this form for maintenance. Multi-meristems were successfully shipped to the USDA Plant Quarantine Station to develop a standard operating procedure. All phases of this work have been expanded and efficiency increased during the year. The following work has been accomplished in 1975:

* 32 clones (Generation "0") are being freed of virus, six of them are now in the final steps of re-checking for virus.

* 20 clones (Generations I and II) are being maintained as virus-free material, and increased for distribution.

  11 clones (Generations I and II) of pathogen-free materials involving a combined total of 2,391 tubers and cuttings were sent to Bolivia, Ecuador, and Peru for variety testing and/or multiplication. These pathogen-free clones are also being used by CIP scientists in their work.

* 22 clones (Generations IV and V) continue to be propagated for "low-virus" content seed for CIP use in amounts from 25 kgs. to 4,500 kgs.

* Eleven tuber families from segregating populations are being produced for testing by national potato programs.

* 700 Kgs. of four clones of "low-virus" (Generations V) tubers were given to the Peruvian National Program.

Potato Tissue and Cell Culture

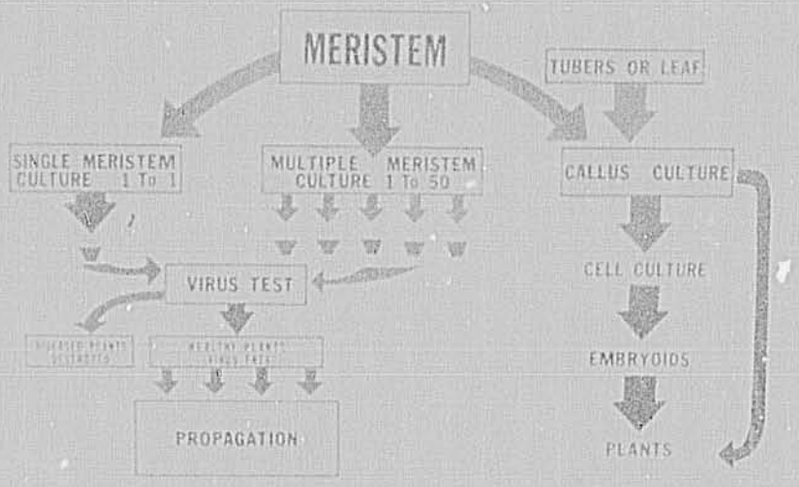
During April 1975, Dr. H.C. Henshaw visited CIP under arrangements of the Overseas Development Ministry research grant. The tissue culture program was reviewed with CIP scientists and a coordinated plan was established for continuation of the work. It was decided that the Birmingham group was to place priority studies on long-term storage. The CIP group is to concentrate research on meristem and tissue culture techniques to propagate and distribute potato germ plasm in a disease-free condition.

Work at CIP for 1975 emphasized the "multi-meristem" culture technique. This system has more potential for high rates of propagation compared to the meristem culture system. A single meristem tip, subjected to the chemical and physical conditions of the techniques developed by CIP scientists, will develop into a morphogenic structure which is intermediate between a completely organized shoot and a completely disorganized callus. When this morphogenic cell structure is transferred to stationary media, the cell structure differentiates into many schools, as illustrated in this photograph.

Later, each multiple shoot can be transferred to solid medium as shown to the left.

A group of potato plants which had as their mutual origin a group of cells from a single meristem tip.

Study is underway to use the multi-meristem culture technique as a means to preserve virus-free clones. This system will allow CIP scientists to maintain *in vitro*, germ plasm materials which can be transferred to pots for mature plants.



THE TISSUE CULTURE SYSTEMS

The general procedure for potato meristem culture has been simplified to allow a more straight forward method of increasing virus-free plants. It has been found that rooting of plantlets *in vitro* is not necessary. The small plantlets have been transferred to small plastic cups containing a substrate of coarse sand, irrigated with distilled water and then with 1/3 strength Hoaglandd's solution. Plantlets rooted well and grew well under this procedure.

Propagation of Potato Stocks by Stem Cuttings and Related Techniques

The need to increase the rate of multiplication of disease-free potato materials to the maximum possible quantity has resulted in research into ways of using stem cuttings. Four virus-free cultivars were used to evaluate the usefulness of the "tuber milking" technique. The objectives of this research were:

1. To produce large quantities of small (1 to 2 cms.) tubers from a single plant.

2. To keep a "mother" plant in an active, vegetative state for as long as possible producing tubers and stem cuttings.

In searching for further possibilities of multiplication tubers were "planted" on small bricks, in a sand substrate, and covered with dark polyethylene plastic sheets. The sprouts were then guided to grow through small holes in the plastic cover. The picture on the left illustrates the method used. Because of the high temperatures of 20° to 22° C., tuberization was inhibited in all test plants. The growth of tops and stolons was greatly favored. These stolons were harvested and used to propagate new plantlets. This research is continuing.

STEM CUTTINGS

One of the major problems in propagating potato seed is the relatively low propagation rate: 1:10 is the generally accepted rate - i.e., plant 1 Kg. and harvest 10 Kgs. With small grains, 1:50 to 1:80 is an accepted ratio.

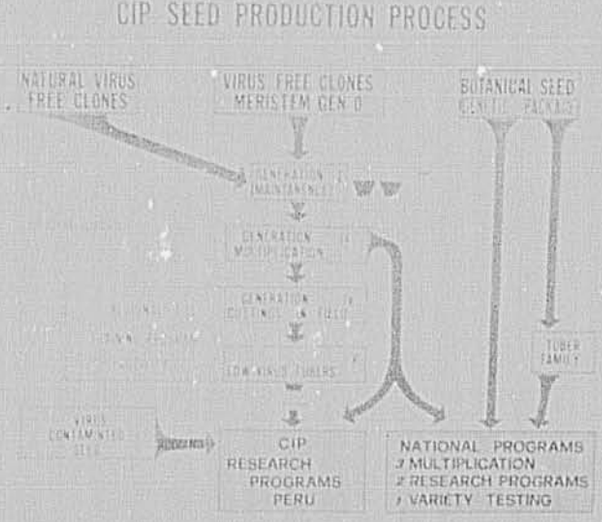
Stem cuttings is a method that for the first generation of a basic seed program, the propagation rate can be increased to as high as 1:180. However, this can be done only once in the earliest generation. However, when utilized, most programs can gain the equivalent of one year or ten times as many seed potatoes in the same amount of time. The method, used primarily by scientists to rapidly increase small amounts of material, has been refined and adapted to large amounts by several countries in the past 6-7 years. It consists of planting a single small tuber or large amounts of tubers in a greenhouse. When these "mother" plants are about eight inches tall the growing point is cut out. This stimulates development of the meristems found at all leaf nodes. When these reach a size of three to four inches, they are cut out and rooted in coarse sand. New axillaries form in about 15 days, and those "cuttings" placed in the rooting medium, form roots in about 15 days.

The original mother plants, depending on variety and species, will yield for up to three months with proper fertilization. Each new rooted cutting can become a mother plant until a desired population of mother plants is obtained. Then, over a 30-day period, two harvest of cuttings are taken rooted and transplanted to a pot. Using this method it is possible to harvest one ton of seed from a single small tuber in a one-year period.

CIP uses stem cuttings to produce all tubers sent out of Peru because the cutting breaks contact with soil borne pathogens carried by tubers, such as nematodes, *Rhizoctonia solani*, most *Fusarium sp.* and seed borne bacteria such as *Erwinia sp.*

Properly manipulated, stem cuttings show great promise for those countries which must grow their own basic seed, and for a variety testing where very limited numbers of tubers are available.

Potato plants used in the research toward improving the propagation ratio for disease-free plant materials.



Flow-chart depicting the seed production process followed by CIP scientists in the multiplication of disease-free plant materials.

STORAGE

CIP research is being rapidly expanded to develop storage technology for the small farmer in tropical and semi-tropical areas of the world. A great deal of technology has been developed for the temperate climate areas of the world. Some of this technology can be adapted in semi-tropical countries where altitude gives some similarity to the temperate climate. In other areas, no information exists and expensive refrigerated storages are used. Alternative methods must be found for concentrating and preserving the potato in a non-perishable form.

In 1975, CIP conducted research in small-above-ground pilot earth storages in Huancayo (3,200 m) where cool night temperatures indicated the possible adoption of technology. Those storages with natural air conducted beneath the pile of tubers gave acceptable results. In those earth storages where no air was provided (as used in Europe) all of the stored tubers were lost.

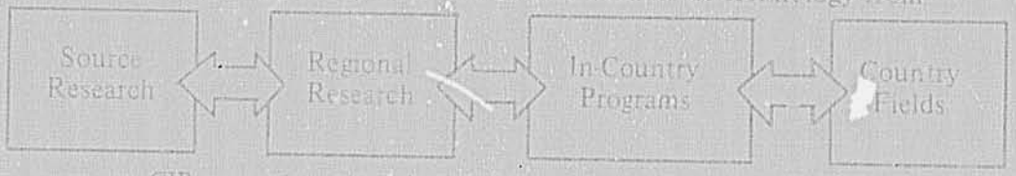
An experimental storage was constructed in co-operation with the Ministry of Agriculture in Ecuador at 3,500 meters, using a partial underground storage with air ducts under the tubers to utilize night temperatures for cooling. Local building materials were used. Potatoes stored for five months had a total loss of less than ten per cent. These results are very acceptable even where the environment can be much better controlled through the use of forced air ventilation.

Research in more tropical conditions will increase in 1976. CIP is co-operating with Egypt on a PL480 grant for storage of seed and ware potatoes under Nile River delta conditions. Further work on seed potato storage is being conducted in co-operation with Ecuador, utilizing a Ford Foundation grant.

REGIONAL RESEARCH AND TRAINING

CIP's research strategy for the development and transfer of technology is different from that of most other Centers in the network funded by the CGIAR. CIP is dealing with a vegetatively multiplied crop with a low multiplication rate per generation. Country quarantine laws seriously impede the transfer of research from CIP to country programs in the form of genetic material to be developed into new varieties.

A portion of CIP's Core Research Program has to be conducted in the regions for a smotth transfer of technology from



CIP recognizes that the ultimate users of the technology resulting from its research are the growers and consumers of food in developing countries. The Regional Research programs are an essential link in the system in order to get the genetic material that is applicable to the country programs. The Regional Research programs receive small amounts of genetic material into which have been incorporated the various resistances needed for the area. This material is multiplied, evaluated, further adapted where necessary, and redistributed into country programs. In general CIP's direct responsibility has to cease when research reaches a country program.

Once CIP research reaches a country program, there are many forces with which CIP cannot be expected to react which influence the use of technology. Some of these forces are local price policies, land reform programs marketing systems, credit, extension programs and priorities for commodities.

CIP inherited the work "Outreach" from the older centers and in the past has utilized this work when referring to work outside of headquarters based research. To avoid confusion, CIP now uses the term "Regional Research" instead of Outreach to accurately reflect the regional activities and programs. Only in a few instances does CIP receive special project funding for in-country programs.

Region I	*South America* - Headquarters - Peru.
Region II	*Central America and the Caribbean* - Headquarters - Mexico.
Region III	*Tropical Africa* - Headquarters - Kenya.
Region IV	*Middle East and North Africa* - Headquarters - Tunisia*.
Region V	*Southwest Asia* - Headquarters - Pakistan.
Region VI	Headquarters - India.
Region VII	*Southeast Asia* - Headquarters - South Korea.
*	Changed from Lebanon in early 1976.

The International Potato Center's Regional Research and Training program reaches to seven regions of the world.

The flow of information and technology in Regional Research is multi-directional. New potential varieties and techniques originating in CIP Lima must be selected and adapted to local conditions by national programs and CIP regional research scientists. In this sense, source research begun in CIP Lima is continued by regional scientists. Scientists in Lima also depend on feedback from national experiments and trials to determine the direction of their own work. The communications section established this year will be concentrating a major portion of its efforts in support of Regional Research and Training Materials for support communications are being developed for use by regional scientists.

During 1975 considerable strides have been made in the organization of Regional Research on a basis similar to that used at CIP in the form of Thrusts. To assist in the planning for Regional Research, a Planning Conference was held in 1975 and a five year plan of activities was developed.

To increase the opportunity for continuity of Regional Research, once Production Specialist position for each region is budgeted into the Core Program. These staff positions are also fortified with special project funding.

Special project funding of BID has markedly increased the activities in Central America in 1975. CIP is in the process of locating a Production Specialist on special project funding at CATIE for Central American countries. Also, Ford Foundation special project funds enabled CIP to work directly with the national potato programs of Bolivia, Ecuador, and Peru in training and specific priority research.

CIP has presently, or will soon contract the following Production Specialists in regional programs.

	Core Programs	Special Projects Bilateral
Region I	1	3
Region II	1	1
Region III	1	1
Region IV	1	2
Region V	1	1
Region VI	1	2
Region VII	1	3
Totals	7	13

REGION I
SOUTH AMERICA
General Activities

During 1975 CIP personnel through Core or Special Project funding for research or training projects visited all countries in South America except Paraguay to help with the development of National Programs. A meeting was held at CIP for leaders of potato research and production programs in Latin American countries. There were participants from all National Programs of the region except Uruguay. The strategy for improving or stabilizing potato production in the countries was discussed along with the identification of priority problems in order to allow CIP and National Programs to develop coordinated programs of co-operation and help CIP determine its research and training priorities for the region. Activities for the region were considerably increased during 1975 and will continue through 1976 due to Special Project funding by BID which provided additional production specialists, an economist and a seed production specialist to concentrate activities in Latin American

Farmer from Cajamarca Peru, tilling the soil in the traditional way very common in the Andean regions today.

Research

In CIP's program of technological transfer through improved potential varietal material in 1975, virus free stem cuttings or tubers were provided to Ecuador, Bolivia, Colombia, Brazil, Chile and Peru. The material included resistance to viruses important in seed production programs, late blight and brown rot.

A very successful pilot potato storage project was developed with Ecuador which demonstrated the feasibility of utilizing simple low cost structures close to the marketing center with substantial economic benefits to growers. Results are being utilized for an expansion of the program. Research with simple low cost structures in Peru gave excellent similar results, and the research and facilities will be expanded in 1976 to be utilized in regional training activities.

Training

Potato scientists from Brazil, Bolivia, Ecuador, Peru and Chile received intensive training at CIP in specific areas of research of importance to their national programs. Eight scientists from Ecuador, Colombia and Peru are presently on formal master degree training at the Universidad Nacional Agraria adjacent to CIP headquarters in Lima.

Seed production courses were held in Ecuador and Peru. A five month course on potato production from planting through harvest was held at CIP facilities with participants from Peru, Ecuador and Bolivia.

REGION II
CENTRAL AMERICA

General Activities

In the past this program has been headquartered at CIMMYT facilities in Mexico and includes an international late blight testing program and annual regional training activities. During 1975, a large portion of the activities were transferred to, and conducted in association with Mexican governmental programs.

Research

The annual international late blight test was conducted as usual at CIMMYT facilities in the Toluca valley, Mexico, and included approximately 3500 clones. The late blight germ plasm collection presently has approximately 450 clones for distribution and utilization in breeding programs on late blight resistance. These were distributed to 12 countries making specific requests in 1975 including the Dominican Republic, Honduras, Panama, Peru, Mexico, Costa Rica and Nepal.

Dr. C. James, visiting scientist from Canada, utilized remote sensing methods in his research to help develop a more efficient international late blight test for CIP.

CIP has an active project on brown rot resistance in association with Costa Rican scientists. This project is being expanded through special project support to speed the results of this research into seed production programs for final evaluation and transfer to growers.

Training

The international course on potato production was held in 1975 from May to October with participants from Mexico, Honduras, Panama, Nicaragua and the Dominican Republic. Special individual technical assistance was given to Mexican potato scientists in nematology, late blight, bacterial wilt, and seed production technology. There were nine participants from this Region, at the Peru meeting for potato program leaders in Latin America in 1975.

REGION III
AFRICA
General Activities

During 1975 CIP identified an African as the Production Specialist for this region who was brought to CIP for an indoctrination-orientation period of several months. He will return to Kenya in early 1976 along with a scientist provided by the Dutch Government for a two year period. During January and February of 1976 they will be joined by Senior CIP staff for an intensive period of program initiation for the region. Although CIP has been conducting annual training programs in association with Kenyan and British scientists, its first production specialist will be in residence in this region in January of 1976.

Miss Lucy C. Tembu, from the East African Plant Quarantine Service/EAAFRO, Kenya, studying at CIP under a short term scholarship in Meristem Techniques.

Research

During 1975, projects were conducted in the region on testing potential new varieties in Ethiopia and Nigeria. A new brown rot and late blight resistant clone was identified as being excellent (in a Nigerian project).

Training

Twenty-four potato scientists from the region participated in the Annual three week workshop - production course. The countries represented were Tanzania, Uganda, Sudan, Malawi, Cameroon, Ethiopia, Nigeria, Ghana and Kenya.

A scientist from the East African Agriculture and Forestry Research Organization - EAAFRO spent two months at CIP in training on tissue and meristem culture techniques. This training will help establish credibility between CIP and the East Africa Quarantine Center in transfer of genetic material to the region.

REGION IV
MIDDLE EAST AND NORTH AFRICA

General Activities

Due to unstable conditions in Lebanon, CIP's regional headquarters was changed to Tunisia on an emergency basis in early 1976. Although many of the 1975 activities in Lebanon were cancelled, when the local political situation returns to normal there is a good basis for a national program in Lebanon. Special project funding is providing a production specialist starting in 1976 for a five year period in Tunisia. Also, the government of Turkey has recently made a considerable investment in a national potato program. This country may be included under region four and would provide an alternative for the location of regional headquarters. Furthermore CIP is looking for a special project funding to place a full time specialist in Turkey during the next three years.

Research

Material resistant to viruses, late blight and bacterial wilt were provided by CIP to the Lebanese Agricultural Research service during 1975 for testing. Two thousand clones which included resistance to the priority diseases in CIP work were provided to the Egyptians for evaluation on their adaptation in Egypt. Included were clones resistant to both late blight and brown rot.

Training

Two short courses on potato production were conducted the first part of 1975 in the Bakaa valley of Lebanon with 50 persons attending each. A one week course on potato production was conducted in Jordan for 40 potato workers. Schools for seed inspectors were conducted in both Lebanon and Syria. A Sudanese potato worker was given five months intensive training in Lebanon working with CIP's regional production specialist.

CIP's production specialists and staff have co-operated intensively with the national programs in the Lebanon, Syria, Jordan, Saudi Arabia and Egypt.

Help to Turkey and Tunisia has progressed from co-operation with national scientists to having official requests received from Ministries of Agriculture and Agreements developed which will be signed in early 1976.

REGION V
SOUTHWEST ASIA

There have been several visits of CIP Staff to Pakistan for discussions necessary in the development of an agreement which has been signed permitting the location of CIP's regional program there. A national potato improvement program has been initiated and the CIP production specialist to be located in Region V has been in Peru on an initial orientation training period and will take up residence in Pakistan in February of 1975.

REGION VI
SOUTH-CENTRAL ASIA

An agreement was signed in 1975 with the Indian Government formally permitting the activation of their regional program. Funding has been identified which would permit CIP to utilize Indian expertise in regional activities of training and the multiplication, evaluation, and redistribution of genetic material sent into the region from CIP.

REGION VII
SOUTHEAST ASIA

The production specialist for this region received several months of indoctrination at CIP in mid 1975 and took up residence in South Korea in November. To help him initiate activities in the region, six senior CIP staff intensively covered the region during late October,November and early December. Countries receiving major attention were Nepal, Philippines, Sri-Lanka, Indonesia, Thailand and South Korea. A course in Seed production technology will be held in Sri- Lanka in February 1976. Participants have been identified to attend a regional workshop in South Korea in June of 1976. There is a concentration of regional activities in Sri-Lanka, Nepal, the Philippines and South Korea on seed production technology with existing varieties, late blight and brown rot resistance, and the training of national personnel.

Formal Degree Training Courses

There are formal training programs at CIP in conjunction with co-operating universities at the Masters, Ph.D. and post-doctoral levels.

Training Leasing to the Masters Degree

This is in conjunction with the National Agrarian University adjacent to CIP's facilities in the La Molina.

Training Leading to the Ph.D. Degree

This program is in association with institutions in developed countries where formal course work is accomplished with major portion of the thesis work done at CIP facilities in Peru.

Post-Doctoral Training

CIP is using some post-doctoral positions to look at future staff members and to train scientists for possible regional assignments as the Regional Research and Training Program is expanded.

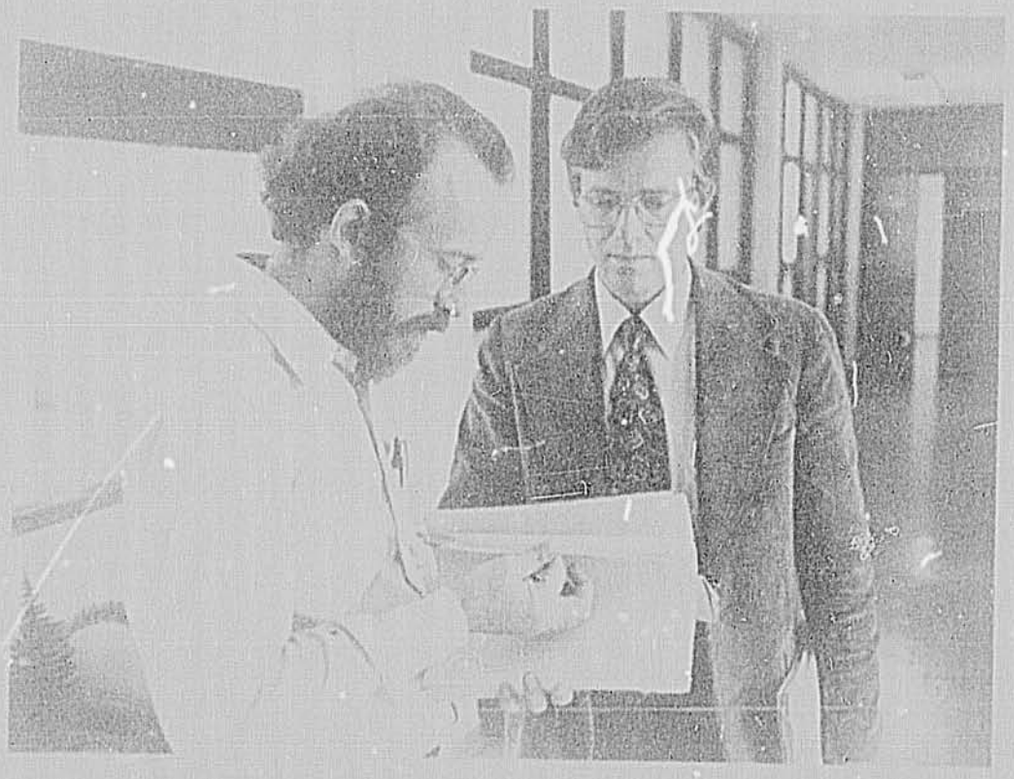
MAN-YEAR OF TRAINING FOR 1975 AND PROJECTIONS FOR 1976

Level of Training	1975	1976
Non Degree	13	16.4
M.S.	15.8	19.0
Ph.D.	10.3	13.0
Post-Doctorate	4.3	5.4

Socio-Economic Program

1975 was a year of considerable program growth. Recent expansion of personnel and the establishment of priorities have allowed work to begin on several substantive projects.

In 1975 the socio-economics staff grew from a single economist to two economists, an anthropologist and four half-time project assistants. In the near future, the team will be rounded out by a third economist and a full time project assistant. Work of the Center's socio-economics staff is complemented by that of consultants, visiting professionals (e.g. a rural sociologist on six-month leave from a U.S. university) and institutions and professionals contracted for special projects.



(L-R) Dr. Douglas Horton, CIP Economist, and Dr. Reed Hertford, Regional Representative of the Ford Foundation, discussing the Regional Research Program.

Priorities

In order to improve the data base on countries where Regional Research activities are taking place, and assist in the determination of Regional Research Activities, two studies have been initiated.

1) Macro-level data from FAO and other sources are being analyzed and summarized in a series of tables and graphs. This information will indicate the absolute and relative importance of potatoes in each region and country. Historical trends in major production and consumption variables will be indicated.

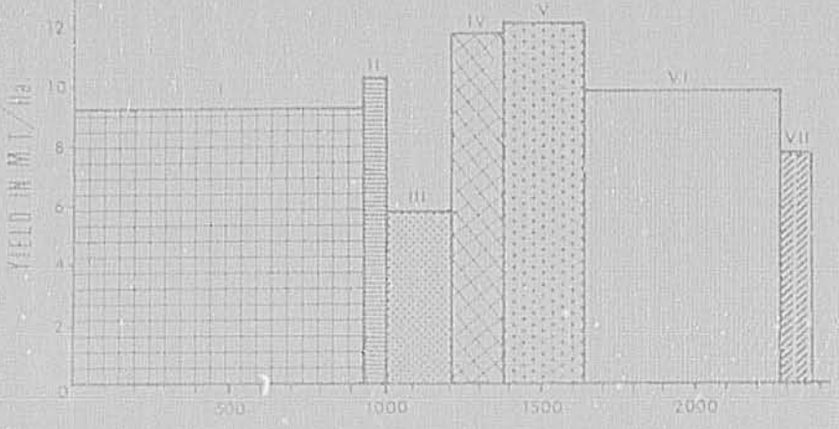
2) Detailed monographs are being written for selected countries in which national potato program interest is strong, and where the International Potato Center hopes to assist in achieving major technological breakthroughs. These country-level studies are interdisciplinary and are executed in strict collaboration with national potato programs. The two main reasons for the research is to define a comprehensive picture of potato production and utilization in countries, and to identify priorities for further work in Regional Research. These studies will also serve as "benchmark studies" for future evaluation of CIP and co-operating national potato programs.

Some Early Results

The foliowing tables and charts present some early results of the analysis of FAO statistics. South America where the potato originated, is the most important CIP Region, in terms of production. India, Nepal and Bangladesh constitute the second largest Region. Yields in the developing countries average less than one third the level of CIP donor countries. Within the developing areas, yields are highest on the irrigated lands of the Middle East, and lowest in Tropical Africa. (Table I).

During the 1960's-- that is, prior to the Center's foundation--, potato yields in the developing areas increased, on average, slightly faster than did those in the donor countries. However, in Central America, South East Asia and the Middle East yields increased very little. In most regions the seeded area rose substantially. Within the Regions, only in Latin America did the seeded area and per capita production decline. In the donor countries, where the income elasticity of demand for potatoes is negative, yield increases were more than offset by reductions in seeded area, and per capita productionof potatoes declined significantly. (Table II, Graph II).

GRAPH II POTATO PRODUCTION IN CIP REGIONS: 1972–1974



Source: FAO Production Yearbooks

I SOUTH AMERICA
II CENTRAL AMERICA MEXICO CARIBBEAN
III TROPICAL AFRICA
IV MIDDLE EAST AND NORTH AFRICA
V NON-ARAB MOSLEM COUNTRIES
VI INDIA NEPAL BANGLADESH
VII SOUTHEAST ASIA

TABLE I

POTATO PRODUCTION IN CIP REGIONS AND DONOR COUNTRIES

1972/1974

	AREA Thousands of Hectares	YIELD Metric Tons/Ha.	PRODUCTION Thousands of M.T.
CIP Regions			
I South America	938	8.4	7,926
II Central America and the Caribbean	70	9.4	658
III Tropical Africa	209	5.4	1,121
IV Middle East and North Africa	156	11.1	1,734
V Non-Arab Muslim Countries	259	11.3	2,933
VI India, Nepal, Bangladesh	639	9.2	5,899
VII Southeast Asia	96	7.4	712
Total Regions I-VII	2,367	8.9	20,983
Donor Countries	1,608	28.6	45,975

Source: FAO Production Yearbooks

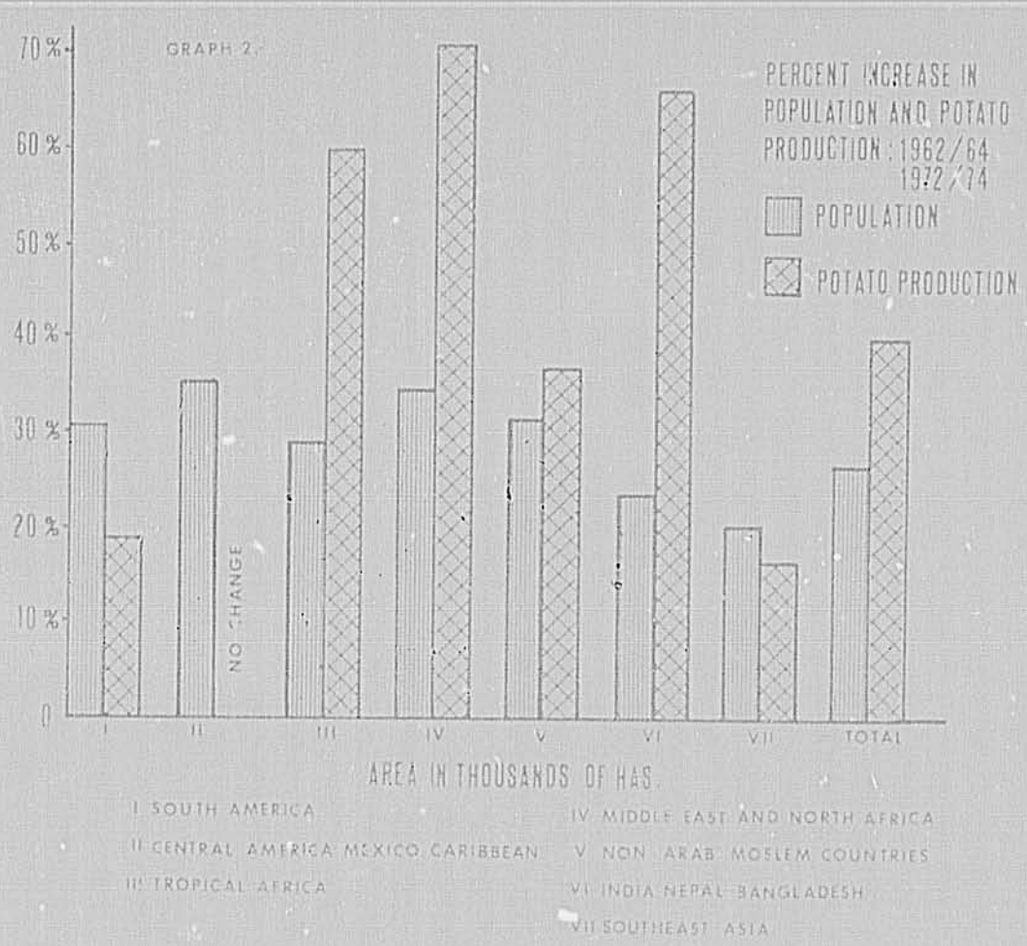


TABLE II

PERCENTAGE CHANGES IN POTATO AREA, YIELDS AND PERCAPITA PRODUCTION IN CIP REGIONS AND DONOR COUNTRIES

1962/64 - 1972/74

CIP Regions:		AREA	YIELD	PRODUCTION	PERCAPITA PRODUCTION
				o/o	
I	South America	3	22	19	- 9
II	Central America and the Caribbean	-5	5	0	-28
III	Tropical Africa	50	11	67	29
IV	Middle East and North Africa	68	2	71	27
V	Non-Arab Muslim Countries	26	10	41	6
VI	India, Nepal, Bangladesh	29	38	77	40
VII	Southeast Asia	12	6	19	- 2
	Total Regions I-VII	15	21	40	9
Donor Countries		-26	19	-13	-21

Source: FAO Production Yearbooks

Study of Micro-Regions

The Socio-economic staff has made plans to co-operate with the Physiology and Pathology scientists in interdisciplinary research within selected micro-regions. It is hoped that by investigating the experience of similar efforts at transfer of technology, insights will be gained which will enable the Regional Research and Training efforts of the International Potato Center to be more successful.

Socio-economic team members are making plans to participate in the training program of Regional Research and Training to assist interns in their orientation and background studies relative to social or economic factors which will influence their effectiveness.

Group of students from Region I, South America, being instructed by Mr. Jim Bryan, Seed Production Specialist of CIP. (L-r) Mr. Aníbal Ubidia del Campo, Ministry of Agriculture, Quito, Ecuador; Mr. Donato Pedro Guerra Desumont, Credit and Rural Assistance Association, Minas Gerais, Brazil; Mr. Jim Bryan of CIP, Lima, Peru; Mr. Odine Gallegos G., Ministry of Agriculture, Quito, Ecuador; Mr. Eduardo Guaracha Guzman, Chief, Department of Seeds, Ministry of Agriculture, La Paz, Bolivia.

HIGHLIGHTS - CONTRACT RESEARCH - 1975

CIP has contractual agreements with twenty universities and institutions in eleven countries. Selected individuals or teams involved in potato research assist CIP in improving the potato for developing countries. The contracts are normally negotiated for periods of one to three years with an annual review and submission of progress reports. Through such contractual arrangements CIP's research capacity is greatly expanded at nominal cost; expert opinion is readily available; the need for costly instrumentation facilities and their maintenance is reduced; and permanent CIP scientific, technical and support staff requirements are minimized. Several of the contracts with developing country institutions are special project funded.

RESEARCH CONTRACT PROJECTS - 1975

Cornell University, Ithaca, *USA* - "The Utilization of *Solanum tuberosum* ssp. *andigena* Germ Plasm in Potato Improvement and Adaptation".

North Carolina State University, Raleigh, *USA* - "Breeding and Adaptation of Cultivated Diploid Species".

University of Minnesota, *USA* - "Evaluation of CIP Germ Plasm Collection for Production of Potato Cultivars with High Quality Protein and with Frost Resistance".

The Swedish Seed Association, Svalov, *Sweden* - "Development of Late Blight Resistance of Cultivated Potatoes".

I. v. P. Agricultural University, Wageningen, *Netherlands* - "Adaptation of the Potato Crop to Drought and High Temperature".

Foundation for Agricultural Plant Breeding, Wageningen, *Netherlands* - "Resistance Breeding Against the Potato Eelworm, *Heterodera rostochiensis*".

International Agriculture Centre, Wageninge, *Netherlands* - "Potato Improvement in the Mid-East and North Africa".

Centro Regional de Investigación Agraria - La Molina, *Peru*.- "Utilización de las Especies Cultivadas Diploides para Mejoramiento en Calidad Culinaria y Nutricional de Papa".

University of Wisconsin, *USA*.- "Developing Potato clones with Resistance to Bacterial Wilt and Improved Adaptation to Tropical Conditions".

Contract - St. Elena Station - *Mexico*.

Universidad Nacional Agraria, La Molina, *Peru*.- "Responses of the Potato Plant to Controlled Climatic factors".

Instituto Nacional de Investigaciones Agrícolas - *Mexico*.

Instituto Colombiano Agropecuario, Popayán, *Colombia*.- "Evaluación de la Resistencia de Material Genético de Papa a *Pseudomonas solanacearum* E.F. Smith"

Instituto Colombiano Agropecuario, *Colombia*.- "Exploración y Recolección de Cultivares de Papas Colombianas".

Universidad Nacional Agraria* - La Molina, *Peru*.- "Fertility and Mineral Nutrition of the Potato"

Universidad Nacional Agraria* - La Molina, *Peru*.- "Effect of Various Systems of Potato Production on Yield, Pathogens, Fertility and Soil Erosion

M.A.N.R. RIYOM, via VOM, Benue Plateau State, *Nigeria*.- "Development of Blight and Bacterial Wilt Resistant Potato Varieties for Nigeria".

College of Agriculture, Haile Sellasie I University, Dire Dawa, *Ethiopia*.- "Evaluation of Potato Germ Plasm".

Universidad Católica Boliviana, *Bolivia*.-* "Investigación de la Papa".

Instituto Nacional de Investigaciones Agropecuarias, *Ecuador*.-* "Development of Potato Culture in Ecuador".

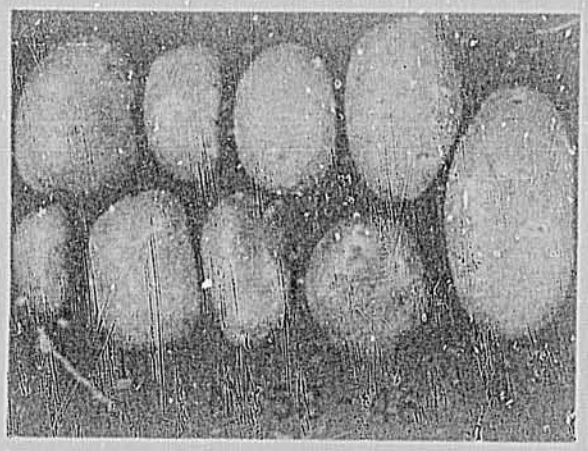
* Special Project Funded

Rather than summarizing the large volume of data from all contract Project Reports, a few selected items are presented in this Annual Report. If more detailed data is desired, the reader should contact the International Potato Center for assistance.

Cornell University, Ithaca, New York, USA

Research contract work at Cornell University is concerned with a series of cycles for phenotypic selection within Andigena tetraploid germ plasm for wider adaptation, earlier maturity, yield, appearance, and pest resistance. Selected clones which show promise are then intercrossed sexually to produce the next generation for further selection. The clone, M725-1-3 shown below represents one of the best clones after one cycle of selection. The clone N558-4o, is one from the fifth cycle of selection. Improvement in table type which is only one of the criteria used in evaluation is clearly evident in these two photographs taken with equal scales of enlargement.

M725-1-3



In 1975 the 6th cycle of mass selection was grown in the field as spaced plants for initial hill selection. Selection on tuber appearance yielded 1183 clones from 26,500. Improvement in shape and yield over the fifth cycle of mass selection was gratifying; some of the clones were equal to *tuberosum* selections. Among the parents which produced seeds for the 6th cycle, the following percentage resistance was found:

RESISTANCE

Disease or Insect	Per Cent Parental Resistance
PVX	88
PVY	48
Late Blight*	32
Verticillium Wilt	43
Scab	22
Wart	88
Green Peach Aphids	3
Potato Aphids	11
Leaf Hoppers	7

* Reading of less than 2 in Mexican late blight test.

Twenty thousand seedlings were grown of the third cycle of a more broadly based *andigena* population. Seeds from this population were sent to CIP, Poland, Japan, Korea, Nepal and Egypt on behalf of CIP.

North Carolina State University, Raleigh, USA

Two base populations of the diploid species *S. phureja* and *S. stenotomum* are being studied for adaptation and utilization in both temperate and lowland tropical environments. The two populations included 14,000 segregating seedlings representing 60 families and 3,000 selected clones representing the same families. These two populations are day-neutral in photoperiodic response and will tuberize under a wide range of day lengths. Tuber families from these selections are being evaluated in Canada for wart resistance and in Peru for disease resistance and adaptation to the lowland tropics.

New families are being evaluated and clones possessing very high solids have been identified. A program of selection and breeding for heat tolerance has been initiated utilizing the North Carolina State University (NCSU) Phytotron. Results from these tests will be correlated with results from tests in the lowland tropics to allow a more rapid evaluation for heat tolerance.

University of Minnesota, St. Paul, USA

Protein Evaluation

Potato clones were selected in 1975 for improved *protein* content (8-10 per cent dry weight) as well as for high yield. This year the yield of one clone was comparable to that of standard varieties indicative that both high yield and protein can be combined.

Protein fractions from tubers of low, intermediate and high total protein have been characterized. The nutritional quality of the protein is high and usually either methionine or isoleucine is the limiting amino acid. The relative amounts of different protein classes may influence which is the limiting amino acid and this is being further investigated.

The nitrate reductase activity in various plant parts of several varieties has been found to increase during growth and when tuber formation starts it declines. Its activity in roots increases slightly from the time of tuber formation to maturity. Preliminary results show there is a positive correlation between nitrate reductase activity in the plant and tuber protein content.

A method for determining the amount of methionine in potatoes has been developed. The values correlate favorably with those from standard chromatography.

Frost Resistance

Pulsed nuclear magnetic resonance spectroscopy was used to study the freezing process in excised leaf tissues of several *Solanum* species. The major difference between the susceptible and hardy species was the ability of the hardy species to tolerate more freezable water at their killing temperatures than the tender species.

It has been found that all of the wild *Solanum* species studied can be cold acclimated in contrast to the cultivated ones which cannot. This suggests genetic control may be transferred to cultivated types.

Swedish Seed Association
Svalov, Sweden

A brief summary of research on late blight resistance during the period of July 1, 1974 to June 30, 1975 follows:

The inheritance of resistance to penetration and invasion was studied in each of five dihaploid and tetraploid families. From a plant breeding point of view it is important to note that resistance to entrance appears to be inherited independently to resistance to invasion. It is possible to combine very high levels of resistance to both components in a clone.

Low viability seems to make dihaploids very susceptible to small environmental changes while tetraploids seem to be better buffered against environmental changes.

A remarkable relation has been noted between germ tube length, frequency of penetrating germ tubes, and IE-v (infection efficiency in relation to cultivar). Prolonged germ tube growth is apparently the critical feature of spore behaviour in varieties with low infection efficiency (No. of lessions/cm2).

It is propo-ed that germinated spores which have not become established by penetration into the underlying leaf tissue will die when the infection droplets dry out. Inoculations aecess period is critical to the establishment of an infection.

Suspension of spores in 10-3 ppm of gibbsrellic acid promotes rapid germ tube growth and reduces infection frequency, even in a resistant variety. This observation supports the conclusion that one of the resistance factors in low IE varieties is the prolongation of germ tubes.

In studies of the relation between leaf and tuber resistance, tuber susceptibility has been correlated to the total field resistance of foliage and to components of leaf resistance. There is evidence for a common inheritance of tuber resistance and resistance to invasion of the leaf tissue. Althoug glass-house screening for field resistance to blight selects for foliage resistance, high levels of tuber resistance can also be anticipated

The components of late blight resistance in the proposed standard set of differentials for the temperate zone are as follows:

Variety	Field Rating (days to 50 o/o defoliation)	Entrance (1) IEv 1,000	Invasion (2) Les.cm2
Bintje	10	107.9	2.32
Eigenheimer	12	105.0	2.36
Record	18	95.0	1.15
Libertas	18	95.5	1.16
Alpha	19	91.4	1.61

(1) Infection efficiency of 1,000 zoospores relative to host variety.
(2) Average lesion size.

Since Bintje, Eigenheimer and Majestic have rather similar ratings, it is recommended that *Bintje* be selected as representative of class 3 (susceptible) since it is very widely grown. Record, Libertas and Alpha are also very similar. However, since Alpha is a standard variety for testing in Mexico, it is recommended that *Alpha* be selected as representative of class 5 (moderate). *Pimpernel* is not the best selection for class 7-9 (*resistant*) since it is extremely late resulting in somewhat misleading behaviour towards blight. The Swedish seedling, Sv 70103 has very high resistance and matures as early as Bintje and might therefore be a useful class 9 differential.

Research Station for Arable Farming, Lelystad,
The Netherlands

This project is concerned with the adaptation of potatoes to drought and high temperatures. As the project was moved from Wageningen to Lelystad in 1975, field work to confirm the 1974 laboratory experiments using a diffusion porometer and a pressure bomb were postponed. However, a measure of stomatal closure as a reaction to water stress was studied using a paraffin oil-kerosene spray which penetrates open stoma. With this method reactions of the stomata to light intensity and on the water stress could be measured consistently.

Research on rooting potatoes in relation to yield and quality was continued. With a very acid peat layer in the sub-soil which restricted rooting depth, yield was reduced by about seven tons/hectare compared with the same soil in which the acid peat layer was broken.

International Agricultural Center, Wageningen,
The Netherlands

This project is concerned with Regional Research and Training activities. During 1975 assistance was given to develop training programs in Lebanon, Jordan and Syria. Consultants (Beemster, Beukema, Sparenberg and Van der Zaag) were made available to work in the above countries. A design for pilot potato storage in Lebanon was completed. Literature, films, serum, seed of plants for virus identification and farm equipment were made available. CIP assisted in identifying candidates for the International Course on Potato Production at Wageningen and provided a fellowship for a Chilean participant.

During 1975, potato materials collected in 1974 by the Dutch Expedition into Peru, Bolivia, and Argentina were tested for resistance to *Heterodera pallida* (Pathotype ABCDE). Both the wild and primative potato types were tested with 17 seedlings each by means of a simple screening method. Most of them were susceptible. With a reduced number, testing will be continued in 1976 with a more reliable method. The results were not satisfactory in 1975 because of an insufficient development of cysts on the root ball.

Considerable effort was put into crossing *S. tuberosum* with *S. spagazzini*, *S. oplocense*, *S. vernei*, and *S. sparsipilum*, which were shown to be resistant to pathotype ABCDE of *H. pallida*. Large numbers of seed will be made available to CIP for research. As much of this material is still close to the wild type, additional exchanges of potato materials with CIP are expected to be necessary in the future.

Ministry of Food
Centro Regional de Investigación, La Molina, PERU

The Peruvian national project for the utilization of cultivated diploid potatoes for the improvement of cooking quality and nutritional quality continues to show progress. The cooking qualities being considered are color, flavor, and texture. The nutritional qualities are: total protein, per cent dry-matter, and total dry-matter per plant.

This project is not only important for the improvement of potatoes for the Peruvian National Program, but supports the CIP research thrust for improving nutritional quality. Work in 1975 identified clones that yielded an average of 500 grams per plant and clones with up to 30 per cent dry-matter.

Thirty clones of the species *S. phureja* and *stenotomum* from Colombia, Bolivia and Peru, were included in the research.

The plan for mass selection back-crossing is being continued. Results have been obtained with original materials from Colombia, Bolivia and Peru. In the breeding program with 10,200 seedling crosses the following results were obtained:

Number of Crosses made	500
Number of viable crosses	452
Number of pollinizations	7,250
Number of seed-pods obtained	2,250
Number of seed-pods without seeds	510
Number of seeds obtained	15,610
Average number of seeds per seed-pod	60.3
Average number of seeds per pollinization	20.1

The selections will be separately maintained and systems of breeding will be used: mass selection, backcrossing, and pedigree.

In the period of 1974-1975 work was done with 70 families of potatoes with a total of 2,245 individuals. From this material, 132 clones were selected and they yielded dry-matter as follows:

Number of Individuals	Yields within the limits (Kg. x Plants)
67	Up to 0,500
67	From 0,500 to 1.000
8	More than 1.000

Agricultural University, Wageningen, The Netherlands

This contract is concerned with overcoming the crossability barriers between cultivated potatoes and certain wild *Solanum* species of Mexico and to produce and evaluate hybrids particularly as related to *Phytophthora infestans* (late blight) resistance. Forty new *verrucosum x bulbocastanum* hybrids were obtained in 1975. Both diploids and colchicine-doubled hybrids are male sterile due to *verrucosum* cytoplasm. A backcross program aimed at substituting the sterilizing *verrucosum* cytoplasm by normal *tuberosum* cytoplasm is in progress.

High levels of *Phytophthora infestans* resistance were detected in species and hybrids of *verrucosum x tuberosum* dihaploids. Varying degrees of resistance were detected in *bulbocastanum* derived material.

The pathogenic induction of 12-chromosome *tuberosum* potato plants (monohaploids) was successful. Another culture is a useful procedure for the production of monohaploids from *bulbocastanum* and *verrucosum*

University of Wisconsin, Madison, USA

This contract project has two main objectives, namely, the elucidation of the genetic control of resistance to bacterial wilt, and the possible relation of agglutinins to the resistance mechanism. It has been found that potato lectin (haemagglutinin) from the Katahdin variety agglutinated avirulent strains of *Pseudomonas solanacearum*. Virulent strains were not affected. However, lectin from the wilt-resistant hybrid, P-13, agglutinated both avirulent and certain virulent strains of the bacterium. It appears that resistance *P. solanacearum* in potato is dependent upon the presence of specific agglutinating factors.

Controlled inoculations indicate that a relatively high proportion of tubers obtained from symtomless plants can harbor large numbers of *P. solanacearum*.

As a result of seedling inoculation procedure, 350 additional wilt-resistant clones were selected from thirty hybrid families.

During 1975, clones developed in this program were distributed to tropical countries for screening for resistance to wilt and late blight, as well as for acceptability in the local markets.

Country	Number of Clones
Taiwan	8
Colombia	12
Egypt	12
Puerto Rico	22
Mexico	47
Nepal	31
Nigeria	36
Kenya	34
Sri Lanka	20
Total	220

University of Birmingham, England *

TISSUE CULTURE FOR STORAGE OF POTATO GERM PLASM

This project is concerned with the long-term storage *in vitro* of meristem culture. Using minimal growth conditions and the cryogenic storage of cells or meristems in liquid nitrogen. The program has been initiated with 12 potato genotypes from CIP. Three clones were supplied at ploidy level, 2, 3, 4 and 5x. One *Solanum tuberosum* cultivar was also included in the research. The clones are being grown on a year-round basis in insect-proof greenhouses at Birmingham. At regular intervals new plants are established by taking cuttings.

Cultivars have been successfully established from axillary-shoot meristems of each of the clones. The type of development ranging from that of *Solanum tuberosum* which produces a small, rooted plant directly from the shoot tip, to that of several of the other clones (3x, 4x and 5x) in which initial callusing is followed by multiple-shoot production. This occurs usually after some roots have been formed.

The cultures have been produced on liquid Murashige-Skoog medium containing a suitable combination of cytokinin, gibberellic acid and auxin, the concentration of the cytokinin being of particular importance.

Plants have been re-established from cultures of all of the clones by transferring to soil rooted plants obtained by growing nodal cuttings on basic medium without hormones. With *S. tuberosum*, propagation potential by the *in vitro* system has been determined by producing, from a single culture, 100 rooted plants, which were transferred to soil and grown to maturity under field conditions. Tubers produced by regenerated plants from 6 of the clones, supplied by CIP, will be returned to CIP for genotype evaluation.

Low temperature storage at 2 degrees to 10 degrees celsius of cultures is now being studied. It has been found thus far that cultures from a number of clones will survive at 2 degrees celcius for at least 4 months. Frozen storage studies with liquid nitrogen have been initiated with a range of culture systems.

** Funded directly by Overseas Development Ministry of the United Kingdom*

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* Scientists working on Research Contract with CIP.

CENTER SUPPORT COMMUNICATIONS

The year 1975 saw the creation of a Support Communications section. This support will be of increasing importance in future years to all of the departments of CIP, and especially in the Regional Research and Training efforts.

The development of communications packages of information materials, both visual and aural which are designated for specific cultures and regions will assist the regional representatives in their work. Other communications packages which are country neutral and which can be adapted to specific audiences in the regions are also being developed. The communications packages will contain such materials as slide sets, wall posters, booklets, and films.

Center Communications Support will also be involved in training of Regional Research personnel to increase their communications effectiveness. Practical work in solving individual problems in communications will be given attention and included in training, both at CIP, Lima, and in the regions. Each year, at the regional representative conference communications constraints and bottlenecks encountered in the field will be studied with a view to keeping the assistance practical and specific to needs.

With the plans for new building facilties at CIP, the space for the Information Service and Library has been under study to effect maximum use of the space allocated. Attention has been given to designing storage and retrieval systems which will allow the consolidation of materials and at the same time make the information easily used by scientists and students. Student study areas have been incorporated into the library and student dormitory areas. Options for use of modern electronic communications have been kept open so future use of Closed Circuit TV and Audio systems will be possible.

Study has been made for the most efficient use of receptionist and guide service in the Center. Information service for visiting scientists and the public is planned so as to allow CIP scientists to make maximum use of their time in research. Prepared programs in an audio-visual format will permit visitors to become oriented and define their interests so their visit will be meaningful. These programs are being prepared in several languages.

As the influence of CIP is spread around the world we are experiencing an increasing flow of visitors. Some of them are in search of scientific findigs, and some have less definite reasons for visiting CIP. The following table indicates the interest in CIP by countries. Not all visitors were registered.

VISITORS BY COUNTRIES

COUNTRY	No.	COUNTRY	No.
Argentina	1	Japan	6
Australia	3	Kenya	1
Bolivia	3	Korea	4
Canada	1	Mexico	1
Chile	3	Nigeria	1
Colombia	3	Peru	12
Dominican Republic	2	Scotland	1
Ecuador	3	The Netherlands	6
England	2	U.S.A.	35
Germany	3	Venezuela	3
Italy	1		

The international nature of the staff and visitors to CIP has required the services of a Professor of Languages. Mr. Jorge Palacios provides language instruction to families and scientists requesting it. He provides language instruction in Spanish and English. During the year 1975 he provided lessons to 19 foreign staff member, nine wives, and seven Peruvians.

FINANCIAL STATEMENTS

DECEMBER 31, 1975

CONTENTS

S/. Peruvian Sol

US$ United States Dollar

Moreno, Patiño y Asociados
Asociados con
Price Waterhouse Peat & Co.

Los Begonias 441 — San Isidro
Lima - Perú
Correspondencia: Apartado 2869

March 22, 1976

REPORT OF INDEPENDENT ACCOUNTANTS

To the Board of Directors
Centro Internacional de la Papa

In our opinion, the accompanying balance sheet of Centro Internacional de la Papa at December 31, 1975 and the related statement of source and application of funds for the year, expressed in United States dollars, present fairly, on the bases stated in Note 1, the translation of the Peruvian sol statements mentioned below. The bases of translation are consistent with those used in the preceding year. Our examination of the financial statements expressed in United States dollars was made in conjunction with our examination of the Peruvian sol statements.

We have also expressed our opinion dated March 22, 1976 that the Peruvian sol statements of Centro Internacional de la Papa for the year ended December 31, 1975, not submitted herewith, present fairly the financial position of the center at that date and the source and application of funds for the year, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year. Our examination of these statements was made in accordance with generally accepted auditing standards and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

Moreno, Patiño y Asociados

Countersigned by

J. Patiño B.
----------(socio)
C. Armando Patiño B.
Public Peruvian Accountant
Registration No. 1245

CENTRO INTERNACIONAL DE LA PAPA

BALANCE SHEET (Note 1)

ASSETS

	At December 31, 1975 US$	1974 US$
CURRENT ASSETS		
Cash	85,518	567,874
Accounts receivable from donors (Note 3)	638,563	626,338
Other receivables		
Advances to third parties for research work	115,015	22,373
Staff advances	60,894	10,320
Other	65,673	17,160
	880,145	676,191
Inventories		
Spares and materials	55,243	31,750
Used vehicles	-	11,980
	55,243	43,730
Prepaid expenses	24,447	15,251
Total current assets	1,045,353	1,303,046
FIXED ASSETS (Note 2)	1,129,267	833,837
	2,174,620	2,135,883

LIABILITIES, CAPITAL BALANCES AND UNEXPENDED FUNDS

	At December 31, 1975 US$	1974 US$
CURRENT LIABILITIES		
Overdrafts	116,258	-
Accounts payable	56,081	19,910
Other liabilities	15,395	5,524
Institute of International Education, balance of remunerations payable to scientists and others	-	14,674
Total current liabilities	187,734	40,108
DEFERRED LIABILITIES		
Reserve for indemnities	48,901	27,047
GRANT RECEIVED IN ADVANCE (Note 3)	134,263	350,700
CAPITAL BALANCES AND UNEXPENDED FUNDS		
Capital grants		
Capitalization of fixed asset	1,129,267	833,837
Funds utilized in excess of grants received	(15,750)	(93,799)
	1,113,517	740,038
Working capital grants	177,930	184,575
	1,291,447	924,613
Unexperded (in excess) operating grants, per accompanying statement		
Core	(36,276)	5,961
Special projects, including US$ 66,128 of earthquake repair funds in 1974	548,551	788,454
	512,275	794,415
	1,803,722	1,719,028
	2,174,620	2,136,883

CENTRO INTERNACIONAL DE LA PAPA

STATEMENT OF SOURCE AND APPLICATION OF FUNDS (Note 1)

	For the year ended December 31, 1975	1974 (Reclassified)
	US$	US$
SOURCE OF FUNDS (Note 3)		
Operating grants		
Unrestricted	1,222,513	1,327,408
Restricted, including in 1975 US$ 2,000 unexpended in 1974	992,000	466,467
	2,214,513	1,793,875
Special projects grants, including in 1975 US$ 722,326 unexpended in 1974	760,995	739,041
Earned income, net	66,295	4,053
Capital grants for:		
Acquisition of fixed assets, net of US$ 93,799 expended in excess in 1974	253,201	343,711
Earthquake repair funds including in 1975 US$ 66,128 unexpended in 1974	114,822	75,000
Working capital	-	184,575
Total source of funds	3,409,826	3,140,255
APPLICATION OF FUNDS		
To Core program		
Potato research program	799,994	701,169
Research support	246,022	132,125
Conferences and training	617,104	531,518
Library and information services	56,184	16,762
General administration	330,327	285,890
General operating costs	241,269	124,502
	2,280,900	1,791,966
To special projects (Note 3)	212,444	16,715
Total operating costs	2,493,344	1,808,681
Carried forward:	2,493,344	1,808,681

	For the year ended December 31, 1975	1974 (Reclassified)
	US$	US$
Brought forward:	2,493,344	1,808,681
To capital		
Capital expenditures:		
Net increase in fixed assets	305,135	437,511
Earthquake repair funds	114,822	8,872
Working capital	-	184,575
	419,957	630,958
Unexpended balances		
Unrestricted (in excess) funds	(43,002)	3,961
Restricted funds	6,726	2,000
	(36,276)	5,961
Capital grants (in excess)	(15,750)	(93,799)
Special projects, including in 1974 US$ 66,128 of earthquake repair funds	548,551	788,454
	496,525	700,616
Total application of funds	3,409,826	3,140,255

CENTRO INTERNACIONAL DE LA PAPA

NOTES TO FINANCIAL STATEMENTS
DECEMBER 31, 1975

1 OPERATIONS AND SUMMARY OF ACCOUNTING POLICIES

The Centro Internacional de la Papa (CIP) was constituted in 1972, in accordance with an Agreement for Scientific Cooperation between the Government of Peru and North Carolina State University, United States of America, signed in 1971.

The CIP is a non-profitable institution, located in Lima, Peru, with an indefinite life. The CIP's principal objective is to contribute to the development of the potato and tuberous roots, at the national and international level, by carrying out research programs, preparation and training of scientists, organization of conferences, forums, seminars and all other activities in accordance with its objectives.

In accordance with existing legal dispositions and the provisions of the Agreement described above, the CIP is exempt from income tax and other taxes.

The aforementioned Agreement provides that, if for any reason the CIP's operations are terminated, all its assets will be transferred to the Peruvian Ministry of Agriculture.

The principal accounting policies are as follows:

a) Grants received and their application are accounted for on an accrual basis. Restricted operating grants and unrestricted grants are accounted for in the period indicated by the donor and, when grants are used abroad, the expenditure is accounted for on the basis of advices received.

In accordance with the instructions of the Consultative Group on International Agricultural Research, the unexpended fund balances at year-end, if authorized by donors, may be treated as income in the next year in order to absorb the corresponding expenses.

Working capital grants are recorded in the year they are received.

Special projects grants are recorded in the year they are received and the related expenses are applied against the respective income when incurred.

b) Bases of translation

The books and accounts of the CIP are maintained in Peruvian soles. Assets and liabilities have been translated into U.S. dollars generally at exchange rates prevailing at each year-end. Fixed assets not subject to exchange fluctuations have been reflected at the rates prevailing when acquired. Capital grants have been translated into U.S. dollars at historical rates. Source and application of funds have been translated at month-end rates.

c) The spares and materials are generally valued at estimated actual value.

d) Fixed assets are recorded as application of funds at the time of their acquisition and simultaneously are capitalized at their purchase cost.

It is not the policy of the CIP to reduce the net value of the fixed assets and the related capital account for depreciation. When assets are sold or retired their cost is removed from fixed assets and the related capital account.

e) Indemnities payable upon severance to the local staff for service time are provided in full in accordance with the legal dispositions of Peru.

2 FIXED ASSETS

The movement of fixed assets during 1975 is as follows:

	Balances at 1.1.75 US$	Additions US$	Retirements US$	Balances at 12.31.75 US$
Operating equipment	27,865	7,481	-	35,346
Research equipment	287,657	24,116	1,967	309,806
Vehicles	164,311	5,055	14,759	154,607
Furniture and fixtures	48,280	29,037	-	77,317
Buildings, construction and installations	247,980	233,583	-	481,563
Other	57,744	12,884	-	70,628
	833,837	312,156	16,726	1,129,267

3 GRANTS RECEIVED

The grants corresponding to 1975 are summarized as follows:

	Grants of 1975 US$	Unexpended grants in 1974 US$	Total US$
Operating grants	2,212,512	2,000	2,214,512
Capital grants	347,001	(93,799)	253,202
Special project grants	38,669	722,326	760,995
Earthquake repairs	48,694	66,128	114,822
	2,646,876	696,655	3,343,531

These grants comprise:

	US$
a) Received and administered by the CIP	
Rockefeller Foundation	100,000
International Development Agency - United States (USAID)	575,000
International Development Agency - Denmark (DANIDA)	220,000
International Development Agency - Sweden (SIDA) received and deferred in 1974	350,700
Overseas Development Administration - United Kingdom (UKODA)	129,675
Netherlands government, including US$ 2,000 unexpended in 1974	202,000
International Development Agency - Canada (CIDA)	310,345
Government of Switzerland	115,000
Interamerican Development Bank (IDB)	470,000
Federal German government	82,488
	2,555,208
Portion of the following grants: DANIDA, Government of Switzerland and Netherlands government, applied to Earthquake repairs	(48,695)
	2,506,513
Donations for special projects, including US$ 722,326 unexpended in 1974	760,995
	3,267,508
b) Received and administered by another institution	
Grants by the German government for the pathology investigation program administered By Deutsche, Forderungsgesellschaft für Entvicklunslander (GAWI)	55,000
c) Portion of grants applied to Earthquake repairs, from DANIDA, Governmen. of Switzerland, Netherlands government including US$ 66,128 unexpended in 1974	114,822
	3,437,330
d) Funds utilized in excess of capital grants received in 1974	(93,799)
	3,343,531

The unexpended balance of the special projects grants at December 31, 1975 was comprised of the following:

	Committed grants US$	Application US$	Unexpended balance US$
Interamerican Development Bank (IDB)	574,297	146,410	427,887
Ford Foundation	108,755	27,563	81,192
West German Government, net of a portion applied to Earthquake repairs	33,710	13,621	20,089
International Mineral Corporation (IMC)	34,233	20,105	14,128
Institut Mondial du Phosphate	10,000	4,745	5,255
	760,995	212,444	548,551

A portion of the IDB grant amounting to US$ 631,837 has not been received yet, and a portion of the West German Government grant of US$ 6,726 has not yet been reported by GAWI. These amounts are shown as Accounts receivable from donors in the balance sheet at December 31, 1975.

During 1975 additional donations of US$ 100,000 and US$ 34,263 were granted by the International Development Association and the West German Government, respectively, to be utilized by the CIP during the year 1976. These amounts are shown as Grants received in advance in the balance sheet at December 31, 1975.

THE INTERNATIONAL POTATO CENTER
Schedule 1.- FUNDS PROVIDED AND COSTS
For the year ended December 31, 1975
(US$ thousands)

		Total Funds Available	EXPENSES CHARGED						% of Support & Gral. Operat. to Direct	Transfer to Unexpended Balance
			Fixed Assets	Total Research	Corp. & Training	Library Doc. & Info.	General Administ.	General Operating		
Unrestricted Core	(1)	1,220.1	-	530.3	346.3	50.2	193.3	142.8	36%	(43)
Restricted Core										
USAID		575.0		245.0	186.0	6.0	78.0	60.0	32%	
Netherlands	(1)	44.5		34.9	8.6	-	-	-		
Germany GAWI		55.0		48.3	-	-	-	-	-	6.7
IDB		350.0		187.5	75.0	-	49.0	38.5	33%	
Total		1,024.5		515.7	270.6	6.0	127.0	98.5		6.7
TOTAL CORE		2,244.6		1,046.0	617.1	56.2	320.3	241.3		(36.3)
Capital Grants										
IDB		120.0	120.0							-
Unidentified Sources (multi-purpose)		227.0	227.0							-
Balance from previous year (deficit)		(93.8)	(93.8)							-
Earned Income		36.2	51.9							(15.7)
Total		289.4	305.1							(15.7)
Special Projects										
Federal Germany		33.7		-	13.6		-	-		20.1
International Mineral & Chemical		34.2		9.5	10.6					14.1
Institut Mondial du Phosphate		10.0		3.4	1.3					5.3
IDB		574.3			146.4					427.9
Ford Foundation		108.8		14.8	12.8					81.2
Total		761.0		27.7	184.7		-	-		548.6
Earthquake Repair										
Balance from previous year		66.1	66.1							-
Unidentified Sources		48.7	48.7							-
Total		114.8	114.8							-
TOTAL GRANTS AND EXPENSES		3,409.8	419.9	1,073.7	801.8	56.2	320.3	241.3		496.6

(1) Includes earned income.

THE INTERNATIONAL POTATO CENTER

Schedule 2.- DETAILED SCHEDULE OF EARNED INCOME

For the year ended December 31, 1975
(US$ thousands)

	Approved Budget	Actual
Sources of Earned Income		
Retained Income prior year	4	4
Sales of Crops	5	.5
Indirect Costs charged on Special Projects	120	26.1
Adjustment prior year	-	22.1
Rate of Exchange adjustment	-	5.7
Other	2	9.9
	131	68.3
Less: Auxiliary Services (Deficit)	-	2.0
	131	66.3
Application of Earned Income		
Applied to Core Operations	85	30.1
Applied to Capital	46	36.2
	131	66.3

THE INTERNATIONAL POTATO CENTER

Schedule 3.- COMPARATIVE STATEMENT OF ACTUAL EXPENSES AND APPROVED BUDGET

For the year ended December 31, 1975

(US$ thousands)

	CORE Unrestricted		CORE Restricted		Capital		Earthquake Repair & Building Improv.	
	Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual
Programs								
Potato Research	587.1	530.3	522.4	515.7				
Conferences & Training	434.2	346.5	270.6	270.6				
Library, Doc. & Info. Services	64.0	50.2	6.0	6.0				
General Administration	173.1	193.3	127.0	127.0				
General Operating Costs	67.8	142.8	98.5	98.5				
Total	1,326.2	1,263.1	1,024.5	1,017.8				
Capital								
Revolving Funds								
Operating Equipment					.2	6.1		
Research Equipment					12.0	7.5		
Installations					16.0	22.1		
Furnitures, Fixtures & Off.Equip.					-	39.5		
Vehicles					14.0	29.0		
Construction & Buildings					-	-		
Site Development					282.0	163.0		
Other					7.0	31.1		
Total					5.0	6.8		
Earthquake Repairs					336.2	305.1		
							41.1	114.8
Analysis of Variances								
Budget Surpluses:								
Net Income Shortage		79.2						
Transfer to Unexpended Balance				6.7				
Repair Funds budgeted but not available		26.9				46.8		
		106.1		6.7		46.8		
Deficits:								
Covered by budgeted Core & Capital income								
Carry-over 1976	43.0				15.7		73.7	
	1,369.2	1,369.2	1,024.5	1,024.5	351.9	351.9	114.8	114.8