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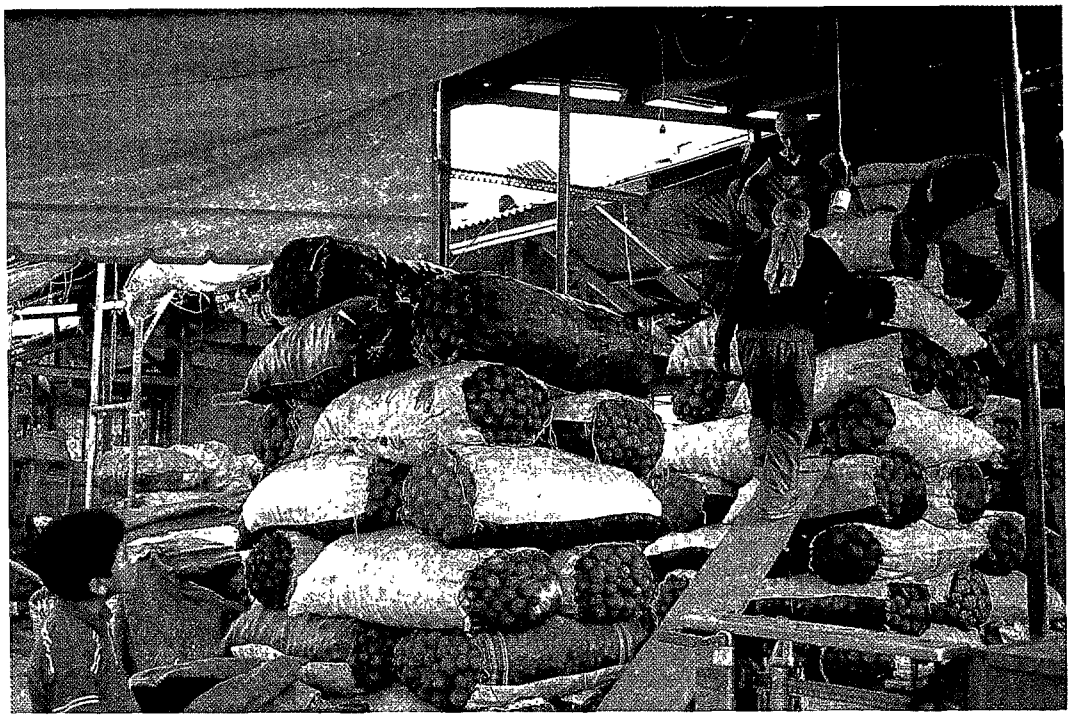
25th Anniversary Edition

CIP in 1995

The International Potato Center

Annual Report



G CHANG

We dedicate this report to the loved ones of
Rosa Rodríguez and Martin and Collette Bicamumpaka.

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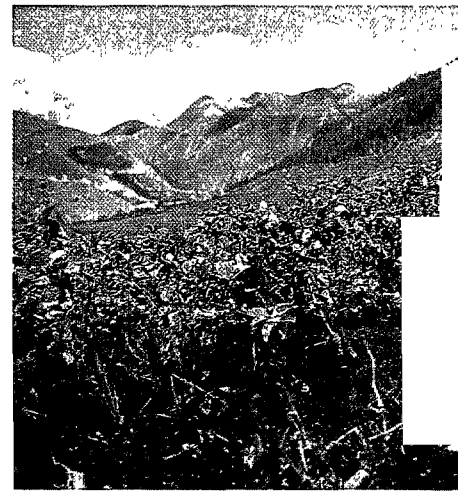

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CIP: 25 Years of Research for Development

A comprehensive study published by FAO and CIP economists in 1995 underscores the notion that production figures for root and tuber crops have been historically underestimated. In its report—*Potatoes in the 1990s*—the FAO-CIP team notes that potato production in the developing world increased at a faster rate over the past 30 years than any other food crop except wheat. The authors go on to say that developing countries will produce more than a third of the world's potatoes by the end of the century.

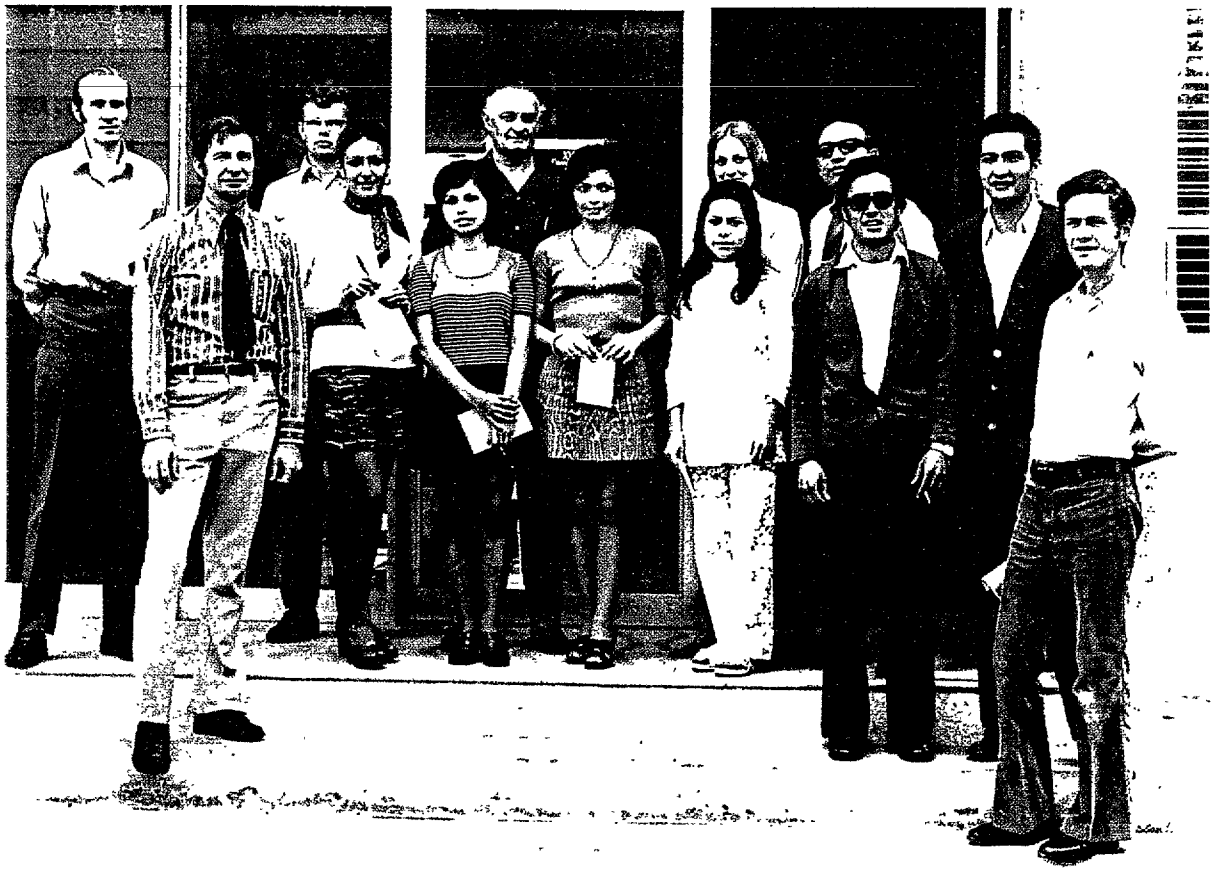
Interestingly, growth in potato production was made possible by the availability of new crop technologies such as high-yielding cereal crops that provide farmers with a small production niche in which to grow potatoes. Throughout Asia, large amounts of potatoes are being grown between the harvest and planting of early maturing rice and wheat varieties developed at IRRI and CIMMYT.

Even so, the potatoes grown in developing countries still yield far below their genetic potential. Experts estimate that the upper limit for potato production now approaches 120 tons per hectare. This means that there is considerable room to expand production without resorting to high-cost research aimed at increasing yields. With a comparatively small investment in research, science should be able to raise average potato yields from their current level of 15 tons per hectare to at least 30 tons across the developing world. Similar increases are also possible for sweetpotato. Thus, research aimed at scaling back losses from pests and diseases—rather than increasing yields per se—should produce significant across-the-board production increases at a relatively modest cost.

To achieve that goal, CIP has assigned its highest priority to late blight, the disease responsible for the Irish potato famine. In the 1980s and 1990s, more aggressive forms of the late blight fungus spread to virtually all important potato-producing countries, causing great concern among farmers, scientists, and politicians. As CIP enters its 25th year, the Center will respond to this dilemma in much the same manner as it has always addressed the problems of resource-poor farmers.

CIP is currently organizing a consortium of researchers to develop potato cultivars with durable resistance to all forms of the late blight fungus. At the urging of national programs and the research community at large, we have agreed to act as the convenor of a global late blight initiative. We hope that our participation will help to link scientists working in advanced laboratories and their colleagues in national systems.

Within five years, the initiative should help farmers to begin controlling late blight within integrated pest management systems in which resistant varieties—rather than chemical fungicides—play the pivotal role. We further expect that the knowledge and technologies developed as part of this initiative will be made available via research partnerships being



CIP founding Director General, Richard L. Sawyer (second from left), and Center staff in the first photograph published in a CIP annual report, 1972.

developed through the ecoregional and systemwide initiatives organized by CGIAR centers. Among these are the CIP-convened Andean Highland Initiative—CONDESAN—as well as ICRAF's East African Highlands Initiative and the Hindu Kush-Himalayan Initiative led by ICIMOD. We also hope to play a useful role in the CGIAR's Rice-Wheat Initiative by virtue of the important role of potato in this unique food production system.

As we have seen over the past 25 years, potatoes are not only a major food crop, but an efficient income generator and an effective tool for crop diversification and sustainability. The growth of potato production over the past quarter century is a tribute to the hundreds of CIP scientists who have labored to make potatoes available in developing countries and to our founders who had the foresight to know that the world's food requirements could not be met by cereals alone.

Hubert Zandstra
Director General

Bright Future for Potato Production

A new, comprehensive study by the United Nations Food and Agriculture Organization and CIP reveals that developing countries will produce more than a third of the world's potatoes by the end of the century. According to the report, since 1962 developing-country production has expanded at an unprecedented rate of 3.6 percent annually.

The study notes that in the nearly 100 developing countries where potatoes are grown, production rose from 30 million tons in the early 1960s to 85 million tons in the early 1990s, an almost threefold increase that is second only to growth in wheat output. Production in the developing world is projected to rise another 2.8 percent annually by the year 2000, compared with 0.3 percent in industrialized countries. The report represents the first comprehensive study by FAO's Commodity and Trade Division to detail the situation and prospects of the world potato economy.

Europe and the area of the former Soviet Union, the report said, still account for the bulk of potato production worldwide, but slow growth will result in a continuing decline in the industrialized world's share of production. In contrast, a rapid expansion of 30 million tons by the end of the 1990s is projected for developing countries, resulting in a harvest of 105 million tons, a 40 percent increase since 1988 alone.

Large Increases Projected for Asia

Gregory Scott, a CIP economist who collaborated with FAO on the study, says that if this transition continues, "most of the world's potatoes will be harvested in Asia, Africa, and Latin America in less than a generation." Asia, he says, accounts for almost 80 percent of potato production in developing countries, with harvests growing at an average rate of 4 percent a year from 1962 to 1992. The region should account for two-thirds of all projected increases in developing countries by 2000.

China, the world's second-largest potato producer after the Russian Federation, and India, the sixth-ranked global producer, are expected to continue to account for about half of this increase in the years just ahead. Pakistan, Indonesia, and Vietnam are also projected to show strong gains as potatoes continue to expand as a second or third crop in that region's rice- and wheat-based cropping systems and as consumers diversify diets.

According to the report, increases in potato production in developing countries were second only to those of wheat over the 30-year span studied. The area planted to potatoes outstripped cassava, wheat, rice, pulses, and coarse grains, the report said. In addition, a decline in potato prices compared with prices of other staple foods has quickened demand and spurred increased supplies.

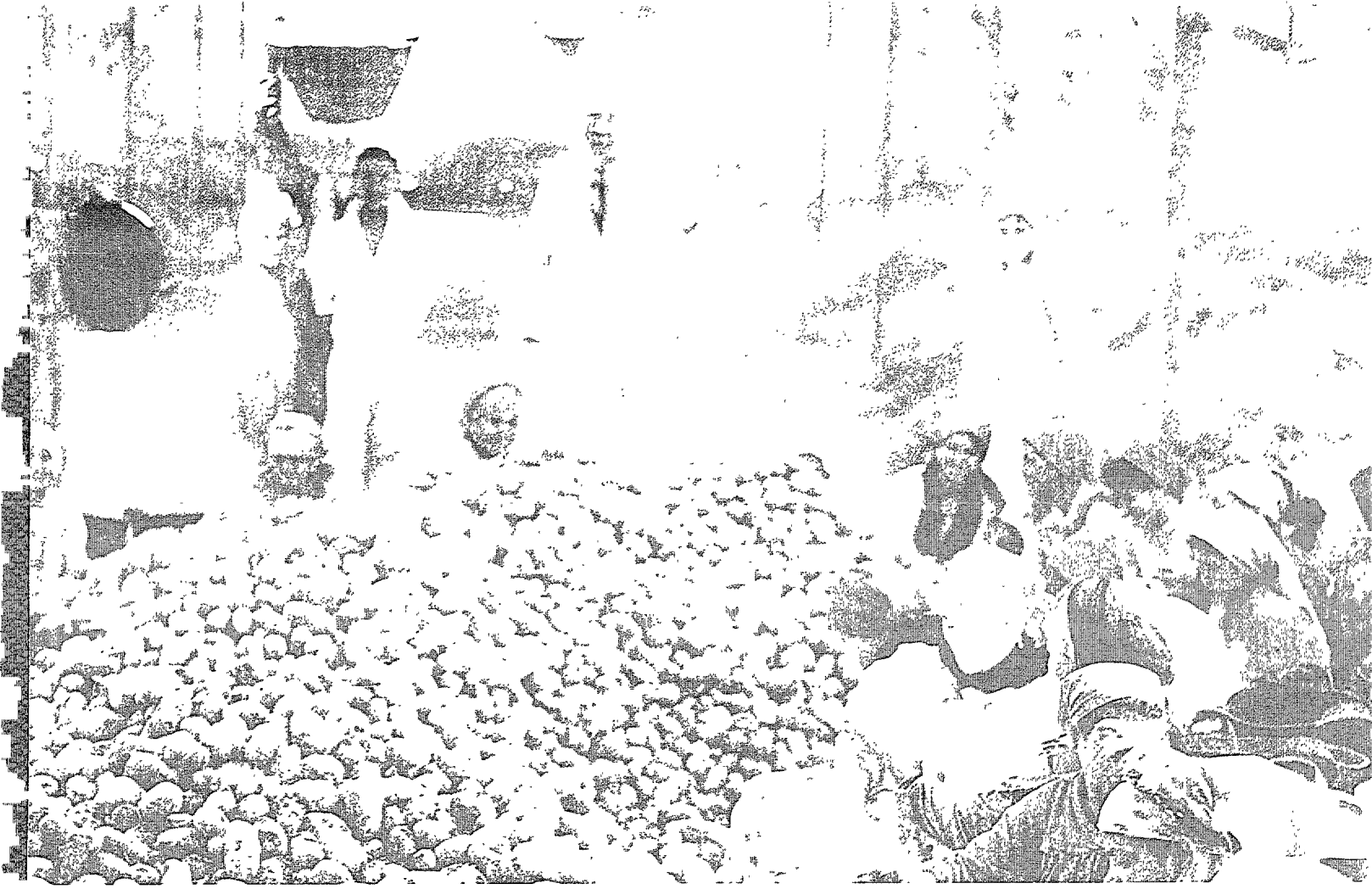
Africa also experienced extensive growth in potato output. Production in sub-Saharan Africa has increased nearly 150 percent since 1962, although beginning from a low base. Production is currently growing faster for potato than for any other major food crop in the region, except for rice and yams.

In Latin America, expansion was due to an increase in productivity as well as growth in area planted. Andean countries, the report said, are expected to recover from sharp cutbacks of the previous decade, whereas production in the region's Southern Cone is forecast to benefit from

World Potato Production in Selected Regions

Region	1961-63 average		1991-93 average		Average annual growth in production (%)
	Production (000 t)	Area (000 ha)	Production (000 t)	Area (000 ha)	
Developing world	29,066	3,562	84,957	6,677	3.6
Asia	20,280	2,327	66,037	4,995	4.0
Africa	1,826	238	6,693	700	4.1
LAC*	6,959	998	12,226	981	1.9
Industrialized world	236,048	18,592	190,398	11,456	-0.7
Total	265,114	22,154	275,355	18,133	0.1

*Latin America and the Caribbean.
Source: FAO/CIP. 1995. *Potatoes in the 1990s: Situation and prospects for the world potato economy.* Rome 39 p.



P. MALAGAMBA

Egypt produces more than 1.7 million tons of potatoes annually; since 1961-63, production has grown at an average annual rate of 4.8 percent.

greater commercialization. Potato production in Latin America increased roughly three-quarters over the past three decades.

Processing and Trade

The study noted that worldwide use of potatoes is shifting away from the fresh market and livestock feed toward processed products such as french fries, chips, and frozen and dehydrated potatoes. Processing, the report says, is the fastest growing sector within the world potato economy, a trend that can be seen in countries such as Argentina, China, Colombia, and Egypt.

Although potatoes are bulky and perishable, world trade in table potatoes and seed rose from 3 million tons in 1962 to 7.5 million tons in 1992, most of it among the 12 member countries of the European Union. FAO statistics do not include trade information on processed potatoes. If they did, Scott says, world potato trade could be running at 10 million tons a year, or about 4 percent of annual global production.

The study underscores CIP's contention that statistical data on potatoes have long been underestimated. CIP Director General Hubert Zandstra notes that the report calls attention to some of the inconsistencies in previous global potato data for supply and demand. This has led to some underestimations in future medium-term projections and created an air of doubt in the minds of scientists and donors about the health and direction of the global root and tuber economy, he says.

For example, one important forecast in 1994 estimated that potato production in developing countries would grow from 75.7 million tons in 1988 to only 89.8 million tons by 2000, an increase of just 18 percent. For many developing countries, including China, those projections had already been exceeded, Scott noted. When FAO and CIP reexamined the data, the developing-country projections increased to 105.4 million tons.

Scott believes that potential payoffs from future investments in potato will be favorable as production growth rates are high and the outlook for continuing demand is good. "The most dynamic factor in the sector," he says, "is the potato processing industry, which will affect both supply and demand."

Research Needed to Halt Rapidly Spreading Late Blight Strains

For a century and a half, late blight disease has been the potato farmer's chief nemesis. Since the Irish famine of the 1840s, in which a million people died and another million and a half emigrated, farmers have spent billions of dollars attempting to control the fungus responsible for what became known in Ireland as the Great Hunger. Even so, late blight remains the world's most devastating food crop disease.

Late blight, caused by the fungus *Phytophthora infestans*, began as a local disease of wild relatives of potato and tomato in Mexico's Toluca Valley. In the early 1950s, John Niederhauser, a World Food Prize laureate, pinpointed the valley as the place now widely accepted as late blight's center of genetic diversity. There he discovered two mating types, called A1 and A2, that reproduce both asexually and sexually. Until then, sexual reproduction of the fungus was unknown.

The A1 strain, a single genetic individual, broke out of its Mexican enclave in the 1840s and spread quickly, resulting in crop failures not only in Ireland but also on the European mainland. Until that time, late blight was foreign to Europe, Canada, and the United States. Eventually, the potato rebounded, following the development of simple fungicides and the integration of a wild Mexican potato species, *Solanum demissum*, into breeding programs early in the 20th century.

A Second Wave

Today, the fungus is staging a resurgence. CIP scientists are monitoring its spread and now consider the likelihood of major crop losses in developing countries to be largely a matter of time. In the mid-1970s, a new migration of late blight, including both the A1 and A2 mating types, is believed to have traveled out of Mexico to Europe on a commercial shipment of potatoes. From Europe, the disease spread rapidly to other parts of the world. By the late 1980s, potato researchers in Europe confirmed their worst fears: evidence of sexual reproduction of the fungus outside of Mexico. In 1992, a significant increase in the A2 and new genes of the A1 were found in Canada and the United States. In Canada's western province of British Columbia, the fungus appeared to be reproducing sexually, and by 1994 A2 strains were discovered in the Andes, the potato's genetic center of origin.

Scientists say that the new migrant A1 and A2 mating types are far more aggressive than the original A1 and cause more severe outbreaks of the disease earlier in the growing season. Worst of all, some strains are resistant to one of the most effective late blight fungicides, metalaxyl. Furthermore, the new migrants are more genetically diverse and are aggressively displacing older late blight populations in many areas. The spores resulting from sexual, as opposed to those from asexual, recombination can survive for extended periods. The possibility of catastrophic crop failures, not unlike those in the 19th century, grows with each report that the new late blight strains have expanded their range.

Research Priorities

Late blight is now poised to strike hardest at the millions of poor people in developing countries who rely on the nutritious potato, but can least afford to purchase expensive

Late blight can destroy a potato field in just three days. Here, late-blight-susceptible plants (foreground) compared with a resistant cultivar.

G CHANG

agrochemicals to keep the fungus in check. More insecticides and fungicides are applied to potato than to any other food crop. Some scientists believe that the success of fungicides such as metalaxyl in controlling late blight may have lulled the research establishment into a false sense of security and caused a loss of urgency in the development of blight-resistant potato varieties.

"That might be true in some countries in Europe and North America where market forces and a dependence on agrochemicals have virtually locked older varieties with narrow genetic bases into place," says Peter Gregory, CIP Deputy Director General for Research. "But it's not true for CIP, where even before the spread of the new strains we accorded the highest priority to late blight research." However, Gregory says, calls for additional research are becoming louder from developing-country potato growers, who are alarmed about the spread of the more diverse fungal strains and the apparent growing immunity of *P. infestans* to fungicides.

Populations A and B

Three years after its founding in 1971, CIP began distributing selected clones developed by national potato programs as a first line of defense against late blight. By 1990, the Center had developed breeding material, known as population A, combining major, or "R," genes and horizontal resistance. But R genes can be a problem to breeders in national programs who want to use the materials to develop late blight resistance in crosses with local varieties. R genes are major immunity genes, each of which can react strongly to a particular race of *P. infestans* and mask durable or horizontal resistance. Horizontal resistance is the result of many genes acting in concert so that the plant can withstand attack from all races of the fungus. Despite these limitations, population A clones have had substantial value and continue to show promise in several locations.

In the 1980s, CIP built upon the success of population A and developed a second generation

J NIEDERHAUSER

Late blight lesions.

of clones, population B, which have horizontal resistance without the presence of R genes. Analyses have also shown that population B has a high level of heritability of durable resistance, thus indicating the possibility of breeding for horizontal resistance in the absence of R genes. CIP scientists have raised the possibility, however, that R genes may in fact be present in population B but could be inactive because of the presence of so-called suppressor genes.

Over the next several years, the Center will seek to expand the genetic base for long-lasting resistance through the transfer of resistance genes from wild species and primitive cultivars to cultivated potatoes. This work will both broaden and strengthen resistance to late blight, Gregory says. Rapid progress is expected because CIP scientists and colleagues have already overcome most of the incompatibility roadblocks between wild species and cultivated potatoes

For the immediate future, CIP will also attempt to combine broader-based durable resistance with locally adapted potato varieties and advanced breeding lines. Scientists hope fo develop resistant populations through a blend of molecular marker-assisted selection and limited chromosome transfer. Additionally, genetic maps will be used to locate resistance genes within the potato genome. The cloned genes will then be inserted into existing potato cultivars.

Gregory says that emphasis will eventually be directed to promoting widespread use of new, late-blight-resistant varieties These materials, he says, should provide the catalyst needed to allow farmers to control late blight through integrated pest management systems in which resistant varieties—rather than chemical fungicides—play the key role.

Will Farmers Accept Resistant Varieties?

There is every reason to believe that developing-country farmers will accept potato varieties with broad resistance if they are accessible. Experience has shown that farmers are eager to grow potatoes that are less dependent on chemical sprays for insect pests and diseases. CIP economists have documented that the potato varieties released in the developing world in the

Canchán Wards off Late Blight with Good Investment Returns

Potato cultivar Canchán-INIAA provides an example of the value of population A in combating late blight, as well as an example of good returns on research investment.

Released in Peru in 1990, Canchán has high levels of late blight resistance and is gaining acceptance among both traditional Andean potato growers and commercial producers in coastal areas.

Developed at CIP in the late 1970s, Canchán's genetic base includes genes from a wild potato

1970s and early 1980s came almost exclusively from clones bred in North America and Europe and, to a lesser extent, from national breeding programs. By the mid-1980s, however, clones bred by national agricultural research systems and identified and distributed by CIP accounted for almost half of all developing-country varietal releases.

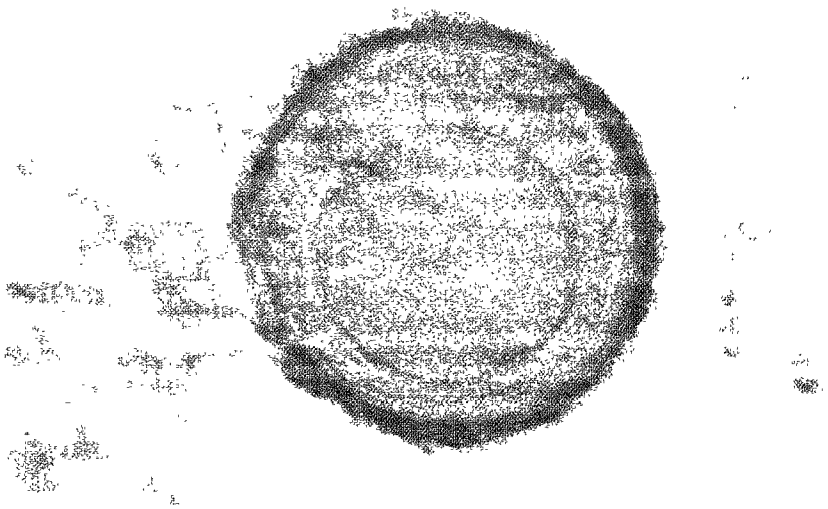
Currently, materials selected from CIP-bred populations account for about 40 percent of all such releases, a figure that Center economists believe will rise significantly as the superior qualities of CIP-bred parents—particularly those with disease and pest resistance—become more widely known.

Gregory says that the new late blight threat brings into question the ability of the potato crop to continue its unprecedented growth, especially in developing countries, where production has soared by nearly 200 percent in the past 30 years and is expected to rise another 2.8 percent a year until the turn of the century. The spread of new migrant strains of A1 and A2, combined with more realistic estimates for the crop's expansion in the developing world, supports CIP's decision to increase funding to its late blight program next year by 25 percent to $1.5 million.

The Cost of Late Blight

CIP has conservatively estimated that global crop losses from late blight are equivalent to 10 percent of the annual potato production in temperate zones and 15 percent in the tropics. Losses in the tropics are greater because of higher temperatures and humidity and year-round disease pressure and because farmers often lack the money to buy fungicides. Assuming that a third of the global output, or 13.75 million tons priced at $200 per ton, occurs in developing countries, the annual economic value of crop losses from late blight would be $2.75 billion.

Center scientists also note that late blight losses are growing despite increases in the use of fungicides. Current fungicide costs are estimated at approximately $100 million, or $15 a hectare, in developing countries. Thus, the value of the crop lost, plus increased costs for late blight control, approaches $3 billion a year. "Losses are likely to rise," Gregory says, "as late blight establishes itself in new locations and as its diversity increases because of sexual recombination of the different mating types."



J. NIEDERHAUSER

Microscopic oospores produced by sexual recombination of different late blight mating types are genetically more diverse than older strains of the disease. Their ability to survive in the soil over longer periods of time poses new threats to developing-country potato farmers.

species and a traditional Andean farmers' variety. Survey results indicate that its late blight resistance has resulted in significant reductions in fungicide use in Peru. During the 1993-94 growing season, Peru's highland potato farmers suffered 40 percent losses, valued at more than $100 million, because heavy rains created favorable conditions for late blight. Only Canchán withstood the fungal outbreak without significant economic losses.

A survey by CIP economists showed that farmers who grow Canchán have cut back spraying by 40 percent. Internal rates of return were calculated at 28 percent on the assumption that coverage will eventually reach 15 percent of Peru's potato production. Recent figures from the country's national potato program, however, indicate that Canchán currently constitutes a fifth of the potatoes grown in Peru's highly productive river basin areas along the Pacific coast.

True Potato Seed: A Piece of the Late Blight Puzzle?

True potato seed, the small botanical seeds produced by the flower of the potato plant, may one day prove to be an important weapon in the battle against late blight.

Using conventional seed tubers, it could take years to move late-blight-resistant cultivars from the research station to resource-poor farmers in developing countries. Experience has shown that at least 10 years are needed to produce enough tuber seed to have even a modest impact in farmers' fields. With TPS, large quantities of disease-resistant planting materials can be ready in one season.

To meet the late blight challenge, national programs will need to move huge quantities of resistant varieties into farmers' hands within the space of just a few years, says Mahesh Upadhya, CIP's program leader for propagation and crop management. "Any farmer accustomed to working with small seeds should be able to use TPS to produce large amounts of top-quality planting material in a short period of time," Upadhya says.

The acceptance of TPS technology in developing countries is growing rapidly, especially in southern and Southeast Asia, where potato production has increased dramatically in recent years. Many Asian farmers are using TPS planting materials, Upadhya says, because they are cheaper than traditional tuber seed and because they produce better yields. "Over the long term," he explained, "it will be difficult for Asian countries to produce the huge quantities of certified tuber seeds needed to meet the growing demand for planting material. It will also be hugely expensive. Conventional tuber seed and propagation via tissue culture require large investments in land, storage and transportation infrastructure, and management."

Once researchers resolved the production problems that had plagued the new seed technology, TPS began to change the mechanics and economics of potato production in the early 1990s. Farmers who normally planted a hectare of potatoes using 2 tons of seed tubers could achieve the same result—at less cost—by planting as little as 50 grams of true potato seed from new, stable-yielding hybrids. TPS is not usually sown directly in the field like maize or wheat seed, but is planted into a seedbed, like tomatoes, or transplanted into the field as seedlings. The small tubers produced from TPS seedlings are then used as seed for planting the next potato crop. Fifty grams of TPS cost about $100, as opposed to $1,200 to $1,500 for two tons of seed tubers. Producing small tubers from TPS can be labor intensive—a decided plus in rural areas that are short of jobs.

True-Seed Research

The TPS technologies now coming on line are the product of more than 20 years of research. "We had many false starts," Upadhya recalls, "and many setbacks. With every step forward, we encountered new roadblocks and new scientific challenges." The basic problem was to produce true-seed hybrids that would meet market standards.

Work began by selecting parental lines with desired characteristics, such as tuber shape and color, and adaptability to daylengths found in two tropical growing seasons.

What was needed, says Upadhya, were cultivars that produce a crop in the autumn season when potatoes are planted under long days and tuberize under short days, as well as cultivars suitable for the spring season when potatoes are planted under short days and tuberize during long days. Today, CIP TPS populations are sufficiently homogeneous to meet the demands of the marketplace, but contain a mixture of genes that protect them from a variety of viruses and plant diseases. An additional advantage of TPS, Upadhya explained, is that it provides farmers with a potato crop made up of numerous gene combinations, rather than a monoculture of genetically identical potato clones, as is the case for crops grown from traditional tuber seed. This mixture of genes could eventually provide farmers with an important tool for fighting diseases such as late blight.

Even with the development of the new hybrids that exhibited good uniformity, however, scientists still faced the problem of seed dormancy. True potato seeds germinate at different times, a defense mechanism that plants use to protect themselves in the wild. The solution to the problem was worked out by CIP's Noël Pallais, a plant physiologist, who learned how to fool the plant into believing it had gone through a full

N PALLAIS

POTATO PRODUCTION FROM HYBRID TPS ON FARM TRIAL 1995-1996

LOCATION Trong Quan Thai Binh Viet Nam

season of dormancy so it would germinate uniformly during the following production season. "In retrospect, the solution was fairly simple," Pallais says. "What we did was reduce seed moisture levels to 4 percent and stored the seed for four months at 40 degrees Celsius. After that, all TPS germinates uniformly."

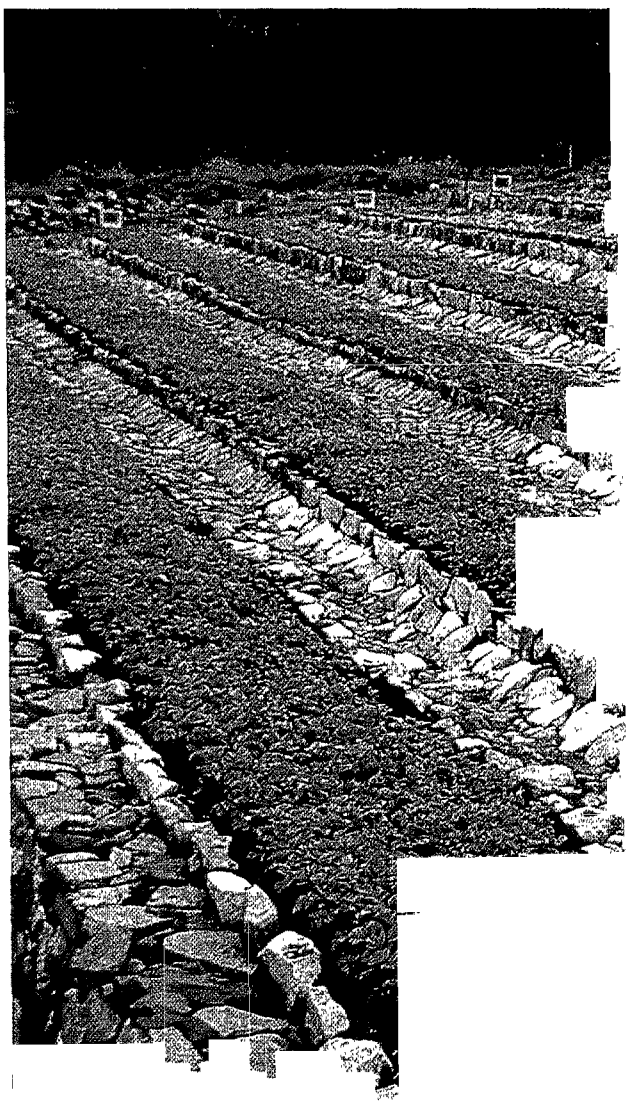
TPS also gives farmers planting flexibility, Pallais says. In tropical regions, where little or no cold storage is available to farmers, tuber seed deteriorates rapidly. One advantage of TPS is that it allows farmers to plant a crop according to their schedule. Growers who rely on clonal seed have little choice but to plant when the tubers arrive from abroad or from a local seed program. With TPS, farmers have more control over timing. For example, in highland zones around Lake Titicaca bordering Bolivia and Peru, farmers are planting seedbeds of TPS to coincide with the onset of the rainy season. Minitubers grown from TPS in the seedbeds are equal in quality and vigor to what is referred to as basic seed, the highest quality seed national programs produce and distribute to certified seed growers. Thus, even the poorest farmers who use TPS can produce the highest quality seed according to their own schedule.

1995 Field Reports

India: In India, the world's sixth-largest potato producer, farmers are growing more than 10,000 hectares of potatoes derived from TPS planting material, a fivefold increase over 1993. CIP economists project that the area planted with the new hybrids should reach 250,000 hectares by the year 2015. India produced nearly 500 kilograms of true seed in 1995, enough to plant 20,000 hectares. With TPS presently wholesaling for $800 a kilogram, Indian producers are selling a portion of their seed to potato programs in Vietnam, Egypt, the Philippines, and neighboring Sri Lanka and Bangladesh. All six TPS hybrids now being produced in India were bred by a CIP team of scientists and were extensively evaluated by India's Central Potato Research Institute and research centers of the All India Coordinated Potato Improvement Project. In recent years, India's Ministry of Agriculture has provided money to state governments to build additional TPS production facilities. The state of Tripura, a leader in TPS production, hopes to produce 200 kilograms in 1996. The objective of the government's investment is to alleviate the country's chronic shortage of quality seed.

Vietnam: In Vietnam, the rapid increase in the use of TPS technology in the rice-based cropping system near Hanoi has surprised many researchers. The increase is largely the result of TPS's ability to fit a highly profitable potato crop between two crops of rice. In 1996, Vietnam plans to import about 30 kilograms of hybrid TPS from India—all of it destined as a third crop in the country's rice bowl, the Red River Delta. Vietnamese agricultural officials expect that by the year 2000, 7,000 hectares of potatoes will be grown in the Red River Delta. Of this total, 2,000 hectares will probably be grown from TPS transplants and 5,000 hectares from first- or second-generation TPS-derived tubers. The government expects that farmers will grow more than 100,000 tons of high-quality potatoes each year thereafter from TPS-derived materials. By the

R. FALCON



turn of the century, Vietnam will require 300 kilograms of TPS valued in excess of a quarter of a million dollars at 1995 prices. By then, Vietnam plans to be self-sufficient in true-seed production. Currently, all of the TPS used in Vietnam are CIP hybrids purchased from India. Vietnamese scientists, however, are experimenting with their own hybrid seed varieties and continuing to screen hybrids introduced by CIP.

Nicaragua: Despite heavy outbreaks of late blight in 1995, potatoes grown from TPS hybrids continue to meet grower expectations. TPS varieties currently represent about 40 percent of the 21,000 tons of potatoes eaten in the country each year. Nicaragua's TPS varieties, which were derived from CIP-Indian hybrids, were first introduced into the country in 1987. Nicaragua now purchases TPS from the Chilean national potato program, but continues to diversify its true potato seed selections to fit production and market niches by growing the white-skinned variety Nicaraguan consumers prefer, or by producing a late-maturing potato to take advantage of higher prices when potatoes are in short supply.

Cuba: After 30 years of spending an estimated $15 million a year on imported seed tubers, many of which carried diseases, Cuba is investing in the construction of three facilities to produce hybrid TPS seedling tubers. Like Nicaragua, Cuba currently imports TPS seed from Chile, including three CIP-Indian varieties that resist late blight.

Egypt: Seed farms in Egypt have turned to producing seedling tubers following "direct seeding" of TPS using mechanized planters. This is believed to be the first instance in which TPS is sown directly into the soil. In 1995, four hectares of TPS were planted on newly reclaimed desert land. CIP-developed hybrids performed extremely well under these conditions. Resulting minitubers will go directly to farmers to plant next year's crop. Egyptian farmers expect to plant 300 hectares of TPS-derived potatoes in 1996 using domestically produced minitubers and commercial quantities of TPS imported from India.

China: In 1994-1995, about 9,000 hectares were planted from hybrid TPS supplied by CIP and the Wumeng Agricultural Institute in Inner Mongolia. Researchers in China are currently testing CIP hybrids and report good results in Sichuan and Yunnan provinces. TPS-derived potato production fell dramatically in the 1980s because of viroid and seed germination problems arising from the use of locally produced, open-pollinated varieties. China, the largest producer of potatoes in the developing world, started producing hybrid TPS in 1988 with technical backstopping from CIP.

Bangladesh: Researchers consider Bangladesh to be an outstanding candidate for TPS technology. In 1995, the government imported 16 kilograms of TPS from India and sold it to growers in the country's six principal potato-growing districts. Bangladeshi farmers expect to harvest about a thousand hectares from TPS-derived planting material in 1996, a 10-fold increase over the previous year.

In Peru, farmers who normally plant 2 tons of seed tubers are achieving comparable and frequently better results by sowing as little as 50 grams of true seed.

New Rice and Wheat Varieties Ignite Asian Potato Production

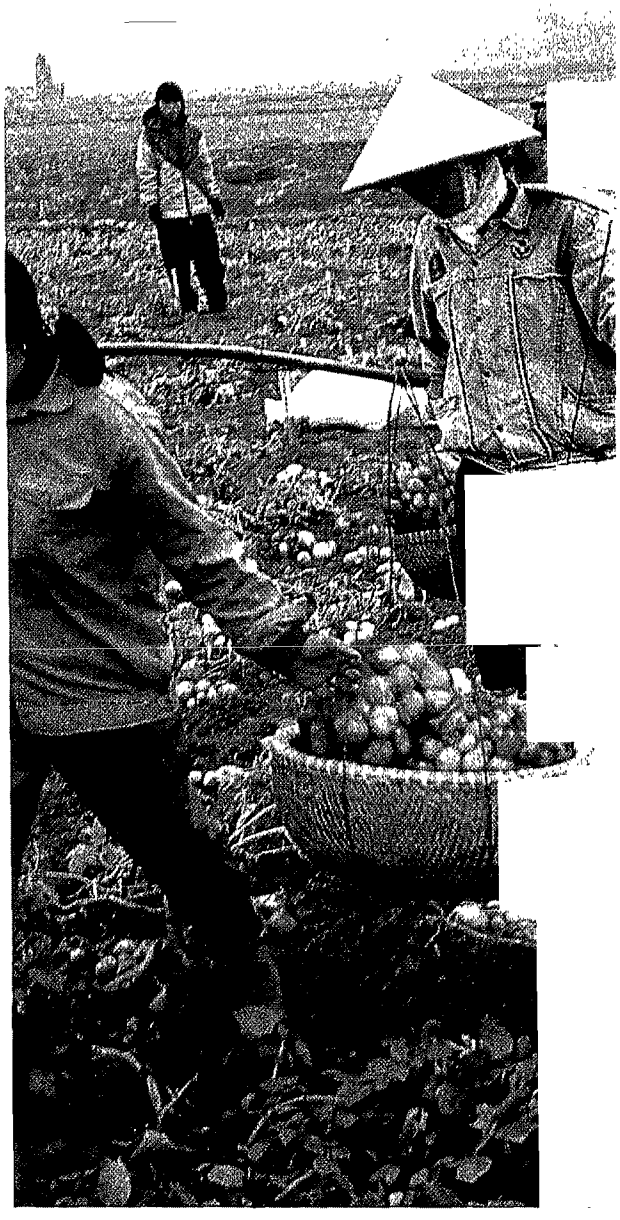
Unwittingly, it was the development and success of early maturing, high-yielding rice and wheat varieties that accelerated the growth of potato production in South Asia.

Because of their short cropping cycle, potatoes fit well into the wheat and rice farming systems that make up much of Asia's agriculture. "The beauty of the new rice and wheat varieties," says CIP economist Gregory Scott, "is that they've opened up a niche in the cropping calendar that allows farmers not only to plant more rice and wheat but also sandwich in a planting of potatoes."

Today, virtually all potatoes grown on the Indian subcontinent are produced in this manner. In Bangladesh, farmers grow upwards of 17 million tons of potatoes on 1.2 million hectares during a three-month production window opened by technologies that lessen the time required to plant and harvest rice. Potatoes are planted in October and November and harvested during a four- to six-week interval from late January to early March, well before the arrival of the southwest monsoons in June and in time to accommodate a wheat crop. This extra supply of potatoes provides food at a time when cereal bins begin to run low and farm families must stretch remaining supplies until the next harvest.

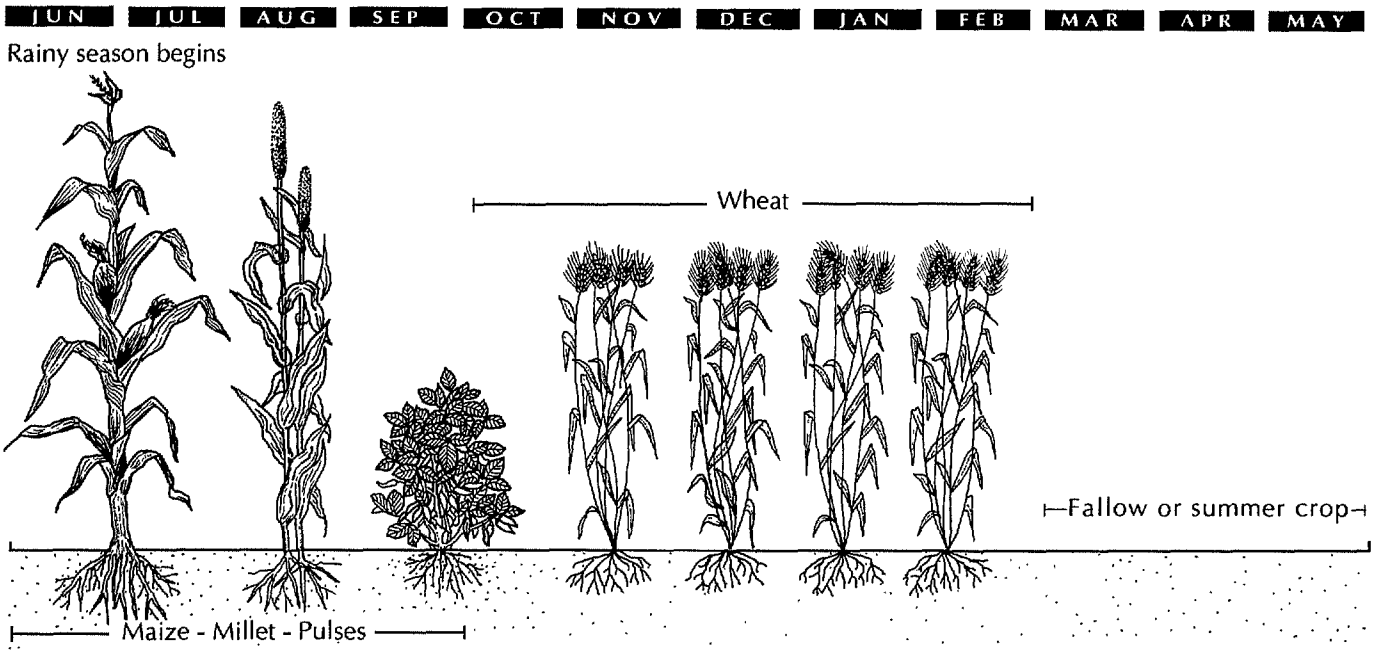
The development of the new rice and wheat varieties made it economically attractive to invest in tube wells and fertilizer to extract maximum yields from cereals. As a result, farmers can usually coax a potato crop through the dry season with residual soil moisture or a

Cropping patterns: Shown below (page 18) is the traditional cropping pattern that existed in South Asia prior to the introduction of high yielding rice and wheat varieties in the 1960s. The current "Rice-Potato-Rice" pattern and the "Rice-Potato-Wheat Summer Pulses" pattern are shown on pages 19 and 20, respectively.



N PALLAIS

TRADITIONAL ASIAN CROPPING PATTERN-1965



Harvesting potatoes in Vietnam's Red River Delta: since 1961-63, potato production in Vietnam has grown at an average annual rate of 6 percent.

small amount of irrigation water. Recent farm surveys have found that even farmers who crop less than a hectare can obtain both irrigation and fertilizer.

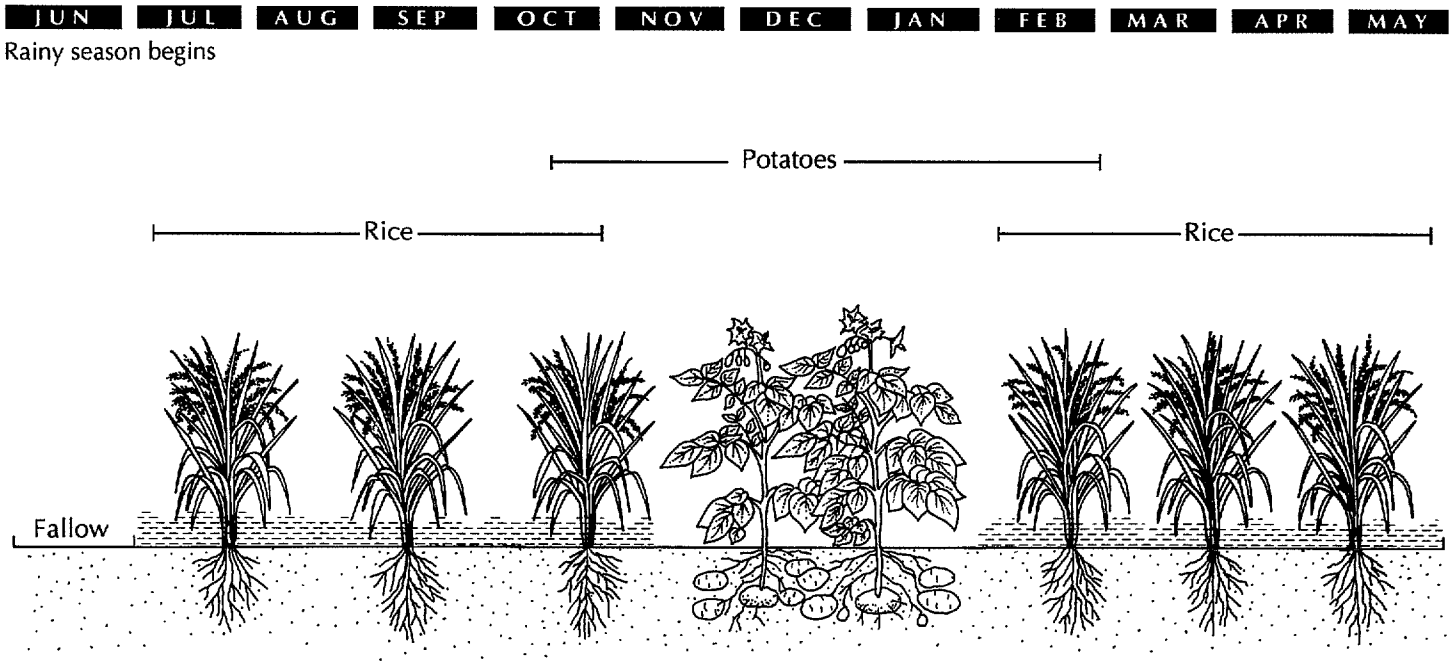
"What happens as a result of growing potatoes after cereals is that the net income of small farmers goes up," Scott explained. "Farmers are then in a better position to self-finance rice and wheat crops by turning that money around for fertilizer and other inputs. Potatoes upgrade and diversify the entire food system. They not only increase cash income but also provide farmers with a natural means to break up pest cycles caused by the sequential cropping of cereals."

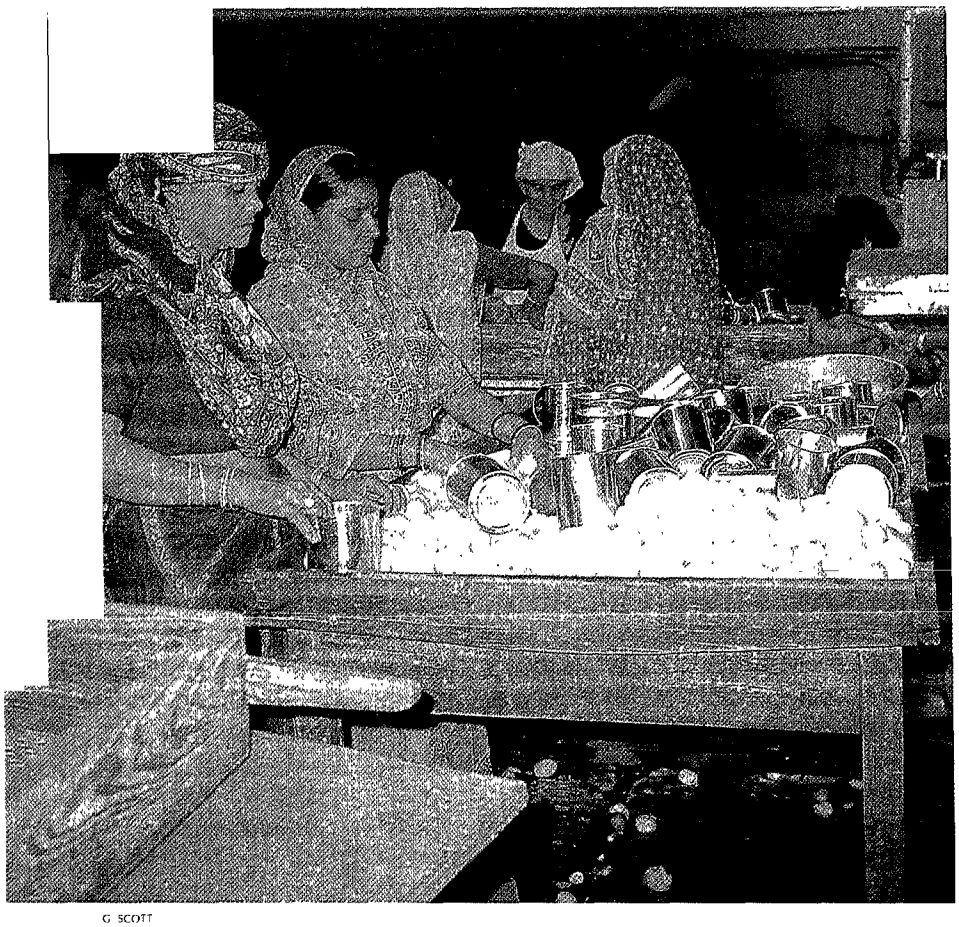
Storage, Trade, and Foreign Exchange

The introduction of potatoes in Asia's cereal-based cropping systems is also having an impact on trade and foreign exchange. By substantially increasing food production with potatoes, countries such as Bangladesh are conserving foreign exchange by not having to import cereals at the volumes and values previously required.

Increased potato production on the subcontinent has also led to dramatic changes in the way the crop is handled after harvest, when in the space of a month nearly 18 million tons of potatoes come out of the ground. "Farmers need some alternative mechanism to manage the supply of potatoes released onto the market," says Scott, noting that this highly skewed seasonal supply pattern puts tremendous pressure on the marketing chain.

RICE-POTATO-RICE





G SCOTT

India has the capacity to conserve about half of its 15.7-million-ton annual potato harvest in cold stores; the remainder must be eaten at harvest, processed, or stored in the countryside.

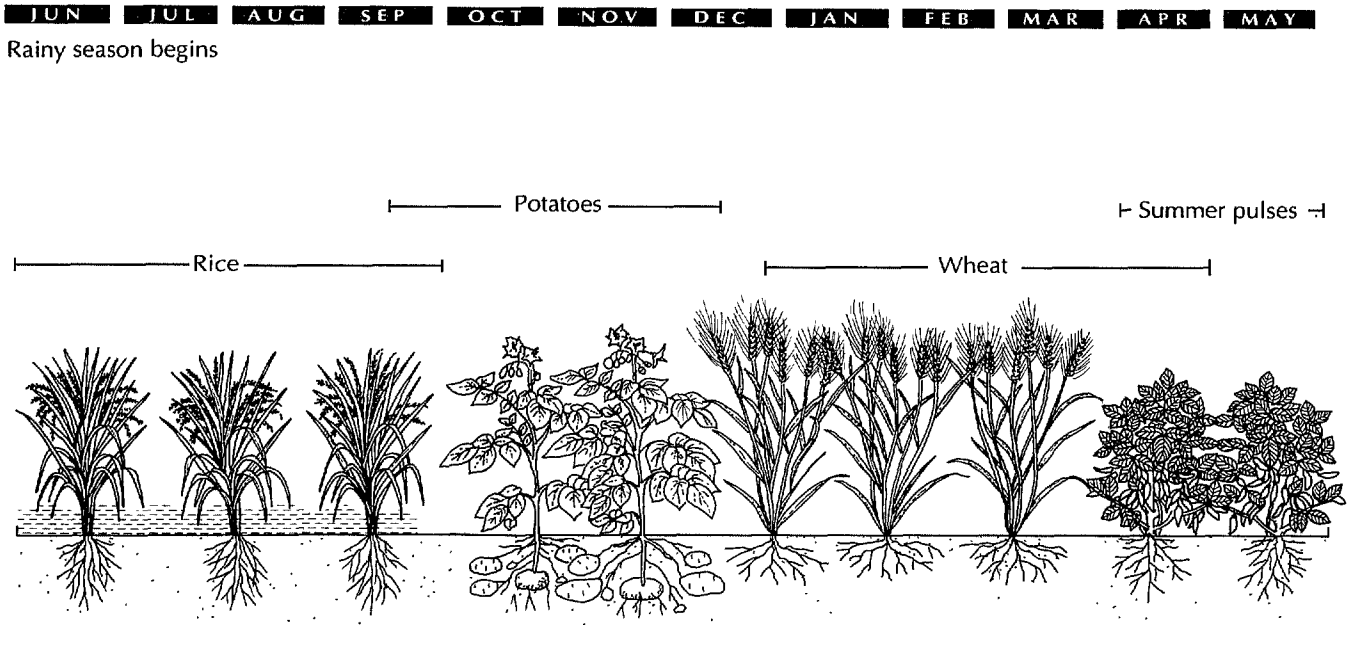
In India and Bangladesh, a portion of the crop goes to market immediately, usually at low prices. A large part of the harvest is then piled in the field for 60 days until the initial glut of potatoes passes and prices recover. The practice is risky because unexpected wet weather can ruin a year's production. About half of the harvest goes into commercial cold-storage facilities to be held until supplies dwindle and prices rise.

India, the world's sixth-largest potato producer, now has a cold-storage capacity for more than 8 million tons. But cold stores are only a partial solution to potato marketing problems. Indian and Bangladeshi farmers, Scott says, would benefit from inexpensive technology to extend crop storage to take advantage of rising prices from February through May, the period before cold-storage potatoes come onto the market.

Over the past 10 to 15 years, CIP has experimented with traditional rustic farm storage methods that are cheap, simple, and effective in maintaining potato stocks for sale in a rising market. In 1994-1995, researchers from the Indian Council of Agricultural Research and CIP conducted on-farm tests with potato stores that use evaporative cooling systems during the warm, dry months. Temperatures inside the stores were 12 to 19 degrees Celsius cooler than outside temperatures. Farmers who used the stores experienced tuber weight losses of only 13-14 percent in storage periods of up to 84 days. In 1994, prices at the time the stored potatoes were sold were 30-60 percent higher than when the crop went into storage; in 1995, prices rose 90 percent.

Farm stores are not a risk-free technology, Scott says. In some years, potato prices fail to rise as the marketing season progresses. "It's sort of like the high-yielding rice and wheat varieties in the sense that farmers have a considerable investment in inputs," he contends. "If there's bad weather or a severe pest attack, the return on the investment will be small, or none at all. But, in four out of five years, farmers are going to see more rupees and takas in their pockets than if they sold their crop right after harvest."

RICE-POTATO-WHEAT-SUMMER PULSES



IPM Studies Show Promise at Grass Roots

Component Technologies Undergo Testing in Africa and the Caribbean

In virtually all of the 82 developing countries that grow sweetpotato, weevil pests are a major source of economic loss. Although the crop can be produced under difficult growing conditions with minimum inputs, weevils continue to plague production despite the use—and misuse—of insecticides.

In 1995, CIP researchers in Africa and the Caribbean reported significant progress in the testing of component technologies that farmers can use in integrated pest management (IPM) programs. In the Caribbean, where the predominant weevil species is *Cylas formicarius*, CIP-recommended IPM practices include the use of natural enemies such as predatory ants, the fungus *Beauveria bassiana*—which can be applied as a biologically safe insecticide—and mass trapping of adult male weevils using sex pheromones.

After two years of large-scale testing sponsored by the OPEC Fund, storage-root damage dropped from 25 percent to 5 percent in the Dominican Republic and from 44 percent to 8 percent in Cuba. In Cuba's case, this is about the same level of damage that farmers experienced when they applied Soviet-supplied insecticides 8 to 12 times per season. When Soviet insecticides became unavailable, Cuba was forced to seek alternatives and turned to IPM.

Large-scale trials in the Cienfuegos area show that sweetpotato grown with integrated weevil management practices produced average yields of 18.2 t/ha—roughly twice that of crops produced without IPM—with damage limited to just 8 percent of the crop. Sex pheromones, which were initially used to attract and monitor pest populations, proved to be effective in reducing pest numbers by luring adult males into trapping or killing devices. In 1995, approximately 40,000 such traps were tested successfully in farmers' fields.

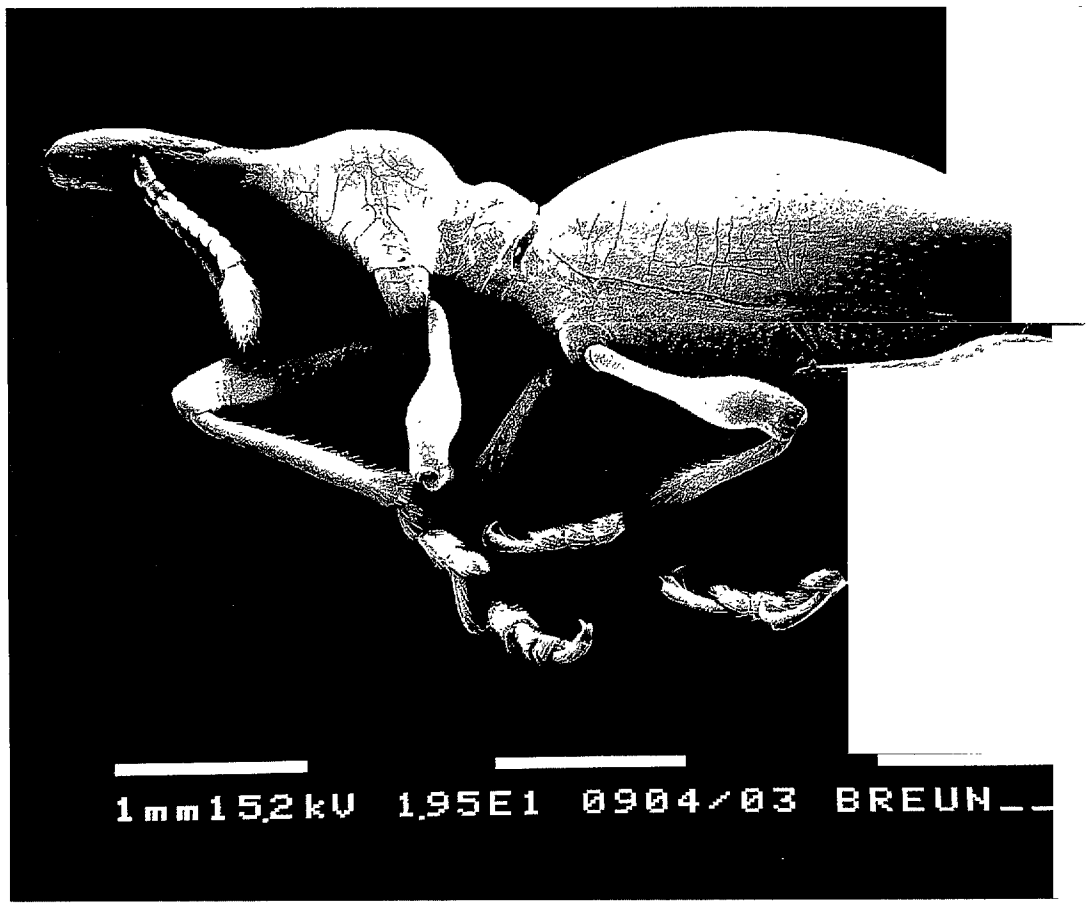
Sweetpotato for the Hungry Months

Encouraging results were also reported in 1995 from East Africa, where sweetpotato is an important secondary crop and plays a critical role in rural diets during the "hungry months." Uganda alone produces 1.7 million tons, making it the fourth-largest sweetpotato producer in the world.

Sweetpotato production in the region is predominantly rainfed and the crop is planted and harvested piecemeal throughout the year. East African sweetpotato growers are usually small-scale, resource-poor female farmers. Production practices contrast with those used in the Caribbean as the predominant weevil species are different. In addition, East African farming traditions and the socioeconomics of production differ from those of other regions. In one district in central Uganda, for example, sweetpotato has replaced cassava as the predominant food staple because of severe losses from cassava mosaic virus. Although sweetpotato is far more nutritious than cassava, cassava can be left in the ground

The Caribbean sweetpotato weevil, *Cylas formicarius*.

R HADDAD



I ALCAZAR

A weevil-infested sweetpotato root: weevil damage renders most crops unusable even for animal feed.

and harvested as needed. Sweetpotato roots are extremely vulnerable to weevils if left unharvested.

CIP's research agenda for sweetpotato in East Africa includes biological studies of the predominant weevil pests in the region, plus field experiments to test the effectiveness of the *B. bassiana* pathogenic fungus as an IPM component technology. In addition, work is under way with Uganda's National Agricultural Research Organization (NARO) and the Natural Resources Institute (NRI) of the United Kingdom to identify female sex pheromones for two African weevil species (*C. brunneus* and *C. puncticollis*). Sample lures developed at NRI were field tested successfully in Uganda using various trap designs to determine the most attractive pheromone blends for the two species and the most effective slow-release pheromone dispensers. "Sex pheromones may be the key to introducing IPM to East African sweetpotato producers," says Cisneros. "The technology has a noticeable impact on farmers and makes the entire package of practices more acceptable. Our experience in Cuba is that sweetpotato growers who know about the technology won't even plant unless sex pheromones are available. We expect that the same will be true in East Africa as well."

G CHANG

Host-Plant Resistance

After many years of study, CIP scientists have concluded that no known cultivated or wild relative of sweetpotato contains a useful form of weevil resistance. Accordingly, Center plant breeders are exploring the possibility of inserting genes from the bacterium *Bacillus thuringiensis*, a natural insecticide, into the sweetpotato genome. This work, which is exceedingly complex, and needs a carefully planned deployment strategy, is still in its infancy. As an alternative, CIP researchers are also evaluating a molecular approach based on a relatively simple concept. Because weevils digest their food with the help of certain proteinases, it may be possible to interrupt their feeding process by incorporating proteinase inhibitor genes into the sweetpotato genome. Such inhibitors have been identified for other *Coleoptera* insects in Canada and could be incorporated into sweetpotato using the transformation and regeneration protocols developed in the 1980s by Peru's National Agrarian University in La Molina and CIP.

IPM in the Sacred Valley of the Incas

In Urquillos, a small farming village in Peru's Sacred Valley of the Incas, crop losses from potato tuber moth have dropped over the past two years from 72 percent to almost zero. Today, increasing numbers of farmers in Urquillos, and in surrounding villages, are using biologically friendly, integrated pest management (IPM) methods rather than chemical insecticides. The switch from hazardous pesticides is the result of technologies developed at CIP and the work of community leader Maritza Marcavillaca.

"In past years," Marcavillaca said recently, "we tried to control the moth with insecticides, including parathion, but the results were poor and we noticed that many of our people became sick from the chemicals." Insecticides, she noted, were not only expensive, but some Urquillos residents thought they were responsible for a rash of miscarriages and illness in the village.

Through the University of Cusco, Marcavillaca contacted CIP to inquire about alternative pest control practices. "CIP receives many such requests, but we refer most to local authorities," says CIP IPM leader Fausto Cisneros. "In Urquillos, we found a dynamic grass-roots organization willing to invest its own resources in a new technology, and willing to work hard to make the technology work." Marcavillaca is the leader of the Urquillos Women's Club, an organization of some 25 women, all of whom are directly involved in potato and maize production.

Starting in 1994, club members, working with CIP IPM specialists and economists, began experimenting with a series of practices that can be used to control tuber moth in seed stores, including the use of native repellent plants, sex pheromones, and a baculovirus. The baculovirus, which can be manufactured within the community, kills tuber moth larvae but is harmless to humans and animals. It is produced by selecting and grinding virus-infected larvae from damaged potato tubers and then mixing them with ordinary talc.

The Urquillos program offered a unique opportunity for participatory research in which the members of a grass-roots organization and scientists could work together and learn from one another. Its success has led several neighboring villages to follow suit. Today, Marcavillaca and her colleagues give seminars to neighboring farmers using educational materials provided by ARARIWA (a local nongovernmental organization), INIA—Peru's National Institute for Agricultural Research, and CIP. Her long-term goal is to get all farmers in the area to use IPM. Urquillos residents, she says, have formed an informal association to teach the new techniques in neighboring villages. But the task has not been easy.

A SOLIMANO

Community IPM leader, Maritza Marcavillaca.

A SOLIMANO

Demonstrating the use of a pheromone trap at a community meeting.

"It was really hard to convince people to change their ways. I would talk and talk but no one would listen or believe me," Marcavillaca notes. "What happens is that people are used to using pesticides because it's a lot easier—but it's also more dangerous, and most people don't know that."

According to CIP agricultural extension specialist Oscar Ortiz, some of the most important things farmers have learned through the Urquillos program are a general knowledge of the pest's life cycle and the dangers of insecticides, which together enable them to make use of IPM component technologies. Many farmers, he notes, have begun using IPM methods on maize as well. "Our philosophy is not to impose on or pressure farmers to use IPM," explained Ortiz. "In this case, the farmers of Urquillos tried out and accepted the new methods, and chose to share their experience with others."

"Pesticide use was always a very big worry for me," Marcavillaca said recently. "So, as a woman and a mother of this village, I knew I had to do something—and I did."

Tecia Threatens Native Potato Species

A pest of Guatemalan origin, *Tecia solanivora*, the Central American potato tuber moth, is headed for Ecuador. If it succeeds, it will almost certainly also reach other Andean countries and become a threat to native potato species in the crop's center of origin. The life cycle of the pest is similar to that of the better-known and more widely spread potato tuber moth, *Phthorimaea operculella*, but its potential for damage is far greater. *Tecia's* rapid geographic expansion through mountainous areas is believed to be caused by the transport of infected seed. In Colombia, its appearance is provoking wide-scale use of pesticides. At present, there are no government-approved chemicals for the pest, and farmers are turning to hazardous chemical cocktails. In response to the problem, CIP and the Colombian national program have established a pilot program to introduce sex pheromones from the Institute for Plant Disease Research in the Netherlands. The program will also assess the possibility of using CIP-developed biocontrol agents such as the granulosis virus currently used to control the *Phthorimaea* tuber moths.

R MEDINA

Tecia solanivora

Florence Wambugu: A Vision for Africa

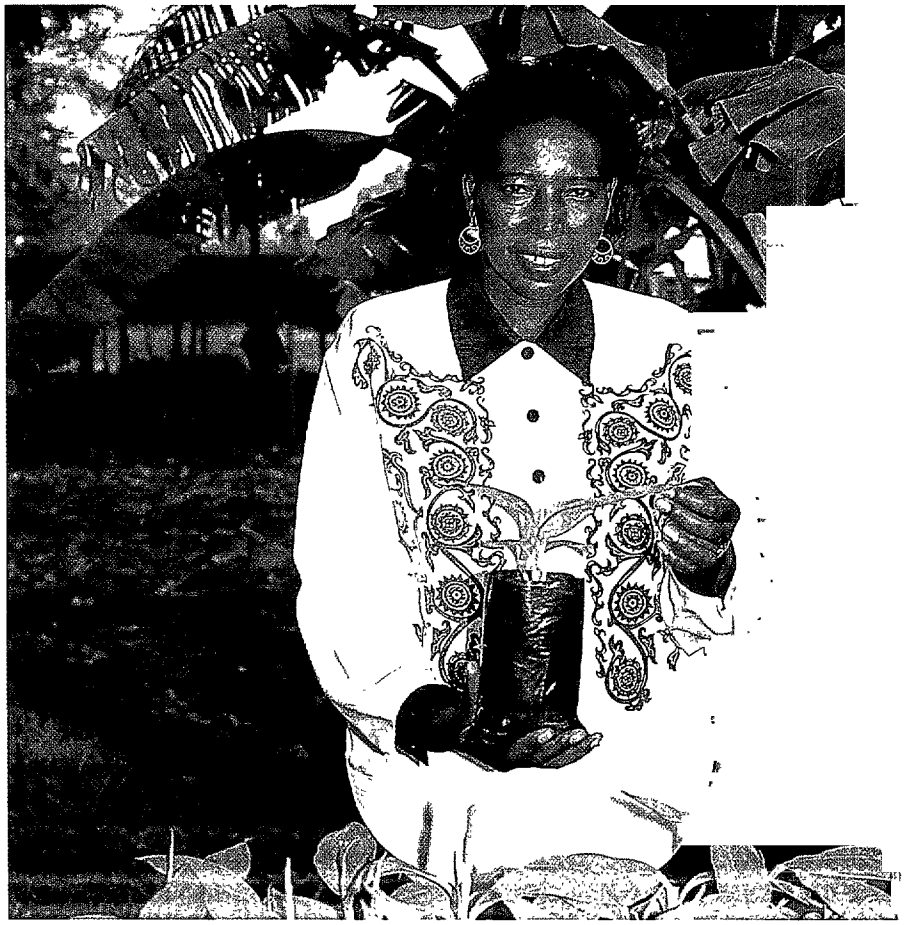
*Beatrice Lacoste**

In their vision of Africa in the twenty-first century, Chinua Achebe, the Nigerian author, and his scientific co-writers in *Beyond Hunger in Africa: Africa—2057* see development as coming from within—African experts trained and working abroad will return to their native land, implement high-technology projects, and channel Africa's energy potential to her people.

Today, with more than half of all professionally trained Africans working outside the continent, Florence Wambugu appears as a pioneer in this vision of the future. In 1994, Wambugu returned from the United States to be the Director in Nairobi of the International Service for the Acquisition of Agri-biotech Applications (ISAAA), which promotes the transfer of technology to developing countries and acts as a broker for transgenic and nontransgenic plants. The program is housed at CIP's regional office for sub-Saharan Africa, located on the campus of the International Livestock Research Institute in Nairobi.

"From my earliest childhood, I was interested in plants," Wambugu recalls. "I grew up in postcolonial times when most men worked on large farms or went to look for employment in the cities. My father and uncles were all away." Wambugu goes on to explain that her mother struggled to feed and educate her six children, her life an endless round of back-breaking chores.

"My mother really believed in education as a passport for life and she never complained about my father being away," she said. Encouraged by her determined mother, she went to boarding school at Kabare Girls Secondary School, a 65-km bus ride from home. In itself, going to school was a small revolution in a country like Kenya where all too often girls are kept home to help with household chores.



Researcher Florence Wambugu.

"Our small farm was the best research laboratory"

Wambugu developed a strong interest in biology and chemistry in secondary school. When she joined the University of Nairobi in 1975, she chose to study botany and zoology: "I have to say that our small farm was the best research laboratory," enthuses Wambugu. "Agronomy, pathology, breeding, call it what you will ... we practiced all of them growing crops...."

After leaving the university, she was offered a job in Muguga, 23 km from Nairobi, at the Kenya Agricultural Research Institute, KARI, where she worked at the Plant Quarantine Station. "This was a turning point in my career," she reflects. "We were releasing fruits and vegetables ... and this is how I first came into contact with CIP. The CIP program was one of our most important activities; at the time, the Center was just beginning to import potatoes from Peru and the new strains arriving from CIP promised new vigor and genetic diversity.

"Tissue culture materials came from Peru in small test tubes," she adds. "My responsibility was to check the material for diseases, a process that took up to six months. During my time, between 1978 and 1982, 250 potato accessions arrived at KARI."

* Beatrice Lacoste is a science writer currently on assignment with the World Food Programme in Kenya.

Wambugu recalls that Sylvester Nganga, CIP's regional representative in Nairobi at the time, and plant breeder Haile Kidanemariam, were closely involved in the effort. "The CIP scientists were very dedicated and really motivated me," she says. In 1981, the Center sponsored her participation in a tissue culture training program at IITA in Nigeria.

"Not only seed money but moral and professional support."

A year later, Wambugu went to North Dakota State University to do a master's degree in plant pathology, specializing in potato viruses. Both KARI and CIP agreed that her studies would have regional applications and were supportive. "I felt driven, and this opportunity to study was a great boost to my career. When I came back to KARI, I was given a job in plant pathology, doing research on root and tuber crops."

From 1984 to 1988, KARI and CIP interacted on both potatoes and sweetpotatoes, and Wambugu worked closely with CIP germplasm specialist Carlo Carli and Kidanemariam. "CIP provided not only seed money, but the professional and moral support that played a crucial part in my career development," she says.

From 1988 to 1991, she conducted thesis research on the epidemiology of sweetpotato virus diseases in a joint Ph.D. program conducted at the University of Bath in cooperation with KARI. "The research involved traveling throughout Kenya to visit farmers and would not have been possible without my previous experience in field research with CIP," Wambugu says.

"CIP had money and an outstanding team of very supportive scientists," she adds. "It was a mutually beneficial association for me, for CIP, for KARI, and, really, for Kenya as a whole." Wambugu is widely credited by her colleagues with having stimulated Kenya's and Uganda's current research programs on sweetpotato virology.

The Promise of Biotechnology

To keep pace with new developments, Wambugu left KARI in late 1991 to do postdoctoral work at Monsanto's biotechnology research center in the United States. "This time, I did not need financial help, but CIP's expertise and moral support were invaluable," she says. "I had an excellent working relationship with CIP's Regional Representative, Peter Ewell, with whom I exchanged a lot of information. Cyrus Ndiritu, Director of KARI, provided all the help he could and Peter Gregory, CIP's Deputy Director General for Research, was also very supportive. I really felt we were a team.

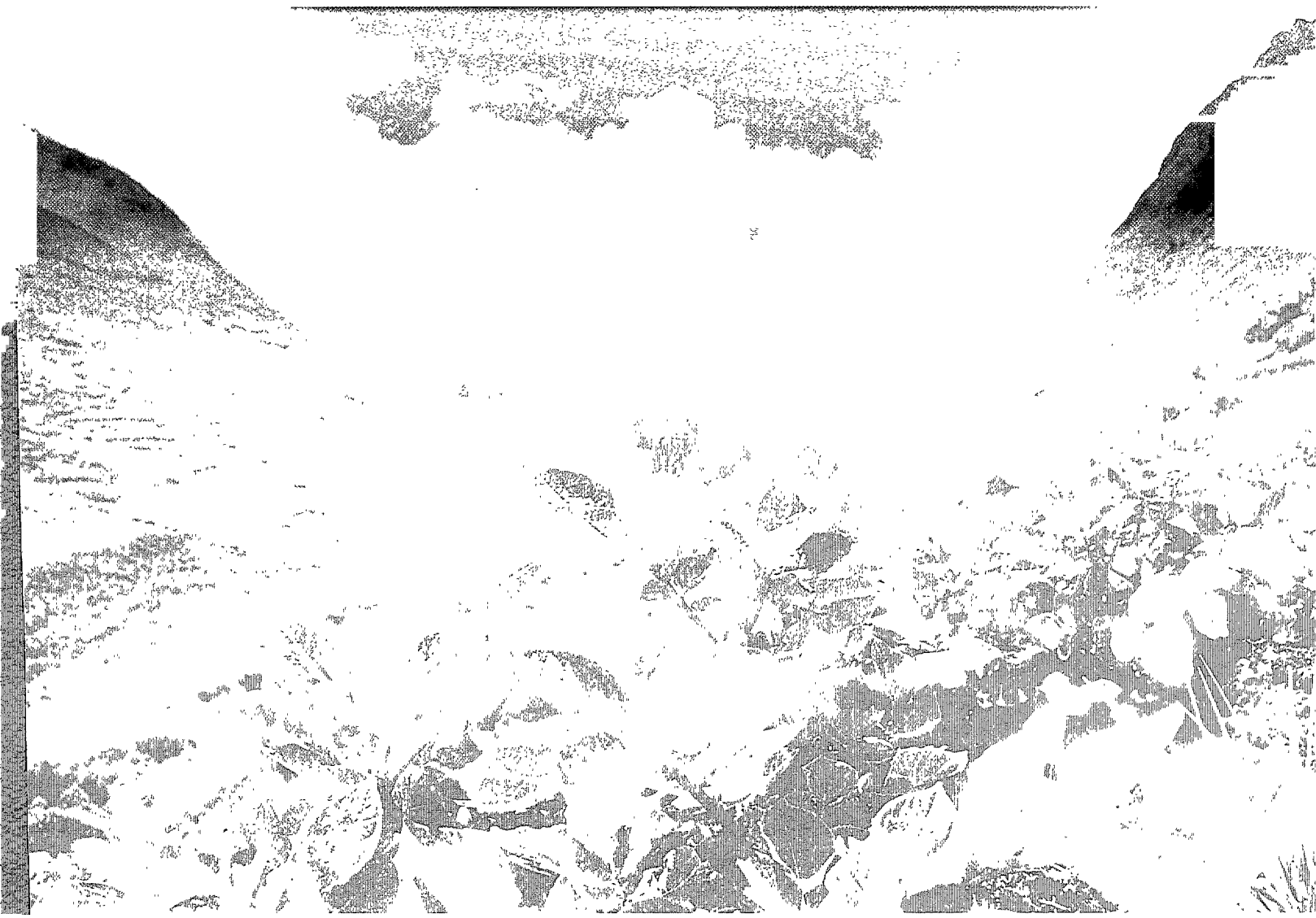
"When I was at Monsanto, I requested help, and Daniel Maingi, a well-trained and dedicated KARI scientist, arrived, later joined by Charity Macharia, another excellent KARI researcher. We worked together on finding a solution to feathery mottle virus, which causes sweetpotatoes to degenerate and dramatically cuts production. Sweetpotato yields in Kenya are about 4-5 tons per hectare, a mere fraction of their potential."

At Monsanto, Wambugu and her colleagues managed to transform African sweetpotato varieties by introducing the viral coat protein (CP) gene that triggers resistance to feathery mottle virus. The CP gene had previously been sequenced by Jorge Abad, a CIP scientist working with James Moyer at North Carolina State University in the United States.

This pioneering work sets an example for future collaboration between developed and developing countries, says Gregory. The scientists involved developed a virus-resistant sweetpotato that stands an excellent chance of becoming a commercial product. Furthermore, Kenya, the first country to obtain ownership of the new cultivar, will not have to pay royalties. Once Kenya has developed its biosafety guidelines, Wambugu adds, importation of the transgenic sweetpotato can proceed.

In the meantime, Wambugu, in addition to her ISAAA responsibilities, is helping CIP researchers in Nairobi conduct training courses. "We have no biotechnology expert or virologist in Nairobi," says Ewell. "Florence provides us with a much-needed resource person on plant pathology and biotechnology, and she recently participated as an instructor in one of our training courses for national scientists from Kenya and Uganda. I guess you could say there is a certain synergy at work here."

CONDESAN: An Ecoregional Approach to Research for the High Andes



N YAMAMOTO

[CONDESAN provides a] novel approach to mountain development ... by looking at ecoregional issues in a comprehensive way, and by being open to a variety of partners.

Boutros Boutros-Ghali
U.N. Secretary-General

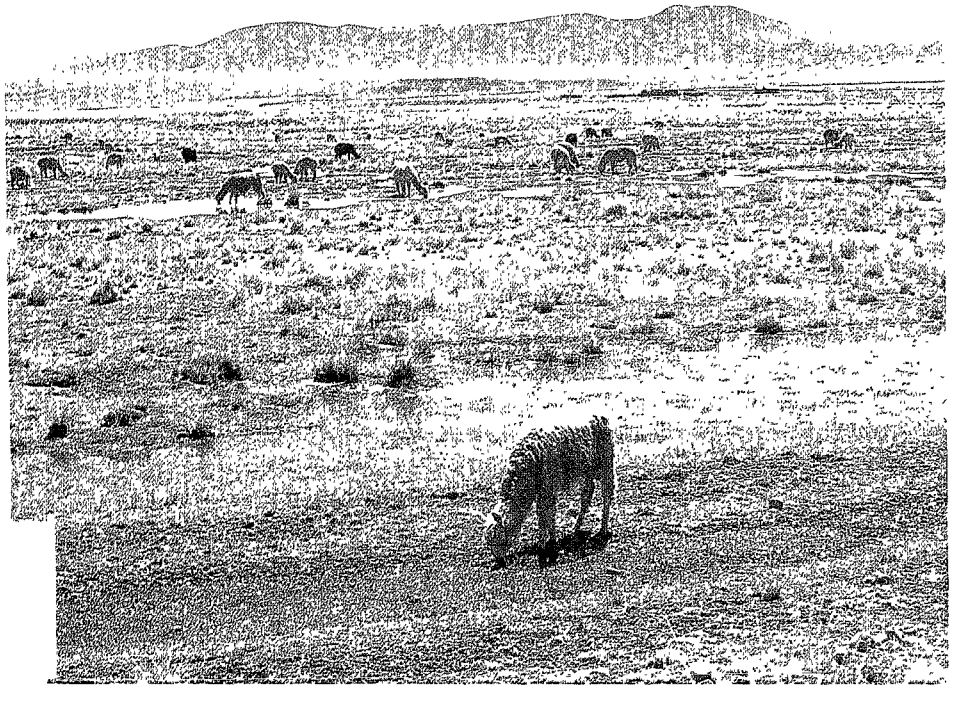
In dozens of isolated Andean communities, genetic conservation experts spent much of 1995 conducting field research and examining historical data on the region's lesser-known root and tuber crops. This research, which was conducted as part of CONDESAN—the Consortium for the Sustainable Development of the Andean Ecoregion—is helping to link genetic resources programs in Bolivia, Ecuador, and Peru.

"The CONDESAN approach," notes the Consortium's biodiversity coordinator Miguel Holle, "is helping to remove the barriers that

previously prevented the exchange of research results across national borders." It is also providing much-needed information on virology, storage, processing, and species variation. "We start in what is called a microcenter of diversity," he says. "This is an area where crop variation is particularly concentrated. The objective is to eventually extend the studies up to the ecoregional level and draw broader conclusions useful to both scientists and policymakers."

Now in its third year, CONDESAN's program for the conservation and use of biodiversity supports the genetic resources programs of 22 organizations. Among them is an unusual group of private-sector, university, and farm organizations with a common interest in developing an export market for maca (*Lepidium meyenii*). Formed in 1995, the group supports pharmaceutical interests in securing adequate supplies of a crop that is believed to act as a natural relaxant.

Bofedales: A traditional land use system in the area surrounding Lake Titicaca in southern Peru and western Bolivia.



E. MUJICA

A Unified Approach

Biodiversity research is one element in a broad, three-year-old ecoregional initiative to rescue one of the world's great mountain systems. Unable to solve the big problems of the Andes piecemeal, a group of scientists, policymakers, and development specialists from seven Andean countries met at CIP in May 1992 to create CONDESAN. The research alliance is now open to all public and private institutions willing to collaborate and share costs.

CONDESAN brings together a vast array of research expertise and resources that crosses disciplines in environmental, agricultural, and social sciences. It actively promotes research partnerships aimed at achieving sustainable development. Collaboration with national agricultural research and development programs continues to be linked to ongoing research projects funded by major donors and local governments.

CONDESAN Research in 1995

Bofedales: In southern Peru, alpaca producers graze their animals on natural pastures arranged in concentric circles, a traditional land use system known as bofedales. Recent studies show that the animal carrying capacity of bofedales can be doubled by constructing small irrigation channels that divert small amounts of water to nearby unirrigated areas. CONDESAN systems analysts, working with experts from CIRNMA, a local NGO, report that the channels can also be used to establish small trout ponds, a practice that improves family protein intake and increases income by more than 30%. The channels have the added benefit of not interrupting the flow of water needed by farmers downstream.

Rustic greenhouses: In the high-plateau region around Lake Titicaca, on the Bolivian-Peruvian border, CONDESAN cooperators are conducting studies aimed at developing food production

Although participation varies, more than 100 institutions from 20 countries are currently members of CONDESAN. These are mainly national agricultural research institutes, universities, international and nongovernmental organizations, and private groups, but individual farmers and communities from the various Andean subregions also participate. Research covers priority topics in four approved themes: biodiversity, land and water management, policy, and production systems.

The Consortium operates under the guidance of a seven-member board of directors, currently headed by Jaime Tola, director general of Ecuador's national agricultural research institute—INIAP. Day-to-day operations are coordinated by José Luis Rueda and a multidisciplinary team of scientists who also provide research support to CONDESAN field projects.

Tola believes that the partnership has been instrumental in bringing about a consensus on the type of agriculture that should be conducted and the policies needed to achieve sustainable improvements in productivity, income, equity, and environmental quality. One goal, he says, is to translate isolated research results into coherent policies that provide alternative production options for watersheds, communities, and the ecoregion as a whole.

CONDESAN's goal is to translate research into policies that provide alternatives for watersheds, communities, and the ecoregion.

"To chart a course for the future, CONDESAN must remain responsive and must bring into harmony different sets of knowledge, different institutional interests, and different demands on the region's resource base," Tola says. "We

CONDESAN

alternatives for animal producers with small tracts of land. One such technology is a low-cost rustic greenhouse fitted with drip irrigation for year-round production of potato, vegetables, and small fruits. The greenhouses, which are filled with barley straw and animal manure, eliminate the risk of crop failures caused by frost and drought. Research has shown that by using the barley straw-manure mixture in conjunction with the greenhouses, farmers can produce up to 350 kg per year of potatoes per 50-square-meter plot, a 500% increase over field-grown potatoes. Because of the program's success, researchers from Peru and Bolivia's national research systems are jointly studying the potential of small-scale greenhouse production of medicinal plants for the international market.

Salt-tolerant pastures: Kauchi, a salt-tolerant plant native to the Altiplano, was evaluated as a possible solution to salinity problems in Bolivia's 600,000-hectare Desaguadero River watershed. The research sites selected for evaluation trials were located using satellite maps developed by the Bolivian Remote Sensing Association for Environmental Studies (ABTEMA), a member of CONDESAN. To date, governmental organizations and NGOs have established more than 50 hectares of experimental kauchi pasture for sheep grazing. Kauchi forage contains up to 16% protein, is 70% digestible, and produces annual dry matter yields exceeding 2 t/ha. Researchers have determined that kauchi yields are comparable to those obtained with alfalfa in nonsaline soils. Future expansion of this technology will depend on resolving kauchi's low rate of seed germination, a problem currently being addressed by scientists working at the Bolivian Institute of Agricultural Technology, another CONDESAN member.

believe that these efforts will benefit not only those currently charged with maintaining natural resources but also those whose job it will be to do so for future generations."

Fieldwork is currently being carried out at six benchmark sites: La Miel in Colombia; Carchi, Ecuador; Cajamarca and Puno, Peru; and Cochabamba and the Aroma Province in Bolivia. At these sites, research is participatory and long-term, and covers studies that range from the community level up to the watershed. New production technologies are being proposed to increase agricultural productivity and promote environmental protection. Results from benchmark sites will eventually be analyzed so that their impact can be measured over larger areas.

To link the system's different projects and work sites and provide an inexpensive way to share information and research results, a communications network, INFOANDINA, was established. Accessible to everyone interested in sustainable management of Andean natural resources, it provides on-line access to global databases and electronic mail services, and will eventually furnish subscribers with information on potato research, commodity prices, water management, indigenous knowledge systems, gender studies, and Andean camelids.

In addition to CIP, three other CGIAR centers are involved. The International Center for Tropical Agriculture in Colombia is helping with agroecological characterization work, particularly on lower hillsides; the International Plant Genetic Resources Institute in Rome participates in the biodiversity effort; and the International Centre for Research in Agroforestry in Nairobi is involved in agroforestry research. CONDESAN also anticipates that the CGIAR's systemwide livestock initiative will respond to research needs in the Andes by supporting a proposed program of livestock research.

CONDESAN is currently strengthening its capability in land and water management, and, through the application of simulation models, is conducting research on land use systems. These activities include agroecological characterization of a variety of biophysical environments, policy and socioeconomic studies, as well as long-term monitoring of biodiversity and soil and water resources. The objective of this research is to analyze the constraints that threaten productivity in Andean agricultural systems. When completed, this research is expected to provide options for alternative land use systems that promote sustainable management of natural resources, Rueda notes. This work is closely linked to CONDESAN's small network of experienced policy analysts who are studying how government policies influence sustainability. Their goal is to provide reliable information that political leaders can use to formulate policies that create jobs, increase incomes, and stimulate economic development.

Opinions and Beliefs: Facts and Analysis

How can scientists respond to the needs of hillside farmers for more productive, environmentally friendly technologies? How can hillside residents make their voices heard among the competing claims in the political processes that determine government policies? These questions motivated the development of a new CONDESAN project that will link Ecuador's national electrical authority with international centers and NGOs, foreign and local universities, and the country's national agricultural research system. The project will finance the development of a decision support system that can screen policies and technologies and identify trade-offs between the environment and agriculture. A combination of expert systems and simulation models, the project should throw light on what is most frequently a debate distinguished by opinions and beliefs rather then facts and analysis.

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* Until April 30, 1995

Finance and Administration

CIP's CGIAR-approved research budget for 1995 was $21.3 million. Although purchasing power decreased by an estimated $0.6 million because of persistent inflation in US dollar terms, the Center increased its commitments to research by $0.4 million and supplemented its operating fund by $0.5 million. These investments were made possible by parallel reductions in administrative costs and by efforts to streamline several administrative departments. Nevertheless, many of the Center's international positions remain vacant and the downsizing of locally recruited staff continues.

Donor commitments for 1995 were $21.3 million, approximately 5% above original estimates. A total of $1.0 million was recovered from overhead charged to restricted and complementary projects; $0.3 million was earned from interest on time deposits and other assets. Earned income was 30% above original estimates. Contributions for complementary

Operational expenses by activity for 1995 and 1996 (%).

	Actual 1995	Estimated 1996
Research	54	58
Research Support	7	6
Training	6	4
Information	4	4
Administration	12	14
Operations*	10	9
Accruals & Provisions	1	0
External Review	1	0
Subtotal	95	95
Depreciation	3	4
Operating Fund	2	1
Subtotal	5	5
Total	100	100

*Includes motor pool, maintenance, security, and general services at La Molina.

BALANCE SHEET (US$000)	1995	1994
	Year ended 31 December	
Current Assets		
Cash and short-term deposits	4,347	3,150
Securities	89	52
Accounts receivable:		
Donors	3,873	3,834
Employees	404	434
Other	219	267
Inventories	845	740
Prepaid expenses	1,350	1,155
Total current assets	11,127	9,632
Investments	572	670
Loans to employees	335	508
Fixed Assets		
Property, plant, and equipment	20,674	19,944
Less accumulated depreciation	(10,976)	(10,485)
Total fixed assets (net)	9,698	9,459

activities totaled $3.5 million, 91% of the amount earmarked for the year. Investment in new capital items was $101,000; replacements totaled $862,000.

Information Technology

CIP started 1995 with a new computer systems architecture implemented in accordance with both sound commercial business principles and the special requirements of a research and development organization. The objective of the new architecture is to eliminate the Center's dependence on an older, inflexible, and more costly centralized system. The shift to more cost-effective modular systems is designed to meet the requirements of scientists working at headquarters and at regional locations.

During the year, the Center's financial information system—connected through the CGNET II electronic mail system—became operational in most regional offices. In addition, a network and telecommunications server was installed in the CIP-PROINPA office in Cochabamba, Bolivia. The server is a prototype that extends headquarters-based scientific and administrative systems to regional locations. Similar servers will be installed in Huancayo, Quito, Bogor, and Nairobi in 1996.

Taking advantage of the CG integrated voice and data network (IVDN), the Center's germplasm and associated seed databases were also upgraded to meet the goals of the CGIAR's Systemwide Information Network for Genetic Resources, also known as the SINGER project. When the CIP component of SINGER is completed, CIP will become one of the first international centers to offer access via Internet and the World Wide Web to a systemwide integrated germplasm database. The database will include both images and geographic information systems functions.

The table below summarizes CIP's finances in 1995. A complete, audited financial statement is published separately, and can be requested from the Controller's Office, CIP headquarters, Lima, Peru.

BALANCE SHEET (US$000)	1995	1994
	Year ended 31 December	
Current Liabilities		
Short-term loans	393	225
Advances from donors	5,049	5,351
Accounts payable:		
Research contracts and organizations	1,317	905
Suppliers and taxes	972	865
Provisions for severance indemnities	64	44
Total current liabilities	7,795	7,390
Long-term Loan	686	511
Accruals and Provisions	443	180
Net Assets		
Capital invested in fixed assets	9,698	9,459
Capital fund	2,332	2,448
Unexpended fund balance	778	281
Total net assets	12,808	12,188
Total Liabilities and Net Assets	21,732	20,269

Donor Contributions in 1995

CIP has had broad, strong support from its 40 donors. Eleven funders provided contributions worth one million dollars or more each. Another three gave more than half a million dollars each.

DONOR (ranked by levels of core contribution in US$000)	CORE	COMPLEMENTARY
Swiss Development Cooperation and Humanitarian Aid	2,496	1,986
World Bank	1,580	
Japan	1,491	
Commission of the European Community	1,470	
Netherlands	1,329	99
United Nations Development Programme	1,329	
Danish International Development Agency	1,279	
United Kingdom Overseas Development Administration	1,258	8
United States Agency for International Development	1,100	504
Inter-American Development Bank	1,013	53
Swedish Agency for Research Cooperation	961	
Germany	930	86
Canadian International Development Agency	817	
Australia	583	
Austria	425	
International Development Research Centre	284	166
Belgium	229	1
France	223	
Luxembourg	200	
Italy	166	24
Norway	154	
Finland	115	
China	90	
Asian Development Bank	73	
Korea	60	
Spain	50	
Mexico	45	
OPEC Fund for International Development	41	
India	37	
Weizmann Institute of Science	2	
Ministerio de Economía y Finanzas (Peru)		187
Natural Resource Institute		50
International Centre for Research in Agroforestry		39
CARE Perú		22
Rockefeller Foundation		14
Scottish Crop Research Institute		11
British Embassy (in Peru)		10
Sociedad Química y Minera de Chile		8
FAO/IPGRI		8
Calbee Potato Inc.		2
Total Contribution	**19,830**	**3,728**

Staff in 1995

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Peter Gregory, PhD, Deputy Director General for Research
Roger Cortbaoui, PhD, Director for International Cooperation
George Mackay, MS, Director of Genetic Resources[1]

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Germplasm Management and Enhancement
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Disease Management
Edward R. French, PhD

Integrated Pest Management
Fausto Cisneros, PhD

Propagation, Crop Management
Mahesh Upadhya, PhD

Postharvest Management, Marketing
Gregory J. Scott, PhD

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(*country*) = post location, but activity regional in scope
country = post location

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Liaison Office - Ecuador
Charles Crissman, PhD

Sub-Saharan Africa (SSA)
Peter Ewell, PhD, Regional Representative (*Kenya*)
Liaison Office - Nigeria
Humberto Mendoza, PhD[4]

Middle East and North Africa (MENA)
Carlos Martin, PhD, Regional Representative (*Tunisia*) (until June)
Aziz Lagnaoui, PhD, Regional Representative (*Tunisia*) (from June)
Liaison Office - Egypt
Ramzy El-Bedewy, PhD

South and West Asia (SWA)
Sarathchandra Ilangantileke, PhD, Regional Representative (*India*)

East and Southeast Asia and the Pacific (ESEAP)
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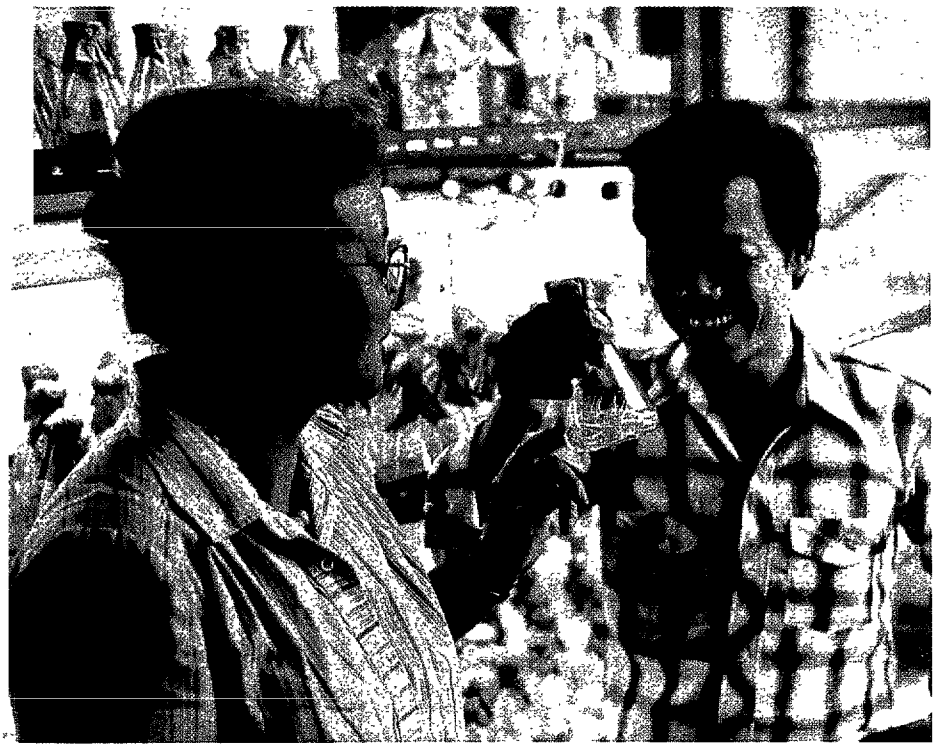
Edward Carey, PhD, Breeder (*Kenya*)[4]
Enrique Chujoy, PhD, Geneticist (*Philippines*)
Il Gin Mok, PhD, Breeder (*Indonesia*)
Haile M. Kidanemariam, PhD, Breeder (*Kenya*)

Tissue culture expert (and current CIP board member) Lieselotte Schilde with Vietnamese collaborator Nguyen Van Uyen circa 1980.



[1] Staff who joined during the year
[2] Staff who left during the year
[3] Staff funded by special projects
[4] Project leader
[5] Deceased

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Ana Luz Panta, Biologist

CIP plant explorer Carlos Ochoa circa 1976.

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Jacques Vandernotte, Pilot
Percy Zuzunaga, Co-Pilot

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Compensation
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Social Work
Martha Piérola, Supervisor
Labor Relations
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Lucero Schmidt, Nurse
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Purchasing Supervisors
Arturo Alvarez
Roxana Morales Bermúdez
José Pizarro
Warehouse
Jorge Luque, MBA, Supervisor

Visitors and Travel
Rosa Rodríguez, Manager[5]
Travel
Ana María Secada, Supervisor
Visitors' Office
Mariella Corvetto, Supervisor

Staff photo 1978.

Selected Scientific Publications 1995

Abad, Z.G., J.A. Abad, and C. Ochoa. 1995. Historical and scientific evidence that supports the modern theory of the Peruvian Andes as the centre of origin of *Phytophthora infestans*. In: Dowley, L.J., E. Bannon, L.R. Cooke, T. Keane, and E. O'Sullivan (eds.). *Phytophthora infestans* 150: Proceedings EAPR Pathology Section, September 1995, Dublin, Ireland. European Association of Potato Research/Boole Press, Dublin, Ireland. p. 239-245.

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Bradshaw, J.E., R.L. Wastie, H.E. Stewart, and G.R. Mackay. 1995. Breeding for resistance to late blight in Scotland. In: L.J. Dowley, E. Bannon, L.R. Cooke, T. Keane, and E. O'Sullivan (eds.). *Phytophthora infestans* 150. Boole Press, Dublin, Ireland. p. 246-254.

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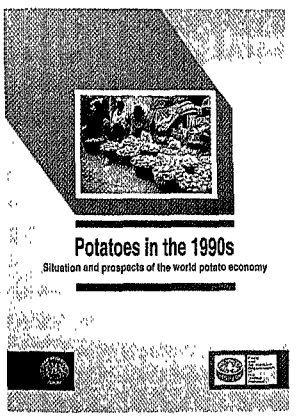

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Core Research in 1995

Program, Project, and Activity	Locations and Partner Networks
Characterization of constraints and opportunities for potato production	
Yield-gap analysis	• Ecuador
Farmer participation in clonal evaluation	• Bolivia
Characterization of potato production systems	• PRAPACE
Characterization of sweetpotato constraints and opportunities	
Sweetpotato characterization	• Africa • India • Southeast Asia
Users' Perspective with Agricultural Research and Development (UPWARD)	• Asia • China • Netherlands
Adaptation and integration of potato production technologies	
Varietal adaptation to diverse agroecologies	• Bolivia • Chile• Cameroon • China • Peru • Philippines
Adaptation of cultivated diploid potato species	• USA
Intercropping	• Tunisia
Expanding production to new regions	• Burundi • Dominican Republic • USA
Adaptation and integration of sweetpotato production technologies	
Varietal adaptation to diverse regions	• Africa • Asia • Cameroon • China • Egypt • India • Peru
Evaluation of the impact and sustainability of potato production technologies	
Impact assessment	• Argentina • Bangladesh • Bolivia • Chile • China • Colombia • Dominican Republic • Ecuador • Egypt • Ethiopia • India • Indonesia • Kenya • Madagascar • Nepal • Peru • PRAPACE • Sri Lanka • Taiwan • Vietnam
Pesticides and sustainability	• Canada • Ecuador • USA

Principal scientist Luis Salazar and research assistant Ernesto Velit circa 1980.

Program, Project, and Activity	Locations and Partner Networks
Potato collection and characterization	
Collection, characterization, conservation, and distribution	• Chile • Peru • USA
In vitro conservation	• Ecuador • Peru
Potato germplasm enhancement, application of molecular technology	
Germplasm enhancement	• Chile • Italy • Peru • USA
Application of molecular marker technology	• Argentina • Chile • Germany • Netherlands • Philippines • UK • USA
Potato genetic engineering for pest and disease resistance	• Austria • Belgium • Peru • UK • USA
Sweetpotato collection and characterization	
Collection, characterization, conservation, documentation, distribution, and evaluation	• Argentina • Bangladesh • Brazil • China • Indonesia • Philippines - UPWARD,
In vitro conservation and virus eradication	• Austria • Peru • USA • Venezuela
Collection and evaluation of indigenous knowledge	• Indonesia - UPWARD
Sweetpotato germplasm enhancement and molecular techniques	
Combining traits using conventional techniques in diverse agroecologies	• China • East Africa (Kenya, Tanzania, Uganda) • Indonesia • Peru • USA
Utilization of wild relatives of sweetpotato	• Germany • Peru • UK
Molecular techniques for sweetpotato improvement	• Japan • Peru
Andean root and tuber crop collection and characterization	
Germplasm management in farmers' fields	• Bolivia • Peru
Development of a network for ex situ conservation	• Bolivia • Brazil • Ecuador • Peru
In vitro conservation and distribution	• Bolivia • Ecuador • Peru
Pathogen eradication and seed production	• Bolivia • Ecuador • Peru
Commodity systems analysis	• Bolivia • Ecuador • Peru
Control of potato late blight (Phytophthora infestans)	
Breeding and screening for resistance	• Argentina • Bolivia • China • Colombia • Ecuador • Kenya • Mexico • Peru
Integrated control	• Bolivia
Fundamental host-pathogen research	• Ecuador • Kenya • Netherlands • Peru • Philippines • Scotland • USA
Integrated control of potato bacterial wilt	
Fundamental research for control strategies	• China • Colombia • England • Peru
Development of resistance	• Brazil • China • Indonesia • Mauritius • Nigeria • Peru • Philippines

CIP's extensive research collaboration brings together many partners worldwide. This table summarizes CIP's core research activities in 1995, and the principal places and networks involved.

Program, Project, and Activity	Locations and Partner Networks
Integrated control	• Burundi • Kenya • Peru
Combining resistances to potato viruses and fungi	
Development of virus- and viroid-resistant materials	• Peru • Poland • Tunisia
Interaction of potato viruses and fungi	• Peru • Philippines
Selection of combined resistance to viruses and fungi	• Argentina • Brazil • Cameroon • Central America and the Caribbean • Colombia • East Africa • Ecuador • Egypt • Nigeria • Paraguay • Peru • Philippines • PROCIPA • Uruguay • USA • Venezuela
Control of field and storage diseases of Andean root and tuber crops, including potato	
Development of resistance to soft rot and blackleg	• Peru
Integrated control of *Erwinia* diseases	• Tunisia
Diseases of ARTC	• Peru
Detection and control of potato viruses	
Resistance to PLRV	• Peru • Scotland
Detection of viruses and viroids	• Bolivia • Colombia • India • Peru
Epidemiology of PVY	• Tunisia
Transmission of potato viruses and viroids	• Peru • Philippines
Identification and control of sweetpotato viruses	
Detection, identification, and eradication of viruses	• Peru • China
Integrated control	• Kenya • Madagascar • Rwanda • Tanzania • Uganda
Control of bacterial and fungal diseases of sweetpotato	
Resistance to diseases	• Southeast Asia • UK
Molecular approaches for detection and control of pathogens	
Genetic resistance and probe development	• Peru • England
Virology of Andean roots and tubers	
Detection and characterization of viruses	• Bolivia • Ecuador • Peru
Elimination of pathogens	• Peru
Production loss by viruses	• Bolivia • Ecuador • Peru
Potatoes with resistance to major insect and mite pests	
Development of resistant genotypes for potato tuber moth and leafminer flies	• Peru • USA
Potatoes with glandular trichomes	• Peru • USA
Transgenic potatoes with insect resistance	• Belgium • Peru

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Program, Project, and Activity	Locations and Partner Networks
Field evaluation of resistant plants	• Peru
Integrated methods for control of potato tuber moth and leafminer fly	
Generation of technologies	• Bolivia • Colombia • Dominican Republic • Peru
Use of sex pheromones and granulosis virus	• Bolivia • Colombia & Peru - PRACIPA • Dominican Republic • Tunisia
Applied field management	• Bangladesh • Bolivia • Colombia • Dominican Republic • Egypt • Kenya • Morocco • Tunisia • Venezuela • Yemen
Integrated methods for control of sweetpotato weevil	
Development of resistance	• Asia • Kenya • Peru • USA
Use of sex pheromones	• Cuba • Dominican Republic
Biological control	• Cuba • Peru • Bangladesh
Applied field management	• Cuba • Dominican Republic • Indonesia • Kenya • Philippines • Uganda
Integrated methods for control of sweetpotato nematodes	
Development of resistance	• Peru
Applied field management	• Peru
Integrated methods for control of Andean potato weevil	
Development of resistance	• Peru
Cultural and biological control methods	• Bolivia • Peru
Applied field management	• Bolivia • Colombia • Ecuador• Peru
Integrated methods for control of potato cyst nematode and false root-knot nematode	
Crop rotation schemes	• Peru
Applied field management	• Bolivia • Ecuador • Peru
PROGRAM: PROPAGATION, CROP MANAGEMENT	
Propagation of healthy clonal potato planting materials in diverse agricultural systems	
Research support to in-country basic seed programs	• Bangladesh • Bolivia • Burundi • Cameroon • Colombia • Ecuador • Paraguay • Peru • Philippines • Uganda • Venezuela • West Africa
Sexual potato propagation	
Breeding for improved TPS families	• Argentina • Chile • China • India • Italy • Kenya
TPS agronomic adaptation to diverse agroecologies	• Bangladesh • China • Egypt • India • Indonesia • Italy • Morocco • Nepal • Nicaragua • Paraguay • Peru • Philippines • Sri Lanka • Tunisia • Vietnam
Studies on TPS production	• Bangladesh • Chile • India • Indonesia • Nepal • Peru • Turkey
Sweetpotato production through improved management techniques	
Crop management practices	• Burundi • Cameroon • China • Peru • Philippines

Program, Project, and Activity	Locations and Partner Networks
Studies on tolerance of abiotic stresses	• China • Egypt • Peru • Philippines
Management of forage-type sweetpotatoes	• Peru
Maintenance, international distribution, and monitoring of performance of advanced potato germplasm	
Ongoing activities (seed units)	• Kenya • Peru • Philippines
Maintenance, international distribution, and monitoring of performance of advanced sweetpotato germplasm	
Ongoing activities (seed units)	• Kenya • Peru • Philippines
Abiotic stresses and potato crop management	
Breeding for improved tolerance of abiotic stresses	• Bolivia • Chile • Peru • Philippines • Southeast Asia
Agronomic research for potatoes grown under stress	• Egypt • Peru • Philippines • Uganda • USA
Propagation of Andean root and tuber crops and management of Andean natural resources	
Seed production, Andean root and tuber crops	• Ecuador • Peru
Management of Andean natural resources	• Peru
PROGRAM FOR POSTHARVEST MANAGEMENT, MARKETING	
Expanding utilization of potato in developing countries	
Low-cost storage of table and seed potatoes	• China • Egypt • India • Kenya • Pakistan • Philippines • Thailand - SAPPRAD
Potato breeding for processing	• India • Peru • Philippines • Tunisia
Marketing and demand for potatoes	• Bolivia • Colombia • England • India • Indonesia • Kenya • Morocco • Netherlands • Tunisia • USA
Potato processing	• Bolivia • China • Indonesia • Peru
Product development for sweetpotato in developing countries	
Evaluation and distribution of elite sweetpotato materials for processing	• China • Indonesia • Kenya • Peru • Philippines • Uganda • USA • Vietnam
Marketing and demand for sweetpotatoes	• Argentina • Bangladesh • China • Indonesia • Kenya • Netherlands • Peru • Philippines • SAPPRAD • USA
Processing of sweetpotato	• China - UPWARD • India • Indonesia • Kenya • Netherlands • Philippines • SAPPRAD • Tanzania • Uganda • UK • Vietnam
Postharvest management of Andean food commodities	
	• Bolivia • Brazil • Colombia • Ecuador • Peru

Training in 1995

Program and Title	Countries Represented	Partner Institution
PROGRAM 1: PROJECT		
In-country course on standardization of research methodologies for root and tuber crops	Tanzania	CIP/SARRNET/NRI
Workshop on impact assessment for agricultural economists in NARS of East and Central Africa	Burundi, Kenya, Uganda, Zaire	USAID/PRAPACE
PROGRAM 2: PROJECT		
Indigenous knowledge in conservation of crop genetic resources	Indonesia, Philippines, Singapore	
International workshop on biotechnology-assisted breeding to reduce pesticide use in potatoes	Argentina, Bolivia, Chile, Uruguay	
II international course on biotechnology for biodiversity conservation	Argentina, Brazil, Chile, Colombia, Ecuador, El Salvador, Mexico, Panama, Peru, Uruguay	CIP/CIAT/OAS
PROGRAM 3: PROJECT		
National workshop on population B breeding and late blight control	Philippines	SAPPRAD/UNDP
Course on diagnosis, detection, and survey of potato viruses in North Sumatra	Indonesia	CIP/WE
Regional workshop on bacterial wilt control in potatoes for extension agents of Central America and the Caribbean	Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, St. Kitts & Nevis, Venezuela	IDB Special Project

Germplasm conservation course in Colombia circa 1985.

Program and Title	Countries Represented	Partner Institution
Workshop on late blight and potato tuber moth management in Africa and Middle East	Burundi, Egypt, Ethiopia, Kenya, Morocco, Syria, Tunisia, Turkey, Uganda, Yemen, Zaire	UNDP/SAPPRAD/ CIP
Potato seed production technology and virology	Burundi, Cameroon, Egypt, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Morocco, Rwanda, Tanzania, Uganda, Zaire	
Regional workshop on evaluation of potato germplasm for field resistance to late blight	Burundi, Eritrea, Ethiopia, Kenya, Uganda, Rwanda, Zaire	PRAPACE
[illegible]		
Workshop on integrated pest management for potato blight	Bangladesh, Philippines	
National workshop on institutional impact of integrated pest management programs	Peru	
II international course on potato integrated pest management	Bolivia, Colombia, Peru, Venezuela	IBTA/CIP/UNDP/ COTESU
Advanced course on potato pest management and general entomology	Peru	SENASA
International workshop on integrated pest management in potato	Costa Rica, Dominican Republic, Guatemala, Peru, USA	CIP/PRECODEPA
I national course on integrated pest management in potato	Dominican Republic	JAD/CIP/MIP/ PRECODEPA
In-country course on biological control of potato tuber moth	Egypt	
PROGRAM 4: PROPAGATION AND MANAGEMENT		
International course on potato seed production	Argentina, Bolivia, Colombia, Cuba, Guatemala, Mexico, Panama, Paraguay, Peru, Venezuela	IDB Special Project
General potato production course with emphasis on soil management practices	Peru	UNA/CIP

An important role of CIP's staff members posted at our regional offices is to develop technical capabilities to support national program needs. Some of this is carried out through the courses and workshops in this list. In addition, in 1995, 41 national scientists received individual training in specialized subjects. An increasing proportion of this training (40% in 1995) is taking place in CIP's regions.

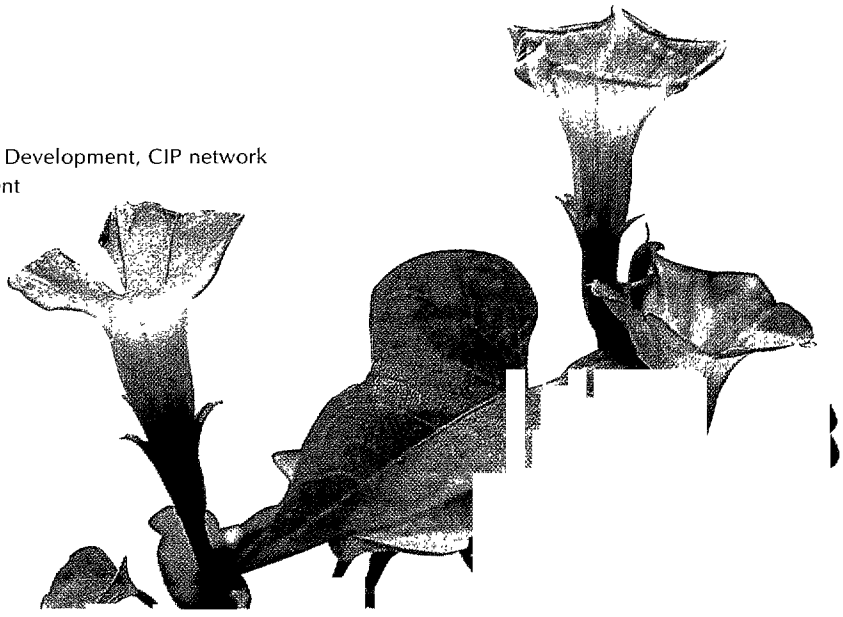
Program and Title	Countries Represented	Partner Institution
Information systems for seed potato production	Bolivia, Chile, Cuba, Ecuador, Mexico, Panama, Uruguay, Venezuela	
Regional workshop on true potato seed (TPS)	Chile, Cuba, El Salvador, Guatemala, Haiti, Honduras, Nicaragua, Panama, Peru	IDB Special Project/ PRECODEPA
Diagnosis and recommendations on soil management and crop fertilization with emphasis on potato	Bolivia	PROINPA/FAO/ CIP
National course on potato seed production	Peru, Ecuador	IDB Special Project
Course on potato basic seed production	Peru	Chacasina Project
Course on potato production from true potato seed	Peru	Chacasina Project
In-country course on true potato seed	Egypt	
Workshop on production and distribution of certified potato seed	Kenya, Uganda	CIP/NARO/ PRAPACE
In-country potato seed production	Rwanda	Seeds of Hope Project
Interregional workshop on TPS production and utilization: Transfer of technology	Bangladesh, China, India, Indonesia, Nepal, Philippines, Sri Lanka, Vietnam	CIP/CPRI
PROGRAM 6: POSTHARVEST MANAGEMENT-MARKETING		
Workshop on sweetpotato processing	Indonesia, Philippines, Vietnam	CIP/UPWARD
Workshop and study tour on sweetpotato processing	China, Hong Kong, Indonesia, Kenya, Malawi, Malaysia, Papua New Guinea, Philippines, Sri Lanka, Tanzania, Thailand, Uganda	CIP/PRAPACE
Regional workshop on baseline studies, monitoring, and impact assessment	Angola, Lesotho, Malawi, Mozambique, Namibia, Swaziland, Tanzania, Zambia, Zimbabwe	SARRNET

Research Partners

AARI	Aegean Agricultural Research Institute, Turkey
ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
AGCD	Administration Generale de la Coopération au Développement, Belgium
AIT	Asian Institute of Technology
ARC	Agriculture Research Center, Egypt
ARCS	Austrian Research Centre at Seidersdorf
AREA	Agricultural Research and Extension Authority, Yemen
BARI	Bangladesh Agricultural Research Institute
	Benguet State University, Philippines
BMZ	German Ministry for Economic Development and Cooperation
	Bogor Agricultural University, Indonesia
BRC	Biotechnology Research Center, Vietnam
CAAS	Chinese Academy of Agricultural Sciences
CARDI	Caribbean Agricultural Research and Development Institute, Trinidad
CECOACAM	Central de Cooperativas Agrarias de Cañete y Mala, Peru
CEMOR	Cemor Editores & Promotores S.R.L., Peru
CGIAR	Consultative Group on International Agricultural Research, USA
	Chiang Mai University, Thailand
CIAAB	Centro de Investigaciones Agrícolas A. Boerger, Uruguay
CIAT	Centro Internacional de Agricultura Tropical, Colombia
CICA	Centro de Investigación en Cultivos Andinos, Peru
CIDA	Canadian International Development Agency
CIED	Centro de Investigación, Educación y Desarrollo, Peru
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement, France
CIRNMA	Centro de Investigación de Recursos Naturales y Medio Ambiente, Peru
CLADES	Consorcio Latinoamericano de Agroecología y Desarrollo
CNCQS	Chinese National Centre for Quality Supervision and Test of Feed
CNPH	Centro Nacional de Pesquisa de Hortaliças, Brazil
CONDESAN	Consortium for the Sustainable Development of the Andean Ecoregion
	Cornell University, USA
CORPOICA	Corporación del Instituto Colombiano Agropecuario
COTESU	Cooperación Técnica Suiza, Switzerland
CPRA	Centre de Perfectionnement et de Recyclage Agricole de Saïda,Tunisia
CPRI	Central Potato Research Institute, India
CPRO-DLO	Centre for Plant Breeding and Reproduction Research-Agriculture Research Department, Netherlands
CRIFC	Central Research Institute for Food Crops, Indonesia
CTCRI	Central Tuber Crops Research Institute, India
EMATER	Empresa de Assistência Técnica e Extensão Rural do Estado de Minas Gerais, Brazil
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária, Brazil
ENEA	Comitato Nazionale per la Ricerca e per lo Sviluppo dell'Energia Nucleare e delle Energie Alternative, Italy
EPAMIG	Empresa de Pesquisa Agropecuária de Minas Gerais, Brazil
ESH	Ecole Supérieure d'Horticulture, Tunisia
FAO	Food and Agriculture Organization of the United Nations, Italy
FONAIAP	Fondo Nacional de Investigaciones Agropecuarias, Venezuela
FORTIPAPA	Fortalecimiento de la Investigación y Producción de Semilla de Papa, Ecuador
FUNDAGRO	Fundación para el Desarrollo Agropecuario, Ecuador
GAAS	Guandong Academy of Agricultural Sciences, China
GTZ	German Agency for Technical Cooperation
IAN	Instituto Agronómico Nacional, Paraguay
IAO	Istituto Agronomico per l'Oltremare, Italy
IAR	Institute of Agricultural Research, Ethiopia
IAV	Institut Agronomique et Vétérinaire, Morocco
IBTA	Instituto Boliviano de Tecnología Agropecuaria

ICAR	Indian Council of Agricultural Research
ICIPE	International Centre for Insect Physiology and Ecology, Kenya
IDB	Inter-American Development Bank
IDEA	Instituto Internacional de Estudios Avanzados
IDRC	International Development Research Centre, Canada
IESR/INTA	Instituto de Economía y Sociología Rural del INTA, Argentina
IFPRI	International Food Policy Research Institute, USA
IIN	Instituto de Investigación Nutricional, Peru
INIA	Instituto Nacional de Investigación Agraria, Peru
INIA	Instituto Nacional de Investigaciones Agropecuarias, Chile
INIA	Instituto Nacional de Investigaciones Agropecuarias, Uruguay
INIAP	Instituto Nacional de Investigaciones Agropecuarias, Ecuador
INIFAP	Instituto Nacional de Investigaciones Forestales y Agropecuarias, Mexico
INIVIT	Instituto Nacional de Viandas Tropicales, Cuba
INRA	Institut National de la Recherche Agronomique, France
INRAT	Institut National de la Recherche Agronomique de Tunisie
INSA	National Root and Tuber Crop Improvement Institute, Vietnam
INTA	Instituto Nacional de Tecnología Agropecuaria, Argentina
IPGRI	International Plant Genetic Resources Institute, Italy
IPO-DLO	Institute for Plant Protection-Agriculture Research Department, Netherlands
IPR	Institute for Potato Research, Poland
IRA	Institut de Recherche Agronomique, Cameroon
ISABU	Institut des Sciences Agronomiques du Burundi
IZ	Instytut Ziemniaka, Poland
JAAS	Jiangsu Academy of Agricultural Sciences, China
KARI	Kenyan Agricultural Research Institute
LAC	Latin America and the Caribbean, CIP region
LEHRI	Lembang Horticultural Research Institute, Indonesia
LSU	Louisiana State University, USA
	Makerere University, Uganda
MARS	Mwara agricultural Research Institute, Indonesia
	McMaster University, Canada
MIP	Programa de Manejo Integrado de Plagas, Dominican Republic
	Mississippi State University, USA
MMSU	Mariano Marcos State University, Philippines
	Montana State University, USA
MPI	Max Planck Institute, Germany
MSIRI	Mauritius Sugar Industry Research Institute
NAARI	Namulonge Agricultural and Animal Research Institute, Uganda
	Nagoya University, Japan
NARO	National Agricultural Research Organization, Uganda
NCSU	North Carolina State University, USA
	Nijmegen University, Netherlands
NOMIARC	Northern Mindanao Agricultural Research Center, Philippines
NPRCRTC	Northern Philippine Root Crops Research and Training Center
NPRP	National Potato Research Program, Nepal
NRI	Natural Resources Institute, UK
OAS	Organization of American States
ODA	Overseas Development Administration, UK
OPEC	Organization of Petroleum Exporting Countries
PCARRD	Philippine Council for Agriculture & Resources, Research & Development, Philippines
PDP	Potato Development Program, Nepal
PGS	Plant Genetic Systems, Belgium
PICA	Programa de Investigación de Cultivos Andinos, Peru
PRACIPA	Programa Andino Cooperativo de Investigación en Papa, CIP network

PRAPACE	Programme Régional de l'Amélioration de la Culture de la Pomme de Terre et de la Patate Douce en Afrique Centrale et de l'Est, CIP network
PRECODEPA	Programa Regional Cooperativo de Papa, CIP network in Central America and the Caribbean
PROCIPA	Programa Cooperativo de Investigaciones en Papa, CIP network in Southern Cone
PROINPA	Proyecto de Investigación de la Papa, Bolivia
PSPDP	Pakistan-Swiss Potato Development Program
	Rothamsted Experiment Station, UK
SAAS	Sichuan Academy of Agricultural Sciences, China
SAPPRAD	Southeast Asian Program for Potato Research and Development, CIP network
SARIF	Sukamandi Research Institute for Food Crops, Indonesia
SARRNET	Southern Africa Root Crop Research Network
SCRI	Scottish Crop Research Institute
SDC	Swiss Development Cooperation
SEAG	Servicio de Extensión Agrícola y Ganadera, Paraguay
SEARCA	Southeast Asian Regional Center for Graduate Studies and Research in Agriculture, Philippines
SEMTA	Servicios Múltiples de Tecnologías Apropiadas, Bolivia
SENASA	Servicio Nacional de Sanidad Agraria, Peru
SPG	Sociedad Peruana de Genética
SPI	Smart Plant International, USA
SPPC	Seed Potato Production Center, Yemen
	Stanford University, USA
TALPUY	Grupo de Investigación y Desarrollo de Ciencias y Tecnología Andina
TARI	Taiwan Agricultural Research Institute
TCRC	Tropical Crops Research Center, Bangladesh
TFNC	Tanzania Food and Nutrition Centre
	Universidad de Ambato, Ecuador
	Universidad Austral, Chile
	Universidad Jorge Basadre Grohmann de Tacna, Peru
	Universidad Mayor de San Simón, Bolivia
	Universidad Nacional Agraria, Peru
	Universidad Nacional de Cajamarca, Peru
	Universidad Nacional del Centro del Peru
	Universidad Nacional Daniel Alcides Carrión, Peru
	Universidad Nacional Mayor de San Marcos, Peru
	Universidad Nacional San Antonio Abad de Cusco, Peru
	Universidad Nacional San Cristóbal de Huamanga de Ayacucho, Peru
	Universidad Ricardo Palma, Peru
	Universidad San Luis Gonzaga de Ica, Peru
	Universidad Técnica de Cajamarca, Peru
	University of Birmingham, England
	University of Georgia, USA
	University of Nairobi, Kenya
	University of Naples, Italy
	University of Oxford, UK
	University of the Philippines, Los Baños
	University of Tübingen, Germany
UCRI	Upland Crops Research Institute, China
UNDP	United Nations Development Programme, USA
UPWARD	Users' Perspective with Agricultural Research and Development, CIP network
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USVL	United States Vegetable Laboratory
ViSCA	Visayas College of Agriculture, Philippines
	Wageningen University, Netherlands
WE	World Education
XSPRC	Xuzhou Sweet Potato Research Center, China
YGPPP	Yemeni/German Plant Protection Project



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(as of April 1996)

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■ UPWARD
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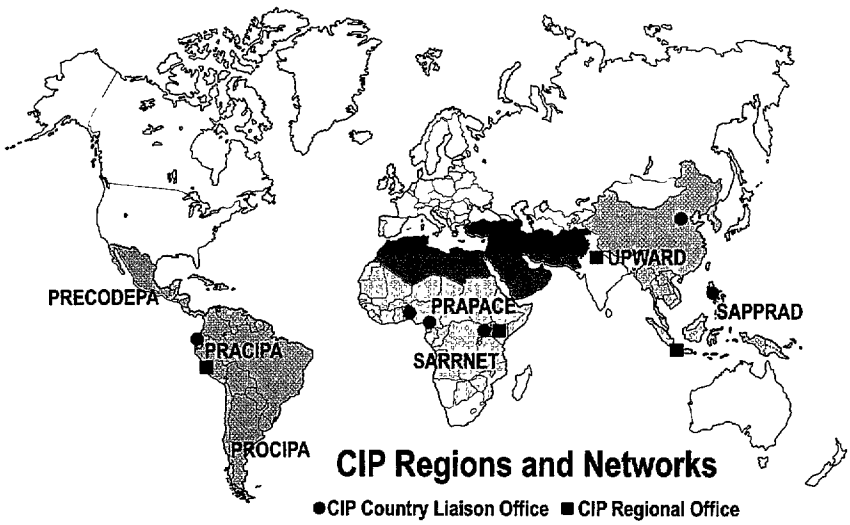

CGIAR and CIP: 25 Years of Research Partnership

For the past quarter century, the CGIAR—the Consultative Group on International Agricultural Research—has been one of the most effective means for advancing sustainable agriculture and food security in developing countries. A voluntary consortium of some 45 public- and private-sector donors, the CGIAR provides funding for 16 international agricultural research centers, including the International Potato Center.

The CGIAR began its work in 1971 by supporting a nucleus of four centers working on the basic food crops and production systems found in tropical areas. Today's CGIAR, under the leadership of Chairman Ismail Serageldin, is a diverse network of independent centers that work collectively, and with national systems, on priority research topics for the developing world. Following a recent process of renewal, the CGIAR has improved its governance, broadened the participation of developing countries, and restructured its finances. Its research agenda now includes work on priority topics involving livestock, forestry, fisheries, irrigation, policy, and institution building.

CIP's Role in the CGIAR

CIP's entry into the CGIAR was based on the belief that potatoes and other root and tuber crops would provide new food alternatives to a world dependent on cereal crops. Because they are naturally high-yielding and genetically diverse, root and tuber crops can be grown successfully in vastly different ecologies and cropping systems. According to the task required, they can be produced for food, for fiber, as animal feed, or for a variety of industrial purposes.

Increasingly, this potential is being recognized as one of the last remaining options for meeting food requirements over the quarter century ahead. Many countries, with centuries-old farming traditions based on cereals, are looking to root and tuber crops to increase food production and maintain economic growth. Many are achieving this goal by tapping into the research and technological options made available from the CGIAR's quarter century of investment in the International Potato Center.