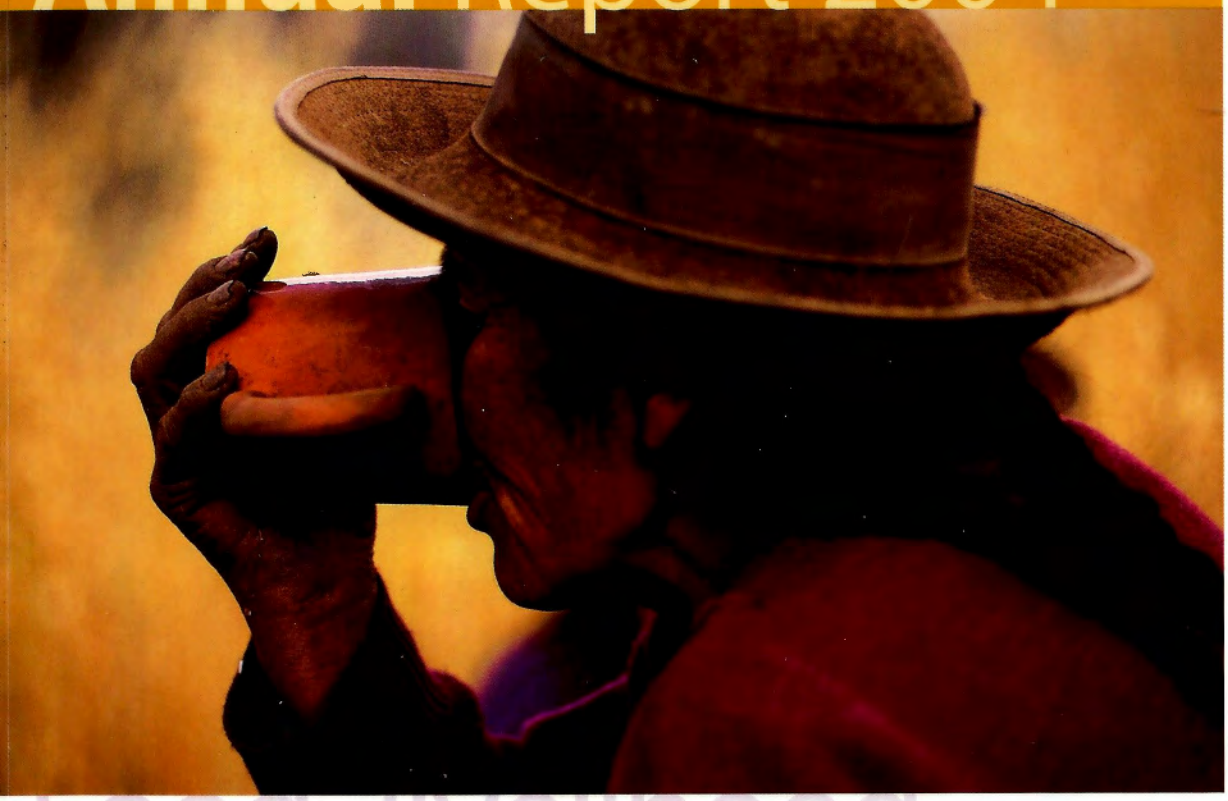
Annual Report 2004



CENTRO INTERNACIONAL DE LA PAPA
CIP

Food, livelihood and health

International Potato Center

Contents

From the director general

From the director general

Potato and sweetpotato remain important food crops throughout the world and will inevitably become more important to food security as the world's population increases in the future. The Millennium Development Goals provide entry points that we can use to achieve impact in the communities that most

demand our attention, among the poor, hungry and sick in the developing countries. With such a wide demand, we are looking closely at where we direct our work, as well as making efforts to carefully measure our impact. CIP, in fact, was the first of the CGIAR centers to base its work on the Millennium Goals.

By realigning our program to match the objectives of the Millennium Goals, it is clear that we are pursuing economic gains to reduce poverty and improve living standards. The innovative participatory market chain approach that Papa Andina is pioneering as a way of adding value to a product is a good example of this. It is also becoming clearer that the operation of our Partnership programs can add value and increase earnings by including products and processes other than those we have traditionally dealt with. The relationship of sweetpotato and pigs or the nexus of potato production and mountain resources management illustrate the value of extending our mandate.

During the year, the reorganized research and program structure generated some significant advances in knowledge that contribute directly to the crucial aspects of food security and poverty alleviation. The research program made fundamental advances in the fight against late blight and considerable progress against bacterial wilt. We also saw the security of CIP's germplasm collection increased through the work of the "Potato Park", a local initiative dedicated to *in situ* conservation of potato biodiversity.

The Partnership programs, which are, in fact, extensions of the research process, are often applying the results of Divisional work directly in their operations. For example, the Vitamin A for Africa (VITAA) program is linking breeding activities of orange-fleshed sweetpotato with active health programs in the community, blurring the lines between mandated research and operational development.

2004 was a year of consolidation and renewal for CIP. Consolidation in the sense that we were able to concentrate on our core work, guided by the visioning exercise

that we completed in 2003. Renewal in the sense that the process of management succession was completed and the leadership of CIP will be assumed early in 2005 by the chair of CIP's Vision, Dr. Pamela Anderson. Buoyed by a history of solid research achievement, CIP is also now on a secure financial footing. Our income continues to grow, with the increased restricted and unrestricted funding reflecting the confidence of our donors in the Center. Through good management practice, our financial security also increased during the year.

Although this report deals with the highlights of the year 2004, I am writing this introduction in March 2005. I will be retiring in April, not with reluctance, because I know the future of the Center is secure, but with great emotion. For the past 14 years my life has been inextricably bound up with CIP and I am proud to have had the opportunity to direct its course for so long. I would like to take this opportunity to thank all of our donors for the commitment they have shown to our work. I would also like to acknowledge my debt to our many partners, without whom we could not operate, and CIP's staff, in headquarters and in the regions, who show levels of dedication and brilliance I could never really demand. My wife Ilse and I will be retiring to Canada, but we will be taking a piece of Peru, and CIP, with us in our hearts.

With thanks and best wishes for the future.

Hubert Zandstra
Director General

Peruvian government honors CIP

The Peruvian government presented Dr. Hubert G. Zandstra, Director General of CIP, with the Grand Cross for Distinguished Service, on May 18 2004. The Grand Cross of the Order of Merit is one of the highest honors that can be bestowed upon a foreigner by the Peruvian government. The Peruvian Minister of Foreign Affairs, Ambassador Manuel Rodríguez Cuadros, representing the ministry at the ceremony, recognized Dr. Zandstra for his contribution to research on

Peru's Ambassador Manuel Rodríguez Cuadros awarding Dr. Hubert Zandstra the Grand Cross for Distinguished Service, for his contribution to research on the potato, sweetpotato and lesser known Andean roots and tubers

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the potato, sweetpotato and lesser known Andean roots and tubers, as well as for his dedication to promoting the integrated management of natural resources in the world's mountain regions, and particularly in Peru.

During the ceremony, which was held at CIP headquarters in La Molina, Ambassador Rodríguez commended Dr. Zandstra's contributions to Peru and in particular his work in the National Working Group on Mountain Ecosystems organized by the Peruvian Ministry of Foreign Affairs in 2002, the International Year of Mountains. Mr. Rodríguez also acknowledged Dr. Zandstra's contributing role in Peru's current influence in international fora on biodiversity conservation and the sustainable development of mountain regions.

The minister highlighted the significance of having CIP headquarters in Peru, the country known as the birthplace of the potato. He commended CIP for the quality of its research and for the opportunity it has given to hundreds of Peruvian university students who have benefited from the high-level training in agricultural research and natural resources offered by the Center.

The minister also emphasized that, just as the cultures of Mexico and Central America are known as maize cultures, the highland cultures of Peru should be known as potato cultures, both for the connection of the crop to Peru's ancient Andean heritage, as well as for the global value of the tuber, the world's fourth most important food crop.

Dr. Zandstra expressed his deep gratitude to Peru and to the Peruvian people for the honor. He recalled that one of his most gratifying experiences over the past 13 years was the reintroduction of true potato seed, a technology used by the Incas, in the Callejón de Conchucos in Ancash in 1994. CIP's involvement with this community began at the request of Father Ugo de Censi, who first approached CIP, desperate, after the farmers of the region had lost all of their seed during a devastating drought. With the seed CIP sent, a potato variety later called Chacasina, the farmers' yields multiplied by five and the community no longer had to constantly search for good quality seed.

Food, livelihood and health

Collaborating in China

Many of China's hungriest people are farmers, especially in densely populated rural hinterlands and remote highlands. At the moment the population is just below 1.3 billion and growing at a rate of 11 million per year. Ensuring those millions have enough to eat is a central feature of the country's long-term

planning, and potatoes have a significant role in achieving that objective.

Potato successes contribute to China's anti-poverty program

Since 1978, the percentage of people in the rural population considered poor, by Chinese standards, is estimated to have fallen from 30 percent to less than three percent. CIP collaborates in several programs which continue contributing to the success of China's anti-poverty program. High on the list of its contributions is a potato developed from CIP crosses in collaboration with the Root and Tuber Crop Research Institute of Yunnan Normal University and the Huize Agricultural Extension Center. Named Cooperation 88 to reflect the importance of partnership in its development and testing (and its origins as S-88 – a CIP cross), this high-yielding variety with superior processing characteristics is currently grown on more than 100,000 hectares in Yunnan alone, as well as in adjacent provinces. Cooperation 88 seed tubers are also traded over China's borders into neighbouring Vietnam and Burma.

True potato seed (TPS) is another valuable contribution that CIP is making to the eradication of rural poverty in China, especially in regions that are difficult to reach, where transportation costs make seed tubers prohibitively expensive. The advantages are obvious: a handful of TPS will produce enough seedling tubers to plant one hectare of potatoes, an area which would require two tonnes of conventional seed tubers. Yunnan's agricultural department began making CIP's TPS varieties available to farmers in the western and eastern extremes of the province in 2001, and since then plantings have reached 1,000 hectares in total. "That might not sound like much," says geneticist Enrique Chujoy, who coordinates CIP's role in the initiative. "But most of the plots making up that total are very small. There are probably several thousand households involved." And for them TPS is invaluable. Labor-intensive and time-consuming? Yes, since producing edible potatoes from TPS is a two-stage, two-season affair. In the first year plants are grown from true seed to produce seedling tubers; in the second, those tubers are planted out to produce a mature crop. But double effort has a double advantage: at the first stage farmers can produce tubers for sale, as well as for themselves; at the second they are assured of a good crop.

"The great thing about TPS is that it can help disadvantaged sections of society in regions where mainstream advances in agricultural technology simply aren't applicable," says Chujoy. "It will never replace clonal crops totally – the economics of time and labor are against it – but a kilo of TPS in the right place can feed a village and give the villagers an income. We have to work with these farmers, and focus our efforts specifically on their needs."

To increase the effectiveness of its work in China and the region, CIP has been continuing to work with the Chinese government to create the CIP-China Center for Asia and the Pacific. CIP is

"Sweetpotato continues to serve China's farmers well"

S. LINGOHR

collaborating with the Chinese Academy of Agricultural Sciences and the Ministry of Agriculture in establishing the Center, which will focus initially on work in areas where potato and sweetpotato can contribute most to reducing hunger and raising incomes.

Sweetpotato increasingly important in generating income

As the purchasing power of households at all levels of society in China has increased, people have diversified their food choices, consuming less rice and more meat, horticultural produce and processed foods. Starch is the principal constituent of processed foods such as noodles and snacks. Sweetpotato for starch extraction is therefore much in demand – so much so that it has ceased to be a staple food and is now grown primarily for starch or animal feed. But even while its use as a food has declined, sweetpotato production has increased. "In this way sweetpotato continues to serve China's farmers well," says economist Keith Fuglie, leader of CIP's Impact Enhancement Division.

China is by far the world's largest producer of sweetpotato, its annual output of almost 100 million tonnes accounting for about 85 percent of global production. The volume that goes into food processing is vast, but medium- and small-scale production systems are vital components of the industry. At the same time they are especially vulnerable to the pressures of China's rapidly growing market economy.

In the late 1980s, CIP began collaborating with Chinese scientists on methods to improve the post-harvest use of sweetpotatoes. Notable

China is by far the world's largest producer of sweetpotato

S. LINGOHR

Sweetpotato is increasingly important in generating household income

S. LINGOHR

successes were achieved. By the mid-1990s the collaboration's improved starch extraction and noodle-making technologies were being widely adopted. Attention has now turned to questions of scale and efficiency as the key to making small operators more productive and competitive – especially those working in sweetpotato-pig production systems.

Making silage dramatically improves prospects of a better life

Research in Vietnam and Papua Province, Indonesia, had shown that a CIP-developed ensilage method of making pig feed from sweetpotato significantly increased the productivity of traditional sweetpotato-pig production systems. Instead of chopping up and boiling sweetpotato for feed, villagers were shown how to use fermentation to make the food digestible. Costs were reduced; pigs fattened faster and household incomes rose. This simple but highly effective CIP-developed technology has subsequently been a key element of projects seeking to improve the sweetpotato-based pig production systems in the uplands of China's Sichuan Province.

Along with improved sweetpotato varieties developed by the Sichuan Academy of Agricultural Sciences (SAAS) in collaboration with CIP, scientists from the Sichuan Animal Science Academy (SASA) working on an International Livestock Research Institute (ILRI) initiative, put CIP ensiling technology high on the list of options they offered the farmers of Tianle and five other villages situated about 170 km northeast of

Chengdu. The majority of farmers in Tianle are very poor, with an average *per capita* income of less than US$100 per year. Livestock contributes up to 80 percent of total farm income. The project has dramatically improved their prospects of a better life. "The use of the improved sweetpotato variety resulted in at least 25 percent increment in root yield," a report on the project reveals, and all farmers who planted improved varieties increased the area planted to that variety in the second year and established multiplication plots to ensure they had enough planting material to cover it. One of the farmers, Mr. Liang Dong Shen said, "Last year I produced enough roots of the new variety not only to ensile, and reserve seeds for this year's planting, but also to give 100 kg as presents to my friends, and even sold 500 kg."

The practice of making silage was also enthusiastically received. All the farmers appreciated not having to cook the sweetpotato roots and vines for their pigs, not least because it spared them two hours or more of hard work every day. Moreover, it saved firewood (and the time devoted to collecting it) and reduced pressure on the forests around them. But it was as an improved feed that the farmers most valued the technology. With the addition of a protein-rich supplement developed by SASA scientists, the sweetpotato silage feed reduced the time taken for pigs to reach market weight by six to eight weeks. This meant that more pigs could be raised per year – in some instances 50 percent more. "Last year Tianle village sold 300 pigs," village leader Mr. Liang Bo told the scientists in early 2004. "But this year we have already sold 380 in the first quarter alone. I estimate that we will sell at least 1200 fattened pigs in 2004, when the average for previous years was less than 800."

The additional income derived from these enterprises is already changing lives in the village. Overall, farmers felt confident of being able to commit themselves to investment expenses that would build upon what has been achieved so far. Two farmers,

The project had enabled them to send their children to an agricultural college

Mrs. Ye Yongju and Mrs. Jufang, said the project had enabled them to send their children to an agricultural college. Others said that some of the additional income was being reinvested in the farm, and the rest put into savings. But perhaps the most visible indication of the changes brought to Tianle by the project is the motorcycles some farmers have bought. "Twenty-five farmers in Tianle village have bought motorcycles this year," Mr. Liang Bo announced proudly. "All thanks to extra income obtained from the pig enterprise."

"The use of the improved sweetpotato variety resulted in at least 25 percent increment in root yield"

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The Generation Challenge Program

"Imagine this conference table is covered in sand," says Merideth Bonierbale. "And every grain is a piece of information. Across the surface, small mounds are rising as scientists bring together the information that makes up their area of research. Occasionally they

may scan the horizon from the summit of their own mound and get a very general view of what is going on elsewhere, but they will rarely have an opportunity of delving into the detail of other mounds. Yet as time and knowledge progress we are evermore certain that information useful to us is hidden there..."

Information bottleneck

Dr. Bonierbale is the head of CIP's Germplasm Enhancement and Crop Improvement Division and she is speaking of a major problem facing today's crop improvement fraternity. Investigations into the genetic characteristics of food plants are advancing so rapidly that traditional methods of disseminating new findings are not enough to make sure that information is available to everyone who could use it. Not every result merits publication in a refereed journal, yet the unpublished research of a laboratory on one side of the globe might apply directly to the work of scientists on the other. How can they locate everything that might be relevant to their own investigations?

Thirty years ago the Green Revolution dramatically increased farm production through the spread of new plant types, irrigation and fertilizer. Today, the emerging Genomics Revolution (see Box 1) can bring new science to bear on problems encountered by the resource-poor farmers who derived little or no benefit from the earlier wave of innovation. But first, there has to be a way of collating, exploring and comparing the accumulating information, effectively and on a reasonable timescale.

Generation Challenge Program

During 2004, CIP's Information Technology Unit has made a significant contribution to alleviating this problem, not simply for the benefit of CIP's own in-house scientists, but also for the benefit of a much wider network of research institutions. CIP's information technology expertise is a valuable component of the Generation Challenge Program (see Box 2). This is an initiative that brings together three sets of partners – CGIAR, advanced research institutes (ARIs) and national agricultural research systems (NARS) in developing countries – with the aim of delivering the fruits of the Genomics Revolution to resource-poor farmers.

"Seventy-five percent of the world's poorest people live in rural areas and rely on agriculture for food and income, and a great many of them live on marginal land, where modern domesticated varieties do not always fare well," points out Robert Zeigler, former Director of the Generation Challenge Program. "Crop varieties that can withstand harsh conditions and survive on few inputs could greatly help these people in their interminable struggle with food insecurity and poverty."

"Most developing countries do not have the scientific infrastructure or trained staff necessary to apply advanced genomics," explained Zeigler. "Unfortunately, this means that the scientific institutions in closest proximity to

The Genomics Revolution

The Genomics Revolution is producing plants specifically designed and bred to overcome the difficult conditions found in smallholders' fields and marginal environments and so improve the quality and quantity of these farmers' yields. It has been fueled by technological advances that have allowed scientists to unravel the genetic code of an organism and draw up maps of the entire genome, with landmarks locating genes associated with particular characteristics, such as adaptability, disease resistance or environmental tolerance. And as the genetic maps are filled with ever-finer detail, breeders are cross-referencing the maps of different species (see illustrations on opposite page and following). In this way, the genetics of whole families of plants can be compared. Thus the existence of genetic information on a particular trait can be predicted in one species, from the detailed genetic studies of another. This is a major advance, making it possible to explore the relationship of gene sequence to function across species, further expanding the opportunities for significant breakthroughs and delivering the promise of the Genomics Revolution.

Up to now, plant breeding has been as much an art as a science. A highly successful art with an honorable pedigree, true, but always a subjective exercise, based on the experience and skill of the plant breeder to choose parents for crosses and to select out, either visually or by means of empirical tests, improved individuals from among the progeny of those crosses. There are notable exceptions, in which a few identified genes have had a dramatic effect when bred into other varieties (for example, the directed introduction of dwarfing genes in wheat and rice was responsible for the increased productivity of the Green Revolution), but comparative genomics has the capacity to make these exceptions the rule and, ultimately, to change the plant breeders' art into an objectively based science.

struggling farmers and poor rural areas are the least equipped to take advantage of the technological revolution that may help those people. To make a lasting impact," he continues, "the Generation Challenge Program must create a global environment that promotes scientific innovation by NARS in those countries."

High Performance Computing system

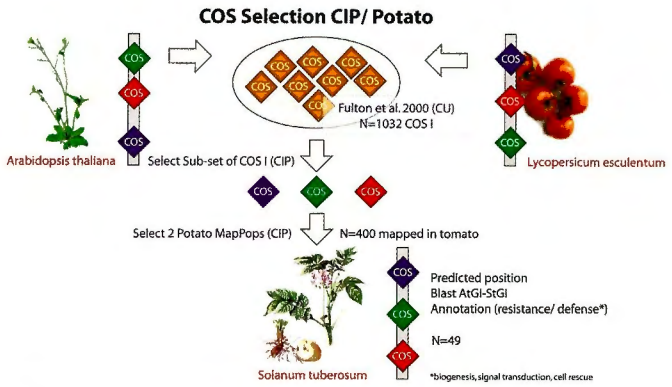
Challenge Program member scientists often quip that the fourth of the Program's five subprograms, Bioinformatics (SP4 see Box 2), "is the lynchpin of the whole global undertaking." If SP4 is the lynchpin of the system, then CIP is responsible for ensuring that it functions smoothly and effectively. Managed by its Head, Anthony Collins, CIP's Information Technology Unit has set up a Paracel cluster computer system made up of four nodes (based at CIP and three other research establishments within the CGIAR network) with dual 64-bit processing units and a terabyte of database storage

(with substantial capability for future expansion), which will facilitate the analysis of very large germplasm, molecular and functional genomics data sets. And this High Performance Computing (HPC) system is already enabling scientists to make progress on important challenges. "For instance, the HPC facility has greatly enhanced the application of comparative genomics to the search for drought-tolerant genes in potatoes," says CIP biotechnologist Roland Schafleitner.

In a world confronting the prospects of climate change, drought is one of the most serious challenges faced by resource-poor farmers. Comparative genomics could provide the vital clues needed to enhance drought-tolerance in potatoes and other staple crops of developing countries. In this work, the drought-stress responses at the genetic level in a known or model plant are compared with those of potato genotypes exhibiting different levels of tolerance. These comparisons provide invaluable information on which genes are involved in drought-tolerance mechanisms, but an enormous amount of data has to be processed to arrive at the result.

The plant used for comparison is *Arabidopsis* – thale cress – a small weed whose entire genome has been sequenced. In recent years, scientists have shown that *Arabidopsis* has about 2,300 genes that are involved with its response to stresses such as drought, cold or high salinity. With this knowledge at hand, scientists tested potatoes for the presence of orthologous genes (meaning genes that have the same stress-responsive function as in *Arabidopsis*), and could begin evaluating the potential of those genes as candidates for drought tolerance research.

The first step in this procedure was to discover whether high-sequence similarity to stress-induced *Arabidopsis* genes also occurred in the potato. "Comparing the 2,300 *Arabidopsis* stress-responsive gene sequences that had been identified with the



***Arabidopsis thaliana* wildtype flower**. Scanning electron microscopy image, artificially colored. *Arabidopsis* is approximately 5mm in size

Photograph © by Jürgen Berger, Max Plank institut for Developmental Botany, Germany

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Potato    AGGAAGCTTTTAGCCTTTTCGACAAGGATGGCGATGGCTGTATTACTACCAAGGAGTTGGGAACAGTGATG
Tomato    AGGAAGCTTTTAGCCTTTTCGACAAGGATGGCGATGGCTGTATTACTACCAAGGAGTTGGGAACAGTGATG
Tobacco   AGGAGGCCTTTAGCCTTTTCGACAAGGACGGCGATGGCTGTATTACTACCAAGGAATTGGGAACAGTGATG
Pepper    AGGAGGCTTTTAGCCTTTTTGACAAGGACGGCGATGGCTGTATTACTACCAAGGAGTTGGGAACAGTGATG
Petunia   AGGAAGCTTTTAGCCTTTTTGACAAGGACGGTGACGGCTGTATTACTACCAAGGAGTTGGGAACAGTGATG
Oak       AGGAAGCCTTCAGCCTCTTTGACAAGGACGGCGATGGCTGCATCACTACCAAAGAGTTGGGAACAGTCATG
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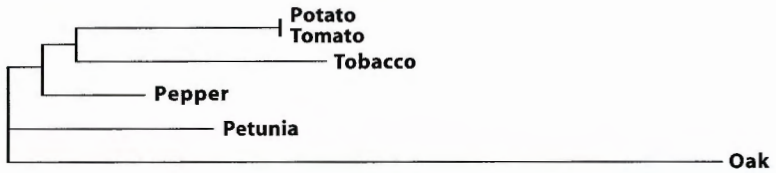


Genetic maps. Genomics allows scientists to create genetic maps that allow cross referencing across species. This example shows similarities in part of a calmodulin gene in different Solanaceae species and in oak. Such sequence similarity among the same genes of different species is the basis of comparative genomics. This particular map is valuable because calmodulin proteins are cellular calcium sensors. These proteins interact at the same time with calcium ions and a wide range of other proteins, translating calcium signals into modulation of enzyme activity. Calmodulin-mediated signals are involved in a many important cellular functions, such as growth, development and stress response.

approximately 40,000 potato gene sequences available today, would have meant performing 2,300 searches on the potato material," Roland Schafleitner explains. "So we began by clustering the 2,300 stress-responsive *Arabidopsis* genes according to their spatial and temporal expression patterns, and then selected some 450 genes whose role was consistently significant. Then we had to search for orthologs to those genes in the potato material. With conventional equipment that would have taken days and driven us crazy," he adds. "But we had the HPC system. The results were available almost immediately as a sound foundation for further research into drought tolerance in potatoes."

SP4 an innovator in the field

"It is important to remember that CIP's HPC is part of a process, not just a facility," says Reinhard Simon, Head of CIP's Research Infomatics Unit, who coordinated the establishment of an

Box 2

The Generation Challenge Program

CGIAR's Generation Challenge Program has five subprograms, within which scientists

1. explore the genetic diversity and potential of its 22 mandate crops*
2. focus on developing genomic technologies and approaches to advance understanding of genetic principles across significant crop species in developing countries
3. seek ways to increase the efficiency, speed and scope of plant breeding
4. build a viable bioinformatics platform
5. work to improve the research capabilities of developing countries.

* Andean root and tuber crops, barley, cassava, chickpea, coconut, cowpea, finger millet, forages, groundnut, lentil, maize, *Musa*, pearl millet, *Phaseoulus*, pigeon pea, potato, rice, sorghum, soybean, sweet potato, wheat and yam

infrastructure for building capacity, storing and exchanging data across the network in a standard form. "With genomics breaking down the knowledge boundaries between plant genomes, the informatics systems must work seamlessly across institutes and crops to meet the storage and analysis needs of this increasingly integrated world of plant genetics," he explains. "Every aspect of the system we are building in SP4 has to be agreed upon by every information technology manager in the network. It has to overcome the problems of using existing data, capturing all experimental data and then storing everything in a mutually comprehensible and interactive form. It's a challenge," he concludes, with characteristic understatement.

But it is a challenge that excites an enthusiastic response, not least in Theo van Hintum, a bioinformatics specialist at Wageningen University in the Netherlands, who heads SP4. He is optimistic about the potential of the SP4 platform. "There is a clear commitment among our partners to make the SP4 infrastructure easily accessible and to make our increasingly complex analyses easier," he says. "SP4 gets really interesting when we start talking about processing all the information that is available through the network. There is a whole range of applications that researchers have only dreamt about that this platform will enable us to do. These new applications and analyses will make SP4 an innovator in this field, and the Generation Challenge Program a leader in making high science work for the people who need it most."

Late blight – new developments

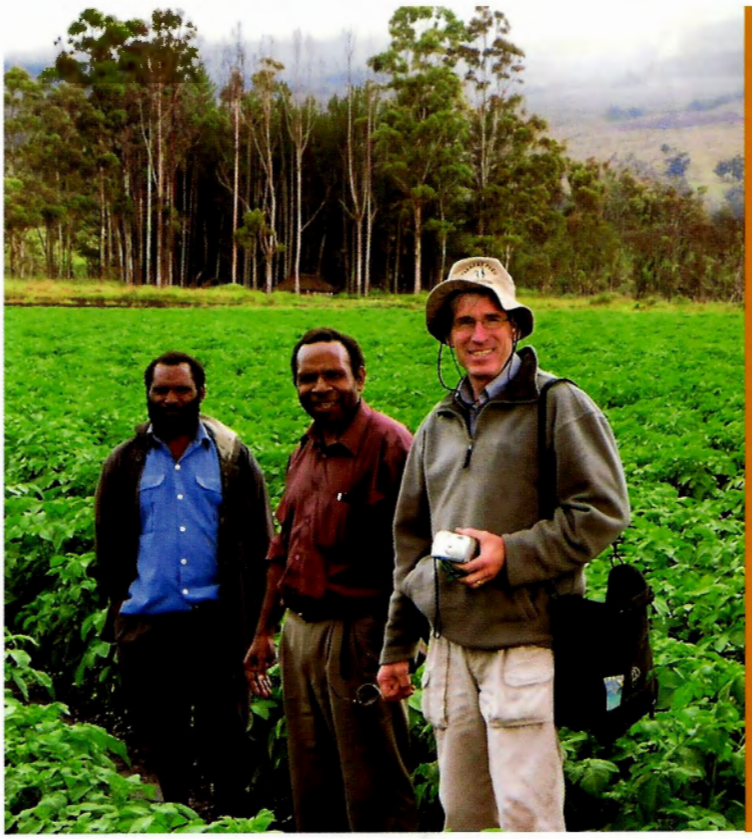
At Pokeramanda, in the high mountains of eastern Papua New Guinea, villagers had uprooted the dying potato plants and laid them out at the roadside – like the victims of an unknown plague. "They just died," So Wan Kusit said, bewildered. "I don't know why."

But Dr. Sergi Bang, research leader of Papua New Guinea's National Agricultural Research Institute (NARI) knew. He had travelled to the remote village with a deep sense of foreboding, and a brief inspection was enough to confirm his worst fears: late blight. Hitherto, Papua New Guinea had been free of the disease. Now, in a matter of weeks it was sweeping across the country, closing down a young but flourishing commercial potato-growing industry (already worth $11 million per year) and destroying crops that were to have fed the family of So Wan Kusit and many thousands like her.

Arrival from Irian Jaya

Dr. Bang could guess what had happened. Late blight, caused by the fungus-like *Phytophthora infestans*, had probably drifted into Papua New Guinea on winds from across the border with Irian Jaya, where thousands of refugees from elsewhere in Indonesia were planting infected seed potatoes. He told the villagers to bury the uprooted plants and advised them not to cultivate potatoes again for a couple of years "to allow the late blight fungus to die."

In a country slightly larger than California, but with less than 500 miles of paved roads and only 1.9 percent of its land surface suitable for growing crops, the



Fields of the PNG government seed system, which eventually made dissemination of resistant cultivars feasible (CIP's Greg Forbes on the right)

F. EZETA

Market scene in Papua New Guinea

F. EZETA

potato had been a prized crop. Especially among the 85 percent of a 5.4 million population that depends entirely on subsistence farming for food and livelihood. The potato was particularly well-suited to the country's highlands, where altitude tempered the heat of an equatorial sun and year-round rainfall watered fertile soils. In such cool and humid conditions farmers could grow potatoes throughout the year. But once late blight arrived it spread very quickly. By May 2003 the devastation was complete. While subsistence farmers struggled to survive on alternative crops, and urban consumers bought imported potatoes at three or four times the price for local produce, the government appealed for help.

Global Initiative on Late Blight

As part of an Australian response to the catastrophe, Australian and CIP scientists, including Greg Forbes, plant pathologist and coordinator of the Global Initiative on Late Blight (GILB) convened by CIP, visited the island and formulated an extended research and development project to help Papua New Guinea deal with the problem. "Initially, late blight-resistant cultivars from CIP will be introduced and evaluated to select a variety that will replace the susceptible variety currently grown in Papua New Guinea," says Forbes. "To this end, 10 resistant CIP clones are being multiplied under quarantine conditions for shipment in June 2005," he adds. "After further multiplication in Papua New Guinea, they will be assessed in the field for adaptation and late blight resistance."

Potato late blight is a devastating disease. Resource-poor farmers in the developing world alone spend more than US$750 million per year on fungicides to control late blight while still losing an additional US$2.5 billion in yield; to which must be added the millions spent on controlling the disease in the developed world. The pathogen's taxonomy and biology are very well

understood, but a fully effective response remains elusive. Breeders have succeeded in producing varieties that will tolerate various degrees of infection but none is completely immune. The problem is that *P. infestans* is highly adaptable. "Over the past few years we've been finding new forms of *P. infestans* that have never been seen before," says Forbes. "The pathogen is evolving faster than the control measures used to combat it. New approaches are urgently needed."

Fuller understanding of pathogen populations

Among the new approaches being developed, CIP scientists are collaborating with colleagues from national programs worldwide to track movements and changes in pathogen populations in key locations. DNA fingerprinting techniques and other state-of-the-art methods are used to detect variation among pathogen strains. These investigations are giving scientists a fuller understanding of how the pathogen populations evolve, so that they can begin to build models predicting future directions and thus stay one step ahead of the disease.

Meanwhile CIP's plant breeders have been working towards developing varieties with a resistance to late blight that lasts. So far, durability has been elusive. The point is that although a degree of resistance occurs naturally in some varieties, and breeders have been able to intensify that resistance, it has eventually broken down. "That's because the resistance was due to either a major gene on the one hand, or to minor genes on the other," Juan Landeo, of CIP's breeding program explains. "In the case of major gene resistance, it's as though there was one big padlock with one big key keeping the pathogen out. It worked very well for a while, but eventually the pathogen found a way through. And that's it: no more resistance!"

Landeo speaks from personal experience. He is the man who bred Canchan, one of Peru's most popular and widely grown varieties, which was renowned for its resistance to late blight. But not any more. In recent years Canchan's ability to withstand the disease has broken down. Landeo shrugs. "Only one padlock," he says. "A strong one, but not durable, or else there were low levels of resistance due to minor genes built in."

Recurrent selection for new varieties

With this in mind Landeo began a breeding program in the early 1990s that was designed to develop varieties which would be protected by many small padlocks (minor genes), and be free of major genes

Canchan's ability to withstand the disease has broken down

understood, but a fully effective response remains elusive. Breeders have succeeded in producing varieties that will tolerate various degrees of infection but none is completely immune. The problem is that *P. infestans* is highly adaptable. "Over the past few years we've been finding new forms of *P. infestans* that have never been seen before," says Forbes. "The pathogen is evolving faster than the control measures used to combat it. New approaches are urgently needed."

Fuller understanding of pathogen populations

Among the new approaches being developed, CIP scientists are collaborating with colleagues from national programs worldwide to track movements and changes in pathogen populations in key locations. DNA fingerprinting techniques and other state-of-the-art methods are used to detect variation among pathogen strains. These investigations are giving scientists a fuller understanding of how the pathogen populations evolve, so that they can begin to build models predicting future directions and thus stay one step ahead of the disease.

Meanwhile CIP's plant breeders have been working towards developing varieties with a resistance to late blight that lasts. So far, durability has been elusive. The point is that although a degree of resistance occurs naturally in some varieties, and breeders have been able to intensify that resistance, it has eventually broken down. "That's because the resistance was due to either a major gene on the one hand, or to minor genes on the other," Juan Landeo, of CIP's breeding program explains. "In the case of major gene resistance, it's as though there was one big padlock with one big key keeping the pathogen out. It worked very well for a while, but eventually the pathogen found a way through. And that's it: no more resistance!"

Landeo speaks from personal experience. He is the man who bred Canchan, one of Peru's most popular and widely grown varieties, which was renowned for its resistance to late blight. But not any more. In recent years Canchan's ability to withstand the disease has broken down. Landeo shrugs. "Only one padlock," he says. "A strong one, but not durable, or else there were low levels of resistance due to minor genes built in."

Recurrent selection for new varieties

With this in mind Landeo began a breeding program in the early 1990s that was designed to develop varieties which would be protected by many small padlocks (minor genes), and be free of major genes

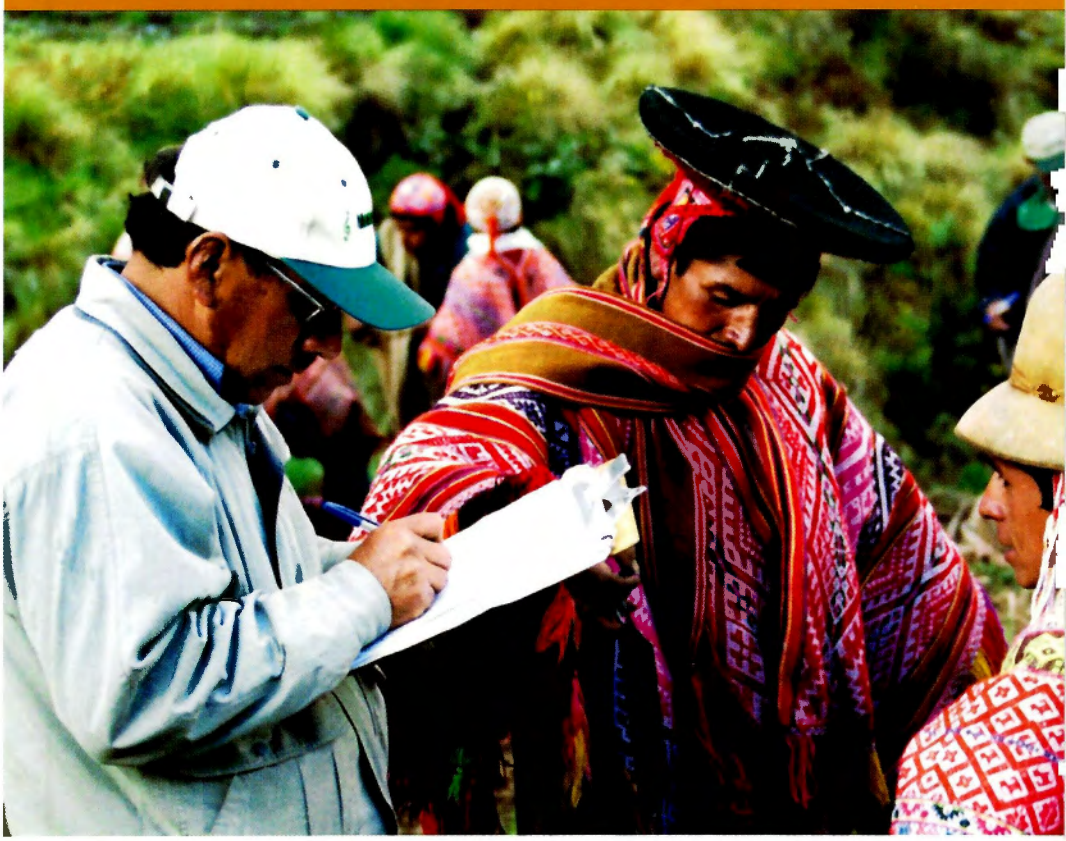
Canchan's ability to withstand the disease has broken down

(single big ones). The technique, known as recurrent selection, was applied to two main genetic sources of resistance (breeding populations), with the aim of upgrading gene frequencies for partial resistance to late blight (due to minor genes) and raising higher levels that would eventually lead to the selection of new varieties. "In effect, each partially resistant variety has numerous small padlocks," Landeo explains. "And I wanted to incorporate as many as possible into breeding populations, from which varieties would emerge with a string of padlocks to keep the pathogen out. The plant wouldn't be totally immune to infection, but if there were enough padlocks it would survive long enough to produce tubers."

Working with thousands of "pureblooded" native Andean potato plants, Landeo found that although they all died when exposed to normal levels of late blight infection, specimens from 60 clones survived at

Gathering data from test fields in Chacllabamba on late blight resistance

J. LANDEO



Local farmers in traditional dress gathering the potato harvest in Chacllabamba

J. LANDEO

lower levels. Crossing these clones and repeating the selection and crossing procedures through five cycles over a period of 13 years, he found 150 clones that survived to maturity when exposed to severe levels of late blight. "What"s more, they preserve the color, taste, texture and culinary qualities of the original varieties," says Landeo.

Landeo had an opportunity to test his clones when the Quechua-speaking farmers of Chacllabamba, a remote village in the high Andes, appealed to CIP (via their local government agricultural advisory service) for help. Their crops of native potatoes had been almost totally destroyed by an enemy previously unknown to them: late blight. In Chacllabamba, at more than 4,000 meters above sea level, harsh climate conditions had kept *Phytophthora infestans* at bay. But the increased rain and temperatures associated with global climate change had allowed late blight to creep up the mountainside, taking hold in areas where it was not previously a threat. "When we got news of their plight I selected 20 clones from among the late blight-resistant breeding populations we were working with," says Landeo, "and sent 100 tubers of each up to Chacllabamba."

New clones perform well

In May 2004, when Chacllabamba's potato fields were due for harvesting, a team including scientists from CIP returned to see how the new clones had fared and hear what the villagers thought of them, in terms of both their agronomic and culinary characteristics. Appearance, taste and cooking qualities are very important to the people for whom native potatoes are the staple food. "They grow potatoes and eat potatoes at every meal – often potatoes *are* the meal – so of course they have strong opinions about what constitutes a good potato," says Landeo.

The new clones had produced better harvests than the traditional highland varieties, and seven of them scored high marks in the villagers' overall estimation. They had not succumbed to late blight or frost, they produced good harvests, their tubers were well-formed, the right color, they cooked well, had the right texture and tasted very good. "The program has been a success," says Landeo. "We have bred highland-type potatoes that resist late blight while retaining the qualities that make them acceptable to consumers." It is his hope that these new potatoes (and some more *tuberosum*-like clones also developed in the program) will eventually be available to people in Africa and Asia, and there can be little doubt that villagers in the highlands of Papua New Guinea would have a use for them too.

Breakthrough in bacterial wilt resistance

"It's true," says CIP plant pathologist Sylvie Priou. "We have found that seven genotypes from two wild Andean potato species have high levels of resistance to wilt and tuber infection." This is the first real proof of bacterial wilt resistance in nature. And since the

resistance comes from a wild relative of the domesticated potato its transfer to commercial varieties should not be too difficult – whether by conventional breeding procedures or by direct gene transfer.

Major constraint

Bacterial wilt is the number two constraint (after late blight) on potato production in more than 40 developing countries. More than four million hectares are infected, causing damage estimated to exceed US$0.5 billion annually. Tens of millions of farm families are affected, suffering yield reductions that can amount to total loss. To have found a source of resistance to this scourge is a major breakthrough that ultimately could increase productivity by an average of 10 percent across the developing world and by substantially more in the most severely afflicted regions.

Priou and her team at CIP have spent four years on a large-scale screening effort: 4461 genotypes from 113 wild species and subspecies of potato were tested for resistance. In first-of-their-kind tests conducted during 2004, genotypes that showed resistance were re-exposed to the pathogen in less severe conditions, to assess the presence of latent infection in tubers. Seven wild potato genotypes came through very successfully, exhibiting high levels of resistance to both wilt in the stems of mature plants and latent infection in the tubers. Studies to identify the mechanisms and genetic basis of the resistance will proceed during 2005, before the trait is transferred to commercial potatoes – and from there to the fields of farmers in developing countries. "I'm 90 percent certain that our final tests will confirm the resistance we have already seen," says Priou. "Just a few more months ..."

Priou's reluctance to make a definitive announcement at this stage reflects both scientific caution and her respect for a tough and resourceful adversary. *Ralstonia solanacearum*, the bacterium that causes bacterial wilt (see Box 3), has been outwitting farmers and scientists for a very long time. For developed nations, keeping the disease at bay is essential and, fortunately, affordable. The same cannot be said of developing nations, and it is here that the work of Sylvie Priou and her team at CIP is especially relevant.

Supersensitive methodology

An important milestone in the battle against bacterial wilt was passed in the late 1990s, with the development at CIP of a procedure that vastly enhanced available methods of detecting *Ralstonia solanacearum* in its latent form. Priou and the CIP team refined the procedure, which multiplies the bacteria in samples to be tested with the NCM-ELISA technique (enzyme-linked immunosorbent assay on nitro-cellulose membrane). It is one million times more sensitive than methods previously used to detect

Wild species growing in CIP's screenhouses

M. VARGAS

A healthy *Solanum chacoense* in the laboratory

M. VARGAS

Solanum acaule in its native habitat

A. SALAS

latent infection in potato tubers. The procedure is as sensitive as the sophisticated techniques used in developed countries – but simpler, and far cheaper.

"The most effective way to prevent bacterial wilt is to detect the pathogen on seed before it reaches the farmers' fields," says Priou. "Seed taken from infected fields often carries latent infection, even if it comes from healthy-looking plants." CIP distributes detection kits at a cost of US$120 each that allow users to evaluate up to 250 tonnes of tubers, enough seed to plant 150 to 200 hectares. They are already in use in more than a dozen countries, doing good work.

But while certification, containment and good farming practices ease some of the damage caused by bacterial wilt, no one doubts that the availability of resistant varieties would achieve more. With no susceptible potatoes to feed on,

Ralstonia solanacearum would fade out on even the most heavily infested soils.

Although CIP's plant breeders had been working on the development of a resistant variety for about 15 years, the prize had eluded them. The vastly more sensitive NCM-ELISA procedures re-invigorated the search. Since it is so sensitive, scientists can be confident that if no traces are found, then the samples are free of the pathogen. But first, were any wild species resistant to bacterial wilt in even its visible form?

Resistance exists in nature

CIP is the custodian of the world's largest collection of potato germplasm, so there were several thousand genotypes from 199 wild species and subspecies of potato that could ultimately be tested, but CIP's plant taxonomist Alberto Salas was able to give the team a clue as to which might be resistant. "I was on an expedition collecting wild species high up in the Porcon area of Cajamarca," he recalls. "It was in the 1970s. We were not looking for resistance in particular, just any wild potato species, but close to where I had found a few healthy specimens of wild *Solanum acaule*, I noticed a field of cultivated potatoes that was badly infected with bacterial wilt." Within this general gene pool were also 30 newly acquired wild species that had never been tested.

"Alberto Salas' observations gave us the first indication that resistance to bacterial wilt might exist in nature," says Priou.

After four years of intensive sceening, CIP's team has found 49 genotypes of 11 species resistant to at least five strains of the pathogen. The most virulent forms of the pathogen found in different parts of South America were used to infect the wild potatoes to test the staility of their resistance. After having challenged 28 of the 49 selected genotypes in less severe conditions that allowed the plants to produce tubers, six genotypes of the wild species Alberto Salas saw that day – plus one genotype of another wild species, *Solanum chacoense* – showed high levels of resistance to both wilt and tuber infection. But there are still 21 selected genotypes of five other species to be tested for tuber infection, which could greatly broaden the genetic basis of resistance.

"Alberto Salas' observations gave us the first indication that resistance to bacterial wilt might exist in nature"

Bacterial wilt also completely destroys the potato tuber

P. ALEY

As the likelihood of confirming wilt resistance in wild species became a reality, Priou and her team broadened their investigations: was there bacterial wilt resistance among genotypes known to have some resistance to another disease: late blight? Results so far are promising. "During the current project period, we have tested 177 of the genotypes that CIP's late blight team previously found to have some level of resistance," Priou explains. "And among these the selection rate of wilt-resistant genotypes reached 18.6 percent, compared with only 3.3 percent for other material tested."

Late blight and bacterial wilt together cause widespread hardship and cost farmers worldwide over US$1.5 billion in control costs and lost harvests. "If combined resistance to both diseases can be confirmed, it would represent an important advance," Priou notes, with commendable understatement.

Box 3

An expensive disease

Ralstonia solanacearum, the bacterium that causes bacterial wilt, can survive in small numbers in even the worst circumstances, and then proliferate rapidly when conditions allow. Low concentrations are enough to sustain a viable population in the soil, and a potato planted in such ground will very quickly become infected. As the plant grows, its vascular system becomes clogged with the rapidly multiplying bacteria. The plant wilts and dies; the bacteria retreat to the soil and the tubers, there either to concentrate as a pus-like mess in the vascular ring that causes the tuber to rot, or to adopt its latent state.

The latent state of *Ralstonia solanacearum* is the most difficult. The bacteria are invisible to all but specialized testing. The tubers appear healthy, but will spread the disease wherever they are planted. They can be eaten, since mammals are immune to the organism and its latent form does not affect the taste or nutritional value of the tubers. This may seem a blessing, but the bacteria can survive a journey through the digestive system. Even sewage treatment plants do them no harm, and when they reach water, aquatic plants serve as staging posts for further proliferation as they disperse via irrigation systems and back onto the land.

Ralstonia solanacearum is thought to have evolved on native *Solanum* species in the Andean region of South America. Europe was invaded by virulent strains of *Ralstonia* in the 1990s. Now all of Western Europe maintains a rigorous system of quarantine, testing and certification. More recently, the arrival of potato-like strains in the United States on *Geranium* was an immediate and potentially serious threat to the huge US potato industry.

Containing the outbreaks of bacterial wilt in Europe and the United States cost millions and maintaining a quarantine on the disease is a massive recurrent expense, but there is a lot at stake. A huge industry, supplies of a staple food and many livelihoods depend upon the continuing viability of potato production. And in developing countries it is often a matter of life and death.

Innovation alleviating poverty in the Andes

"Scientists invent," says André Devaux. "We need technical innovation that goes beyond science: the creative idea plus its implementation. That's what innovation systems are all about." Devaux is coordinator of the Papa Andina initiative, a CIP Partnership program that uses

innovation as its main driving force (see Box 4). The innovation Devaux is talking about includes many areas of intervention, from seed technology and integrated crop management to processing and marketing. "CIP doesn't have expertise in all of these areas. We have to develop strategic alliances with key partners to cover that much ground."

One such partner is the rural development group known as ADERS (Asociación para el Desarollo Sostenible del Perú), run by Celfia Obregón Ramírez. Obregón is particularly familiar with the plight of the smallholder farmers who produce yellow potatoes in the very high Andes, above 3,500 meters. Yellow potatoes, valued by Peruvian consumers over white potatoes for their floury texture and rich flavor, are among the very few native potatoes always available in Peru's rural and urban markets. Even so, most of the farmers who grow them live in extreme poverty, largely because of the inequity and inefficiency in the traditional potato supply chain.

In 2002, when Obregón was considering new avenues for ADERS, yellow potatoes seemed to be a sure bet. Not only were they grown by the poorest of the poor, their potential for development was obvious. "The product is excellent, demand is good, and the prices of yellow potatoes don't drop like they do with white ones," she explains. "It

Papa Andina – what is it?

Papa Andina's overriding mission is to improve the livelihoods of subsistence and small-scale producers by helping them to respond to the changing political and social contexts in which they operate. Papa Andina was conceived within the new multiple actor paradigm of technology innovation. It is a "learning" project developing national capacities through collaborative learning with partners, progressively incorporating new ideas, adapting them to local circumstances and finding new ways to achieve goals. Papa Andina brings together a heterogeneous group of partners, including agricultural and development institutions, private sector stakeholders, farmers and numerous other players in the potato market chain.

Papa Andina generates synergy in research and promotes technology spillover among national partners in Bolivia, Ecuador and Peru. It is governed by a coordinating committee that includes representatives from the Swiss Agency for Development Cooperation, the project's major funder, CIP and the ministry of agriculture of each country. They are joined by a member of the lead institution in each of the participating countries: the PROINPA Foundation (Fundación para la Promoción e Investigación de Productos Andinos) in Bolivia, the Ecuadorian National Program for Roots and Tubers, and INCOPA (Proyecto de Innovación Tecnológica y Competitividad de la Papa en el Perú) in Peru. Two CIP staff complete the committee: André Devaux, who is based in Lima, and Graham Thiele, a social scientist who operates out of CIP's Ecuador office. Both of them coordinate the actions of the project with national partners.

At 3500 meters in the high Andes,...

PAPA ANDINA

was clear to me that we could make a real difference by simply marketing our product better."

With her knowledge of potato production in Peru, Obregón chose Huánuco as the place to start. "Huánuco has the best yellow potato on the market: Amarilla Tumbay, the queen," she explains. At the same time, Obregón's familiarity with CIP made it clear who she should work with. "I knew that with CIP's expertise and backing, we had a winner. So I went to see André."

Obregón's conviction was right. The proposal she and CIP put together won a competition convened by INCAGRO (Innovación y Competitividad del Agro Peruano), a competitive fund of Peru's Ministry of Agriculture. Co-funding was provided by Papa Andina's strategic partner INCOPA (Proyecto Innovación Tecnológica y Competitividad de la Papa en el Perú).

Success in San Pedro de Cayna

"It's rewarding to see the signs of progress among you," says Obregón two years later, to a group of producers from San Pedro de Cayna, in Peru's Province of Ambo, who have come together to exchange their experiences. "Your enthusiasm and determination have allowed you to make headway."

These yellow-potato growers still use ancient methods of cultivation, rotating their crops to allow their fields to rest and using animal manure as fertilizer. Thanks to the INCAGRO-INCOPA project, the farmers have seen productivity in their fields grow by 45 percent, on average. The benefits are evident throughout the small

...potatoes are part of the diet of everybody in the family

C. GRAVES

community. "A few years ago there weren't even telephones in Cayna," continues Obregón. "Now the roads have improved and you even have your own radio station," said Obregón at the meeting.

One of the workshop participants, Pedro de la Cruz Ramírez, is also president of the Empresa Comunal de Servicios Agropecuarios San Pedro de Cayna. This producer association evolved out of a participatory research group in postharvest practices to become the trading company and service provider of the community. De la Cruz is presenting the results of the INCAGRO-INCOPA project at the workshop. The audience includes potato farmers from nearby areas who have come to learn from their neighbors' achievements. "I'm impressed by what you have accomplished for yourselves and your community," says Leonidas Acosta Valdiviezo of Chaglla. "I'd like to do the same for my community. What is the key to your success?"

De la Cruz responds without hesitation, "In the first place, organization and planning." De la Cruz goes on to explain that the first priority of the communal group, made up of 45 families, was to produce quality seed. They developed a seed system using disease-free material supplied by CIP's highland station in Huancayo. From there, they went on to build a distribution and storage facility, from which they are now able to sell their product directly in Lima without depending on intermediaries. This means more profits for the producers as well as much better market prices for consumers.

The Cayna producers aim to refine their knowledge and capabilities to produce starter seed and services for others in the region. "Since the project began we have learned a lot. We've had the opportunity to participate in training events here and elsewhere," explains de la Cruz. "With CIP's help, we hope to learn even more. If we can begin to supply high-quality seed to our neighbors, we can cover much more ground."

Leonardo Espinoza Ramirez has been supervising the Cayna producers. He is the manager of the producer group and one of the new generation of potato technicians that have emerged from training programs run by CIP and its partners. As well as seed-multiplication techniques, Espinoza has taught fundamental concepts such as integrated pest control and crop planning to the farmers.

As well as technological expertise, however, encounters with other groups in the potato market chain have been crucial. "We have INCOPA to thank," says Obregón, "INCOPA and CIP." The INCOPA project, which is coordinated by Papa Andina for CIP, has helped develop stakeholder platforms made up of different groups in the potato market and supply chain, from researchers to producers to chefs. Despite their diversity, all have one thing in common: their desire to help small-scale growers improve the competitiveness of Peruvian potatoes by taking advantage of new and emerging market opportunities. They expect to do so using the participatory market chain approach (see Box 5).

Boiling potatoes in the Andean Highlands

C. GRAVES

INCOPA brought the Cayna producers to Lima, where they met buyers in the wholesale market and the big supermarkets. The farmers understood the quality criteria behind market demand and adapted their practices to meet them. The Cayna growers now know that it is crucial to plan their plantings to ensure that they will not be flooding the market when demand is low. They have also begun to select their potatoes, delivering them in graded, preweighed bags to eliminate steps in the chain that were raising costs and damaging the product from handling. "This was possible thanks to the mutual confidence built up through the INCOPA interchanges," says Obregón. "The people who are buying our product are sure that they are getting what they are paying for."

Clear impact

The Cayna growers are enthusiastic about their success. They have significantly increased their average yearly family income from sales of Tumbay. Above and beyond the boost to their livelihoods, they have made gains that are far less tangible, but equally important. "We've had success and failures," says de la Cruz. "But we've gained confidence and the community believes in us. They have seen that our success also benefits them."

The producers of San Pedro de Cayna are enthusiastic about the future. They are looking at new products, such as processed potatoes for purée, and are thinking about training programs that will help them share their knowledge with other farmers.

"You know it all by heart," says Obregón, summing up the technical expertise they have gained. "With your effort, experience and enthusiasm, we can take off from here, adding value to our potatoes and giving them the value they deserve." A brighter future for the farmers of Cayna is just beginning to unfold.

Canchan's ability to withstand the disease has broken down

BOX5

Papa Andina's participatory market chain approach

Papa Andina's innovative participatory market chain approach (PMCA), developed in conjunction with CIP'S Impact Enhancement Division, is a demand-driven research and development model that aims to identify, analyze and implement joint market opportunities through a participatory research process during its three phases of implementation.

PMCA seeks to generate group innovations in a shared decision-making process that defines and implements joint activities. Commercial innovations that bring added value to native potatoes drive technological and institutional innovations that are achieved through its implementation.

The first phase begins with diagnostic research, accomplished through extensive interviews. These interviews allow researchers to get to know and understand the key people and groups in the market chain and to understand their interests, problems and ideas. Based on this research, small working groups are then formed of members with shared areas of interest.

The working groups exchange ideas and experiences in meetings, collectively identifying and evaluating challenges and opportunities with a strong demand-oriented focus. "This is

Objectives	Participants	Leading Institution
Phase 1 **To get to know** the different market chain actors, their activities, interests, ideas, problems, etc.	Interest	Leadership
Phase 2 **To analyze** potential market opportunities using participatory methods	Trust	Facilitacion
Phase 3 **To implement** joint innovations: • new market products • new technologies • new institutions	Collaboration	Backstopping

when everyone talks about their problems," says CIP's André Devaux. Specialists may be called in to support the process, but the idea is that the members of each group select the problems they feel are most pressing, the best opportunities and together agree on actions to take. In the process, confidence and trust is built among the many people involved. "It can be summed up in two words," Devaux concludes, "Collective learning". In the final stage of this second phase, identified market opportunities are presented by each working group and discussed with a wider audience, which allows the integration of new people into the research and development process.

The third and final phase concentrates on implementing the activities needed to take advantage of the market opportunities the groups have envisioned. Guided by the lead institution, with support from CIP, this process may take from three to six months. The commercial innovations obtained may come as new or improved products or services, such as two new brands of yellow and native potato chips, "Papy Bum" from Peru and "Lucana" from Bolivia.

At the end of the process, the participants present the positive outcomes of their activities. More than just a ceremony, the event is actually intended to capitalize on the project's outcomes to help the actors move forward with their initiatives. By inviting media representatives, politicians and donors, the organizers generate interest in the larger community and fuel continuing support. "The idea is that we pass full responsibility over to the actors," says Devaux, "helping to ensure that they have what they need to sustain the innovations, of which they are now the proud owners".

VITAA – lifesaver turns moneyspinner

"It's not often that a lifesaver turns out to be a moneyspinner for people in communities where it's saving lives," says Jowelia Sekiyanja, a Ugandan mother of eight. "But that is what's happening here. Many housewives are not only giving their families daily portions of vitamin A-

rich orange-fleshed sweetpotato, but are also earning a living from the sale of roots and processed products. I myself make juices, doughnuts, cakes and chips that I sell from my kiosk. People like them too much."

Vitamin A is essential for normal development, especially in children and in pregnant and nursing mothers (see Box 6). CIP pioneered the Vitamin A for Africa (VITAA) partnership, which is thought to be the world's first large-scale food-based initiative to eradicate vitamin A deficiency (see Box 7). The principal thrust has been to encourage Africans to grow and eat orange-fleshed sweetpotatoes (which are rich in vitamin A) in addition to the white varieties (which have no vitamin A) that are widely grown in Africa. Since its launch in 2001, VITAA has made real progress, largely because its concerns are aimed at the section of society people care for most: young children, and harnesses the energy of a large and dedicated workforce: their mothers.

A sharply focused project aimed at children

"We have made VITAA a sharply focused program," explains Regina Kapinga, VITAA's Africa-based coordinator. "There are 50 million children in Sub-Saharan Africa who are at risk from vitamin A deficiency. For all of them, eating just 100 g – that's about half a cup – of orange-fleshed sweetpotato each day would solve the problem. And if children grow up with the habit of eating it as part of their staple diet they'll feed it to their children too. A vitamin A-rich diet will become part of the culture."

And the signs so far are good. "My children love it," says Florence Kiwendo, a farmer and mother of six in crowded central Uganda. "At first I wasn't keen myself, because it's not what I was brought up on. But now I'm getting to like it too. The nutritional advisor at our clinic says it will add a sparkle to my eyes!"

A major advantage of VITAA is that it does not ask people to start growing and eating a food they are not used to. Orange-fleshed sweetpotatoes differ from white varieties in taste (they are sweeter) and texture (more moist) – but they are not as different as carrots, for instance, and will grow wherever the white varieties will.

"Even so, persuading people to eat something they're not accustomed to was never going to be easy," says David Yanggen, agricultural economist leading a CIP initiative that is assessing the impact of orange-fleshed sweetpotato on health. "But the need is immense." In Uganda alone, a survey in 2000-2001 found that in most parts of the country, more than 50 percent of pregnant and lactating women were deficient in vitamin A. Among Ugandan children, nearly one-third were deficient. The good news is that a first-of-its-kind study conducted by South African scientists under the umbrella of VITAA confirmed that eating orange-fleshed sweetpotatoes really does make a difference. School children aged between 5 and 10 years who ate a daily portion of orange-fleshed sweetpotatoes (100-200 g) had significantly increased

Ugandan children in the sweetpotato fields

M. HERMANN

levels of vitamin A after just 11 weeks.

"VITAA has the capacity to help massive numbers of people," says Yanggen. "The introduction of orange-fleshed sweetpotatoes has already had a significant impact in target areas of Uganda. What we're looking for now is that orange-fleshed sweetpotatoes will advance to become integrated into African food production and consumption systems."

The sweetpotatoes offer women the chance of earning money

Although health is the primary incentive for the introduction of orange-fleshed sweetpotato, family economics are also helping to carry its potential over the threshold and onto the dinner tables of Uganda. The sweetpotatoes offer women the chance of earning money, as well as saving their children from vitamin A deficiency. "Sweetpotatoes are traditionally a woman's crop," explains Regina Kapinga. "And when you offer a woman something that is both good for her children *and* brings in some extra money you have a win-win situation."

Jowelia Sekiyanja is one of the many women throughout Uganda who are the living proof of this contention. Jowelia's active involvement in sweetpotato growing began in 1975, the year she was married. In customary fashion, she established a small garden (1/4 acre) and raised a growing family on its white-fleshed sweetpotatoes, bananas, maize, beans and cassava. The garden supplied food, while Jowelia's husband (a civil servant) provided money for household essentials. Jowelia had no income of her own. Things began to change, however, when Makerere University's Child Health and Nutrition Program told her and other mothers of the dangers of micronutrient deficiency in children – especially vitamin A deficiency. Through the VITAA program she learned of the new orange-fleshed varieties that could supply the missing vitamin A and began growing them. As the promotion of orange-fleshed sweetpotato as a means of combating vitamin A deficiency spread through

Vitamin A deficiency

Vitamin A is essential for a child's normal mental and physical development and for keeping the body healthy and strong Vitamin A deficiency is one of the leading causes of early childhood blindness and death in Africa. The lack of it can be a death sentence, in some cases directly but more often via a weakened immune system, which exposes victims to diseases such as measles, pneumonia and malaria. Vitamin A deficiency also reduces the ability to see clearly in poor light and can lead to blindness.

The actual amounts of vitamin A and other micronutrients required by the body are very small but, overall, micronutrient deficiency is a notorious "hidden hunger" of the developing world. And along with the health issue there is an inevitable economic consequence. By affecting the learning ability of children and sapping the energy of working-age people, micronutrient deficiency causes billions of dollars of lost productivity in countries that can least afford it.

It is only since the 1980s that nutritionists have assembled compelling evidence that the diets of many children (especially young children) and adults in developing countries do not provide health-sustaining amounts of essential vitamins and minerals. Vitamin A deficiency is one of the most prevalent problems, particularly in Sub-Saharan Africa and South Asia, where "severe vitamin A deficiency has very high fatality rates (60 percent)," according to World Bank nutritionist Judith McGuire, and "even sub-clinical deficiency is associated with a 23 percent increase in pre-schooler mortality in areas with endemic vitamin A deficiency."

A massive international effort to combat vitamin A deficiency has been underway since the early 1990s. Emphasis in many countries was initially placed on supplementation programs, believing that the distribution of vitamin capsules could solve the problem quickly. However, experience has shown that although supplementation can be cost-effective, it must be repeated every six months and thus can be difficult to implement in countries with poorly developed health and road infrastructure. A second approach, that of fortifying common foods with a micronutrient, has been used successfully in some instances (iodized salt successfully treats iodine deficiencies, for example). But in countries where markets for food are not well developed, it has been difficult to identify appropriate foods to fortify and ensure they would reach the consumers who are most at risk.

A third approach is to improve dietary quality and quantity through diversification. Here the aim is to achieve and maintain an adequate intake of vitamin A (and the other essential micronutrients) as part of an adequate total diet. A food-based approach such as this requires an inter-sectoral perspective, which means providing agricultural and educational inputs, together with a keen awareness of cultural, socio-economic, market and health conditions – a challenging proposition but likely, economists believe, to be the most sustainable of the three available options. The advantage is that once achieved, food-based approaches are self-sustaining and by far the lowest cost approach.

The VITAA partnership

Sweetpotato

CIP ARCHIVES

The VITAA partnership, winner of the 2003 CGIAR Partnership Award, is a novel initiative that is achieving a major impact in Sub-Saharan Africa (SSA). On May 9, 2001, an international group of 70 agriculturists, health experts and nutritionists launched what is believed to be the first crop-based initiative to attack the tragic consequences of vitamin A deficiency in the region.

Pioneered and led by CIP, more than 50 partner agencies from the health, nutrition and agricultural sectors are now working together to extend the impact of orange-fleshed sweetpotato in more than ten partner countries in the SSA region. The original VITAA countries included Ethiopia, Kenya, South Africa, Tanzania, Uganda, Mozambique and Ghana. CIP and partner scientists are working in this region, and for the larger global community.

the community, people were keen to buy roots from Jowelia, and the vine cuttings with which they could begin growing the orange-fleshed varieties themselves. Before long, 90 of the 95 households in her own community were growing and eating orange-fleshed sweetpotato regularly.

Jowelia Sekiyanja now had an income of her own, and as it grew, her status in the family and the community was transformed. She could pay the childrens' school fees instead of having to depend on her husband. "Before, the children would have to wait at home, missing school, until their father could bring the money. They don't have to wait like that anymore," she says. Jowelia bought a site in the nearby trading center, built a house for the family and bought clothes, a radio and a refrigerator. Her sweetpotato holding expanded to five hectares, and she is putting up a building on the commercial site she bought – all initially from the sale of fresh

sweetpotato and vines. Lately, though, there has been an added value element. Each day, Jowelia processes and sells juice, doughnuts, pancakes and cakes made from sweetpotato. "I've opened a savings account, and every day I put more money in it," she says.

"As a wife who was entirely depending on her husband I feel really proud for having made this," says Jowelia. And she is not the only one to have benefited in this way. In her community and across the country, "the arrival of orange-fleshed sweetpotato has been a moneyspinner for many women," she says.

"Orange-fleshed sweetpotato is definitely a life-saver first, and a money-spinner second," reflects Regina. "It is nice to see mothers making some money from providing vitamin A supplements, instead of the pharmaceutical industry," she adds, whimsically.

Villagers are now producing a variety of products from the orange-fleshed sweetpotato, increasing earnings and improving their livelihoods

R. KAPINGA

Farming in the city

They had been chatting about the business of raising pigs in Saracoto, a district of Lima's Lurigancho-Chosica municipality, and the mood was friendly until Rocio Oyola introduced the subject of health and cleanliness. Luis Céspedes and his colleagues stiffened; their smiles faded. Ms. Oyola is junior administrator for

urban agriculture in the municipality, and responsible for ensuring its farmers are aware of city health regulations. "You must clean up this place," she told Luis again.

Luis was not inclined to argue. Indeed, there could be no argument, and it was not just the pigsty that needed cleaning up: most of Saracoto was in desperate need of attention. Luis shrugged, and led the group away from the pigs, towards the shack in which he lived with his young wife. Their first child was due very soon. They had made a respectable home out of discarded corrugated iron and timber. It was clean. A cage with two song birds hung in the shade of an awning; purple-flowered bougainvillaea climbed a corner post. Luis stood proudly now. The shack and his body language said it all: "Yes, we know, all of Saracoto should be as clean as this. Give us a water supply and we'll hose it down tomorrow".

And there's the problem. While the municipality is responsible for enforcing health regulations, the public water supply is a service of the state. Saracoto has yet to be scheduled for connection. Meanwhile, its residents must buy their water from private suppliers, and it is not cheap.

"We have to help wherever we can"

The municipality is not insensitive to the difficulties facing Luis Céspedes and his colleagues in the Saracoto Association of Pig Marketers. "We know they must have somewhere to live", says Rocio Oyola, "They have to make a living. We are very concerned about the health risks, but we have to understand their situation too. Our job is not just to enforce regulations, we have to help as well, wherever we can."

It is at this interface, where urban agriculture confronts the edicts of an urban municipality that CGIAR's Urban Harvest initiative (see Box 8) operates. Rocio Oyola is employed by the municipality with a brief to utilize the services and expertise of Urban Harvest, which CIP coordinates, wherever possible. Already this has allowed her to liase effectively between farmers and local authorities on issues of land ownership and the legitimacy of pigraising as an urban occupation. Saracoto's water supply now features prominently on her agenda.

Farming in cities sounds like a contradiction in terms, but growing food has become a lifeline for millions of people in cities, bringing a measure of self-sufficiency to the poorest of families. Most of those crowding into the cities of the developing world are from rural communities. Any open piece of ground is an opportunity to feed themselves and earn some money as well. After all, cities are concentrations of wealth as well as poverty, with a constant demand for fresh vegetables, meat, cut flowers, ornamental plants and other agricultural products.

Box8

Urban Harvest

Uganda is the largest producer of sweetpotato in Africa

HENK DE ZEEUW

URBAN HARVEST

Urban Harvest provides strategic information and practical technology to practitioners and policy makers involved in urban agriculture. Its research is designed to enhance food security, augment nutrition and help urban families improve their earning capacity. In the process, Urban Harvest aims to reduce environmental pollution and mitigate the health risks stemming from poorly managed urban production. Fundamentally, its mission is to promote the view that urban and peri-urban agriculture, when practiced sustainably, is not only productive but can also make a valuable contribution to the development and wellbeing of the world's urban centers.

"Urban Harvest is a response to a pressing need," says anthropologist Gordon Prain, who coordinates the initiative from CIP's headquarters in Lima. "The past 30 years have seen an explosion in urban populations and urban poverty. Urban agriculture provides an important opportunity for new migrants to supplement household food supplies and earn cash incomes. It can make a valuable contribution to the nutritional status and income of vulnerable households. But it is vitally important to ensure that it is supported and recognized by local government policies and regulations, and contributes to a healthy environment."

Focusing its activities on large, rapidly growing cities with significant concentrations of poor people and a high proportion of food and nutritional insecurity, Urban Harvest has established platforms for stakeholder dialogue and policy analysis in a number of locations. "Stakeholder dialogue is crucial," says Prain. "All parties must discuss the issues with one another. Often there is misunderstanding, sometimes hostility, but urban agriculture offers positive opportunities on many levels, and once that is understood and accepted, people begin working together towards a resolution."

Millions of urban families depend on technically illegal activity

Urban farming is not an activity that municipal authorities facilitate or even approve of. In many instances, city ordinances condemn it. Yet an estimated 800 million people already earn their living in this way, a number that will continue to rise rapidly through the first half of the twenty-first century. This means millions of urban families around the world depend on an activity that is technically illegal, yet in total they make a significant contribution to urban food supply networks and economies. This is a paradox that Urban Harvest aims to resolve.

Urban Harvest initiatives in Hanoi, Manila and Kampala are already producing positive results (see CIP Annual Reports 2001, 2002 and 2003). Most recently, stakeholder dialogues in Kampala led to new regulations being drawn up by the City Council. "These will simplify or nullify dozens of superfluous laws, set the stage for real reforms that will reduce health risks to farmers and consumers, and improve the quality of life in the city," says Diana Lee-Smith, Urban Harvest's Regional Coordinator for Sub-Saharan Africa.

"Kampala is the model for what we would like to achieve here in Lima," says Dr. Blanca Arce, a specialist in animal production systems who coordinates Urban Harvest initiatives in Latin America. Stakeholder dialogues involving farmers and city officials are already ongoing, and Dr. Arce is directing the research and development activities of the urban agriculture project in Lurigancho-Chosica, on the north-eastern fringes of Lima. The appointment of Urban Harvest liaison officers to municipal administrations in two of Lurigancho-Chosica's five sectors is an encouraging measure of progress. One of them is Rocio Oyola.

As Lima has grown from a city of 973,000 in 1950 to approaching nine million in 2005 it has swallowed up the surrounding agricultural land. The projected plan for Lima in 2010 makes no provision whatsoever for agriculture in Lurigancho-Chosica. It is this unquestioned assumption of inexorable urban expansion that Blanca Arce's work is tackling – both in the meeting rooms of the city administration and in the fields, gardens and livestock pens of Lurigancho-Chosica. "There are 20,000 families who are involved in agriculture in some way or other," she points out. "seventy percent of their plots are less than one hectare, some are very small, a few range up to ten hectares, but in all cases, farming is a crucial part of the household economy."

Two hundred fifty families are directly involved with the program. They have good fertile land: with irrigation it can be cropped continuously, producing three or four harvests of various crops a year. "We don't preach," Dr. Arce insists. "We respond to the farmers' enquiries – with workshops on how to

Lima has grown... it has swallowed up the surrounding agricultural land

improve productivity and marketing, for instance, and by helping farmers to set up Farmer Field Schools that can give advice on specific issues, such as fertilizers and pest control."

"The neighbours laughed at me – but it worked"

On the meticulously furrowed hectare of land in the Ñaña district of Lima that has supported Leoncio Rivera Hijar and his family for 25 years, insect pests had become a problem. Pesticides were prohibitively expensive, so Mr. Rivera Hijar turned to Urban Harvest for advice. "They told me to put up fly-traps made of yellow plastic and smeared with grease. The neighbours laughed at me. It was embarrassing. But it worked." Now he is president of the local Farmer Field School and the neighbors are working with him on experimental plots that should tell them which fertilizer is best suited to which crop – chicken manure, stable manure or commercial fertilizer.

Over at Carapongo, Esteban Malpartida looks on approvingly as a local farmer harvests a hectare of radishes. Mr. Malpartida is president of the elected 8-person committee responsible for ensuring that the complex irrigation network of the former hacienda is kept in good order, and its waters equitably distributed. "That's a good crop," he says of the radishes, but does not need reminding that the stream of water in which the bunches are being washed has previously run through the village on the hill above – where it could have been contaminated with household effluents. "This is something we are working on," he says.

Lima is hungry for pork

And then there is Luis Céspedes and his colleagues in the Saracoto Association of Pig Marketers. Out on the dirt road that runs through Saracoto's ramshackle buildings and pigsties he explains that, although the Association bought the land ten years ago, they obtained legal title to it only in November 2004 – after Urban Harvest advisors had helped to clarify crucial ownership issues. Just recently, the Lima city authority officially recognized pig raising as a legitimate livelihood. Urban Harvest advisors were involved with that development too, and now Mr. Céspedes is hoping they can help the Saracoto Association improve their husbandry and living conditions. "At present we market an average of

around 10 pigs a day," he says. "It could be more. We could sell 100 a day. Lima is hungry for pork."

Like most cities, Lima does not yet fully appreciate the value of what urban farmers have to offer. The Saracoto Association is already making a positive contribution to the food budget of the city – and doing the municipality a favour in the process. "eighty percent of what we feed our pigs is kitchen waste we collect from restaurants and factory canteens," Mr. Céspedes explains. "If we didn't collect it, the municipality would have to pay someone else to do it."

Pigs grow well in the city and offer a profitable livelihood to urban families. They also eat kitchen waste which would otherwise be a refuse problem

URBAN HARVEST

Sowing prosperity: New varieties enhance Peru's potato production capacity

"It's as much a matter of courage as it is of science," says Enrique Chujoy, Head of CIP's Acquisition & Distribution Unit.

Chujoy is describing the process of producing new potato varieties. Almost 30 potato varieties have been released

in Peru from CIP-derived materials in recent years.

"We couldn't have achieved this," he says, "without the Peruvian farmers and scientists who have worked side-by-side with us to develop and test the varieties. They deserve much of the credit, for their conviction and dedication."

CIP potato plant breeder Juan Landeo can testify to this. He has spent a good part of his career contributing to the pool of potatoes available to farmers in Peru. Working closely with his Peruvian partners, Landeo has been able to develop and test the new varieties on the ground.

"Talk to Alejandro Mendoza," he says. "He's helped to produce most of the varieties that have been released in Peru from CIP materials."

Partnerships that pay

Alejandro Mendoza has worked for 20 years in close cooperation with CIP as head of the Peruvian national experimental station in Huánuco, professor of the National University Hermilio Valdizán in Huánuco, and now, since 2002, as a member of the Proyecto de Reducción y Alivio a la Pobreza (Proyecto PRA). Mendoza calculates that he has participated in the evaluation of some 20,000 CIP-derived potatoes.

"We have Juan Landeo to thank for placing his bet on Huánuco," he says. "And it has certainly paid off." Mendoza is referring to the success of Canchan, a high-yielding, late blight-resistant potato variety tested and released by the Huánuco experiment station from materials developed by Landeo and his team. Although official figures are lacking, CIP scientists estimate that Canchan easily covers at least 50 percent of the area planted to commercial potato production in Peru.

"It all began in 1983," recalls Mendoza. "Nobody wanted to invest in Huánuco – coca production and terrorism made the risks too high. But when Juan told me that CIP was looking for the ideal spot to evaluate its late blight-resistant materials, I told him to come to Huánuco." The department of Huánuco, one of Peru's poorest, comprises enormous ecological diversity.

"Right now," continues Mendoza, signaling the surrounding landscape. "We're at 3,500 meters above sea level. But just over those mountains is the jungle. In an hour we can be in Tingo Maria, where there's 80-90 percent humidity all year long. That's late blight paradise."

The proof is in the potato

"We had to face a lot of resistance," explains Mendoza. "Believe it or not, nobody wanted a new potato variety. The markets had been selling Yungay for twenty years and they preferred to keep the status quo. We ended up having to disguise it as another, more familiar variety to sell the product of our first cycle of seed production in the markets."

The variety's outstanding characteristics had not gone unnoticed, however, by the farmers who had been testing it in their fields.

Checking progress on a new variety, to be called "Huanuqueñita"

C. GRAVES

"Canchan is a classic example," says Landeo, "of how the will and effort of the small farmers can prevail." Impressed not only by how well it stood up to late blight, enabling them to cut their pesticide applications to a minimum, but also by its cooking quality, the farmers were determined to use it.

"It didn't take long for the word to spread among them," says Mendoza. Summing up years of experience in one phrase, he adds: "If a potato is good, it will find its own way."

"I soon got a call from a farmer from Mala, a coastal valley near Lima," Mendoza continues. "He had heard about Canchan and wanted to try it. He ended up producing 40 tonnes per hectare in his first season." Although this is a normal yield for European or US potato fields, average potato yields in Peru reach only 12 to 13 tonnes per hectare.

The variety that could, the farmers that would

In terms of quality, the coastal farmer's results were even better than he had expected: at sea level, Canchan produced a potato that was extremely low in sugar content. This made it ideal for processing, an emerging source of demand.

"After this," recalls Mendoza, "we began to sell Canchan seed from Huánuco like popcorn." The variety still hadn't been officially released. But the farmers pushed the envelope.

Canchan's success has continued to this day, making it the predominant commercial variety on the Peruvian market. In 1996 CIP economists published an impact study, calculating benefits per hectare at US$280 to $600, mainly from reduction in use of pesticides, with a stream of net benefits of US$8 million. Their estimates for future success, while quite encouraging, were characteristically conservative: they foresaw some 25,000 hectares planted to Canchan in Peru by the year 2020.

According to Mendoza, they probably missed the mark by over a hundred thousand hectares. "My calculation is that Canchan covers anywhere from 140 to 150,000 hectares in Peru today," he says. "I am permanently in contact with growers and researchers all over the country, and they give me their information. Twenty hectares here, fifty there – it adds up." Updated analyses by CIP put Canchan's economic benefits in Peru at some US$90 million per year.

Cultivating change

Landeo and Mendoza both recognize, nonetheless, that it is time for a change. In 2000, Canchan's resistance to late blight began to break down. Farmers who once thought the variety was invincible began to see their fields "melt" in the face of the disease.

"They are controlling it with fungicides, but really that isn't necessary," Landeo says enthusiastically. "There's more where Canchan came from."

Landeo is referring to a new potato that has great consumer and processing quality, unprecedented resistance to late blight, and fantastic yields. One of the secrets to the new variety's success is its ancestry, which includes native potatoes. This gives it its deep purple skin color and floury texture.

Huanuqueñita, as Mendoza hopes to name the new variety, promises to do everything Canchan has done, and more. To draw farmers' attention, he planted a field of the new potatoes next to another, smaller plot sown to Canchan. After a few months, the message was clear even to the untrained eye; while Canchan's foliage was withered and brown,

"After this we began to sell Canchan seed from Huánuco like popcorn"

displaying clear signs of late blight, Huanuqueñita's stood tall and green, topped by beautiful purple flowers.

CIP Director General Hubert Zandstra is encouraged by the prospect of change. "Breeders are continuing to stretch the life-span of the new varieties," he says. "But they will never make one eternal. We need to make change a habit."

Peruvian farmers have given the world one of the greatest gastronomic treasures: the potato. CIP's work with Peruvian scientists to develop new and better varieties is a way of giving back to the farmers some of that richness.

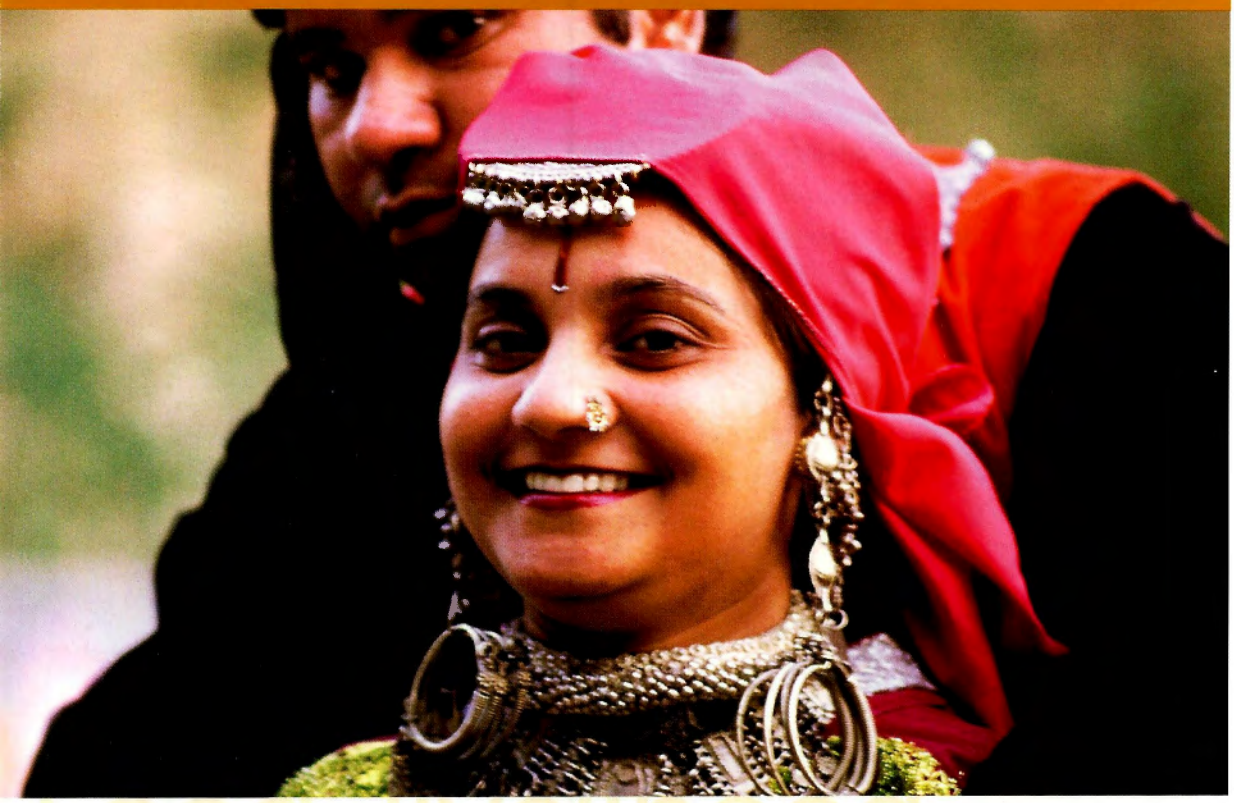
Building better resistance

Canchan's defenses against late blight included what breeders refer to as "major" or "R" genes. Although these genes convey very high levels of resistance, they also have their down side.

"The problem," says Landeo, "is that there are so many different strains of the late blight pathogen. No one gene is resistant to all of them." When breeders test potatoes with major genes, he continues, "these often 'mask' or 'mimic' resistance to certain strains, which makes it impossible to detect their vulnerability. As soon as your potatoes come up against that strain in the field, their resistance breaks down."

This is why, in the 1990s, Landeo devised a way to eliminate major genes, allowing breeders to overcome the masking and mimicking effects. "Our job," he emphasizes, "is to assure farmers that what they have will not break down, or at least, that its resistance will be long-lasting and effective."

CIP has contributed to the development of some 60 potato varieties with horizontal resistance to late blight in 22 countries. In addition, since 1996 a new batch of about 100 potatoes with higher resistance levels as well as improved adaptation and market qualities has been lined up for distribution and testing. Many of these potatoes have already made it to farmers' fields in Africa, Asia and Latin America. Huanuqueñita is just one of them.



In Brief

P. DEMO

Small-scale seed efforts with big results in Uganda

Without a laboratory facility or scientific equipment, two researchers working closely with national and CIP seed programs in Uganda are leading the production of improved basic seed potatoes in this African nation. The availability of disease-free seed has been one of the biggest constraints on Uganda's potato production. Although people depend more on beans, sweetpotatoes and field peas for food security, potatoes bring in scarce cash and, in some cases, are farmers' primary cash crop.

The clean seed produced by researchers William Wagoire and Rogers Kakuhenzire, who are working for Uganda's National Agricultural Research Organization (NARO), is only a small part of the planting material used each year in Uganda. Yet this seed plays an important role in introducing new potato germplasm into the country's production system.

Lacking laboratory facilities and any sort of equipment for disease testing, Wagoire and Kakuhenzire choose mother plants that look to be free of virus and bacterial wilt symptoms, and then multiply cuttings from these plants to produce up to 100 tonnes of basic seed. This is enough for the farmers that they have trained in local workshops to produce about 1,000 tonnes of clean seed, which can then be sold to other farmers, enough to plant about 500 hectares. Many of the farmers trained to multiply the basic seed belong to nongovernmental organizations, farmers' associations and local government councils.

Although 500 hectares represent only about one percent of the area planted yearly in Uganda, it still provides an important mechanism for making new varieties available to other farmers. "The Uganda seed system is one of the best I've seen in the region," says CIP scientist Greg Forbes, who oversees CIP's pathology work on the destructive potato disease late blight. "It could be that the success of this program comes from its simplicity."

In addition to their seed production activities, Wagoire and Kakuhenzire collaborate on all CIP-supported activities with NARO and conduct experiments on late blight management. NARO researchers see successful disease management as the poor farmers' key to increasing productivity, reducing production costs, and reducing negative impacts on their health and environment.

P. DEMO

CIP ARCHIVES

Maca gene could aid in fight against late blight

A prize-winning discovery of an anti-pathogen protein in a lesser-known Andean root is an important step forward in the work to control late blight, one of the deadliest potato diseases worldwide. Julio Solis, an MSc student of the Peruvian San Marcos University, won the prize for his work in isolating the gene in maca that codes for a defensin, a protein that proved to have activity against *Phytophthora infestans*, the microorganism that causes late blight.

The National Council of Science and Technology of Peru awarded Solis their 2004 Prize for Scientific Investigation. Solis won the prize in a contest against 80 other entries during the second National Fair of Science and Technology held in Peru in November 2004.

Late blight causes damage to potato crops worldwide worth more than US$2.5 billion a year. The discovery of this new defensin from maca could lead to the development of new control strategies for *P. infestans*. In his experiments, Solis, who carried out his research in CIP's Laboratory of Applied Biotechnology, showed that the defensin strongly inhibited the growth of a particularly virulent strain of *P. infestans*. Such a defensin will be effective against any strain of *P. infestans*. "This is the first time that a defensin gene or peptide sequence of maca, an Andean root that grows in Peru above 4,000 meters, has been reported worldwide," said Marc Ghislain, head of CIP's Biotechnology Laboratory, who directed this research. CIP was the main supporter of this investigation, providing the necessary infrastructure, equipment, materials and intellectual counseling.

R. KAPINGA

Enhancing the nutritional value of the potato and sweetpotato

Higher levels of iron and vitamin C in potatoes and sweetpotatoes came a step closer to reality in 2004. CIP scientists conducting a preliminary characterization of genebank accessions and breeders' lines during the past year confirmed their suspicions that Andean potatoes may be a prime source of nutritional traits for higher-than-expected levels of iron and vitamin C. Enhancing the nutritional value of root and tuber crops while not sacrificing quality, value and consumer preference, continues to be one of the most complex

challenges for CIP breeders and geneticists today.

Screening potato and sweetpotato germplasm for higher levels of iron and vitamin C in Andean potatoes, and ß-carotene in sweetpotato, together with the selection of new breeding material, will allow scientists to estimate the extent to which these CIP mandate crops could help alleviate undernourishment and hunger in poor potato- and sweetpotato-producing regions around the world, where iron and vitamin A deficiencies continue to be the leading cause of malnutrition.

During 2004, CIP breeders confirmed that a yellow-fleshed Peruvian potato landrace contains 35 mg of vitamin C per 100 g of fresh weight – or almost twice the amount indicated in previous reports. Losses in cooking are variety-dependent, which, combined with the good heritability previously shown for vitamin C, is favorable for crop improvement. The highest iron content found so far is more than twice that previously known for peeled potatoes, although iron content seems to have been sacrificed during improvement for other important characteristics.

In sweetpotato, advanced orange-flesh selections have reached 8.5 mg of ß-carotene per 100 g of fresh weight, which is well above the previously recorded levels. Although the dry matter contents range from 22 percent to 39 percent in advanced breeding material, there is still a gap for those varieties with both elevated dry matter and ß-carotene content. So far, CIP breeders and geneticists have developed high dry/medium ß-carotene varieties as well as medium dry/high ß-carotene varieties with profitable yields. CIP is currently testing this material in elite demonstration trials, together with national agricultural research systems and CIP regional offices in the target regions of the world. Prospects are high for sweetpotato breeding to fill this gap without losses in yield and yield stability by simultaneous improvement of both nutritional quality and yield traits. Success here will eventually mean that the varieties will have a significant impact on the nutritional levels of people in many developing countries.

O. ORTIZ

Bringing together science and development

Development organizations are crucial in creating mechanisms to merge scientific information and farmer knowledge. These efforts are particularly important in poor economies with restricted governmental research and extension initiatives. "This is when non-governmental organizations become important providers of information and technologies to rural families, and thus key partners for the dissemination of research results," says Oscar Ortiz,

leader of CIP's Integrated Crop Management Division.

CARE, the humanitarian organization fighting global poverty, and CIP, in a collaboration that started 12 years ago, have been developing, testing and disseminating integrated pest management (IPM) of potato in small farming communities in the Peruvian Andes. In addition to the economic benefits for farmers, the experience has promoted IPM and participatory research and training in Peru.

The farmer field school approach to participatory research has turned out to be a good way to work with small farmers on potato-related problems, particularly late blight. In the highland region of Cajamarca, for example, the new knowledge and technologies gained through participation in farmer field schools have brought higher potato yields, and thus better food security and higher incomes for farmers.

The lessons learned by the CIP-CARE collaboration have already benefited other institutions, for example, in Ethiopia (Ethiopian Agricultural Research Organization and Self-Help Development International), Uganda (National Agricultural Research Organization and AFRICARE), China (Chonqing Plant Protection Institute and Extension Service), Bangladesh (Tuber Crop Research Center and CARE-Bangladesh) and Bolivia (Programa de Investigación de la Papa and the local nongovernmental organization Asociación de Servicios Artesanales y Rurales).

CIP researchers plan to further disseminate the approach to other countries, such as Georgia, where CARE also operates, and Kenya and Ecuador, where a number of NGOs plan to participate during the next couple of years.

Meanwhile, CIP continues to enhance its partnership with CARE. In 2004, it signed a three-year agreement to continue conducting participatory research to find innovative ways to promote technological innovation on the potato crop in the Andes. Learning to face new challenges, such as improving farmer competitiveness in emerging markets, is another key goal of the agreement.

Efforts like this not only help teach research and development organizations how to work together for the benefit of resource-poor farmers, but also lead to a more efficient contribution to CIP's underlying development goal of poverty and hunger alleviation.

CIP ARCHIVES

Expanding potato production in Korea and Bhutan

A new CIP-led potato project launched in Korea and Bhutan last year is set to help rehabilitate and develop potato production in these two countries, where the potato is an important cash crop and a primary source of nutrition among rural households.

The project, aims to establish sustainable seed production and distribution systems, develop measures to reduce storage losses in ware and seed potatoes, and improve pest and disease control techniques. According to Fernando Ezeta, CIP's regional leader for East and South East Asia, the objective of the project is to help improve potato yields and increase areas planted to potato in the Democratic People's Republic of Korea (DP Korea) and Bhutan, and therefore ultimately improve the income and nutrition of resource-poor farmers.

In DP Korea, where the demand for potato is rising sharply, the total area planted to potato has already increased from 42,000 hectares in the mid-1990s to 187,000 hectares in 2002, which equals 9.4 percent of the country's total arable land. "Particularly in the country's mountainous areas, potato, with its strong tolerance to stress and relatively high yields, is a substitute for major crops such as maize and rice," adds Fengyi Wang, project coordinator based in DP Korea.

In Bhutan, major emphasis is being given to seed-related issues, with the objective of helping potato producers capitalize on the opportunities for seed export to West Bengal. In Bhutan, as in Korea, efforts are being developed to rehabilitate seed-producing facilities, introduce improved methods for production of quality seeds and identify post-harvest storage and handling technologies suitable to the local climate and economic conditions.

Introducing germplasm, meanwhile, is one of the key activities of the CIP-led project in Korea. This includes new varieties that could be grown directly in DP Korea and valuable clones that could be used in breeding programs. Developing and implementing quick, low-cost and sensitive identification methods is also a project priority in DP Korea, where virus diseases are serious problems for potato and particularly seed production.

The Rehabilitation and Development of Potato Production for North Korea and Bhutan coordinates research and development activities among the different agencies and institutions involved in the project. In Bhutan, these include the Department of Agriculture and the Council of Renewable Natural Resources Research for Bhutan, and in DP Korea the Swiss Agency for Development and Cooperation, Cooperazione e Sviluppo Onlus, German Agro Action, as well as some institutes in northeast China. This project forms an integral component of the Bhutan Potato Development Program, established by the Department of Agriculture in June 2004 to coordinate all aspects of potato research, development, marketing and processing. The UN's Food and Agriculture Organization has been assigned a supervisory role.

Board of trustees

Notes from the chair

The international community has emphasized its intention to support the Millennium Development Goals (MDG) and we in the Consultative Group on International Agricultural Research (CGIAR) can contribute to many of the targets set within those goals. Currently the Science Council of the CGIAR is setting priorities for the CGIAR System to address them in a systematic manner, with the intention that the donor community will support them and give a strong foundation for long term research to prosper and produce Global Public Goods. The International Potato Center (CIP) has agreed on a new vision which addresses these MDGs, but vision in itself is not enough, we are now actively embedding this within the institution both in programs and with our staff.

The Board of Trustees has been active in ensuring we have the highest standards of governance. In 2004 the Board of the Alliance of the Future Harvest Centers of the CGIAR initiated board orientation and training courses to improve standards of governance at all centers, CIP has been an active participant in this. It is through good governance that the Board exercises its responsibilities to provide leadership, direction and oversight that are rightly required by our stakeholders. Indeed in 2004 this leadership was demonstrated when the Board selected a new Director General, Dr. Pamela K. Anderson to succeed Dr. Hubert Zandstra when he retires in 2005. A planned and controlled change of Director General creates a stable environment in which our work can flourish. The Center has again achieved its financial targets whilst at the same time ensuring our research output is both relevant and productive.

I express my thanks to my Board and all the staff at CIP for making this another successful year for the International Potato Center.

This Annual Report will give you an insight into the high quality of work that takes place at CIP and demonstrates we have real outputs and outcomes that improve the lives of many of the poorest people in the world.

Jim Godfrey
Chairman

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Dr. Madhura Swaminathan
Indian Statistical Institute
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Peru

Donor contributions

The International Potato Center is grateful for the generous support of all its donors. The funding received helps CIP to develop high quality research and training that helps reduce poverty and achieve food security on a sustained basis in some of the poorest areas of the world.

Donors (ranked by level of contribution) **(US$000)**	**Unrestricted**	**Restricted[1]**	**Total**
Swiss Agency for Development and Cooperation (SDC)	1,029	1,214	2,243
Government of Spain		1,904	1,904
Department for International Development (DFID), UK	1,129	762	1,891
International Bank for Reconstruction and Development (World Bank Group)	1,200	442	1,642
Canadian International Development Agency (CIDA)	1,170	458	1,628
European Commission (EC)		1,453	1,453
Government of Netherlands	448	864	1,312
United States Agency for International Development (USAID)	962	287	1,249
Government of Germany (BMZ/GTZ)	247	880	1,127
Swedish International Development Cooperation Agency (SIDA)	968	91	1,059
Government of Austria		763	763
International Development Research Centre (IDRC)		561	561
Government of Luxembourg		487	487
Danish International Development Agency (DANIDA)	327	73	400
Global Environmental Facility (GEF)		384	384
Association for Strengthening Agricultural Research in Eastern & Central Africa (ASARECA)		366	366
Australian Centre for International Agricultural Research (ACIAR)	216	143	359
New Zealand Agency for International Development (NZAID)	328		328
Government of Japan	197	111	308
Government of Norway	294		294
Common Fund for Commodities (CFC)		274	274
Government of Italy	117	156	273
Bill & Melinda Gates Foundation		266	266
International Fund for Agricultural Development (IFAD)		258	258
Government of Peru - STC CGIAR		181	181
Food and Agriculture Organization of the United Nations (FAO)		156	156
The McKnight Foundation		145	145
CGIAR - IWMI - International Water Management Institute		125	125
Government of China	120		120
Government of the Republic of Korea	60	56	116
Swiss Centre for International Agriculture (ZIL)		104	104
Government of Belgium	98		98
The Rockefeller Foundation		89	89
Organization of Petroleum Exporting Countries (OPEC) / Fund for International Development		79	79
International Livestock Research Institute (ILRI)		57	57
Government of Israel		56	56
Government of India	37		37
United States Agency for International Development - International Center for Agricultural Research in Dry Areas (USAID) - (ICARDA)		37	37
United States Department of Agriculture (USDA)		30	30
Natural Resources Institute (NRI), UK		21	21
Conservation, Food and Health Foundation, Inc.		19	19
Wageningen University		15	15
Ministerio de Agricultura - Perú		14	14
Centro Internacional de Agricultura Tropical (CIAT)		10	10
CGIAR - IFAR- International Fund for Agricultural Research		10	10
Government of Brazil	10		10
Government of Mexico		10	10
International Plant Genetic Resources Institute (IPGRI)		10	10
Centro de Investigación Agricola Tropical (CIAT - Bolivia)		7	7
Inter-American Institute for Cooperation on Agriculture (IICA)		5	5
Servicio Nacional de Sanidad Agraria (SENASA)		4	4
Pioneer Hi-Bred International, Inc		2	2
Syngenta Foundation		1	1
TOTAL	**8,957**	**13,440**	**22,397**

1 Restricted revenues are recognized if the funds are received and spent. For this reason, some restricted revenues may differ from the amount committed or transferred by donors.

Financial report

In 2004 the International Potato Center achieved a net surplus of US$1.1 million. The result exceeded the budget by US$0.7 million, or 163 percent, increasing the Center's financial reserves from US$4.5 million to US$5.6 million by the end of 2004.

CIP's total revenues in 2004 were US$22.7 million, 24 percent greater than 2003 revenues. Total revenues included US$9 million of unrestricted donations and US$13.4 million of restricted donations. At the end of 2004, US$3.6 million of grants approved (15 percent of total revenues) had not been released.

The increase in donations from Canada and United Kingdom and the new contribution from New Zealand helped to expand unrestricted revenues in 2004. In addition, the continued weakening of the US Dollar in 2004 increased CIP's unrestricted and earmarked revenues by US$0.76 million. CIP's revenues are received in US Dollars, Euros and in several other currencies, but they are booked in US Dollars.

Accumulated expenditures reached US$21.6 million in 2004, representing a 24 percent growth with respect to 2003.

Expenditures grew in all categories. Specifically restricted expenditures grew by 36 percent, due to the success in fund raising during the previous years, thereby expanding project-based contributions. In addition, during the year, steps were taken to improve cost recovery from ongoing and new restricted projects, which resulted in additional resources that contributed to project development and implementation.

CIP's financial health continued to strengthen during the year. The current ratio grew from 1.4 in 2003 to 1.6 and net working capital measured as the number of days of expenditures excluding depreciation grew from 97 days in 2003 to 99 days in 2004. However, the financial stability index, which measures the number of days of unrestricted net assets, fell from 97 days to 95 days. Financial indicators are within the acceptable range established by the CGIAR providing flexibility to deal with short-term negative effects from unanticipated events.

During the year, 90 new project proposals for US$53.0 million were submitted to donor agencies and 51 were approved for total commitment of US$12.5 million. The average donation approved per project declined from US$0.29 million in 2003 to US$0.25 million in 2004. By the end of the year, the backlog of projects pending approval increased by US$18.6 million to US$51.7 million.

Austere and prudent policies and programmatic growth reduced the share of CIP's indirect expenses. Following the CGIAR indirect cost ratio guidelines, the indirect cost ratio declined from 13 percent in 2003 to 12 percent in 2004. The Center plans to continue exercising prudent policies to strengthen even further CIP's financial health.

The statement here summarizes CIP's financial position as of December 2004. A copy of the complete audited financial statements may be requested from the office of the Director General, at CIP headquarters in Lima, Peru.

Statement of financial position

Year ending 31 December 2004

(compared with 2003-US$000)

	(US$000)	
	2004	**2003**
ASSETS		
Current Assets		
Cash and cash equivalent	10,561	8,151
Investments	99	
Account Receivable:		
Donor	3,582	4,268
Employees	259	283
Others	215	316
Inventories	385	436
Advances	154	475
Prepaid Expenses	179	261
Total Current Assets	**15,434**	**14,190**
Non-Current Assets		
Investments non-current	369	1,039
Furnishing and Equipment, Net	2,745	2,596
Total Non-Current assets	**3,114**	**3,635**
Total Assets	**18,548**	**17,825**
Liabilities and Net Assets		
Current Liabilities		
Accounts Payable		
Donor	3,508	4,290
Others	6,295	6,278
Provisions	243	125
Total Current Liabilities	**10,046**	**10,693**
Non-Current Liabilities		
Long -term loan	250	
Total Non-current Liabilities	**250**	
Total Liabilities	**10,296**	**10,693**
Net Assets		
Designated	2,598	2,596
Undesignated	5,654	4,536
Total Net Assets	**8,252**	**7,132**
Total Liabilities and Net Assets	**18,548**	**17,825**

Training highlights

CIP's Training Department is designed to support CIP's research divisions and partnership programs in their efforts to share knowledge and expertise for enhancing the performance of national agricultural research and related institutions. The Department assists CIP scientists in developing and making accessible guidelines and training materials, together with strengthening the capacities of research and related institutions to provide training and institutional development. Further, the Department provides support in organizing specialized training for technical and professional staff of partner organizations in areas where CIP has specific expertise and comparative advantage.

CIP leads training sessions and workshops, organizes and sponsors international conferences and develops training materials. Participants from more than 60 countries attended the 25 main group-training events conducted across the world in 2004. These events focused on issues such as potato seed production, integrated crop management, agricultural economics, statistical packages and natural resources management, targeted at NGOs, government organizations and development agencies.

At CIP headquarters, individual training was provided for participants from 11 countries. CIP also supported training in distant locations by distributing publications and manuals, as well as via electronic media, including downloads of manuals, articles and reports from CIP's training website (www.cipotato.org/training), and electronic conferences and workshops. During 2004, CIP's training department became the technical coordinator of CGIAR's ICT/KM Online Learning Resources (OLR) project, leading to the development of an online repository of training materials.

With the opening of the Multimedia Training Lab at CIP's Headquarters in 2004, CIP's Training Department now offers space for multimedia production and software-related training courses at eight workstations.

Summary of training events
(by type of training)

Events (number)	Duration (days)	Participants (number)
Group training & conferences		
25	95	592
Individual training		
19	345	22
Total		
44	440	614

Summary of training events
(by type of degree)

Male	Female	Total
MSc		
22	15	37
PhD		
1	0	1
Interns (BSc)		
49	53	102
Total		
72	68	140

Principle group training events

Event (number of participants in parentheses)	**Participating countries**
2nd Global Meeting of the Mountain Partnership (135)	Argentina, Austria, Belgium, Bolivia, Bulgaria, Cuba, France, Ghana, India, Indonesia, Iran (Islamic Republic of), Italy, Jamaica, Kyrgyzstan, Lesotho, Mexico, Nepal, Pakistan, Peru, Philippines, Poland, Romania, Russian Federation, Slovenia, Spain, Sri Lanka, Switzerland, Tunisia, United Kingdom, USA
3rd meeting of NARIs in Latin America (32)	Argentina, Chile, Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Panama, Peru, Portugal, Spain, Uruguay, Venezuela
Course on advanced methods for the diagnosis and identification of fungi, straminopiles and bacteria affecting plants (14)	Peru

Event (number of participants in parentheses)	Participating countries
Course on molecular virology techniques (11)	Peru
East Africa tradeoff analysis workshop (26)	Kenya, Netherlands, Uganda, USA
ICM potato seed production training course (37)	Afghanistan
Identify research and development needs to increase potato production in central Asia (30)	Afghanistan, Azerbaijan, Georgia, India, Kazakhstan, Kyrgyzstan, Peru, Tajikistan, Turkmenistan, Uzbekistan
Late blight management training course (6)	Bhutan, China, Vietnam
Mini-Symposium on late blight (57)	Peru
Participatory breeding and decentralized production of Andean crop seeds (18)	Peru
SIG training course – Teledetection (11)	Peru
Stakeholders workshop of IFAD-funded project (18)	Bolivia, Ethiopia, Netherlands, Peru, Uganda, USA
Statistics for agricultural and genetic resources applications with R. (11)	Peru
TAVERNA web service workshop (5)	Peru
Training course on marketing of seed potatoes (3)	Afghanistan, India
Training course on potato variety development, seed production, integrated disease management and processing (16)	Angola, Burundi, Cameroon, Eritrea, Ethiopia, Kenya, Madagascar, Mozambique, Nigeria, Rwanda, Tanzania, Uganda
Training course on the use of ELISA (enzyme-linked immunosorbent assay) techniques for detection of latent infection of bacterial wilt and viruses in potato seed (6)	Burundi, Cameroon, Ethiopia, Madagascar, Rwanda, Uganda
Training workshop introducing the farmer field school methodology (31)	Peru
Workshop on gene flow in originating centers and diversity impact (35)	Belgium, Peru
Workshop on Late Blight simulation (9)	Denmark, Ecuador, Peru
Workshop on potato SSR analysis and database development (32)	Argentina, Belgium, Bolivia, Colombia, Ecuador, France, Peru
Workshop on the development and dissemination of improved varieties (32)	Argentina, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Ecuador, Panama, Peru, Venezuela
Workshop on the homologation of potato and Andean roots and tubers genetic resources collections - Part II (6)	Bolivia, Ecuador, Peru
Workshop on the participatory development of productive chains and platform consultations (17)	Bolivia, Ecuador, Peru, Switzerland
Workshop on the politics impacting waste land ecosystems: Analysis and proposals (18)	Bolivia, Ecuador, Peru

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Partners

AARI Aegean Agricultural Research Institute • **AARI** Ayub Agricultural Research Institute • **AAS** Academy of Agricultural Sciences • **ACIAR** Australian Centre for International Agricultural Research • **ADB** Asian Development Bank • **ADT** Akukuranut Development Trust • **AFRENA** African Resource Network in Agro-Forestry, Uganda • **AFRICARE** • **AGERI** Agriculture Genetic Engineering Research Institute • **A**ustrian Agency for Health and Food Safety • **A**gricultural Research Council • **A**gricultural Research Institute • **AHI** African Highland Initiative - convened by the World Agroforestry Center • **A**inshams University, Faculty of Agriculture • **AIAT-WS** Agricultural Technology Assessment Institute West Sumatra • **AIT** Asian Institute of Technology • **A**lemaya University of Agriculture • **A**ngola Seeds of Freedom Project • **A**nhui Academy of Agricultural Science • **APPRI** Agricultural Plant Protection Research Institute • **APROSEPA** Asociación de Productores de Semilla de Papa • **A**rapai College • **A**ssociation for Andean Technical-Cultural Promotion • **ARC** Agriculture Research Centre • **ARC** Agricultural Research Corporation • **ARC** Agricultural Research Council • **ARCsr** Agriculture Research Centre, Seibersdorf • **ARDC** Agricultural Research and Development Centre • **AREA** Agricultural Research and Extension Authority • **ARI** Agricultural Research Institute • **ARI** Agricultural Research Institute • **ARO** Agricultural Research Organization • **ASAR** Asociación de Servicios Artesanales y Rurales • **ASARECA** Association for Strengthening Agricultural Research in Eastern and Central Africa • **ASPADERUC** Asociación para el Desarrollo Rural de Cajamarca • **ATDTP** Agricultural Technology Development and Transfer Project • **AT-Uganda** Appropriate Technology Uganda • **AVRDC** Asian Vegetable Research and Development Center • **A**wasa Research Centre • **BADC** Bangladesh Agricultural Development Corporation • **BAR** Bureau of Agricultural Research, Department of Agriculture • **BARI** Bangladesh Agricultural Research Institute • **B**aguio City Nutrition Council, Philippines • **B**eratungsgruppe Entwicklungsorientierte Agrarforschung • **B**iodiversidad y Genética • **B**angladesh Rural Advancement Committee • **BRC** Biotechnology Research Center, Vietnan • **BRRI** Bangladesh Rice Research Institute • **B**enguet State University • **B**iotecnología Agropecuaria SA • **B**uganda Cultural Development Foundation • **B**vumbwe Research Station • **CAAS** Chinese Academy of Agricultural Sciences • **CAB** International • **C**ollege for Agriculture and Forestry • **CARDI** Caribbean Agricultural Research and Development Institute • **CARE**-Bangladesh • **CARE**-Kenya • **CARE**-Peru • **CARE**-Rwanda • **C**hina Agricultural University • **CavSU** Cavite State University • **CBC** Centro Bartolomé de las Casas • **C**hinese Center for Agricultural Policy • **C**entral de Cooperativas Agrarias de Cañete y Mala • **C**entro Ecuménico de la Promoción y Acción Social • **CEMOR** Cemor Editores & Promotores • **CENA** Civil Engineers Network Africa • **C**endrawasih University • **C**entro de Investigación Agrícola Tropical, Bolivia • **C**entro de Investigación en Biotecnología • **C**entros de Reproducción de Entomógenos y Entomopatógenos • **CERGETYR** Centro Regional de Recursos Genéticos de Tuberosas y Raíces • **CFC** Common Funds for Commodities • **C**hiang Mai University • Christian **AID** • **CIAAB** Centro de Investigaciones Agrícolas A. Boerger • **CIAD** Center for Integrated Agricultural Development • **CICA** Centro de Investigación en Cultivos Andinos • **CIDA** Canadian International Development Agency • **CIED** Centro de Investigación, Educación y Desarrollo • **CIPDER** Consorcio Interinstitucional para el Desarrollo Regional Cajamarca • **CIRNMA** Centro de Investigación de Recursos Naturales y Medio Ambiente • **CLADES** Consorcio Latinoamericano de Agroecología y Desarrollo • **CLSU** Central Luzon State University • **CNCQS** Chinese National Centre for Quality Supervision and Test of Feed • **CNPH** Centro Nacional de Pesquisa de Hortaliças • **CODESE** Comité de Semilleristas • **C**omunité de Yaounde • **CONAM** Consejo Nacional del Ambiente • **CONCYTEC** Consejo Nacional de Ciencia y Tecnología • **CFHF** Conservation, Food and Health Foundation • **C**onsorcio Surandino • **COPASA** Cooperación Peruano Alemana de Seguridad Alimentaria • **CORPOICA** Corporación del Instituto Colombiano Agropecuario • **CPPS** Chongqing Plant Protection Station • **C**entre de perfectionnement et de recyclage agricole de Saïda • **CPRI** Central Potato Research Institute • **CPRS** Central Potato Research Station • **C**entro Regional de Investigación en Biodiversidad Andina • **CRIFC** Central Research Institute for Food Crops • **CRIH** Central Research Institute for Horticulture • **CRP**-Gabriel Lippmann, Luxembourg • **CRS** Catholic Relief Services, Kenya, Uganda, Sudan, Indonesia • **CTCRI** Central Tuber Crops Research Institute • **DAE** Department of Agricultural Extension • **DANIDA** Danish International Development Agency • **DARHRD** Department of Agricultural Research and Human Resource Development • **D**epartment of Agriculture • **D**epartment of Agriculture • **D**epartment of Agriculture, Phichit Horticultural Research Center • **DFID** Department for International Development • **DINAREN** Dirección Nacional de Recursos Naturales Renovables, Ecuador • **D**inas Peternakan Wamena • **D**irección Nacional de Sanidad Vegetal • **D**irectorate of Root Crop Production, Ministry of Agriculture • **DPP** Department of Plant Protection, Ministry of Agriculture and Rural Development • **DPKR AAS** Academy of Agricultural Sciences of the DPRK • **DRCFC** Dalat Research Center for Food Crops • **DRDS** Department of Research and Development Services • **DRUK** Seed Corporation of Bhutan • **IAR** Ethiopian Agricultural Research Organization • **EARRNET** Eastern Africa Root Crops Research Network • **EC** European Commission • **ECABREN** Eastern and Central Africa Bean Research Network • **ECAPAPA** Eastern and Central Africa Programme for Agricultural Policy Analysis • **EMBRAPA** Empresa Brasileira de Pesquisa Agropecuária • **E**mpresas de Cultivos Varios del Ministerio de Agricultura • **ESH** Ecole supérieure d'horticulture • **ETH** Swiss Federal Institute of Technology Zurich • **FAO** Food and Agriculture Organization of The United Nations • **FAPESP** Fundação de Amparo à Pesquisa do Estado de São Paulo • **FCRI** Food Crops Research Institute,

Vietnam • **FDR** Fundación para el Desarrollo Rural, Peru • **FIELD** Farmer Initiatives for Ecological Livelihood and Democracy • **FOFIFA/FIFAMANOR** Centre national de la recherche appliquée au développement rural • **F**ood Crop Research Institute • **F**ondo Regional de Tecnología Agropecuaria/Red Internacional de Metodología de Investigación de Sistemas de Producción • **FOODNET** (ASARECA network implemented by IITA) • **FORD** Foundation • **F**ortalecimiento de la Investigación y Producción de Semilla de Papa • **FOVIDA** Fomento de la Vida • **FUNDAGRO** Fundación para el Desarrollo Agropecuario • **FUNDANDES** Fundación para el Ambiente Natural y el Desarrollo • **GAAS** Guangdong Academy of Agricultural Sciences • **GKF** Grameen Krishi Foundation • **G**overnment of Belgium • **G**overnment of China • **G**overnment of Denmark • **G**overnment of France • **G**overnment of Germany • **G**overnment of India • **G**overnment of Italy • **G**overnment of Mexico • 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Agronómico Nacional • **IAS** Institute of Agricultural Sciences, Ministry of Agriculture and Rural Development • **IASA** Instituto Agropecuario Superior Andino • **IAV** Institut agronomique et vétérinaire Hassan II • **ICA** Instituto Colombiano Agropecuaria • **ICAR** Indian Council of Agricultural Research • **ICO CEDEC** Instituto de Capacitación del Oriente • **IDEA** Instituto Internacional de Estudios Avanzados • **IDIAP** Instituto de Investigación Agropecuaria de Panamá • **IDRC** International Development Research Centre **CBNRM** Community-Based Natural Resources Management Programme • **IEBR** Institute of Ecology and Biological Resources • **IESR/INTA** Instituto de Economía y Sociología Rural del INTA • **IFAD** International Fund for Agriculture Development • **INN** Instituto de Investigación Nutricional • **IIRR** International Institute of Rural Reconstruction • **IMA** Instituto de Manejo de Agua y Medio Ambiente • **INAMHI** Instituto Nacional de Meteorología e Hidrología • **INCAGRO** Innovación y Competitividad para el Agro Peruano • **INERA** Institut nationale d'études et de recherches agricoles • **INIA** Instituto Nacional de Investigacão Agronómica • **INIA** Instituto Nacional de Investigación Agraria • **INIA** Instituto Nacional de Investigaciones Agropecuarias • **INIA** Instituto Nacional de Investigaciones Agropecuarias • **INIA** Instituto Nacional de Investigaciones Agrícolas • **INIA** Instituto Nacional de Investigaciones Agropecuarias • **INIFAP** Instituto Nacional de Investigaciones Forestales y Agropecuarias • **INIVIT** Instituto Nacional de Investigación de Viandas Tropicales • **IMPOFOS** Instituto de la Potasa y el Fósforo • **INRA** Institut national de la recherche agronomique • **INRA** Institut national de la recherche agronomique • **INRAT** Institut national de la recherche agronomique de Tunisie • **I**nstituto Rural Valle Grande, Cañete, Peru • **INTA** Instituto Nacional de Tecnología Agropecuaria • **IPAC** Instituto de Promoción Agropecuaria y Comunal • **IPB** Institut Pertanian Bogor Indonesia • **IPDA** Instituto de Promoción y Desarrollo Agrario • **IRA** Institut de recherche agronomique • **IRAD** Institut de recherche agricole pour le développement • **IRD** Institut de recherche pour le développement • **IRI** International Research Institute for Climate Prediction • **ISABU** Institut des sciences agronomiques du Burundi • **ISAR** Institut des sciences agronomiques du Rwanda • **ISTPC** Instituto Superior Tecnológico Público de Cañete • **JAAS** Jiangsu Academy of Agricultural Sciences • **J**erusalen de Porcon Cooperative • **JKUAT** Jomo Kenyatta University of Agriculture and Technology • **JTTK** Jaringan Tani Tanah Karo, Indonesia • **KARI** Kenyan Agricultural Research Institute • **K**augu & Katheri Farmers • **KEPHIS** Kenya Plant Health Inspectorate Service • **L**a Habana University, Chemistry Faculty, Cuba • **L**ake Basin Development Authority • **LDI** Landscape Development Intervention • **M**akerere University • **MANRECUR** Manejo Colaborativo de Recursos Naturales en la Subcuenca del Río el Angel • **MARDI** Malaysia Agriculture Research Development Institute • **MARS** Mwara Agricultural Research Institute • **M**ianning Agriculture Bureau • **M**inisterio de Agricultura • **M**inisterio Presidencia • **M**inisterio Relaciones Exteriores • **M**inistry of Agriculture, China • **M**inistry of Agriculture, Ecuador • **M**inistry of Agriculture, Eritrea • **M**inistry of Agriculture and Cooperatives, Division of Research and Development • **M**inistry of Agriculture and Land Reclamation • **M**ariano Marcos State University • **MSIRI** Mauritius Sugar Industry Research Institute • **M**unicipalidad Distrital Baños del Inca Peru • **N**amulonge Agricultural and Animal Research Institute • **N**anchong Agricultural Research Institute • **NARC** National Agricultural Research Centre • **NARC** Nepal Agricultural Research Council • **NARO** National Agricultural Research Organization • **NRI** Natural Resources Institute • **NCVESC** National Center for Variety Evaluation and Seed Certification • **NIAH** National Institute of Animal Husbandry • **N**kozi University • **NOAA** National Oceanic and Atmospheric Administration • **NOMIARC** Northern Mindanao Agricultural Research Center • **N**omorionteetab Kibagenge • **NPRC** National Potato Research Centre Tigoni • **NPRP** National Potato Research Program • **NUS** National University of Singapore • **ODER** Oficina de Desarrollo Rural–Chalaco • **PCARRD** Philippine Council for Agriculture, Forestry and Natural Resources Research and

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Mercadeo de Tubérculos Andinos, Universidad Mayor de San Simón • **P**rograma de Modernización de Servicios Agropecuarios • **PRONAMACHCS** Proyecto Nacional de Manejo de Cuencas Hidrográficas y Conservación de Suelos • **PROSHIKA** A Centre for Human Development • **PRP** Potato Research Programme • **RANTIK** Ltd • **RAU** Rajendra Agricultural University • **RDA** Rural Development Agency • **REFSO** Rural Energy and Food Security Organization • **R**egional Agricultural Research and Development Centre • **RIAP** Research Institute for Animal Production • **RIFAV** Research Institute for Fruits and Vegetables • **R**esearch Institute for Food Crops Biotechnology • **RILET** Research Institute for Legume and Tuber Crops • **RIV** Research Institute for Vegetables • **RCRC-VASI** Root Crop Research Center, Vietnam Agricultural Science Institute • **RNC-RC** Jakar • **R**ockefeller Foundation • **SAAS** Shangdong Academy of Agricultural Sciences • **SARDI-UMCOR** Sustainable Agricultural and Rural Development Initiative–United Methodist Committee on Relief • **SARIF** Sukamandi Research Institute for Food Crops • **SARRNET** Southern Africa Root Crops Research Network • **UK Ltd** Save the Children • **SDC** Swiss Agency for Development and Cooperation • **SEAG** Servicio de Extensión Agrícola y Ganadera • **SEAMEO** Southeast Asian Ministers of Education Organization Regional Center for Graduate Study and Research in Agriculture • **SEMTA** Servicios Múltiples de Tecnologías Apropiadas • **SENASA** Servicio Nacional de Sanidad Agraria • **SENASAG** Servicio Nacional de Sanidad Agropecuaria e Inocuidad Alimentaria • **SENASEM** Service National de Semences, DR Congo • **U**nidad de Producción de Semilla de Papa • **SESA** Servicio Ecuatoriano de Sanidad Agropecuaria • **ShAAS** Shandong Academy of Agricultural Sciences • **SHDI** Self-Help Development International • **SiAAS** Sichuan Academy of Agricultural Sciences • **SIDA** Swedish International Development Cooperation Agency • **SINITTA** Sistema Nacional de Investigación y Transferencia de Tecnología Agraria • **SITIOS** Servicios Inteligentes y Tecnologías Complejas Superiores Ltd • **SLART** Sociedad Latinoamericana de Raíces y Tubérculos • **SNSA** Service National des Statistiques Agricoles • **SOCADIDO** Soroti Catholic Diocese Development Organization • **S**okoine University of Agriculture • **S**outh China Agricultural University • **S**outh China Potato Center • **S**outhern Regional Agricultural Bureau, Ministry of Agriculture • **S**outhwest Agricultural University • **SPDA** Sociedad Peruana de Derecho Ambiental • **SPG** Sociedad Peruana de Genética • **C**entro de Investigación de Semilla de Papa • **S**ukarami Agricultural Technology Assessment Institute • **TAAS** Tianjing Academy of Agricultural Sciences • **TALPUY** Grupo de Investigación y Desarrollo de Ciencias y Tecnología Andina • **TARI** Taiwan Agricultural Research Institute • **TCA** Tarlac College of Agriculture • **TCRC** Tuber Crops Research Centre • **T**eso Community Development Project • **TFNC** Tanzania Food and Nutrition Centre • **T**hai Nguyen University • **T**hang Binh District Agriculture and Rural Development Bureau • **T**he International Foundation • **T**he McKnight Foundation • **T**he Micronutrient Initiative • **T**he OPEC Fund for International Development • **T**ibetan Academy of Agricultural and Animal Science • **TP4** Tim Petani Pemandu PHT Pengalengan • **UANRDEN** Urban Agriculture National Research, Development and Extension Network • **U**gunja Community Resource Centre • **UNEP** United Nations Environment Programme • **UNHAS** Hasanudin University • **U**niversidad Austral • **U**niversidad Nacional de Cajamarca • **U**niversidad Católica de Santa Maria • **U**niversidad Central • **U**niversidad Central de las Villas • **U**niversidad de Ambato • **U**niversidad de Caldas • **U**niversidad de los Andes • **U**niversidad Federal Rio de Janeiro • 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Institute • **PICTIPAPA** Centro Internacional de Agricultura Tropical • **ILRI** International Livestock Research Institute • **WAU** Wageningen Agricultural University • **T**he University of California, Davis • Waseda University • **CENARGEN** • **USDA** United States Department of Agriculture • **C**ornell University • **G**ross Lusewitz • **U**niversity of Wisconsin • **C**atholic University of Leuven • **A**gencia Sueca de Cooperación Internacional para el Desarrollo • **NRI** Natural Resources Institute • **U**niversity of Wageninen • **C**ornell University • **CIRAD** • **T**exas A&M University • **ASDI-SAREC** Agencia Sueca de Cooperación Internacional para el Desarrollo • **INTA** Instituto Nacional de Tecnología Agropecuaria • **U**niversity of Buenos Aires • **C**atholic University of Leuven • **EMBRAPA** • **ER**, Agropolis, Montpellier • **v**on Mikroorganismen und Zellkulturen GmbH • **A**gricultural University of Norway • **P**ontificia Universidad Católica del Perú • 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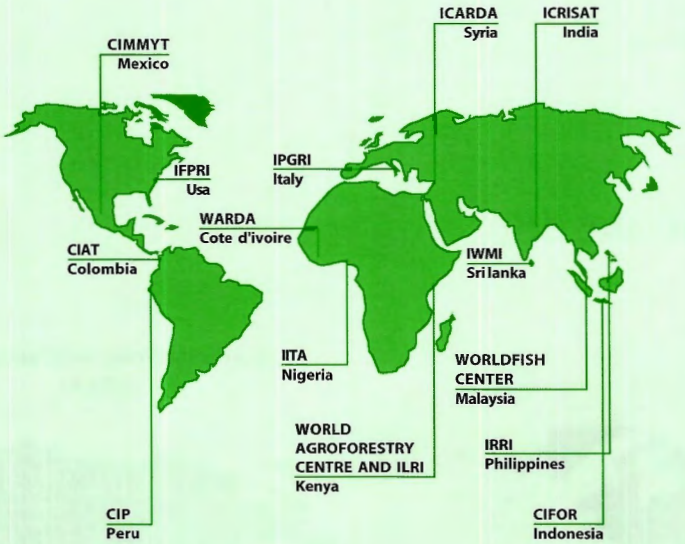
CIP in the world

Future Harvest

CIP is one of 15 food and environmental research centers located around the world that make up the Future Harvest Alliance. The Future Harvest Centers receive their principal funding through the Consultative Group on International Agricultural Research (CGIAR), a strategic global partnership of countries, international and regional organizations, and private foundations. Working with national agricultural research systems, the private sector and civil society, the CGIAR mobilizes agricultural science to reduce poverty, foster human wellbeing, promote agricultural growth, and protect the environment.

The Centers collaborate among themselves and with their diverse partners through numerous projects and system-wide programs. The CGIAR is also creating a series of independently governed partnerships among a wide range of institutions for high-impact research that targets complex issues of overwhelming global and/or regional significance. CIP has substantial participation in each of these Challenge Programs, and intends to extend this involvement to the Sub-Saharan Africa Challenge Program, currently being formulated. Over the past two years, three Challenge Programs have been established:
The Challenge Program on Water and Food, The HarvestPlus Challenge Program, The Generation Challenge Program

Future Harvest Center



CIAT	Centro Internacional de Agricultura Tropical
CIFOR	Center for International Forestry Research
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo
CIP	Centro Internacional de la Papa
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
IPGRI	International Plant Genetic Resources Institute
IRRI	International Rice Research Institute
IWMI	International Water Management Institute
WARDA	West Africa Rice Development Association
	World Agroforestry Centre
	WorldFish Center

The International Potato Center (CIP) seeks to reduce poverty and achieve food security on a sustained basis in developing countries through scientific research and related activities on potato, sweetpotato, and other root and tuber crops, and on the improved management of natural resources in the Andes and other mountain areas.

The CIP Vision

The International Potato Center (CIP) will contribute to reducing poverty and hunger; improving human health; developing resilient, sustainable rural and urban livelihood systems; and improving access to the benefits of new and appropriate knowledge and technologies. CIP, a World Center, will address these challenges by convening and conducting research and supporting partnerships on root and tuber crops and on natural resources management in mountain systems and other less-favored areas where CIP can contribute to the achievement of healthy and sustainable human development.
www.cipotato.org

CIP is a Future Harvest Center and receives its principal funding from a group of governments, private foundations, and international and regional organizations known as the Consultative Group on International Agricultural Research (CGIAR).
www.futureharvest.org
www.cgiar.org

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Annual Report 2004

The international community has emphasized its intention to support the Millennium Development Goals (MDG) and we in the Consultative Group on International Agricultural Research (CGIAR) can contribute to many of the targets set within those goals. Currently the Science Council of the CGIAR is setting priorities for the CGIAR System to address them in a systematic manner, with the intention that the donor community will support them and give a strong foundation for long term research to prosper and produce Global Public Goods. The International Potato Center (CIP) has agreed on a new vision which addresses these MDGs, but vision in itself is not enough, we are now actively embedding this within the institution both in programs and with our staff.

The Board of Trustees has been active in ensuring we have the highest standards of governance. In 2004 the Board of the Alliance of the Future Harvest Centers of the CGIAR initiated board orientation and training courses to improve standards of governance at all centers, CIP has been an active participant in this. It is through good governance that the Board exercises its responsibilities to provide leadership, direction and oversight that are rightly required by our stakeholders. Indeed in 2004 this leadership was demonstrated when the Board selected a new Director General, Dr. Pamela K. Anderson to succeed Dr. Hubert Zandstra when he retires in 2005. A planned and controlled change of Director General creates a stable environment in which our work can flourish. The Center has again achieved its financial targets whilst at the same time ensuring our research output is both relevant and productive.

This Annual Report will give you an insight into the high quality of work that takes place at CIP and demonstrates we have real outputs and outcomes that improve the lives of many of the poorest people in the world.

Jim Godfrey
Chairman

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