CIP
INTERNATIONAL POTATO CENTER

Annual Report 2018

Towards food system transformation

Towards food system transformation

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CIP/ H. Rutherford

Foreword

Innovative technologies and dynamic markets can offer women and young agripreneurs opportunities, consumers greater access to nutritious food, and farmers help in adapting to and mitigating climate change.

These opportunities come with challenges. Pushing our planet's environmental boundaries means we will have to produce more with less in the future. No one food source has all the solutions. But as the third and sixth most important food crops in terms of human consumption, potato and sweetpotato can play a central role in contributing to global food system transformation.

Sweetpotato has a proven capacity to contribute to the reduction of vitamin A deficiency, one of the most harmful forms of undernourishment affecting children under 5 in Africa and Asia. Consumed by more than one billion people worldwide, potato contributes to the incomes and wellbeing of tens of millions of small-scale farmers and businesses. New heat- and drought-tolerant potato and sweetpotato varieties are helping farmers adapt to the ravages of climate change. Early-maturing potatoes provide more flexibility for cultivation, allowing the crop to be grown during fallow periods of cereal-based systems, which relieves pressure on scarce land and water resources, improves farm incomes, and contributes to the sustainable intensification and diversification of agri-food systems.

In pursuing a healthy, inclusive and resilient world through root and tuber farming systems, the International Potato Center (CIP) works closely with a myriad of national and international partners in providing evidence to decision-makers, facilitating the adoption at scale of science-based practices and building capacities of key stakeholders. Our outcomes—the scientific evidence, proven technologies and development pathways—contribute to meeting seven of the United Nations Sustainable Development Goals (SDGs).

Between 2013 and 2018, research for development by CIP and partners has benefited more than seven million households. This report provides examples of how CIP and its many partners are helping to meet specific SDGs. These include: upskilling farmers for new opportunities in Asia; catalyzing markets in Kenya; enabling greater food and nutrition security in Malawi; safeguarding and using agrobiodiversity in Peru; and climate-smart sweetpotato breeding in Africa.

By developing, disseminating and promoting biofortified orange-fleshed sweetpotato varieties, CIP-led work has established this crop as a cost-effective and sustainable nutritious food source. By working with large food processors and fresh root traders in Africa, we have also facilitated the development of new sweetpotato value chains and income generating opportunities for women and young people. Our adaptive research on the management of potato seed quality, integrated cropping, postharvest and value chain approaches has helped farmers in Africa, Asia and Latin America significantly increase yields and incomes.

The dynamic and highly heterogeneous farming and production systems worldwide require new approaches. To enhance our capacity to deliver innovative science-based solutions, CIP revised its corporate strategy in response to changing global needs and development priorities. Over the next five years, it will guide our efforts in reaching a further 10 million households with innovative technologies to improve nutritional outcomes, foster employment and business growth, and drive climate resilience.

All these achievements have been made possible by the generosity of our funders, the dedication and passion of our staff and partners, and the strength of our broad-based agri-food system partnerships. Central to our partnerships has been the CGIAR Research Program on Roots, Tubers and Bananas (RTB). A truly collaborative endeavor, recognized for its research achievements, RTB demonstrates how targeted investments in research for development can contribute to the delivery of innovative solutions for the world's most pressing challenges.

Barbara H Wells
Director General

Rodney Cooke
Chair, Board of Trustees

CIP/S. Quinn

Business opportunities

Women in Concepción village, on the Philippine island of Bohol, produce sweetpotato candies for sale (credit CIP/ S. Fajardo).

Down to business

Gaining skills and grasping opportunities in the Philippines

Small-scale farmers grow their crops with few guarantees of markets for them.

Limited business skills or information on demand frequently means these farmers have to rely on intermediaries who set prices for their goods. Small farms often unable to sell their crops, or are just able to grow enough to feed their families. Greater knowledge of markets, credit and product development could contribute to adding value to and extending the shelf life of their goods.

Institutionalizing processes which commit government partners to supporting start-up businesses has been a focus of the International Fund for Agricultural Development (IFAD). The United Nations agency supports sustainable rural development through the provision of a mix of loans to governments and grants to partners. One such successful grant initiative has been the farmer business school, which combines a focus on crop production and processing with participatory market chain approaches to help smallholders develop new products and engage with other value chain actors.

In 2011, the International Potato Center (CIP) first received a grant to run farmer business schools in the Philippines, followed by a second grant in 2015 extending the work to India and Indonesia. The 6- to 10-month business schools teach farmers how to undertake market assessments, and develop and market new products.

Attentive to the importance of inclusive growth, scientists developed gender-responsive training materials and checklists for field staff, who ensured that at least half the participants were women. Participants are helped to pool their resources to produce the larger volumes of products needed to be competitive. Each school group develops a business, which is then launched on graduation day.

In San Carlos, a remote community on the Philippine island of Bohol, where the poverty rate is almost 50%, CIP combined the business school approach with agronomic training and distribution of planting material for nutritious orange- and purple-fleshed sweetpotato varieties. In 2018, a group of women in San Carlos launched Camoteville, a business producing and selling sweetpotato jams, juices and candies on the island.

Camoteville manager Catalina Escabas explained that the farmer business school had an important impact on her

life. "I finally know how to start up a business and how to turn *camote* (sweetpotato) into a profit, so I can earn more income for my family," she said.

And they have thrived! One IFAD loan which started in the Philippines in 2011 with six pilot schools that launched businesses grew to almost 100 business groups by 2015. By 2019, they numbered more than 150 in three countries, and 79% of graduates were women. The approach has been taken up by government agencies and NGOs in the partner countries. For instance, partners such as the Visayas State University have also adopted the model and implemented it with other NGOs to reach even more farmers.

Originally focusing on root and tuber crops, the business schools were adapted and expanded to fishing communities in the Philippines. The 'aqua-based business schools' served 36 coastal communities participating in the IFAD-funded Fisheries, Coastal Resources and Livelihoods (FishCORAL) project. They launched an array of products, prompting FishCORAL managers to organize a second round of business schools for 2019.

Such buy-in attests to the potential of inclusive farmer business schools in improving competitiveness and incomes. The institutional support received from key civil society groups and government partners bodes well for the sustainability of such initiatives.

Catalina Escabas and her neighbors in San Carlos, on the Philippine island of Bohol, launched a business called Camoteville that makes sweetpotato juices, sauces and other products (credit CIP/ S. Fajardo).

Funders: CGIAR System donors through the CGIAR Research Program on Roots, Tubers and Bananas; European Commission; International Fund for Agricultural Development.

Key partners: Bureau of Fisheries and Aquatic Resources, Philippines; Central Tuber Crops Research Institute, India; Central Potato Research institute, India; Department of Agriculture, Philippines; Department of Environmental and Natural Resources, Philippines; Indonesian Agency for Food Security; Indonesian Center for Agricultural Postharvest Research and Development; Indonesian Legumes and Tuber Crops Research Institute; International Center for Tropical Agriculture; Meghalaya Basin Development Authority, India; Ministry of Agriculture, Indonesia; Visayas State University.

Associated CGIAR Research Programs: Roots, Tubers and Bananas; Climate Change, Agriculture and Food Security.

Potato apical cutting production in a Stokman Rozen Ltd screenhouse in Naivasha, Kenya (credit CIP/ E. Atieno).

Seeds of success

Catalyzing potato value chains in Kenya

Potato is an increasingly important food crop in much of Africa. Production on the continent has risen 15-fold since 1960.

Long a food security crop, potato is increasingly seen as an employment and income generator, both for farmers and agribusinesses. In Kenya alone, estimates put employment along the value chain at 2.5 million people and the value of the annual potato harvest in 2017 at USD 480 million.

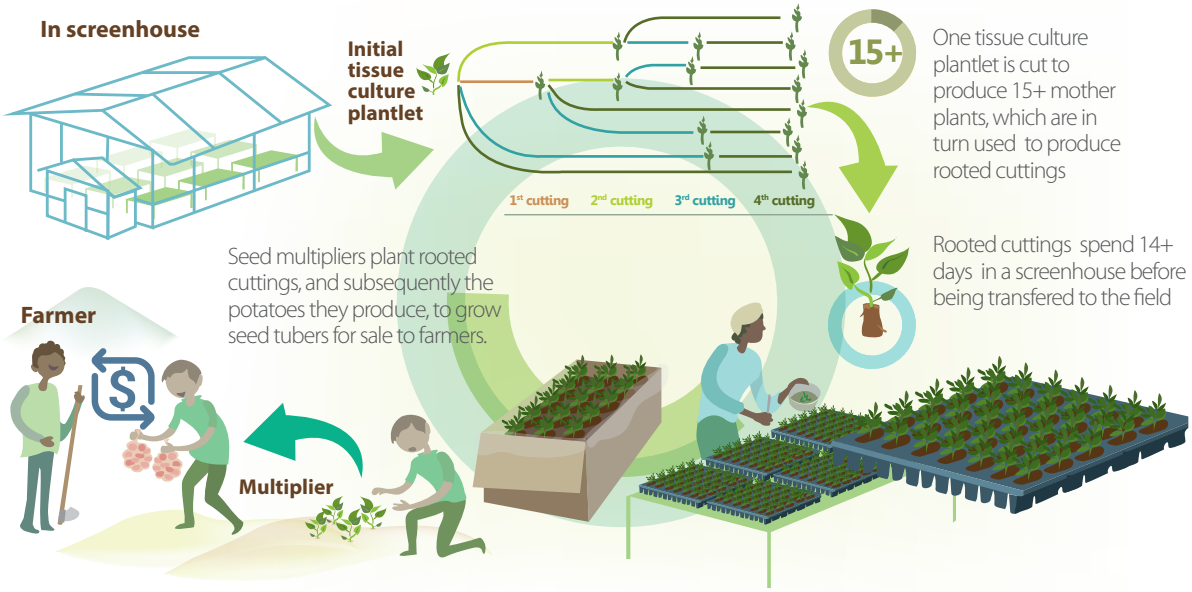
Yet growth in farm incomes in Kenya, and other countries, is hindered by low yields: 8-15 tons per hectare, about half of what smallholder farmers could realistically achieve. Most African potato farmers plant poor quality seed tubers they save from earlier harvests or purchase on largely unregulated local markets. Often infected with diseases, these seed potatoes perform poorly. Expanding farmer access to quality seed of improved potato varieties is essential to boosting yields and earnings.

Scientists from the International Potato Center (CIP) chose Kenya—a major potato producer in Africa —to introduce a simple yet innovative technology to ramp up production of high-quality seed. Known as rooted apical cuttings, the technology was developed years ago by scientists from CIP and the Vietnamese Research Center for Experimental Biology and has greatly improved potato yields in southern Vietnam. It is now driving business opportunities in the East Africa nation.

The problem is that seed potato multiplication rates are low compared to other crops—approximately 10 seed tubers per plant. This seriously hinders production. Over the past decade, CIP-promoted technologies for the production of mini-tubers—used to grow disease-free seed potato—have contributed to a ten-fold increase in supply in Africa.

The use of apical rooted cuttings further accelerates the multiplication process, producing more seed potato more quickly and cheaply than other methods. Researchers estimate that growers can earn 40% more from apical cuttings than from mini-tubers.

The innovation begins with tissue culture plantlets grown in a screenhouse. Before the plantlets mature, cuttings are taken from their shoots and placed in seedling pots. More cuttings are then taken from each new plant. One tissue culture plantlet can thus produce more than 100 rooted cuttings, and in turn 1,000–2,000 seed potatoes.



Introduced in Kenya just two years ago, the technology has already been included in the new national potato certification protocol and private companies produce and sell apical cuttings to farmers, who use them grow seed tubers. More than 265,000 rooted apical cuttings were sold in Kenya in 2018, half of which were purchased by farmers for approximately USD 16,000. In just two planting cycles (one year), those cuttings could potentially generate seed potato worth USD 265,000–500,000.

Dozens of seed 'multipliers' and smallholder farmers have purchased cuttings to produce seed. One of them, Cecinta Nduru, used to grow potatoes for the local market but now earns much more as a seed producer. With CIP training, she began producing her own apical cuttings from tissue plantlets in a small nursery.

"This technology gives very high returns in terms of seed quantity and quality," Cecinta said.

Cecinta is one of a growing number of multipliers who are producing apical cuttings in satellite nurseries in Kenya. The technology is also being used by two private companies in Uganda. It has the potential to greatly expand the supply of quality seed potato, which can double farmer yields under current smallholder conditions. It is poised to contribute significantly to CIP's goal of improving the yields and incomes of five million households by 2023.

Cecinta Nduru shows farmers disease-free seed potatoes grown from rooted apical cuttings, Meru County, Kenya (credit CIP/ V. Atakos).

Funders: CGIAR System donors through the CGIAR Research Program on Roots, Tubers and Bananas; Deutcshe Gesellschaft fur Internationale Zusammenarbeit; Federal Ministry for Economic Cooperation and Development, Germany; Syngenta Foundation for Sustainable Agriculture; United States Agency for International Development.

Key partners: Farm Input Promotions Africa; Kenya county governments of Elgeyo-Marakewt, Meru, Nandi and Uasin Gishu; Kenya Plant Health Inspectorate Service.

Associated CGIAR Research Programs: Roots, Tubers and Bananas; Agriculture for Nutrition and Health.


CIP/ A. Frezer


Food and
nutrition security

Orange-fleshed sweetpotato has contributed to a vast reduction of vitamin A deficiency in children in Malawi (credit CIP/ S. Quinn).

Leaving hunger behind

Productivity gains in drought-prone Malawi

Malawi is an excellent example of the potential of potato and sweetpotato for bolstering food and nutrition security.

Multi-partner efforts have enabled approximately 1.6 million people in rural Malawi to improve their diets and farm resilience with the help of nutritious, high-yielding sweetpotato and potato varieties.

In 2018, Malawi's Department of Agricultural Research Services released three orange-fleshed sweetpotato varieties — progenies of crosses between International Potato Center (CIP) breeding lines and local varieties. They brought the number of Malawian orange-fleshed varieties to nine, as part of a multi-pronged approach that combines breeding, seed systems to disseminate quality planting materials, agronomic training, and nutrition and diet diversity education.

Just 125g of orange-fleshed sweetpotato meets the daily vitamin A needs of a child under 5. Sweetpotato and potato also have high levels of vitamins C and B6 and other nutrients that make them good dietary complements to maize — Malawi's principal staple crop. Their vitamin content and ability to produce plenty of calories per hectare relatively quickly make them ideal crops for combatting hunger and undernutrition.

Most new potato and sweetpotato varieties are also drought tolerant, vital in a country with up to eight months a year of dry weather. During an especially severe drought in 2016, approximately 6.5 million Malawians depended on food aid to make ends meet. The release and dissemination of climate-smart sweetpotato varieties by the government, CIP and partners has been a game changer for more than 300,000 farming households who had received planting material and agronomic training.

Loveness and Lighton Kalira and their four children in southern Malawi are one such household. The Kalira family, who traditionally grew maize and pigeon peas, added orange-fleshed sweetpotato several years ago. Despite an extended dry spell in 2017-18 wiping out their maize crop, their sweetpotato harvest boomed. The Kaliras sold their surplus sweetpotato when prices were high, earning enough to buy maize for the year and pay school fees for their youngest child. Orange-fleshed sweetpotato is now grown and sold across most of Malawi. It has contributed to a reduction in vitamin A deficiency in preschool-aged children from 59% in 2003 to 4% in 2016.

Potato has long been an important food and cash crop in Malawi. To raise the traditionally low yields, more than 60,000 households have received starter packs of 40 seed tubers of improved potato varieties for multiplication and eventual sale.

Because those varieties are early maturing and high yielding, they produce edible tubers before most crops are ready to harvest and much more food per hectare than older varieties. Leonard Mideyo, in central Malawi, received his first packet of seed potatoes in 2015. He now dedicates most of his land to potato, which he eats and sells, earning enough to renovate his home and diversify his diet.

Government programs that produce disease-free planting material for more than 160 decentralized 'multipliers' facilitate the distribution of quality seed tubers or sweetpotato vine cuttings to farmers across the country. Through the provision of nutrition education and support to local businesses in developing new products, such as packaged chips and sweetpotato breads, more families have adopted improved varieties.

Strong multisectoral partnerships have enhanced food productivity, not only increasing the supply of nutritious potato and sweetpotato to approximately 8% of Malawi's population, but also creating capacity to step up wide-scale adoption of improved varieties, with a goal of reaching 1 million households by 2028.

Loveness Kalira in her sweetpotato field (credit CIP/ V. Atakos).

125g

of **orange-fleshed sweetpotato** meets the daily needs of a child under 5

>300,000

households reached with improved varieties, enhancing food and nutrition security

Contributing to reduced malnutrition in Malawi

Vitamin A deficiency in children under 5

2003 59% ▸ 2016 to 4%

Stunted children under 5

2010 47% ▸ 2016 to 37%

Funders: Alliance for a Green Revolution in Africa; Bill & Melinda Gates Foundation; Biotechnology and Biological Sciences Research Council; CGIAR System donors through the CGIAR Research Program on Roots, Tubers and Bananas; Department for International Development United Kingdom; European Union; Irish Aid; United States Agency for International Development.

Key partners: CADECOM; Concern Worldwide; Emanuel International; Malawi Red Cross; Ministry of Agriculture, Irrigation and Water Development Malawi; International Institute of Tropical Agriculture; Project Concern International; Root and Tuber Crops Development Trust; Save the Children; Tetra Tech; United Purpose; Universal Industries Ltd; We Effect; Welt Hunger Hilfe; Youth In Agriculture for Economic Development.

Associated CGIAR Research Program: Roots, Tubers and Bananas.

Just 125 g of orange-fleshed sweetpotato meets the daily vitamin A requirement of a child under 5 (credit CIP/ V. Atakos).

Baskets of health

Advancing biofortification in Nigeria and Tanzania

3 GOOD HEALTH AND WELL-BEING

Nearly a quarter of Africans are affected by micronutrient malnutrition, or hidden hunger, which can result in stunting, mental retardation or blindness in children, increasing their risk of death.

Estimates of the long-term cost of malnutrition on gross domestic product on the continent have been put at 2-11%. Yet experience in Nigeria and Tanzania demonstrates the effectiveness of advocacy with targeted research for development interventions. Over three years, nearly 1 million households, (approximately 5 million individuals), were able to introduce nutritious foods into their diets.

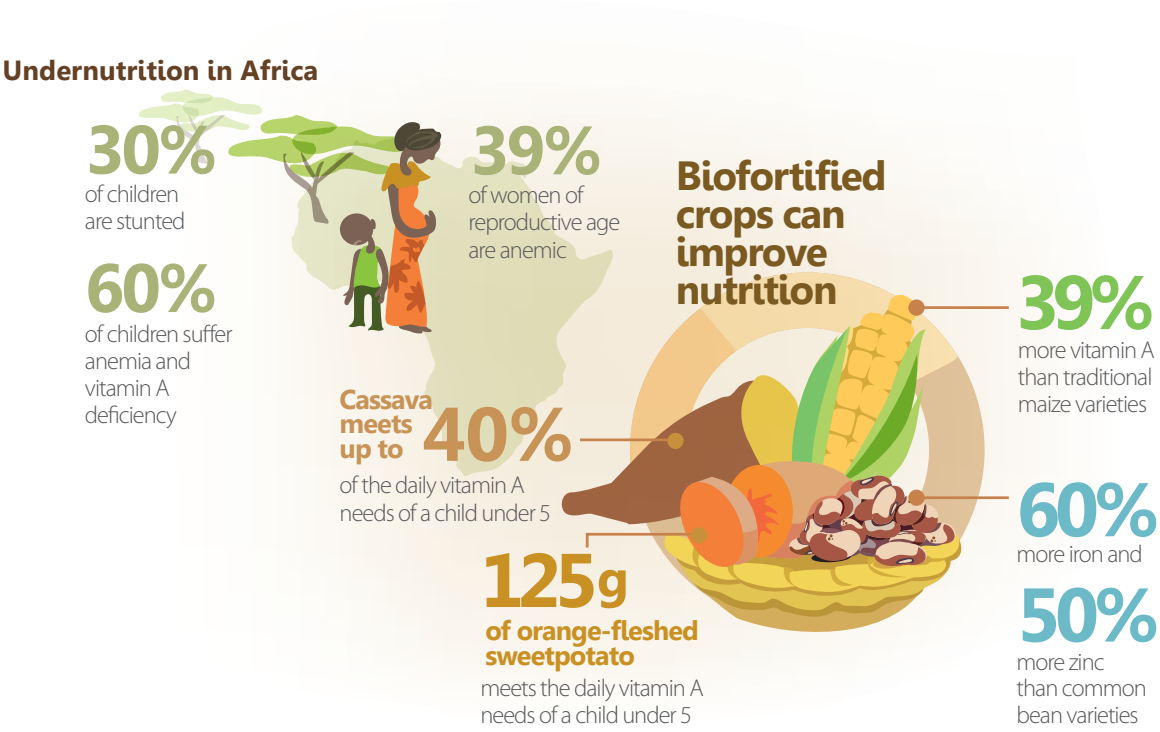
Peer reviewed studies have affirmed that biofortified crops—the products of breeding to increase vitamin and mineral density—can contribute to reducing hidden hunger. An initiative of four CGIAR centers in Nigeria and Tanzania, designed to build nutritious food baskets, leveraged growing concern about malnutrition.

From 2015 to 2018, the multi-partner initiative facilitated greater production of four biofortified crops: pro-vitamin A sweetpotato, cassava and maize, and high iron and zinc bean varieties.

As the lead center, the International Potato Center (CIP) applied its decade-long experience promoting consumption of orange-fleshed sweetpotato in Africa to raise awareness, stimulate investment in biofortified crops and strengthen local capacities to breed, disseminate, grow and process them. In addition, seven nutritious varieties of corn, bean and sweetpotato were released, with another six sweetpotato varieties due to be released in Tanzania by 2020.

To create a more conducive environment, CIP led the recruitment and training of government advocates. They in turn helped ensure the prioritization of biofortification in 11 food and nutrition policy documents and its inclusion in new school feeding programs and regional initiatives.

By the end of 2018, governments, businesses and development organizations in Nigeria and Tanzania had invested more than USD 6.5 million in biofortified crops. The initiative also developed the capacity of NGOs, civil society groups and government agencies ranging from Nigeria's Federal Ministry of Agriculture and Rural



Development to the Tanzania Food and Nutrition Centre to promote biofortified crops.

More than 11,400 'change agents' were trained, including agricultural extension agents, nutritionists and researchers. Gift Buduzhi Oguzor, a community nutritionist in Rivers State, Nigeria participated in a 10-day training-of-trainers course in 2017. Within a year, he had trained 275 other facilitators who in turn trained farmers, contributing to the adoption of pro-vitamin A sweetpotato by more than 1,500 households. His advocacy also encouraged local businesses to begin selling and promoting sweetpotato and related products ranging from juices to breads.

More than half the nearly 12,000 advocates trained were women, who continued to promote biofortified crop cultivation and consumption. Because of their role in food marketing activities and influence over family diets, their participation in capacity building and other activities was prioritized. One example is Fortunatha Mmari, Managing Director of AFCO Investment Company Ltd, in Tanzania, which was supported to begin producing and selling flour made from vitamin A-rich orange maize and sweetpotato.

In addition to empowering a cadre of advocates and entrepreneurs like Gift and Fortunatha, and catalyzing the inclusion of biofortified crops in seven Nigerian and Tanzanian programs, the CGIAR centers validated a model

Thousands of young mothers learned about the nutritional benefits of biofortified crops (credit CIP/ J. Maru)

that can be used to take biofortified crops to scale in other countries or regions. It is expected to result in significant nutritional and financial gains in the coming years, opening up another role for biofortified crops in helping families earn the resources to purchase more varied and healthy foods.

Funder: Bill & Melinda Gates Foundation.

Key partners: African Union Development Agency–New Partnership for Africa's Development; Forum for Agricultural Research in Africa; Government of Nigeria; Government of Tanzania; HarvestPlus; International Center for Tropical Agriculture; International Maize and Wheat Improvement Center; International Institute of Tropical Agriculture.

Associated CGIAR Research Program: Roots, Tubers and Bananas.


CIP/ J. Torres


Climate-resilient,
biodiverse
agriculture

Breeding resilient sweetpotato varieties has been essential for getting that nutritious crop to nearly six million households (credit CIP/ I. Corthier).

Smart about breeding

Hardier sweetpotatoes for harsher climates

13 CLIMATE ACTION

For thousands of years, farmers have chosen the best landraces to improve farm resilience and productivity.

It's a process breeders have systematized with the application of scientific knowledge. Now scientists need to take breeding to a new level to get nutritious sweetpotato into family diets while staying within the earth's environmental boundaries, in the face of population growth, urbanization and climate change.

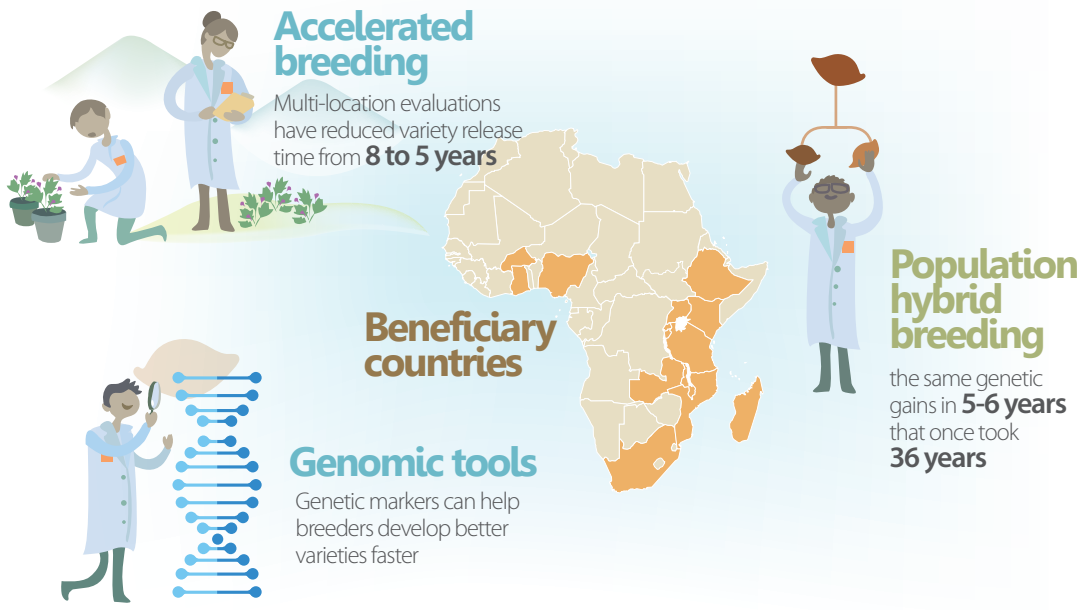
Targeted breeding has been central to the success of the International Potato Center (CIP) in improving the nutritional outcomes of nearly six million households in Africa and Asia since 2010. Extremely rare in Africa 15 years ago, orange-fleshed varieties are now sold in markets across the continent. CIP has catalyzed this process with disease-free planting material and capacity building of their national counterparts in 14 countries.

Over the last decade, CIP established three regional breeding platforms in Africa and made training available for national counterparts. The time needed to launch new varieties was cut from eight years to five and average yields of farmers who adopt those varieties have increased from 10.9 to 18.5 tons per hectare. These innovations have underpinned the release of more than 130 sweetpotato varieties in Africa—mostly of pro-vitamin A orange-fleshed sweetpotato.

To ensure adoption, breeders need to develop nutritious, climate-resilient varieties that combine the most important traits for their target area. This multi-trait selection requires compiling information on the preferences of men, women, children and industry processors, as well as laboratory data on the chemicals and genes responsible for traits.

Understanding gender preferences is key because women usually manage family diets and are increasingly involved in sweetpotato farming and marketing. CIP breeder Maria Andrade is working with a gender responsive breeding tool produced by scientists involved in the CGIAR Gender and Breeding Initiative.

"If we release climate-smart varieties which do not meet the needs of buyers, few farming families will adopt them. Farmers take a range of factors into consideration—taste, texture, nutrition and market value. If the buyers are women, breeding only for what men want will not help adoption," she said.



Developing new varieties that combine climate resilience and the characteristics farmers and markets demand is essential but challenging, because sweetpotato is genetically complex. Its 90 chromosomes arranged in groups of six make understanding the functions of specific genes more difficult, compared to the paired chromosomes of crops like maize and rice.

In 2018, CIP and partner scientists made a series of breakthroughs that could revolutionize conventional sweetpotato breeding. They produced the first-ever reference genome for sweetpotato—a map of its genes and their locations on chromosomes—deepening understanding of this complex plant. They then created tools and protocols to standardize measurement of specific plant traits designed to facilitate implementation of genomics-assisted breeding approaches.

But most significantly, they demonstrated proof-of-concept that hybrid breeding schemes could take sweetpotato improvement to previously unimaged magnitudes. Breeding parents in Peru and at African regional platforms have been divided into two distinct groups, because the progeny of crosses between genetically different parents tend to be superior to either parent—a phenomenon called hybrid vigor or heterosis. Multiple breeding trials have demonstrated the genetic gains achieved within 5-6 years can equal those which have traditionally taken 36 years.

More than propel delivery of nutritious sweetpotato to 15 million households by 2023—a CIP institutional goal—these innovations are laying the groundwork for sweetpotato breeding that will respond to the opportunities and challenges of an increasingly populous, climate-changing world.

Scientists need to breed sweetpotato varieties with characteristics that both men and women want to ensure widespread adoption (credit CIP/ I. Corthier).

Funder: Bill & Melinda Gates Foundation; CGIAR System donors through the CGIAR Research Program on Roots, Tubers and Bananas; Department for International Development United Kingdom; United States Agency for International Development.

Key partners: Alliance for a Green Revolution in Africa; Boyce Thompson Institute; Council for Scientific and Industrial Research-Crops Research Institute, Ghana; French Agricultural Research Centre for International Development; Michigan State University; National Crops Resources Research Institute; National Agricultural Research Organization, Uganda; North Carolina State University; University of Queensland.

Associated CGIAR Research Program/Platform: Roots, Tubers and Bananas; Excellence in Breeding Platform.

In 2018, CIP scientists David Ellis and Alberto Salas participated in the first collection of potato wild relatives in Peru in two decades (credit CIP/ S. Fajardo).

Wild potatoes

Safeguarding Peru's agrobiodiversity for future generations

Potato has 155 wild relatives growing in varied ecosystems across the Americas, from highland cloud forests to coastal deserts, where they have evolved to withstand diseases and harsh conditions.

Most of those species produce tiny, inedible tubers, but their genetic diversity holds opportunities for breeding more resilient potatoes. Yet, as scientists try to tap into that potential, many wild potatoes are threatened by the expansion of farming, industry and infrastructure, growing urbanization, and changing climates.

Crop breeders at the International Potato Center (CIP) have long used wild species to improve potato varieties. Four years ago, they began crossing wild and cultivated potatoes to produce offspring that combine heat and drought tolerance with resistance to the most important diseases affecting the crop—threats that will grow as global warming advances. Conservation of our agrobiodiversity is increasingly urgent as lost diversity diminishes our potential to adapt to climate change.

To ensure that enough wild potato diversity is conserved for current and future needs, CIP and Peru's Instituto Nacional de Innovación Agraria (INIA) undertook a series of collection trips in 2017-18 to fill genetic gaps in the CIP Genebank collection.

Scientists ventured widely across the center of potato diversity in Peru, which has 80 wild potato species and approximately 3,000 cultivated landraces. Collecting 337 samples of 45 species often meant digging up and transferring plants to greenhouses, so they produced flowers, tubers and seeds for their long-term preservation. The genebank now safeguards 2,338 accessions of 140 wild potato species in trust for humanity using the latest technologies.

The collection forays were organized by former CIP Genebank head David Ellis with Cinthya Zorrilla and Rosa Angelica Sanchez of INIA's genetic resources and biotechnology department. They benefited from the knowledge of retired CIP agronomist Alberto Salas, who has collected potato wild relatives in 16 countries and discovered about 20 species.

"The potential of the wild relatives is immense. They hold the genetic resistance to the diseases that affect potato, as well as tolerance to freezing, heat and drought," Alberto said.

He noted that species in Central America and Mexico have high resistance to late blight—the most destructive potato

disease—whereas those native to Peru's dry coastal region tolerate drought and saline soils.

While some of those traits have been successfully transferred to cultivated potato varieties, the many differences between wild species and edible potatoes present challenges for crossbreeding. Wild potatoes also have undesirable traits such as bitterness that often transfer to cultivated potatoes in the initial cross and must be removed through subsequent crossing and selection.

In 2018, researchers evaluated the disease resistance of wild species and hybrids produced by earlier crosses. They also began working with Peruvian farmers to select the best of those potatoes in terms of production and flavor, for possible release as varieties in Peru and sharing with breeding programs in Africa and Asia.

These efforts should result in the release of climate-smart potato varieties in the coming years, but they have only involved a small fraction of the wild potato species preserved in genebanks. Evaluating and harnessing the genetic diversity of these species, most of which have hardly been studied, could be key to enabling future generations of potato farmers to overcome environmental challenges that we can hardly imagine today. The potato and its wild relatives hold a wealth of untapped potential for improving food and nutrition security in the near and distant future.

Wild species are crossed with cultivated potato to produce resilient varieties (credit CIP).

Funder: Norwegian Agency for Development Cooperation (via the Global Crop Diversity Trust); Organization of the Petroleum Exporting Countries Fund for International Development.

Key partners: Instituto Nacional de Innovación Agraria, Peru; Global Crop Diversity Trust; Royal Botanical Gardens Kew.

Associated CGIAR Research Program/Platform: Roots, Tubers and Bananas; Genebank Platform.

CIP at a glance

LATIN AMERICA AND THE CARIBBEAN

- Bolivia
- Ecuador
- Peru

AFRICA

- Burkina Faso
- Cameroon
- Democratic Republic of Congo
- Ethiopia
- Ghana
- Kenya
- Madagascar
- Malawi
- Mali
- Mozambique
- Nigeria
- Rwanda
- Tanzania
- Tunisia
- Uganda
- Zambia

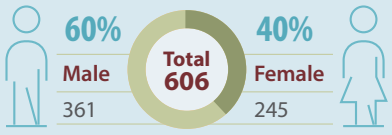
ASIA

- Bangladesh
- Bhutan
- China
- Georgia
- India
- Indonesia
- Nepal
- Philippines
- Tajikistan
- Vietnam

Crops by countries

- Potato
- Sweetpotato
- Both

CIP staff



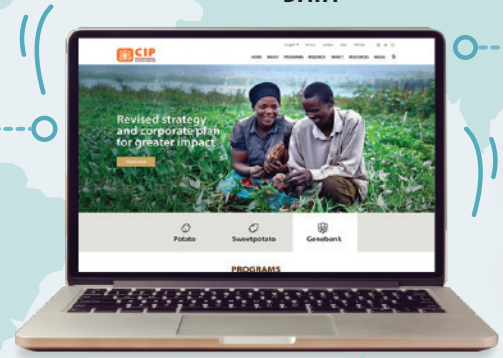
38 Nationalities

Sharing knowledge

2018 ▶ COMMUNICATIONS DATA

https://cipotato.org/

CIP's WEBSITE VISITS
2018 ▶ 265,520



MEDIA

Media exposure
2018 ▶ **994** media stories mentioning CIP

Advertising value equivalent (AVE)
2018 ▶ **USD 4.43 million**

SOCIAL MEDIA

	REACH*	ENGAGEMENT*	INCREASE IN FOLLOWERS
Facebook	Total ▶ 1,875,259	Total ▶ 39,351	25.9%
Twitter	Total ▶ 639,320	Total ▶ 9,969	30.6%

*Individuals reached and numbers who engaged with CIP posts

CIP CGSpace
A Repository of Agricultural Research Outputs

178,841 Visits ▲ 222%

29,982 Documents downloaded ▲ 20%

COMMUNICATING SCIENTIFIC KNOWLEDGE

Journal articles	63
Books / book chapters	9
Briefs / brochures	28
Posters / presentations	19
Manuals / reports / working papers	36
Conference papers / proceedings	5
Total	**160**

Social reach of scientific publications

Two of the research papers co-authored by CIP scientists received Altmetric scores above 400 in 2018. That means that they were cited and shared hundreds of times on the web. Altmetrics are metrics and qualitative data that are complementary to traditional, citation-based metrics. They can include peer reviews, citations on Wikipedia and in public policy documents, discussions on research blogs, mainstream media coverage, bookmarks on reference managers like Mendeley, and mentions on social networks such as Twitter. All publications in CGSpace, the CGIAR repository, have Altmetric scores, which are visually displayed with a 'donut' to reflect where they captured attention.

TOP 5 Altmetrics scores

Reconciling conflicting phylogenies in the origin of sweet potato and dispersal to Polynesia
Current Biology
https://hdl.handle.net/10568/92130

Stacking three late blight resistance genes from wild species directly into African highland potato varieties confers complete field resistance to local blight races
Plant Biotechnology Journal
https://hdl.handle.net/10568/99120

Genome sequences of two diploid wild relatives of cultivated sweetpotato reveal targets for genetic improvement
Nature Communications
https://hdl.handle.net/10568/98495

Ortervirales: New virus order unifying five families of reverse-transcribing viruses
Journal of Virology
https://hdl.handle.net/10568/97669

Current strategies of polyploid plant genome sequence assembly
Frontiers in Plant Science
https://hdl.handle.net/10568/98292

Mentioned in
- News outlets
- Blogs
- Twitter
- Facebook
- Wikipedia
- Google+
- Reddit
- Video

Citations
- Dimensions

Readers on
- Mendeley

CIP in CGIAR

CGIAR
Science for a food-secure furture

POTATO

A potato contains about half the daily adult requirement of vitamin C and significant amounts of vitamin B, iron, potassium and zinc.

China is the world's largest producer, harvesting more than 73 million tons of potato a year.

More than a billion people worldwide eat potato as a staple food.

Potato can grow in almost any climate, from sea level to about 4,000 meters above sea level.

There are 5,000 different varieties of potato in CIP's genebank, half of them can only be found in Peru.

Potato is the third most important food crop after rice and wheat and produces more calories per hectare than either of those grains.

Potato produces more food per unit of water than any other major crop.

CGIAR Research Programs

Led by CIP

Roots, Tubers and Bananas

- Genetic resources
- Productive varieties and quality seed
- Resilient crops
- Nutritious food and added value
- Improved livelihoods at scale

CGIAR Platforms

Led by CIAT

Big Data

- Data generation, access and management
- Big data and agricultural development
- Big data analytics

CGIAR is a global partnership that unites organizations engaged in research for a food secure future. With 15 centers around the world, CGIAR is dedicated to reducing rural poverty, increasing food security, improving human health and nutrition and ensuring more sustainable management of natural resources. Tackling these challenges, which are at the heart of the United Nations Sustainable Development Goals, requires research to identify state-of-the-art solutions and effective partnerships to deliver them.

The CGIAR Research Portfolio is structured around two interlinked clusters of challenge-led research programs: agri-food systems and global integrating programs. CIP leads the agri-food system CGIAR Research Program on Roots, Tubers and Bananas and participates in several global integrating programs. CIP also works closely with the CGIAR research support platforms.

Led by IFPRI

Policies, Institutions and Markets

- Technological innovation and sustainable intensification
- Inclusive and efficient value chains
- Social protection for agriculture
- Gender research

Led by CIAT

Climate Change, Agriculture and Food Security

- Priorities and policies
- Climate-smart technologies and practices

Led by IFPRI

Agriculture for Nutrition and Health

- Food systems for healthier diets
- Biofortification

Led by the Global Crop Diversity Trust

Genebank Platform

- Conservation, use and policy
- Quality management, Information systems
- Germplasm health

Led by CIMMYT

Excellence in Breeding

- Product design and management
- Genotyping and phenotyping tools and services
- Bioinformatics, biometrics and data management

SWEETPOTATO

Just 125 g of fresh orange- fleshed sweetpotato root contains enough beta carotene to provide the daily vitamin A needs of a preschool-aged child. The crop is also a valuable source of vitamins B, C, and E.

Sweetpotato is also a healthy, cheap animal feed. Studies suggest that livestock fed on sweetpotato vines produce less methane, meaning its use could potentially mitigate global warming.

More than 105 million tons are produced globally each year, with 95% in developing countries.

Worldwide, sweetpotato is the sixth most important food crop after rice, wheat, potato, maize and cassava, but it ranks fifth in developing countries.

Sweetpotato is a storage root, not a tuber like the potato.

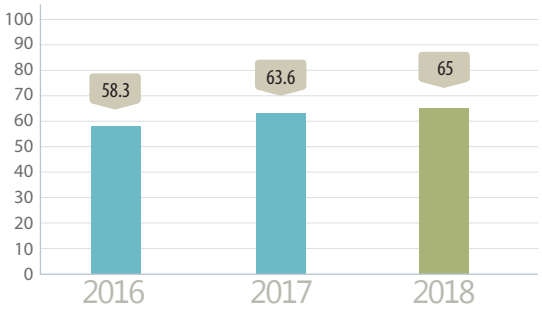
Sweetpotato can grow at altitudes from sea level to 2,500 meters above sea level, and comes in varieties ranging in color from white to yellow, orange or purple.

CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
IFPRI	International Food Policy Research Institute

Funding

As a CGIAR research center, much of research undertaken by the International Potato Center (CIP) is conducted through CGIAR Research Programs. Funding for those programs, and for bilateral projects, comes from public and private organizations, governments and foundations across the globe. The Center also receives generous in-kind support from national partners and international collaborators. CIP gratefully acknowledges the countries, organizations, partners and individuals that supported its agricultural research for development in 2018. We also thank all the funders that globally support CIP's work through their contributions to the CGIAR system (https://cgiar.org/funders). Without this intellectual and financial support, CIP could not have made the contributions to better lives reported here. Total revenue and expenses reported by CIP (in 2018) were USD 65 million and USD 64.1 million respectively, reflecting a surplus of USD 0.9 million for the year. The full financial report for 2018 is available at: https://hdl.handle.net/10568/101475

Revenue



USD 65 million

Liquidity and financial stability

92 days reserves

Funders in 2018

The International Potato Center gratefully acknowledges the countries, organizations, partners and individuals that supported its agricultural research for development in 2018. We also thank all the funders that globally support its work through their contributions to the CGIAR system (https://cgiar.org/funders).

- 2BLADES Foundation
- African Agriculture Technology Foundation
- African Development Bank
- Agenzia Nazionale per le Nuove Tecnologie, L'Energia e lo Sviluppo Economico Sostenible, Italy
- American Institutes for Research
- Australian Centre for International Agriculture Research
- Austrian Development Cooperation
- Bill & Melinda Gates Foundation
- Biotechnology and Biological Sciences Research Council
- CGIAR Genebank Platform
- CGIAR Platform for Big Data in Agriculture
- CGIAR Research Program on Climate Change, Agriculture and Food Security
- CGIAR Research Program on Policies, Institutions, and Markets
- CGIAR Research Program on Roots, Tubers and Bananas
- CGIAR Trust Fund
- Convention on Biological Diversity Secretariat
- Department for International Development, United Kingdom
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
- European Commission
- Food and Agriculture Organization of the United Nations
- Gansu Agricultural University
- Global Crop Diversity Trust
- Government of China
- Government of India
- Government of the Federal Republic of Germany
- International Center for Tropical Agriculture
- International Food Policy Research Institute
- International Fund for Agricultural Development
- International Institute of Tropical Agriculture
- International Livestock Research Institute
- International Plant Genetic Resources Institute
- Irish Aid
- McKnight Foundation
- McLaughlin Gormley King Company
- Ministry of Agriculture and Irrigation, Peru
- National Science Foundation, United States of America
- Organization of the Petroleum Exporting Countries Fund for International Development
- Programa Nacional de Innovacion Agraria, Peru
- Rural Development Administration, Republic of Korea
- Save the Children International
- State government of Haryana, India
- State government of Odisha, India
- Swiss Agency for Development and Cooperation
- Syngenta Foundation for Sustainable Agriculture
- United Purpose
- United States Agency for International Development
- University Court of the University of St Andrews
- World Bank Group

CIP/ J. Torres

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* Joined in 2018
** Left in 2018

CIP/A. Balaguer

www.cipotato.org

CIP is a research-for-development organization with a focus on potato, sweetpotato and Andean roots and tubers. It delivers innovative science-based solutions to enhance access to affordable nutritious food, foster inclusive sustainable business and employment growth, and drive the climate resilience of root and tuber agri-food systems. Headquartered in Lima, Peru, CIP has a research presence in more than 20 countries in Africa, Asia and Latin America.
www.cipotato.org

CIP is a CGIAR research center
CGIAR is a global research partnership for a food-secure future. Its science is carried out by 15 research centers in close collaboration with hundreds of partners across the globe.
www.cgiar.org

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