



# CIP Strategy and Corporate Plan

Research,  
Innovation,  
and Impact

2014-2018

**CIP**  
**Strategy**  
and  
**Corporate**  
**Plan**  
Research,  
Innovation,  
and Impact  
**2014-2018**



**CIP Strategy and Corporate Plan**  
Research, Innovation and Impact. 2014-2018

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# ACRONYMS

## A

<b>ARIs</b>	Advanced Research Institutes
<b>ARTCs</b>	Andean Root and Tuber crops
<b>ASARECA</b>	Association of Strengthening Agricultural Research in Eastern and Central Africa
<b>AU</b>	African Union

## B

<b>BMGF</b>	Bill & Melinda Gates Foundation
<b>BecA</b>	Biosciences eastern and central Africa
<b>BW</b>	Bacterial Wilt

## C

<b>CAADP</b>	Comprehensive Africa Agriculture Development Program
<b>CACILM</b>	Central Asian Countries Initiative for Land Management
<b>CBD</b>	Convention on Biological Diversity
<b>CBO</b>	Community-Based Organization
<b>CCAFS</b>	CGIAR Research Program on Climate Change, Agriculture and Food Security
<b>CCCAP</b>	CIP China Center for Asia and the Pacific
<b>CFSVA</b>	Comprehensive Food Security and Vulnerability Analysis
<b>CIAT</b>	International Center for Tropical Agriculture
<b>CIFOR</b>	Center for International Forestry Research
<b>CIP</b>	International Potato Center
<b>CIMMYT</b>	International Maize and Wheat Improvement Center
<b>CO</b>	Corporate Objective
<b>CoP</b>	Community of practice
<b>CORAF/ WECARD</b>	West and Central Council for Agricultural Research and Development
<b>CPAD</b>	Communications and Public Awareness Department
<b>CRP</b>	CGIAR Research Program
<b>CWR</b>	Crop wild relatives

## D

<b>DFID</b>	Department for International Development
<b>DSS</b>	Decision Support System

## E

<b>EPPO</b>	European and Mediterranean Plant Protection Organization
<b>ERP</b>	Enterprise Resource Planning
<b>ESEAP</b>	East and Southeast Asia and the Pacific

## **F**

<b>FAO</b>	Food and Agriculture Organization
<b>FARA</b>	Forum for Agriculture Research in Africa
<b>FSV</b>	Food Security and Vulnerability

## **G**

<b>GADU</b>	Germplasm Acquisition and Distribution Unit
<b>GAM</b>	General Assessment Methodology
<b>GCDT</b>	Global Crop Diversity Trust
<b>GO</b>	Government Organization
<b>GPS</b>	Global positioning system

## **H**

<b>HCA</b>	Host Country Agreement
<b>HH</b>	Households
<b>HQ</b>	Headquarters

## **I**

<b>IA</b>	Intellectual Asset
<b>ICARDA</b>	International Center for Agricultural Research in the Dry Areas
<b>ICM</b>	Integrated crop management
<b>ICRISAT</b>	International Crops Research Institute for the Semi-Arid Tropics
<b>ICT</b>	Information and communication technology
<b>IDO</b>	Intermediate Development Outcome
<b>IFAD</b>	International Fund for Agricultural Development
<b>IFDC</b>	International Fertiliser Development Center
<b>IFPRI</b>	International Food Policy Research Institute
<b>IICA</b>	Inter-American Institute for Cooperation in Agriculture
<b>IRRI</b>	International Rice Research Institute
<b>IITA</b>	International Institute of Tropical Agriculture
<b>ILRI</b>	International Livestock Research Institute
<b>IP</b>	Intellectual property
<b>IPM</b>	Integrated pest management
<b>IRR</b>	Internal rate of return
<b>IT</b>	Information technology
<b>ITPGRFA</b>	International Treaty on Plant Genetic Resources for Food and Agriculture
<b>IWMI</b>	International Water Management Institute

## **K**

<b>KM</b>	Knowledge management
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**L**

<b>LAC</b>	Latin America and the Caribbean
<b>LAMP</b>	Loop mediated isothermal amplification
<b>LANSA</b>	Leveraging Agriculture for Nutrition in South Asia
<b>LB</b>	Late blight

**M**

<b>M&amp;E</b>	Monitoring and evaluation
<b>MDGs</b>	Millennium Development Goals
<b>MoA</b>	Ministry of Agriculture
<b>MOST</b>	Ministry of Science & Technology
<b>MT</b>	Metric tons

**N**

<b>NAPPO</b>	North American Plant Protection Organization
<b>NARS</b>	National Agricultural Research Systems
<b>NEPAD</b>	New Partnership for Africa's Development
<b>NGO</b>	Non-Governmental Organization
<b>NOAs</b>	Needs and Opportunity Assessments

**O**

<b>OAU</b>	Organization of African Unity
<b>OCS</b>	One Corporate System
<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>OFSP</b>	Orange-fleshed sweetpotato

**P**

<b>PANI</b>	Pan-African Nutrition Initiative
<b>PGRFA</b>	International Treaty for Plant Genetic Resources for Food and Agriculture
<b>PLRV</b>	Potato leafroll virus
<b>PoC</b>	Proof of Concept
<b>PPE</b>	Personal Protective Equipment
<b>PPP</b>	Public-private partnership
<b>PSTV</b>	Potato tuber spindle viroid
<b>PTM</b>	Potato tuber moth
<b>PVS</b>	Participatory varietal selection
<b>PVX</b>	Potato Virus X
<b>PVY</b>	Potato Virus Y

**Q**

<b>QDPM</b>	Quality Declared Planting Material
<b>QTL</b>	Quantitative trait loci

## **R**

<b>R&amp;D</b>	Research and development
<b>RBM</b>	Results Based Management
<b>RMTs</b>	Rapid multiplication technologies
<b>ROI</b>	Return on investment
<b>RTB</b>	CGIAR Research Program on Roots, Tubers and Bananas
<b>RTCs</b>	Roots and Tuber Crops

## **S**

<b>SADC/FANR</b>	The Southern African Development Community's committee: Forum for Agriculture and Natural Resource
<b>SAFANSI</b>	South Asian Food and Nutrition Security Initiative
<b>SCP</b>	Strategy and Corporate Plan
<b>SDGs</b>	Sustainable Development Goals
<b>SHE</b>	Safety, health, and environment
<b>SLO</b>	System Level Objective
<b>SO</b>	Strategic Objective
<b>SoWPGR-2</b>	Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture
<b>SPAAR</b>	Special Program for Agriculture in Africa
<b>SPHI</b>	Sweetpotato for Profit and Health Initiative
<b>SRF</b>	Strategy and Results Framework
<b>SRO</b>	Subregional organization
<b>SRSA</b>	Small RNA sequencing and assembly
<b>SSA</b>	Sub-Saharan Africa
<b>SUN</b>	Scaling Up Nutrition
<b>SWCA</b>	Southwest and Central Asia
<b>SWOT</b>	Strengths, weaknesses, opportunities, and threats

## **T**

<b>ToC</b>	Theory of Change
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## **U**

<b>UNFCC</b>	United Nations Framework Convention on Climate Change
<b>USAID</b>	United States Agency for International Development

## **V**

<b>VAD</b>	Vitamin A deficiency
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## **W**

<b>WFP</b>	World Food Program
<b>WFS</b>	World Food Summit

# GLOSSARY

Abbreviated and Full Names of the 16 CGIAR Research Programs

<b>Dryland Systems</b>	Dryland Systems
<b>Humidtropics</b>	Integrated Systems for the Humid Tropics
<b>AAS</b>	Aquatic Agricultural Systems
<b>PIM</b>	Policies, Institutions and Markets
<b>WHEAT</b>	Wheat
<b>MAIZE</b>	Maize
<b>GRiSP</b>	Global Rice Science Partnership
<b>RTB</b>	Roots, Tubers and Bananas
<b>Grain Legumes</b>	Grain Legumes
<b>Dryland Cereals</b>	Dryland Cereals
<b>Livestock and Fish</b>	Livestock and Fish
<b>A4NH</b>	Agriculture for Nutrition and Health
<b>WLE</b>	Water, Land and Ecosystems
<b>FTA</b>	Forests, Trees and Agroforestry
<b>CCAFS</b>	Climate Change, Agriculture and Food Security
<b>Genebanks</b>	Managing and Sustaining Crop Collections



# Foreword

2013 has been a challenging year for CIP staff and the CIP Board of Trustees. The two key responsibilities of the Board—overseeing the strategic direction of CIP and recruiting a new DG—coincided this year. CIP’s recasting of its strategic direction is manifest in this Strategy and Corporate Plan (SCP).

The Board, with senior management, decided in late 2012 that the profound changes in CIP’s operating environment required a new SCP. These fundamental changes include the emergence of a post-2015 development framework; evolving regional and national frameworks that recognize that countries lead their own development; CGIAR reform, with a sharpened focus that explicitly addresses food and nutritional security; a more diverse partnership landscape that embraces the civil and private sectors; and the demand to deliver promptly on key development challenges, driving the focus on Results-Based Management (RBM), the scaling up of innovations, and a heightened emphasis on gender issues.

The new SCP recognizes that CIP must assume increasing responsibility for uptake pathways to development while maintaining its core business as a science-based research organization. The SCP builds on a solid legacy of CIP achievements, outlined in the Introduction. A principal aim of the SCP is to enhance CIP impact by focusing on six strategic objectives (SOs). Three of the SOs (1–3) focus on the research and development (R&D) space in order to deliver shorter term solutions to food security in our target commodities and geographies. The R&D SOs comprise Combating Micronutrient Deficiency with Resilient, Nutritious Sweetpotato; Enhancing Food Security in Asia through the Intensification of Local Cereal-based Systems through the Adoption of the Early-Maturing Agile Potato; and Improving Livelihoods of Potato Farmers in Africa by Tackling Deteriorated Seed Quality through an Integrated Approach.

Two of the SOs (4 and 5) address more upstream research. The research-for-development SOs are Accelerating the Discovery of Game-changing Solutions for Enhancing Food Security; and Addressing the Food Security Challenge through Roots and Tubers: Transforming Vulnerability to Resilience. The sixth SO, Conserving Diversity for the Future—the CIP Genebank, underlines our continuing commitment to protect and utilize the world potato and sweetpotato collections. We will mainstream gender throughout the SOs and target for socially excluded populations and youth.

The SOs enable CIP to facilitate agricultural development and deliver on the CGIAR’s System Level Objectives by continuing to raise the quality of CIP science—the relevance and effectiveness of programs. The SOs expand CIP’s work along the development continuum: from upstream research to develop stronger interactions with uptake pathways, and so to downstream development impacts. This work, together with the strengthening of the CIP strategic research encompassed in SOs 4–6, present new corporate challenges.

CGIAR is required to demonstrate value for money through its RBM framework. This necessitates continuing to raise the quality of CIP management, organizational structures, financial management, knowledge management, and communications, in order to grow and strengthen the Center. Meeting these challenges looks to the staffing and career development of CIP’s personnel; the efficiency and economy of its operations; and the ability of CIP to influence investors and partners. Consequently, after discussing the SOs, CIP’s SCP describes the associated corporate objectives (COs). These COs address the corporate challenges that will be required to successfully implement the SOs.

The SCP, with its array of SOs and COs, derives from a year of intensive analyses and reflection by CIP staff and partners, in consultation with the Board. The formulation of each of the SCP chapters was charged to the CIP staff teams indicated on the following page. These teams were led and inspired by Dr. Anderson through 2013. Completion of this task was a major achievement, and we underline here the commitment and hard work of all CIP staff in bringing together the SCP and acknowledge its high quality.

The Board approved the SCP in November 2013 (subject to minor fine tuning, incorporated here). This Board-approved document captures CIP’s proposed strategic priorities and programs in the light of its established strengths, achievements, and comparative advantages. The next stage is implementation. This calls for more in-depth discussions at the country level as specified in each of the SOs. These consultations with country stakeholders and investors will lead to implementation of the SCP in terms of business plans.

The news emerged in July that Dr. Anderson would be leaving CIP in early 2014 to lead the Agriculture Programme of the Bill and Melinda Gates Foundation. Pamela led CIP staff through the demanding challenge of elaborating and finalizing the SCP with her characteristic capacity for inspirational vision and enthusiasm. The successful recruitment of Dr. Barbara Wells as the incoming director general (DG), together with an outline of her career achievements, is recorded in the CIP newsletter of December 2013. She is committed to realizing the implementation of the SCP objectives. We congratulate CIP staff on the formulation of the SCP, and look forward to realizing our joint mission to implement this route to delivering the CGIAR’s objectives.



Dr. Pamela Anderson  
DG 2005–2013



Dr. Rodney Cooke  
Board Chair from April 2013



Dr. Barbara Wells  
DG from February 2014

### SCP CIP Staff Writing Focal Points

- SO 1:** Combating Micronutrient Deficiency with Resilient, Nutritious Sweetpotato-- Simon Heck
- SO 2:** Enhancing Food Security in Asia through the Intensification of Local Cereal-based Systems through the Adoption of the Early-Maturing Agile Potato-- Julian Parr
- SO 3:** Improving Livelihoods of Potato Farmers in Africa by Tackling Deteriorated Seed Quality through an Integrated Approach – Monica Parker
- SO 4:** Accelerating the Discovery of Game-changing Solutions for Enhancing Food Security--Marc Ghislain
- SO 5:** Addressing the Food Security Challenge through Roots and Tubers: Transforming Vulnerability to Resilience -- Gordon Prain
- SO 6:** Conserving Diversity for the Future—the CIP Genebank -- David Ellis Beem

### COs Corporate Objectives

- CO 1:** Growing Together -- Ulrika Martinius
- CO 2:** Expanding Organizational Capacity -- Amalia Perochena
- CO 3:** Financial Stewardship-- Michael Gerba
- CO 4:** CIP’s Business Development and Marketing-- Joel Ranck
- CO 5:** Safety, Health, and Environmental Sustainability -- Carla Lazarte

Acknowledgement is extended to the Strategic and Corporate Plan Process Group consisting of Pamela Anderson, Michael Gerba, Oscar Ortiz, Amalia Perochena, and Gordon Prain.

Special thanks is also extended to Graham Thiele for his valuable input in several sections of this plan.

# Research, Innovation, and Impact

## Executive Summary

There have been dramatic changes in both CIP's operating environment and the broader external environment, particularly in the urgency to deliver tangible development impact. In response, CIP has developed a new Strategy and Corporate Plan (SCP) for the next 10 years. Some of the fundamental changes driving the SCP include the following: the emergence of a post-2015 development framework; evolving regional and national frameworks that empower countries to own and lead their own development; CGIAR reform, with an expanded focus that explicitly addresses food and nutritional security; a richer and more diverse partnership landscape; and a heightened sense of urgency that it is imperative to catalyze a step-change in development impact within the next generation. This shift is driving the focus on Results-Based Management (RBM), the scaling up of innovations, and an emphasis on gender issues.

The new SCP builds on a solid legacy of CIP's past achievements. The overarching strategic question is: how do we enhance our impact? We propose to streamline our program to focus on six strategic objectives (SOs). Three of the SOs (1–3) will move us into the research and development (R&D) space in order to deliver shorter term solutions to food security in our target commodities and geographies by going to scale with flagship technologies. Two SOs (4 and 5) will continue to address more upstream research for development that intends to deliver research outputs, through the discovery flagships, representing longer-term solutions for development. The sixth SO, on biodiversity conservation and use, underlines our continuing commitment to protect and utilize the world potato and sweetpotato collections.

Clearly, going to scale requires testing models, then carefully monitoring and evaluating them so that the best options contribute to scaling up the technologies. This will be done by moving from proof of concepts, to coordination in an out-scaling stage, to finally reaching a scale-up phase with development partners. Throughout, CIP's pro-poor R&D cycle will guide the process. Gender-transformative research and social inclusion need to be taken into account in the implementation of this cycle. This will make the design, testing, and going to scale of technologies more efficient and ensure that gender relationships are not harmed. Capacity development of partners and CIP's teams, as well as monitoring and evaluation (M&E) and learning, will be essential for moving forward with the SCP.

The R&D SOs are:

- **SO 1:** Combating Vitamin A Deficiency with Resilient, Nutritious Orange-Fleshed Sweetpotato (OFSP).
- **SO 2:** Enhancing Food Security in Asia through the Intensification of Local Cereal-based Systems with the "Precocious" Potato. (NB: Here "precocious" refers to early-maturing agile potatoes, to indicate the robustness deriving from the intended desirable traits. The term "early-maturing agile potatoes" is used in the name of SO 2 from this point onward in the SCP.)
- **SO 3:** Improving Livelihoods of Potato Farmers in Africa by Tackling Deteriorated Seed Quality through an Integrated Approach.

Although SOs 1 and 3 are closer to going to scale, and SO 2 still requires additional proof of concept, we expect to start achieving impacts at the household (HH) level from each of these SOs over the next five years.

The research-for-development SOs embody 21<sup>st</sup>-century upstream research on biotechnology and systems research. They are:

- **SO 4:** Accelerating the Discovery of Game-changing Solutions for Food Security
- **SO 5:** Addressing the Food Security Challenge through Roots and Tubers: Transforming Vulnerability to Resilience.

Finally, **SO 6**, Conserving Diversity for the Future—the CIP Genebank, focuses on conserving biodiversity for the future. This focus lies at the heart of CIP’s mission, building on the legacy of conserving genetic resources over the last 40 years to ensure that conservation and utilization is enhanced for the coming decades.

In addition to the SOs, CIP’s SCP (2014–2023) outlines corporate objectives (COs). The COs address the operational challenges that will be required to implement the SOs successfully.

The best way to enhance CIP’s impact over the next 10 years is to assume great responsibility for uptake pathways to development while maintaining our identity and core business as a science-based organization.

## 1. Why a New Strategy for CIP?

Over the past five years, there have been dramatic changes in both our operating and external environments. These changes represent challenges and opportunities to better realize our mission and enhance our impact. There are a number of fundamental changes that led the CIP Board of Trustees to call for a new SCP:

- An evolving global development agenda now looking beyond 2015 and the Millennium Development Goals (MDGs)
- Strengthened frameworks at the regional and national levels
- Reform of the CGIAR System
- Expanded focus from the poverty and natural resources management lens for development to also, explicitly, one that addresses food security and links agriculture to nutrition
- Emergence of new partners
- Urgency to scale up impact
- Recognition of the need for gender-transformative research and social inclusion
- Refocusing on capacity development within CGIAR and with its partners
- The move towards RBM.

The following section reviews these external changes in greater detail. It summarizes the resulting shifts we are proposing to align CIP more strategically with our external environments.

## 2. The Fundamental Changes Driving the Need for a New SCP

### 2.1 The Post-2015 development framework

Whereas the MDGs<sup>1</sup> created the first truly global agreement on development priorities and focused investments, their implementation taught us important lessons as we move to a post-2015 framework. The Sustainable Development Goals (SDGs), which are currently under discussion by the United Nations-led Sustainability Solutions Network, will need to articulate goals that are relevant for the entire planet, not just the developing countries. The objectives of economic development, environmental sustainability, social inclusion, and good governance that are expected to emerge will need to be more holistic, balanced, and negotiated from the bottom-up as well as developed from the top-down. Unlike the MDGs, the SDGs are expected to have

<sup>1</sup> <http://www.undp.org/content/undp/en/home/mdgoverview/>

explicit targets for food security and agriculture. Preliminary documents<sup>2</sup> give a flavor of what those targets might look like:

- Ensuring food security and sustainable food supplies
- Ending extreme poverty and promoting sustainable growth
- Fulfilling the promise of technology for sustainable development
- Protecting biodiversity and ecosystem services
- Averting dangerous climate change and industrial pollution
- Promoting gender equality, personal security, and well-being.

In aligning with the post-2015 SDGs, we will also need to align our new SOs with the frameworks evolving out of the international agreements on aid effectiveness—that is, the regional and national frameworks.

## 2.2 Regional and national frameworks: from aid to partnerships

From the 1990s onward, the Organization for Economic Co-operation and Development (OECD) countries and aid organizations began to note the differing levels of aid effectiveness, particularly vis-à-vis development approaches. Donors as well as developed and developing countries wanted to ensure that aid would be used as effectively as possible, and that aid would play an optimum role in achieving the MDGs by the year 2015. Thus, a new paradigm of aid as a partnership—rather than a one-way relationship between donor and recipient—began to evolve, gaining ground toward the end of the 1990s. It was particularly recognized as valid in the 2002 International Conference on Financing for Development, formalized as the Monterrey Consensus.<sup>3</sup>

Aid officials and recipient countries agreed to take stock of ways to better coordinate and streamline activities. This resulted in a meeting in Paris, where countries around the world endorsed the Paris Declaration on Aid Effectiveness.<sup>4</sup> This formal agreement was meant to be a more comprehensive attempt to change the way donor and developing countries do business together, based on principles of partnership. The Paris Declaration laid out five fundamental principles for making aid more effective:

- **National ownership.** Developing countries set their own strategies for reducing poverty, improving their institutions, and tackling corruption.
- **Alignment.** Donor countries align behind these objectives and use local systems.
- **Harmonization.** Donor countries coordinate and simplify procedures, and share information to avoid duplication.
- **Results.** Developing countries and donors shift focus to development results and results get measured.
- **Mutual accountability.** Donors and partners are accountable for development results.

This movement was adopted as “best practice,” and continues to be improved. In 2008 the subsequent forum, held in Accra, Ghana,<sup>5</sup> took stock of progress and built on the Paris Declaration to accelerate the pace of change. This movement emphasizes country leadership in delivering development programs as well as the need for international organizations such as CIP to continue strengthening their national partnerships.

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<sup>2</sup> <http://sustainabledevelopment.un.org/index.php?menu=1300>

<sup>3</sup> <http://www.un.org/esa/ffd/ffdconf/>

<sup>4</sup> <http://www.oecd.org/development/effectiveness/34428351.pdf>

<sup>5</sup> <http://www.oecd.org/dac/effectiveness/theaccrahighlevelforumhlf3andtheaccraagendaforaction.htm>

## 2.3 Reform of the CGIAR System

In 2008, the members of CGIAR agreed to undertake a reform of the CGIAR System, which went into effect beginning in 2010 (Fig. 1). Programmatically, CGIAR's new vision is to reduce poverty and hunger; improve human health and nutrition; and enhance ecosystem resilience through high-quality international agricultural research, partnership, and leadership. To realize this vision, CGIAR has approved a Strategy and Results Framework (SRF)<sup>6</sup> and established 16 CGIAR Research Programs (CRPs), as implementation vehicles for the SRF. The goals of CGIAR are encompassed within four System Level Objectives (SLOs), which are described in the SRF:

- Reduction in rural poverty
- Increase in food security
- Improving nutrition and health
- More sustainable management of natural resources.

The SLOs represent an expanded focus from the poverty and natural resources management lens of the 1990s to, explicitly, also addressing food security and linking agriculture to nutrition. In the future the work of the Consortium of CGIAR Centers is expected to align with CGIAR's SLOs.

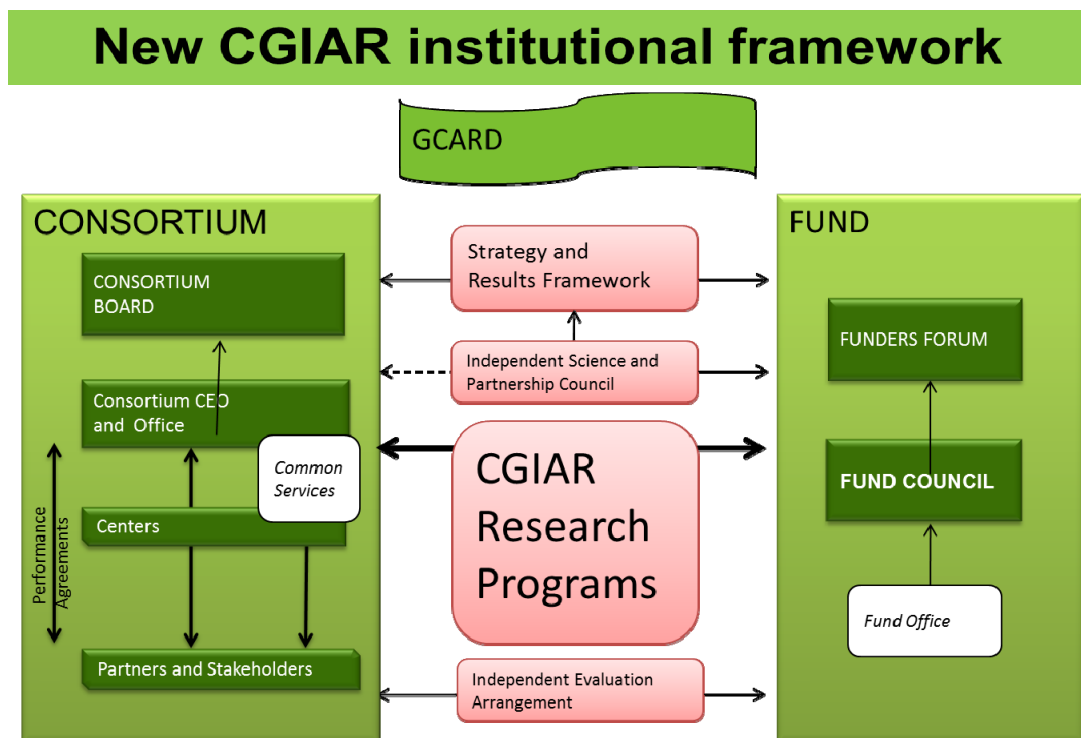


Figure 1. The reformed CGIAR structure

The CRPs can be categorized into five groupings and are described below.

The CRP on Managing and Sustaining Crop Collections (Genebanks) spans the 11 CGIAR Centers that are the guardians of world commodity collections. Managed by the Global Crop Diversity Trust (GCDT), this is the first time in the history of the CGIAR Centers that there is explicit and dedicated funding to protect the conservation and distribution of these invaluable global public assets. The management of this CRP by the GCDT aims to link the funding of the CGIAR genebanks

<sup>6</sup> [http://consortium.cgiar.org/wp-content/uploads/2011/08/CGIAR-SRF-Feb\\_20\\_2011.pdf](http://consortium.cgiar.org/wp-content/uploads/2011/08/CGIAR-SRF-Feb_20_2011.pdf)

to the endowment funding and standards of the Trust, as an intermediate stage of the evolutionary process towards full endowment by the Trust.

The second grouping of seven CRPs covers the classic commodity work of CGIAR:

- Global Rice Science Partnership (GRiSP)
- Wheat
- Maize
- Roots, Tubers and Bananas (RTB)
- Grain Legumes
- Dryland Cereals
- Livestock and Fish.

The third grouping of CRPs represents the expanded CGIAR agenda to natural resources management:

- Water, Land and Ecosystems (WLE)
- Forests, Trees and Agroforestry (FTA)
- Climate Change, Agriculture and Food Security (CAAFS).

Two of the CRPs address the linkages among the sectors of agriculture–health–policy:

- Agriculture for Nutrition and Health (A4NH)
- Policies, Institutions and Markets (PIM).

And a final grouping of three CRPs represents the cutting edge of the new portfolio; that is, how to integrate these commodities and sectorial dimensions into an integrated systems approach:

- Dryland Systems
- Integrated Systems for the Humid Tropics (Humidtropics)
- Aquatic Agricultural Systems (AAS).

CIP leads RTB and participates in seven other CRPs: Genebanks, WLE, CCAFS, A4NH, PIM, Dryland Systems, and Humidtropics.

## **2.4 Landscaping: emergence of new partners**

When CGIAR began its work in the 1970s, it was the only provider of global research for development. As the International Monetary Fund structural adjustments of the 1980s weakened national programs, we witnessed global and local nongovernmental organizations (NGOs) and local universities take up the development space, followed, slowly, by universities in developed countries during the 1990s. The emerging states—China, India, Brazil, Mexico, and Egypt—developed strong national research programs that have extended beyond their own borders since 2000.

But it was the “food crisis” of 2007–2008 that dramatically shifted the landscape. The compartmentalized global architecture of crisis response and mitigation—research—development has begun to blur. For example, the World Food Program began local sourcing of their food aid to support more rapid transition out of crisis; the international development NGO Catholic Relief Services opened a research branch. Development banks have begun to collaborate more closely with research institutions. Research organizations have been encouraged by investors to accept responsibility not only for research but also for development outcomes and impacts. And, the private sector has committed to development in a significant manner.

Major private sector players are now embracing the challenges of enabling the world’s poor to become market-linked producers and new consumers as a major driver of their future growth. Those with brands based on agricultural ingredients that are perishable or uneconomical to transport and who aspire to place branded goods on sale in every village around the world can only achieve this goal by establishing local supply chains with poor farmers, individually or collectively. CIP’s mandate crops fit this dynamic, and we are in an ideal position to help shape this important strand of the globalization agenda.

At the May 2012 Camp David Summit, G-8 and African leaders announced the New Alliance for Food Security and Nutrition, led by the New Partnership for Africa’s Development (NEPAD).<sup>7</sup> The New Alliance is a commitment by G-8 nations, African countries, and private sector partners to lift 50 million people out of poverty over the next 10 years through inclusive and sustained agricultural growth. Under the New Alliance, a technology platform was created to be led by CGIAR and the Forum for Agriculture Research in Africa (FARA), but encompassing other partners as well. The main objective is to create an initiative that will assess the availability of improved technologies for food commodities critical to achieving sustainable yield, resilience, and nutrition impacts; identifying current constraints to adoption; and creating a roadmap to accelerate adoption of technologies. Members of this alliance have been present at the most recent CGIAR/CAADP alignment workshops.

## 2.5 Urgency: scaling up impact

Changes in the external environment are increasingly being driven by a deeply shared sense that it is imperative from the perspectives of global justice, sustainability, and security to close the global gap between rich and poor worldwide and, in particular, between sub-Saharan Africa and the rest of the globe within one generation (i.e., 25 years). Given the comparable transformations that many once-poor countries and societies in Asia have been able to achieve, this can be done. One objective is to put ourselves and many of our development partners “out of a job” by enabling in the next 10–15 years the “launch pad” for better governments, stable civil societies, and the private sector to travel the final stretch during the following 10–15 years.

In 2003, the CIP visioning exercise concluded that to enhance impact, it was necessary to move from the linear, science-driven paradigm, which generated research outputs and handed them over to partners, toward a more targeted and balanced, demand-and-supply-driven paradigm. A pro-poor R&D paradigm was then conceived (Fig. 2). Although the original paradigm was developed to address poverty reduction more effectively, it is very well adapted to addressing key aspects of the new focus on food security (see SO 5). The paradigm has been modified for continued application to the current strategy work.



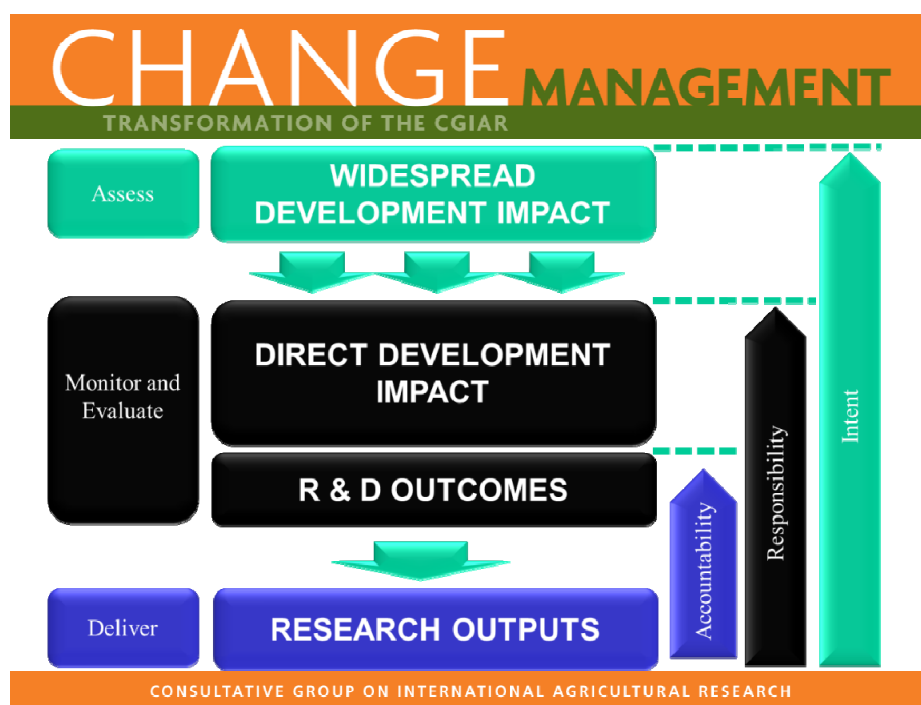
<sup>7</sup> <http://www.whitehouse.gov/blog/2012/05/18/new-alliance-food-security-and-nutrition>

**Targeting** assumes that to achieve more effective impacts on poverty, food insecurity, malnourishment, and degraded environments, we must precisely identify where the poor, hungry, undernourished, and degraded environments are located.

Once located, **Characterization** of those livelihood systems, food production systems, dietary systems, and natural systems provides the context and informs a **Needs and Opportunities Assessment**. Institutional landscapes as well as national frameworks and policies must be seen as part of characterization.

The **Research** agenda is informed and constructed by both the short-term and the longer-term needs and opportunities defined through characterization and assessment, but also by opportunities emerging through new science and technology breakthroughs.

Historically, CIP and CGIAR Centers have planned and delivered research outputs and research outcomes. However, many of the principal donors to CIP and the CGIAR System are indicating that research outcomes are no longer sufficient. They argue that our responsibility and intent should extend to development impacts at the HH level (Fig. 3). We agree. Assuming responsibility for development impacts will necessarily extend the nature of CIP’s work from research *for* development to also include research *and* development. And, this will require explicit attention to **Going to Scale**.



**Figure 3.** Outputs, outcomes, and impacts

### 2.5.1 Going to Scale<sup>8</sup>

Scaling-up is currently receiving much attention as a method to achieve greater impact. An important methodology of scaling-up begins with a vision for the long-range impact of an existing

<sup>8</sup> Much of this material is derived from Cooke, Rodney D. 2013. "Uptake pathways for SLO 1 & 2: a development practitioner's view." A paper prepared for the ISPC meeting in March 2013 on CGIAR IDOs and uptake pathways, Rome, Italy, 46 pp.

or new intervention, along with a time horizon for taking it to scale.<sup>9</sup> Next comes the identification of individual and institutional champions who are committed to the project's success, along with the drivers (including market forces) that will push it forward. With assistance from the champions, whatever obstacles may exist—be they policy-related, institutional, fiscal, cultural, social, or other impediments—are cleared to create spaces where the project can thrive. The conditions thus established constitute the pathway to scale up successfully.

Scaling-up pathways can follow different “dimensions”: they may simply expand services to more clients in a given geographical space. They can involve “horizontal” replication, from one geographic area to another; and “functional” expansion, by adding additional areas of engagement. Another dimension is “vertical” up-scaling (i.e., moving from a local or provincial engagement to a nationwide engagement) that often involves policy dialogue to help achieve the policy and institutional conditions needed for successful national-level scaling-up. We refer to these multiple pathways as “going to scale.”

There are two sets of factors that need to be considered in designing the appropriate pathway for going to scale in any given case:<sup>10</sup>

**1. Drivers:** these are the forces pushing the scaling-up process forward:

- **Ideas and models.** There has to be an idea or model that works at a small scale. It emerges from research or practice.
- **Vision and leadership.** A vision is needed to recognize that scaling-up of a (new) idea is necessary, desirable, and feasible. Visionary leaders or champions often drive the scaling-up process forward.
- **External catalysts.** Political and economic crisis or pressure from outside actors (donors, EU, etc.) may drive the scaling-up process forward.
- **Incentives and accountability.** Incentives are key to drive the behavior of actors and institutions toward scaling-up. They include rewards, competitions, and pressure through the political process, peer reviews, other evaluations, and so on. M&E against goals, benchmarks, and performance metrics are essential ingredients to establish incentives and accountability.

**2. Spaces:** these are the opportunities that can be created, or potential obstacles that need to be removed, to open up the space for interventions to grow.<sup>10</sup> The most important are:

- **Fiscal/financial space.** Fiscal and financial resources need to be mobilized to support the scaled-up intervention; and/or the costs of the intervention need to be adapted to fit into the available fiscal/financial space.
- **Natural resource/environmental space.** The impact of the intervention on natural resources and the environment must be considered, harmful effects mitigated, or beneficial impacts promoted.
- **Policy space.** The policy (and legal) framework has to allow for needs to be adapted to support scaling-up.
- **Institutional/organizational/staff capacity space.** Institutional and organizational capacity has to be created to carry the scaling-up process forward.
- **Political space.** Important stakeholders, both those in support of and those against the intervention, need to be considered through outreach and suitable safeguards to ensure the political support for a scaled-up intervention.
- **Cultural space.** Possible cultural obstacles or support mechanisms need to be identified and the intervention suitably adapted to permit scaling-up in a culturally diverse environment.

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<sup>9</sup> Linn, J.F., A. Hartmann, H. Kharas, R. Kohl, and B. Massler. 2010. Scaling up the fight against rural poverty: an institutional review of IFAD's approach. The Brookings Institute, Washington, DC.

<sup>10</sup> <http://www.brookings.edu/research/papers/2008/10/scaling-up-aid-linn>

- **Partnership space.** Partners need to be mobilized to join in the effort of scaling-up.
- **Learning space.** Knowledge about what works and what does not in scaling-up needs to be harnessed through M&E, knowledge sharing, and training.

There are six steps in the scaling-up process, which are being applied by the International Fund for Agricultural Development (IFAD) as part of the IFAD-Brookings Institute collaboration on scaling-up:

- **Step 1:** define the scale of the issue to be addressed and the appropriate scale of intervention up front, along with a suitable time horizon.
- **Step 2:** define suitable pathways of scaling-up by identifying the drivers and spaces for scaling-up, including the costs for delivery.
- **Step 3:** explore the institutional, organizational, and policy context that allows scaling-up.
- **Step 4:** define the partners who can assist with or take over the scaling-up process and what needs to be done to bring them on board.
- **Step 5:** define the appropriate operational instruments for the scaling-up process.
- **Step 6:** monitor and evaluate the pilot or experimental project as well as the scaling-up process in terms of the suitability of the pathway and impact on the rural poor.

The United States Agency for International Development (USAID) has developed a framework for scaling-up that involves three stages (Table 1):<sup>11</sup>

- **Stage 1,** proof of concept, is intended to test the real-world viability of an innovative development solution. The application must describe how the solution is clearly linked to a development change.
- **Stage 2,** scaling and impact evaluation, provides innovative solutions that have demonstrated success at a pilot or small-scale stage and now require support to assess if the solution can achieve larger-scale development impact and can be successfully implemented at such a scale. Stage 2 projects must include a rigorous evaluation component that clearly demonstrates the solution's impact on development outcomes. Cost-effectiveness analysis is also required.
- **Stage 3,** transitioning projects to large scale, provides innovative solutions that have credible and rigorous evidence of development impacts at significant scale. Stage 3 projects will transition an innovation from large-scale implementation to widespread adoption in one country and/or replication in at least one other country.

RTB in its 10-page proposal laid out a similar framework for scaling-up.<sup>12</sup> In each stage, CIP will have distinct strategic leadership roles and *research challenges*. The point on research challenges is worth underscoring. Movement into development impact is not intended to change the nature of CIP as a research organization. Rather, it will build on CIP's historical and unique role in the international architecture: the ability as honest brokers to convene and manage the complex partnerships that are necessary for scaling-up at the national level. Successfully scaling up for development impact will have its own research content: gender-transformative research, partnership research, delivery systems, cost-effectiveness, capacity-strengthening methodologies, and M&E and learning methodologies. Traditional compartmentalization of R&D within the global architecture has resulted in limited and fragmented research on these mission-critical areas of understanding.

<sup>11</sup> <http://www.usaid.gov/div/model>

<sup>12</sup> [http://www.rtb.cgiar.org/publication/planning-for-greater-impact-rtb-current-thinking/wppa\\_open/](http://www.rtb.cgiar.org/publication/planning-for-greater-impact-rtb-current-thinking/wppa_open/)

**Table 1. Stages of scaling up in focus countries**

Scale of Impact at Country Level		Stage 1	Stage 2	Stage 3
		Up to 10,000 HHS reached	Up to 200,000 HHS reached	More than 200,000 HHS reached
CIP's roles	Strategic leadership	<b>Catalyze</b> <ul style="list-style-type: none"> <li>Identify demand</li> <li>Demonstrate what's possible</li> <li>Catalyze new alliances</li> </ul>	<b>Coordinate</b> <ul style="list-style-type: none"> <li>Coordinate new programs</li> <li>Promote integration solutions into national programs and investment plans</li> </ul>	<b>Convene</b> <ul style="list-style-type: none"> <li>Transfer responsibility and enable leadership by national partners</li> <li>Link up diverse initiatives</li> <li>Facilitate cross-sectorial learning and continued training</li> <li>Link countries to regional and global networks</li> </ul>
	Research	proof-of-concept research; varietal selection; pilot seed systems and value chains	<b>Supportive</b> build strong evidence base; strengthen national research programs and link them to diversified value chains	<b>Strategic</b> assess scaling-up process; strategic research on key bottlenecks and new opportunities for expanding impact

## 2.6 Gender transformative research and social inclusion

CIP's mission is to work with partners to achieve food security, well-being, and gender equity for poor people in root and tuber farming and food systems in the developing world. For this to happen, all farmers and other end-users—men and women—must be able to benefit from science and technology interventions developed by the R&D community. A key goal for gender strategy is to “level the playing fields” where possible by providing access to knowledge, capacity development, and market opportunities, and by ensuring that the technology developed through the research programs is made available to both men and women.

There are two types of gender-linked development outcomes:

- With gender-responsive development outcomes, both men and women benefit and neither is harmed.
- With gender-transformative development outcomes, both men and women benefit while gender roles are transformed and more gender-equitable relations between men and women are promoted.

The more straightforward approach is to achieve gender-responsive outcomes by ensuring that women are included equitably in the activities of the research program. Gender-responsive research also analyzes technologies for gender bias and addresses inefficiencies in aligning technologies with women's and men's needs, knowledge, and skills.

It is more challenging to achieve gender-transformative outcomes, given the structural inequalities in many sectors deriving from entrenched gender norms that often constrain women's agency, including their ability to actively take advantage of agricultural innovations.<sup>13</sup>

<sup>13</sup> Muñoz Boudet, Ana María, Petesch, Patti, and Turk, Carolyn, with Angélica Thumala. 2013. On Norms and Agency. Conversations about gender equality with women and men in 20 countries. The World Bank, Washington, DC.

Gender-transformative research, including both programmatic and policy approaches, challenges the distribution of resources and allocation of duties between men and women.<sup>14</sup> A recent FAO publication makes it clear that constraints on women’s agency and unequal distribution of resources reduce the scope of developmental impact through agricultural innovation. It forcefully argues for the need to promote shared power, control of resources, decision making, and support for women’s empowerment.<sup>15</sup> Because inequalities derive from multiple sectors, gender-transformative research will need new types of high-quality, collaborative research across the CGIAR System and broader partnerships with centers of gender expertise outside CGIAR. The Consortium gender network, in which CIP is an active participant, is currently building this new type of collaboration to address the challenges of transformative gender research. Working with the World Bank and other agencies, the network is developing a cross-CRP, global study on how gender norms and agency affect agricultural innovation and how agricultural research needs to respond. CIP remains committed to mainstreaming gender equity in our R&D work. Social inclusion and/or social justice, however, must reach beyond gender to explicitly address the issues of clans, castes, classes, tribes, ethnic groups, and religions. One of the major “brakes” on the scale of change required is the understandable fear of cultural loss, homogenization, and de-differentiation. On the basis of its experiences in the Andes, CIP has much to add on how to both protect traditional cultures and values while encouraging their constructive evolution.

## 2.7 Capacity development

In the context of the 2005 Paris Declaration on Aid Effectiveness, capacity development is considered the responsibility of host countries, with partners such as CIP playing a supportive role.<sup>16</sup> Thus, while CIP is committed to developing its own capacity to deliver expected results, it is also committed to helping partner organizations develop their respective capacities to achieve mutually agreed results. CGIAR is moving towards a common strategy on capacity development, using a systems approach and building on key partnerships. This will enhance CGIAR’s and partners’ competencies, skills, and leadership to deliver research outputs and, particularly, development outcomes, which require a set of skills that the CGIAR community may not fully have.

Capacity development in CIP has evolved over time to accommodate changing needs and circumstances (e.g., broadening approaches from individually focused training to developing multidisciplinary teams; from controlled scientific experiments to participatory community-based approaches; from information sharing to facilitating learning). Within the context of the current SRF, capacity development is conceived within the framework of the impact pathway: scientific proof of concept—piloting promising innovations—out-scaling promising pilots—up-scaling innovations to achieve broad-based outcomes and impact (Fig. 4). One of the key implications of this approach is that capacity development must be conceived at different levels of operation:<sup>17</sup>

- Individual-level capacity: to improve knowledge, skills, and attitudes
- Team-level capacity: to build disciplinary and multidisciplinary teams
- Organizational capacity: to manage and deliver medium- and long-term results, often requiring multi-organizational partnerships

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<sup>14</sup> Gill, Kirrin, Brooks, Kim, McDougall, Janna, Patel, Payal, and Kes, Aslihan. 2010. Bridging the Gender Divide: How Technology Can Advance Women Economically. International Center for Research on Women (ICRW), Washington, DC.

<sup>15</sup> FAO. 2011. The State of Food and Agriculture 2010–2011. Women in Agriculture: Closing the gender gap for development. FAO, Rome.

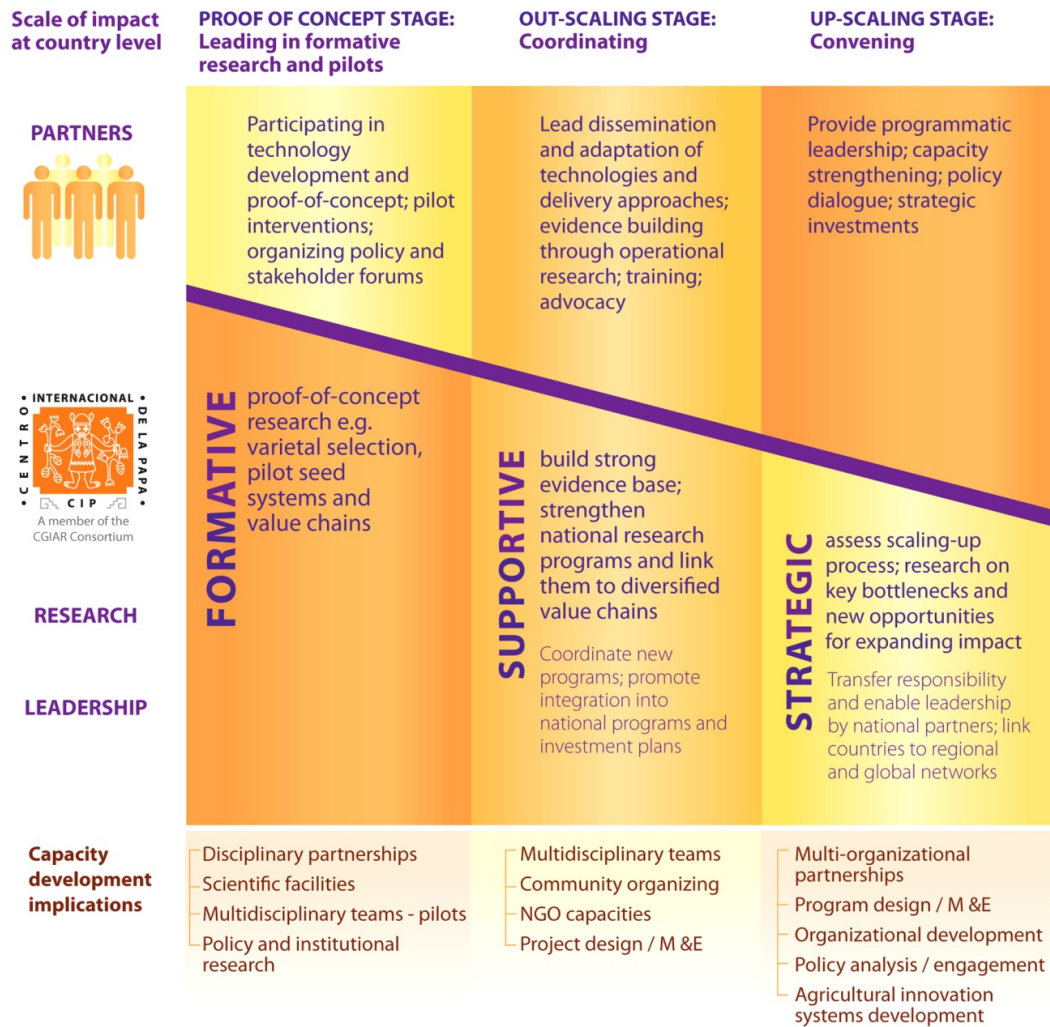
<sup>16</sup> OECD. 2005/2008. Paris Declaration on Aid Effectiveness/Accra Agenda for Action. Paris: OECD, p. 4, para. 22.

<sup>17</sup> Adiel, N. Mbabu, and Hall, Andy (eds.). 2012. Capacity Building for Agricultural Research for Development: Lessons from Practice in Papua New Guinea. 274 PP. United Nations University-Maastricht Economic and Social Research and Training Centre on Innovation and Technology (UNU-MERIT), Maastricht: The Netherlands.

- Systemic capacity: to support policy and institutional innovations for collective action (e.g., multisectoral initiatives such as agriculture for health and nutrition; value chains).

The other key implication of this approach to capacity development is that CIP will need to develop its own skills and abilities to deal with the diverse capacity needs within the organization and among partner organizations. These capacities include the following:

- Systems thinking* to accommodate impact pathways and relevant value chains
- Change management* skills to facilitate organizational and systemic learning towards managing for results (outcomes and impact)
- Action learning* skills to align individual action to collective action at organization and system levels
- Partnership management* skills to enhance collective action between public and private sectors along respective value chains to achieve expected outcomes and impact
- Adult learning* skills to facilitate rural innovations for social change and development.



**Figure 4.** CIP’s capacity-development roles along the impact pathway

It is noteworthy that while at proof-of-concept stage, CIP will essentially be relying on its specialized disciplinary skills and partnerships with advanced research institutes, including public

and private universities. In this situation, disciplinary capacities and partnership management skills will be central to CIP's capacity development strategy. However, in piloting the proof-of-concept initiatives, CIP will need to partner with national governments to develop appropriate policies and regulations; and in collaboration with the private sector develop intellectual property rights regimes. CIP will also need to engage actively with national and regional organizations to understand their strategic planning and priority setting as context for needs and opportunity assessment.

To address these capacity needs effectively, CIP will need to strengthen in-house competencies in the following areas: systems thinking, change management skills, managing for results, action learning skills, partnership management skills, team-building skills, adult learning facilitation, and knowledge management.

Considering the longer-term nature of these interventions, plans for capacity development activities will be anchored at the SO level. We expect the CIP China Center for Asia and the Pacific to have a prominent role in planning and delivering capacity development activities for all SOs, with a particularly active set of exchange programs among Asia and Africa.

## 2.8 Results-Based Management and theories of change

In the international R&D arena, the trend is toward RBM to guide implementation of scientific research programs in order to optimize their contribution to development outcomes and impact. The approach provides a framework for setting priorities and allocating resources, and in turn assessing and rewarding good results and performance. Its adoption will help organizations like CIP and its donors to better understand, plan, and report the impact of its work. RBM rests on a theory of change (ToC) linking outputs, outcomes, and goals with clearly defined accountabilities at these different levels. A pilot phase for the design and systematic use of RBM is envisaged as a key part of how CIP's SCP will implement plans for the SOs. These will be aligned and coordinated with the CRPs, particularly RTB.

**Delivery flagships and linked products** focus on near market-ready research products that will generate significant outcomes and impact over the next nine years. They include outcome support services to create the capacities, development partnerships, and innovation environment for product delivery to take outcomes to scale and enhance gender equity. **Discovery flagships and linked products** provide well-targeted, high-potential upstream research, contributing to next- and end-user outcomes in the longer term. Examples include next-generation breeding to accelerate genetic gain in yield and quality traits in a client-responsive way, and game-changing traits for recalcitrant challenges to breeding. Discovery flagships will generate products for delivery once proof of concept is established.

As part of the shift to RBM, CGIAR has agreed to develop ToCs that explain clearly how research activities and their products in CRPs carry through to CGIAR's four SLOs. ToCs are predictions about what is expected to happen in the future. They describe impact pathways, also known as results chains, showing the sequence of results from research products (flagship product/linked products) to research outcomes to development outcomes. Good impact pathways are understandable and credible, made so by a narrative describing the underpinning ToC.

To provide an operational basis for RBM, a set of common Intermediate Development Outcomes (IDOs) has been developed (Table 2), and each CRP has adapted its own set of IDOs from the common IDOs. The IDOs provide the basis for developing an M&E framework.

Each of CIP's six SOs presents a stylized description of its impact pathway, with the IDOs that it proposes to address, and a set of quantified geographically specific indicators. This will establish the basis for an integrated M&E system that crosscuts all SOs and seamlessly links to CRP reporting up to the Consortium. It is important to highlight that CIP has contributed to the design of some of the RTB delivery and discovery flagships, and is using the same but transformed into SOs. Therefore, the RBM system to be designed will serve both RTB and CIP.

**Table 2.** CGIAR Common IDOs

No.	Short Name	IDO
1	<b>Productivity</b>	Improved productivity in pro-poor food systems
2	<b>Food security</b>	Increased and stable access to food commodities by rural and urban poor
3	<b>Nutrition</b>	Improved diet quality of nutritionally vulnerable populations, especially women and children
4	<b>Income</b>	Increased and more equitable income from agricultural and natural resources management and environmental services earned by low income value chain actors
5	<b>Gender and Empowerment</b>	Increased control over resources and participation in decision-making by women and other marginalized groups
6	<b>Capacity to Innovate</b>	Increased capacity for innovation within low-income and vulnerable rural communities, allowing them to improve livelihoods
7	<b>Adaptive Capacity</b>	Increased capacity in low-income communities to adapt to environmental and economic variability, shocks, and longer term changes
8	<b>Policies</b>	More effective policies, supporting sustainable, resilient and equitable agricultural and natural resources management developed and adopted by agricultural, conservation, and development organizations, national governments, and international bodies
9	<b>Environment</b>	Minimized adverse environmental effects of increased production intensification
10	<b>Future Options</b>	Greater resilience of agricultural/forest/water-based/mixed crop livestock, aquatic systems for enhanced ecosystem services
11	<b>Climate</b>	Increased carbon sequestration and reduction of greenhouse gases through improved agriculture and natural resources management

### 3. CIP'S 2014–2018 SCP

#### 3.1. Building on CIP's legacy

Moving forward with a new CIP SCP, we have a solid legacy to build on.

SO 1 builds on clear evidence that effective biofortification can be delivered by OFSP. A controlled feeding trial was conducted in South Africa with children aged 5–10 years (van Jaarsveld et al. 2005).<sup>18</sup> Vitamin A liver stores improved significantly among children consuming OFSP compared to those consuming white-fleshed sweetpotato, establishing OFSP's efficacy. Similarly, the effectiveness of OFSP introduction and promotion integrated with demand creation was assessed in Mozambique by Low et al. (2007)<sup>19</sup> in three severely resource-poor districts over four growing seasons. Intervention children showed much higher vitamin A intakes and improved vitamin A status than control group children. From 2006 to 2009, the cost-effectiveness of reaching 24,000 HH using the integrated agriculture-nutrition approach was done in a HarvestPlus-led OFSP intervention in Uganda and Mozambique. Results demonstrated high adoption rates (>60%) and a doubling of vitamin A intakes in both countries among women and children (Hotz et al. 2012).<sup>20</sup>

<sup>18</sup> Jaarsveld, P. V., Faber, M., Tanumihardjo, S. A., Nestel, P., Lombard, C. J., and Benade, A. J. 2005. Beta-carotene-rich orange-fleshed sweet potato improves the vitamin A status of primary school children assessed with the modified-relative-dose-response test. *The American Journal of Clinical Nutrition* 81: 1080–1087.

<sup>19</sup> Low, J. W., Arinond, M., Osman, N., Cunguara, B., Zano, F., and Tschirley, D. 2007. A food-based approach introducing orange-fleshed sweet potatoes increased vitamin A intake and serum retinol concentrations in young children in rural Mozambique. *Journal of Nutrition* 137: 1320–1327.

<sup>20</sup> Hotz, C., Loechl, C., Lubowa, A., Tumwine, J. K., Ndeezi, G., Masawi, A. N., Baingana, R., Carriquiry, A., Brauw, A. D., Meenakshi, J. V., and Gilligan, D. O. 2012. Introduction of b-Carotene-Rich Orange Sweet Potato in Rural Uganda Results in Increased Vitamin A Intakes among Children and Women and Improved Vitamin A Status among Children. *J Nutri* 142: 1871–1880.

Hotz et al. 2011<sup>21</sup>). In Uganda, vitamin A status among children was measured and a reduction in prevalence of vitamin A deficiency found (Hotz et al. 2012). In all studies, it is clear that children love the color and taste of OFSP. The color, moreover, has emerged as an effective marketing tool. These results are the foundation of CIP's SO 1 (see Section 3.2)

SO 2 is related to intensification of cereal-based systems with early-maturing potato varieties in Asia, which builds on CIP's previous work in collaboration with the West Bengal Department of Agriculture. Both partners developed and tested the double-transplanting of rice seedlings technology to enable farmers to grow both potato and rice in sequence on the same land, without sacrificing yields of either crop. The introduction of potato with this technology incremented the net return by up to 178% compared to the traditional rice–rice system. Household interviews showed that the additional job opportunities favored local women (Bardhan et al. 2007<sup>22</sup>). Research on minimum tillage in lowland areas of South China showed that potato production can be improved through simple techniques like mulching with rice straw, reaching up to 25 t/ha (Tang et al. 2012<sup>23</sup>).

This work also builds on CIP's long experience of introduction, evaluation, and dissemination of potato varieties, which led to the adoption of CIP-related varieties on more than one million ha (Thiele et al. 2010<sup>24</sup>).

SO 3 is based on previous work on seed potato, which has been a strength in CIP's program in recent years and has led projects to improve farmer seed management in the seven East, Central, and Southern African potato-producing countries. This experience has generated complementary insights and lessons learned and impacted more than 150,000 smallholder farmers. Our flagship 3G (three-generation seed production) project was implemented in October 2008–June 2011 in Kenya, Rwanda, and Uganda. Funded by USAID 3G laid the groundwork and increased small-scale farmers' access to seed potato and improved its production by involving both the public and private sectors. The project achieved a number of successes, chiefly the introduction of aeroponics and other rapid multiplication technologies that accelerated adoption of the 3G seed multiplication strategy. 3G improved knowledge and skills on potato production technologies and best practices, leading to increased average yields by 20% for over 15,000 smallholder growers (Schulte-Geldermann et al.<sup>25</sup>). The result was a doubling of the yield of adopters of high-quality seed potatoes (Schulte-Geldermann et al. 2010<sup>26</sup>). The project also demonstrated that women farmers were more likely to adopt and continue using the 3G approach than were men. Finally, a model was created for establishing partnerships with private sector farms to invest in seed potato (e.g., Kisima Farm alone is now responsible for about 60% of all quality seed distribution in Kenya).<sup>27</sup>

SO 4 is based on the scientific experience that CIP has accumulated over its four decades of existence, which is a unique know-how in potato and sweetpotato genetics and biotechnology with relevancy to developing country smallholders. Our scientists and their partners were able to

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<sup>21</sup> Hotz, C., Loechl, C., De Brauw, A., Eozenou, P., Gilligan, D., Moursi, M., Munhau, B., Van Jaarsveld, P., Carriquiry, A., and Meenakshi, J. V. 2011. A large-scale intervention to introduce orange sweet potato in rural Mozambique increases vitamin A intakes among children and women. *Br J Nutr* 108(1): 1–14.

<sup>22</sup> Bardhan Roy, S. K., Saha, N. K., Kadian, M. S., Quiroz, R., and Ilangantileke, S. 2007. Improving the livelihood of farmers by intensifying the rice-potato-rice system through double transplanting of rice in West Bengal, India. Natural Resources Management Division, Working Paper No. 2007-1. International Potato Center, Lima Peru, 21 pp.

<sup>23</sup> Tan Zhouping, Li Wenjuan, He Xinmin, Tan Guanning, and Xie Kaiyun. 2012. Effect of Different Rice-straw Mulch and Planting Patterns on the Yield of Winter Potato in Guangxi. *Chinese Potato Journal* 26(3): 147–154.

<sup>24</sup> Thiele, G., Hareau, G., Suarez, V., Chujoy, E., Bonierbale, M., and Maldonado, L. 2008. Varietal change in potatoes in developing countries and the contribution of the International Potato Center: 1972–2007. Working Paper 2008-6. International Potato Center (CIP): Lima, Peru.

<sup>25</sup> Schulte-Geldermann, E., Gildemacher, P. R., and Struik, P. C. 2012. Improving Seed Health and Seed Performance by Positive Selection in Three Kenyan Potato Varieties. *American Journal of Potato Research* 89(6) December: 429–437.

<sup>26</sup> Schulte-Geldermann, E., Wachira, G., Ochieng, B., and Barker, I. 2010. Effect of field multiplication generation on seed potato (*solanum tuberosum*) quality in Kenya, 8th African Potato Association Conference, 5–9 December 2010, Cape Town, South Africa.

<sup>27</sup> CIP. 2011. The “3G” seed strategy: A novel innovation to breaking the seed potato bottleneck in eastern and central Africa-Key project achievements in Kenya, Rwanda, and Uganda. Prepared for USAID, CIP, Lima, September 2011.

characterize and use allelic diversity of the crops' germplasm and make significant progress in genetic improvement. Numerous biotechnology applications were developed in our facilities by means of direct gene transfer (transgenics) or marker-assisted breeding. Next-generation transgenic technology is coming under the form of technologies achieving sequence-targeted modifications (often referred to as "genome editing"). However, what makes our timing propitious is the recent progress in whole-genome research. Genomic-assisted breeding makes use of whole-genome technologies, which unlike with previous technologies allow breeders not only to focus on single genes or major quantitative trait locus (QTL) but also to consider minor QTL while discarding undesirable genes and loci. CIP was a critical (albeit minor) contributor to the discovery of the first potato genome sequence, first published in *Nature* in 2011, and is about to play a similar role in the sweetpotato genome sequence.

SO 5 builds on CIP's experience in the Andes with the "Participatory Market Chain Approach." This approach engages potato market chain actors in a collective process that identifies and exploits potential equitable business opportunities to improve the livelihoods of small farmers, taking advantage of potato biodiversity. It also builds on the "Innovation for Food Security and Sovereignty in the Andes" (IssAndes) project financed by the European Commission, and the work of FoodSTART, a five-country R&D project financed by IFAD in South, Southeast, and Eastern Asia that targets poor populations in the region where roots and tubers can contribute to improving food security. Based on a food security framework, with particular emphasis on food vulnerability, FoodSTART uses a cyclical process model (the pro-poor R&D cycle) to undertake systematic targeting; characterization; and needs and opportunities assessments of root crop biodiversity, crop production, value chains, and food consumption to identify interventions for enhancing food security. The project has developed an innovative collaboration with large-scale, public sector development projects that are currently taking FoodSTART innovations to scale in value chains and farmer organizations. This SO also builds on sound modeling work on agro-ecological factors that are needed to understand future potato and sweetpotato scenarios and plan proper adaptation strategies (Segnini et al. 2011<sup>28</sup>).

SO 6 (conserving diversity for the future) builds on the long tradition and experience of CIP for the conservation and evaluation of genetic resources. From the beginning of CIP's existence, the genebank has worked towards conserving and making available valuable diversity of potatoes and sweetpotatoes. It has a world-class reputation for excellence, transparency, and expertise to support breeding programs and sustain global food productivity and security.

### 3.2. CIP's new strategic objectives

The overarching question for CIP still remains: How do we enhance our impact? But answering this question now has a greater sense of urgency.

In response to recent decades of dramatic changes, particularly over the past five years, CIP's new strategy proposes some equally dramatic shifts in how we will work going forward.

Our SCP is aligned with and supports the global, regional, and national paradigms in our target areas. It is also fully aligned with the CGIAR SRF and more directly with the vision for the next phase of CRPs, as formulated by RTB.

We propose to streamline our program to focus on the six SOs. Three of the SOs (1–3) will move us into the research *and* development space in order to deliver shorter-term solutions to food security in our target commodities and geographies with the proposed delivery flagships. Our two new SOs (4 and 5) will continue to address more upstream research *for* development that intends to deliver research outputs that will deliver development impacts in the longer term through the discovery flagships. We will mainstream gender throughout the SOs and target for socially excluded populations and youth.

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<sup>28</sup> Segnini, A., Posadas, A., Quiroz, R., Milori, D.M.B.P., Vaz, C.M.P., and Martin-Neto, L. 2011. *Journal of Soil and Water Conservation* 66: 213–220.

The research *and* development SOs are:

- **SO 1:** Combating Vitamin A Deficiency with Resilient, Nutritious Orange-Fleshed Sweetpotato—with high contribution to food utilization.
- **SO 2:** Feeding Asia, Diversifying Economies and Diets through the Adoption of the Early-Maturing Agile Potato—with high contribution to food availability.
- **SO 3:** Improving Livelihoods of Potato Farmers in Africa by Breaking the Seed Bottleneck—with high contribution to food access through income generation.

SOs 1 and 3 are closer to going to scale; SO 2 still requires additional proof of concept. We expect to start achieving impacts at the HH level from each of these SOs over the next five years (Fig. 5).

The research *for* development SOs are:

- **SO 4:** Accelerating the Discovery and Delivery of Game-Changing Solutions for Food Security—that will lead to enhanced food availability in the longer term.
- **SO 5:** Transforming Food Vulnerability to Resilience through Systems Research—that will operationalize the food security paradigm at the national level, with particular contribution to food vulnerability.

These two SOs embody 21st-century upstream research: biotechnology and systems. They both address the broader question of what research we need to be undertaking now in order to develop and deliver future solutions that will contribute to sustainably feeding our planet in 2030 and 2050.

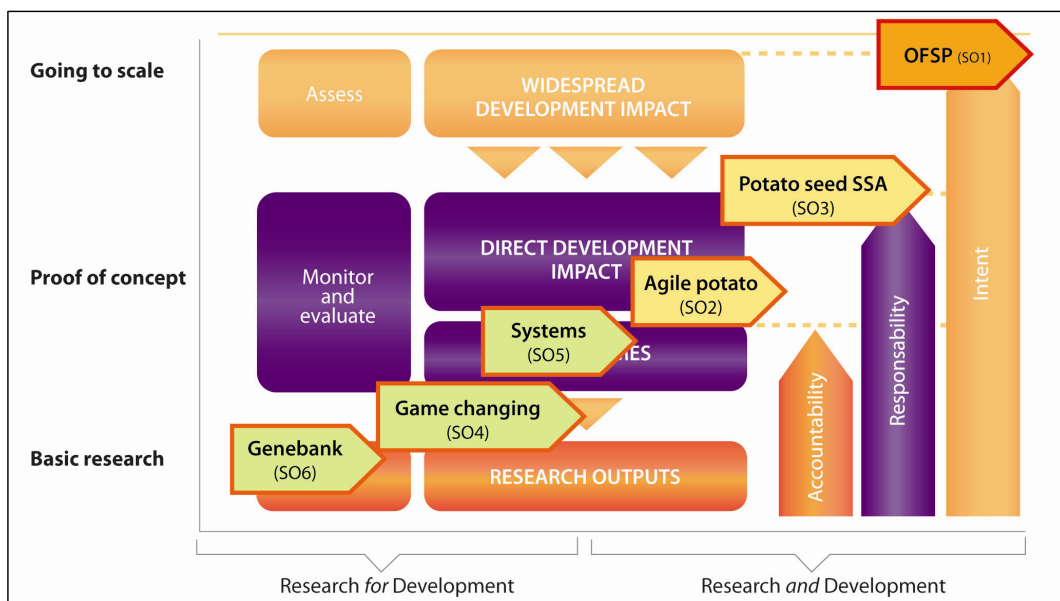
CIP includes a sixth SO, which builds on the Center’s core function of conserving genetic resources over the last 40 years:

- **SO 6:** Conserving diversity for the future: the CIP genebank—that will continue a core function but looks to improve conservation and use of genetic resources to face future challenges.

The full portfolio of CIP’s SOs is represented graphically in Figure 5, which shows a balanced portfolio along both the research *for* development and the research *and* development continuum. The figure also shows that CIP aims at having some quick wins in terms of outcomes and impact, but taking care of the core function of developing new science-based solutions for the future.

In addition to the SOs, CIP’s SCP (2014–2018) outlines corporate objectives (COs). The COs address the operational challenges that will be required to successfully implement the SOs.

Implementation of this strategy will demand innovation in our partnerships as we move toward greater implementation and impact.



**Figure 5.** CIP’s portfolio of SOs in the research *for/and* development continuum, in relation to the change process of CGIAR and request for contribution to outcomes and impact

### 3.3 What is new in the SCP?

CIP's SCP (2014–2018) embodies some important advances for the institution. Most significantly, it allows us to take advantage of the drive in the global agricultural community to decartmentalize R&D. The SCP explicitly expands CIP's accountability for research outputs and outcomes to an agenda that also includes responsibility and intent to deliver development outcomes and impacts. This enhanced agenda is laid out in the SOs on Research *and* Agriculture (1–3).

Programmatically, while we push our agenda further down the R&D continuum we are also pushing it up the R&D continuum. With SOs 4 and 5 we challenge ourselves to move more boldly into the 21<sup>st</sup>-century agendas for biotechnology and systems research.

The SCP also explicitly recognizes the political and operational importance of the Paris Declaration, and particularly the principle of national ownership of development strategies. CIP's research outcomes and outputs must support the declared goals and priorities of the countries that we work with. Scaling-up for development impact must be conceptualized and conducted within national frameworks.

At the writing of the last CIP corporate strategy, CGIAR reform was still under design. The SCP is fully aligned with the CGIAR's reform SRF, SLOs, and CRPs, including the ToCs, IDOs, flagship product concepts, and RBM framework.

CIP's SOs and COs are not focused on specific scientific programs or administrative units, as they were in the previous corporate plan. Rather, the SCP articulates SOs for the program and for operations that are truly corporate. They cut across the Center, and will require the development of integrated teams that draw on our human resources across the scientific departments and operational and administrative units.

The CIP R&D cycle has evolved to reflect a need for explicit gender strategies, partnership strategies, capacity-building strategies, and M&E frameworks all around the stages of the R&D cycle. Gender strategies must be mainstreamed in all of CIP's programs. And, the success of going to scale will depend on thoughtful and appropriate partnership and capacity-building strategies.

We anticipate that during the time frame of the SCP, CIP's China Center for Asia and the Pacific will become fully operational and contribute significantly to the achievement of the goals articulated here in the SCP.

CIP's SOs are fully aligned with the CRPs, RTB. Three of CIP's SOs are flagships in RTB (1–3). The Genebank (SO 6) is fully aligned with the Genebank CRP. CIP's work in achieving its SOs will contribute to the IDOs prioritized by the CRPs and CGIAR. In turn, the work done within the eight CRPs that CIP participates in will also help CIP achieve its SOs.

# SO 1 Combating Micronutrient Deficiency with Resilient, Nutritious Orange-Fleshed Sweetpotato

## 1. Summary of the Strategic Objective

We will enable at least 15 million HH to improve the quality of their diets and raise their crop incomes over the next 10 years in countries with micronutrient deficiencies in sub-Saharan Africa (SSA), Asia, and Haiti. This will be done through farmers' cultivation and use of biofortified sweetpotato, starting by reducing vitamin A deficiency (VAD) through OFSP—a proven technology for reducing VAD among women and small children. Responding to strong regional and national demand for more nutritious foods, we will generate new, locally adapted and nutritious OFSP varieties. We will help our partners scale up use of these varieties through accelerated breeding, improved multiplication techniques, diversified value chain development, and evidence-based policies. We will establish strategic partnerships for going to scale and accompany this process with strategic research to assess cost-effectiveness, pro-poor focus, and gender inclusiveness. SO 1 will spearhead implementation of the RTB Delivery Flagship on OFSP, and seek interaction with the Dryland Systems, Humidtropics, and Aquatic AAS CRPs to contribute to five of the CGIAR IDOs, particularly that of increased intake of nutritious food by vulnerable populations, and to SLOs 1–4.<sup>1</sup>

## 2. Strategic Objective

By 2023, this flagship aims to reach at least 15 million resource-poor HH in SSA, Asia, and Haiti by enabling them to improve the quality of their diet by 20% and raise their crop income by 15%. It will achieve this through increased production and intake of vitamin A-rich OFSP and future biofortified sweetpotato varieties, diversified use of sweetpotato, and expansion of gender-equitable market chains. This target includes at least 2.5 million HH as direct beneficiaries in intervention areas and at least 12.5 million HH as indirect beneficiaries reached through further follow-on dissemination by farmers, extension agents, and other stakeholders.<sup>2</sup> We expect that during the implementation period of SO 1, other biofortified sweetpotato, including varieties rich in iron and zinc, will become available for proof-of-concept research and subsequent scaling-out. These will be promoted as second- and third-wave flagship products using a similar approach as outlined for OFSP in this chapter.

## 3. Development Challenge

At present, FAO estimates that there are 870 million undernourished people on the planet. Almost two billion suffer from “hidden hunger,” or micronutrient deficiency, particularly iron,

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<sup>1</sup> For IDOs, see section 9; for SLOs, see section 5.

<sup>2</sup> We expect additional beneficiaries among consumers from expanding urban market chains. To quantify these, we will develop measurements and processes to monitor consumption of OFSP beyond the HH level.

vitamin A, zinc, iodine, and folic acid deficiencies.<sup>3</sup> The immediate focus of this SO is on combating VAD; reducing iron and zinc deficiency will be subsequent targets over the next 10 years. VAD can limit growth, weaken immunity, cause xerophthalmia, lead to blindness, and increase mortality.<sup>4</sup> Globally, 163 million children under 5 years of age suffer from VAD, with the highest prevalence rates found in Central and West Africa (40%) and South Central Asia (30%).<sup>5</sup> Significant progress has been made in reducing VAD in Latin America and the Caribbean (LAC); Haiti, with a prevalence rate of 22.3%, is the one exception.<sup>6</sup> In SSA and poor countries in Asia, the problem of undernutrition has actually been increasing. The number of underweight children in Africa has almost doubled since 1980 and is forecast to be 25% higher in 2015 than in 1990.<sup>7</sup>

Agriculture in these countries has largely failed to keep up with the changing needs for more nutritious food, as policies have made nutrition less a priority and research systems have fallen behind global scientific advances. Technology and information delivery systems are not well connected to high-impact partners. This has weakened innovation systems. New challenges from climatic changes are threatening agricultural productivity, and global food price fluctuations are jeopardizing food and nutrition security among vulnerable populations. Smallholder farmers largely do not realize the potential benefits of increased market demand for food stemming from urbanization and improved trade. Instead, their agricultural incomes stagnate at low levels in spite of national economic growth in many countries. In Asia, 80–90% of the poor live in rural areas, and in Africa over 70%. In East and Southern Africa over 85% of the poor live on land that has a medium to high potential for increased productivity.<sup>8</sup>

What is urgently required are agricultural technologies that can produce nutritious and marketable food in agro-ecologies and socioeconomic contexts that are important to the rural poor. Sweetpotato offers strategic opportunities to improve nutrition and rural incomes in several countries and regions affected by micronutrient deficiency, including VAD. Sweetpotato is already an important component of the cropping systems in SSA and Asia because of its robustness to produce under difficult conditions. It will grow more important in the face of a changing climate.

#### 4. CIP's Targeted Response

CIP is a recognized global leader in the development and dissemination of biofortified, vitamin A-rich OFSP. The use of OFSP, when introduced along with nutrition education at the community level, is a proven cost-effective strategy for providing vitamin A at high levels of bioavailability to vulnerable populations.<sup>9</sup> OFSP production from 500 m<sup>2</sup> can provide sufficient vitamin A for a family of five<sup>10</sup> and is a good source of energy, a number of B vitamins, and vitamins C and K.<sup>11</sup> These are vital benefits for the majority of people affected with VAD who live in rural areas where conventional VAD interventions such as supplementation and food fortification are ineffective. The strategic advantage of biofortified crops is that they sustainably build micronutrient supply

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3 FAO. 2012. *The State of Food Insecurity in the World*. Rome: Food and Agricultural Organization. <http://www.fao.org/docrep/016/i3027e/i3027e00.htm>

4 WHO. 2009. *Global Prevalence of Vitamin A Deficiency in Populations at Risk*. Geneva: World Health Organization.

5 Standing Committee On Nutrition. 2011. *6th Report On The World Nutrition Situation: Progress In Nutrition*. Geneva: United Nations System.

6 WHO Global Database on Vitamin A Deficiency. <http://www.who.int/vmnis/vitamina/data/en/index.html>

7 FAO. *ibid.*

8 IFAD <http://www.ruralpovertyportal.org/region/home/tags/africa>. Accessed 20 October 2013

9 Van Jaarsveld, P. et al. 2005. Beta-carotene-rich orange-fleshed sweet potato improves the vitamin A status of primary school children assessed with the modified-relative-dose-response test. *American Journal of Clinical Nutrition* 81: 1080–1087. Low, J. et al. 2007. Food-based approach introducing orange-fleshed sweet potatoes increased vitamin intake and serum retinol concentrations in young children in rural Mozambique. *Journal of Nutrition* 137: 1320–1327.

10 Low, J. et al. 2009. Sweetpotato in Sub-Saharan Africa. In: Loebenstein, G. and Thottappilly, G. (eds.) *The Sweetpotato*. Dordrecht: Springer Science + Business Media B.V.

11 U.S. Department of Agriculture, Agricultural Research Service. 2012. USDA National Nutrient Database for Standard Reference, Release 25. Nutrient Data Laboratory Home Page, <http://www.ars.usda.gov/ba/bhnrc/ndl>

into the regular, daily food production and consumption patterns without need for continuous investments in the delivery of nutrition supplements. However, biofortified crops overall lack a strong evidence base of efficacy in the field at this stage—with the notable exception of OFSP.<sup>12</sup> Still, for OFSP to achieve its full nutrition impact, linkages with other biofortification efforts (e.g., providing different micronutrients, using different crops) are important, as are complementarities with nutrition supplementation and education programs. In Zambia, we are already coordinating our OFSP work with the HarvestPlus orange maize project under one joint R&D program. We are also a partner to the HarvestPlus combined OFSP and high-iron beans program in Uganda and Rwanda. In Nigeria, we are developing similar linkages with a yellow cassava program led by the International Institute of Tropical Agriculture (IITA). Working through RTB and A4NH, and also with Dryland Systems, Humidtropics, and AAS CRPs, CIP will pursue its OFSP objective in this wider context, targeting regions and farming systems where sweetpotato has a comparative advantage as a biofortified crop and, where possible, harnessing advances made by other crops in technology development and delivery systems.

Having demonstrated the efficacy of OFSP in several African countries, CIP is now responding to increasing global demand through a phased scaling-up program in SSA, Asia, and the Caribbean (Haiti). These include countries and provinces where sweetpotato is well established as a food security crop and OFSP varieties add specific nutritional benefits. In other countries, OFSP will be the first sweetpotato and its contribution to nutrition will be the main benefit. In all cases, scaling-up efforts will focus on locations where sweetpotato has an inherent agronomic advantage as a short-cycle crop that requires few inputs and can produce comparatively high yields even under marginal conditions. In SSA, sweetpotato is predominantly grown by smallholder farmers—women in particular—with yields of 4–10 MT/ha in most countries. Yet, these yields can be increased by at least 50%, even in rainfed smallholder production systems, through a combination of improved varieties, clean planting materials, and good agronomic practices.<sup>13</sup> In the higher input systems in Asia, sweetpotato reaches yields of over 20 MT/ha, though here, too, smallholder productivity lags behind this potential (see Annex 1 for country-level data). Sweetpotato is thus a valuable and flexible component in a range of farming systems important to the poor.

### **Sweetpotato's fit in farming systems**

Sweetpotato's role varies greatly in local farming systems across SSA and Asia, and our strategy addresses two basic scenarios. In several countries, such as in the high population areas of the African Great Lakes Region and parts of China and South Asia, sweetpotato is well established as a food security crop, though the fit in farming systems differs. In SSA, sweetpotato is often a second or third crop after maize, bananas, or cassava in mixed smallholder farming systems. In Asia it fits within rice-dominated systems as a seasonal crop or is produced on commercial scale in intensive systems. Sweetpotato enjoys high productivity per unit land area and labor even on more marginal lands (4–6 MT/ha). Its short growing cycle either allows for flexible planting and harvesting times in high rainfall regions or, in drier areas or areas prone to droughts or floods, permits quick production within a 4- to 5-month window. Farmers appreciate additional agronomic benefits from sweetpotato such as good groundcover, availability of surplus biomass from vines for animal feed, and the possibility of using planting material from own fields. On all these accounts, sweetpotato enhances the resilience of smallholder farming that is frequently affected by low yields or crop failure of other staple crops due to weather or disease (maize, cassava, and bananas have all been affected by major diseases over the past years in SSA). Sweetpotato is not a regionally or internationally traded crop, so has proven to be less affected by

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<sup>12</sup> Ruel, M.T. et al. 2013. Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? *The Lancet* 382, Issue 9891: 536–551. Published online June 6, 2013 [http://dx.doi.org/10.1016/S0140-6736\(13\)60843-0](http://dx.doi.org/10.1016/S0140-6736(13)60843-0)

<sup>13</sup> Andrade, M., Barker, I., Cole, D., Dapaah, H., Elliott, H., Fuentes, S., Grüneberg, W., Kapinga, R., Kroschel, J., Labarta, R., et al. 2009. *Unleashing the potential of sweetpotato in Sub-Saharan Africa: Current challenges and way forward*. International Potato Center (CIP), Lima, Peru. Working Paper 2009-1. 197 p.

food price fluctuations than most of the main cereals. It continues to provide affordable food during times of high food prices.

In other areas, such as parts of Southeast Asia and Ethiopia, West Africa, and Southern Africa, sweetpotato is a relatively new crop and so is much less prevalent. Dry or high-altitude conditions limit its use. In these locations, farmers have started to adopt OFSP for its nutritional qualities and view it mainly as a supplementary crop, grown on small plots, to meet nutritional needs of children or specific market opportunities. Still, high productivity, short growing periods, and resilience under difficult agronomic conditions are key qualities that motivate farmers to include sweetpotato in their mixed farms.

When promoting biofortified nutritious sweetpotato varieties, we can build on a strong and diverse landscape of sweetpotato production in many of Asia's and Africa's pro-poor farming systems. In addition to supplying increased micronutrients, these varieties will still need to meet the agronomic and consumer requirements of target locations. Our strategy is to focus on those agro-ecologies and socioeconomic contexts where sweetpotato offers particular advantages over other crops and where farmers' demand is strong. Through the RTB and A4NH CRPs, we will seek complementarity with other biofortified crops and food-based nutrition strategies.

Supporting more and more farmers to actually realize the benefits of OFSP requires continued participatory research, by CIP and our partners. Such research is needed to facilitate integration of the crop into a complex set of local systems, including crop production, water use, labor and land allocation, gender relations, food preparation and consumption, and agricultural markets. Complementing these research efforts, we will monitor and assess the scaling-up process itself in order to develop efficient and effective ways to reach large numbers of vulnerable households with OFSP and support them in making and implementing decisions about taking advantage of this technology.

In Asia, sweetpotato is not used primarily for nutrition and food security but as alternatives in industry, as livestock feed, or as high-value urban food. Our partnership with the CIP China Center for Asia and the Pacific (CCCAP) will play a pivotal role in strengthening capacity for sweetpotato—particularly in value chains—by linking pertinent Chinese expertise and experiences to demand in Asian and African target countries. Our present research collaboration with the Institute of Agro-products Processing Science and Technology at the Sichuan Academy of Agricultural Sciences will be expanded to support private sector innovations in countries where we want to foster a wider range of urban demand for nutritious sweetpotato products or where the use of roots and vines for animal feed is a priority. We will seek similar partnerships with other research, training, and innovation centers in China through the CCCAP platform beyond postharvest and animal feed work. Likewise, advances made in SSA in varietal development and delivery mechanisms will be shared with target countries in Asia through research and training partnerships between national agricultural research systems (NARS), private sector companies, and farmer associations in African and Asian countries. All scaling-up projects will include specific capacity-building and technology exchange components that will fully use CIP's global reach to link up national and regional expertise for accelerated learning.

CIP and partners have built a strong evidence base on the nutritional efficacy of OFSP. We have developed strategic partnerships with advanced research institutions (ARIs) and delivery-focused organizations to meet the demand of expanding and diversifying the use of OFSP. Our breeding program at global and regional levels in SSA will continue to generate improved vitamin A-rich OFSP varieties and help increase iron and zinc levels through further biofortification. As discussed in the chapter on CIP's genebank (SO 6), our OFSP germplasm includes the largest collection of sweetpotato genotypes. CIP's OFSP germplasm, together with regionally networked germplasm facilities and expertise from the global breeding teams, is supporting increasingly effective national breeding programs. Key subregional traits such as drought tolerance, virus resistance, or low sugar content are incorporated in subregional parent populations that provide starting points for varietal development by NARS. Along with our national partners and farmers in SSA, we have developed methodologies and tools for accelerating varietal development, seed system

development, intensification of production systems, and improved postharvest management, to support scaling-up of OFSP interventions in the region. Expanding and extending this network approach—to Asia in particular—will help facilitate transfer of experience, skills, and germplasm to new sites where development impacts can be achieved. Research will continue on scaling-up of breeding, seed systems, cropping system intensification, nutrition interventions, value chains, and partnership models (see section 6.1 below).

## 5. Alignment

### 5.1 Global and regional frameworks

There is a renewed global commitment to reducing malnutrition and an understanding that agriculture must contribute much more effectively to this multisectorial effort. Since 2010, the Scaling Up Nutrition initiative has generated unprecedented support for addressing key micronutrient challenges, including VAD, by encouraging multisectorial engagement between government and nongovernmental actors.<sup>14</sup> It is now supporting selected countries, including most OFSP target countries, to develop and implement national nutrition strategies and action plans.

In SSA, the Comprehensive Africa Agriculture Development Programme (CAADP) and the linked Pan-African Nutrition Initiative (PANI) provide a compelling framework and partnership platform. Already, OFSP has been recognized as a potential fast-track project by PANI for the first 10-year period, which emphasizes biofortification and crop diversification through nutrient-rich foods.<sup>15</sup> Under the auspices of the CIP-led Sweetpotato for Profit and Health Initiative (SPHI), productive and nutritious OFSP varieties are now being developed and promoted in 10 SSA countries. As the SPHI is transitioning into a regionally led initiative, linkages with CAADP/PANI and related organizations will be strengthened, resulting in closer alignment with regional policy and investment programs. In South Asia, policy dialogue has so far focused mainly at the national level. But we will now strengthen our engagement with the regional inter-governmental South Asian Food and Nutrition Security Initiative,<sup>16</sup> supported by the World Bank and the Department for International Development (DFID), and the Leveraging Agriculture for Nutrition in South Asia<sup>17</sup> program, which links NGOs from the region with international research organizations.

### 5.2 National frameworks and country targeting

This SO targets countries with high VAD prevalence and significant potential of sweetpotato production identified within the wider set of countries prioritized through CIP's food security index.<sup>18</sup> Pragmatic factors such as security, resource availability, and partner preparedness will further influence the staging of our country engagement. We will work within national frameworks for agriculture development, such as the country CAADP Investment Plans in SSA, and, where available, in support of national nutrition strategies. CIP's mode of engagement in target countries will change over time as national programs strengthen their research capacities and assume leadership of our collaboration. At all stages of implementation, CIP will continue to play a science leadership role, even as the focus shifts from formative to strategic research.

We differentiate three implementation stages, corresponding to the status of program development as measured by numbers of HH reached in a particular country. Table 1 provides an overview of the target countries and their expected progression through the three implementation stages over the next 10 years. Figure 1 show this information in a time series of

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<sup>14</sup> <http://unscn.org/files/Activities/SUN/PolicyBriefNutritionScalingUpApril.pdf>

<sup>15</sup> <http://www.caadp.net/pdf/Pan-African-Nutrition-Initiative-Report2008.pdf>

<sup>16</sup> <http://siteresources.worldbank.org/SOUTHASIAEXT/Resources/223546-1296680097256/7707437-1312574838769/SAFANSIBrochure.pdf>

<sup>17</sup> <http://www.ids.ac.uk/idsresearch/leveraging-agriculture-for-nutrition-in-south-asia-lansa>

<sup>18</sup> Using multiple, weighted food security indicators, the CIP food security index ranks countries for particular SOs.

maps. As further biofortified sweetpotato varieties become available, target countries will be identified according to the potential impact of these new flagship varieties (e.g., on anemia and child stunting through varieties rich in iron or zinc). These subsequent “waves” of new nutritious sweetpotato varieties will become increasingly efficient and effective as they can employ methodologies and capacities established through the OFSP roll-out. We then expect target countries to progress faster through the three implementation stages.

**Table 1.** SO 1 focus countries and 10-year progression through SO 1 implementation

Time Period	Stage 1 (<10,000 HH)	Stage 2 (<200,000 HH)	Stage 3 (>200,000 HH)
Current status	Benin, Burkina Faso, Burundi, Ghana, Madagascar, Nigeria, Rwanda, Zambia, Bangladesh, Indonesia, Papua New Guinea, Haiti	Angola, Ethiopia, Kenya, Malawi, South Africa, Tanzania, Uganda, India (Odisha, West Bengal, Uttar Pradesh)	Mozambique
2014–2016	Benin, Burundi, Madagascar, Indonesia, Papua New Guinea, Haiti	Angola, Burkina Faso, Ethiopia, Ghana, Kenya, Malawi, Nigeria, Rwanda, South Africa, Tanzania, Zambia Bangladesh	Mozambique, Uganda, India (Odisha, West Bengal, Uttar Pradesh)
2017–2019	Papua New Guinea, Haiti	Angola, Benin, Burkina Faso, Burundi, Ghana, Madagascar, Nigeria, South Africa, Zambia, Indonesia	Ethiopia, Kenya, Malawi, Mozambique, Rwanda, Tanzania, Uganda, India (Odisha, West Bengal, Uttar Pradesh), Bangladesh
2020–2023	(possible expansion into new countries depending on momentum and resources)	Benin, South Africa, Papua New Guinea, Haiti,	Angola, Burkina Faso, Burundi, Ethiopia, Ghana, Kenya, Madagascar Malawi, Mozambique, Nigeria, Rwanda, Tanzania, Uganda, Zambia, India (Odisha, West Bengal, Uttar Pradesh), Bangladesh, Indonesia

### 5.3 SRF and CRPs

This SO will contribute directly to CGIAR’s SLO 3 (improved nutrition and health) by improving the diets of women and children through micronutrient-rich OFSP, as well as to SLO 1 (reducing rural poverty), SLO 2 (improving food security), and SLO 4 (sustainable management of natural resources). This SO is included as a delivery flagship in RTB. It is well aligned to most RTB themes and, in particular, contributes to Themes 2 (developing nutritious varieties), 4 (improving availability of quality planting material), 6 (improving postharvest management), and 7 (partnerships for impact). In addition, SO 1 will work closely with the RTB Gender group to develop gender indicators and implement gender-responsive research. Through its nutrition goals and biofortification approach, this SO has a specific link with A4NH. We work closely with the CRP’s HarvestPlus program to develop effective OFSP scaling-up approaches as well as metrics for measuring nutrition and health indicators. Place-based collaboration with the Systems CRPs on Humidtropics, Dryland Systems, and AAS will focus initially on action sites in East/Central Africa

and Haiti, West Africa, and Bangladesh, respectively, to understand and support the role of OFSP in local farming systems and food and nutrition security. Specifically, we will seek to harness innovative research in these key locations on socio-ecological system linkages, development drivers, and effective stakeholder agency in the R&D process that will strengthen the SO's corresponding outcomes. Where feasible, we will build on local CRP operational capacity and partnerships to accelerate the scaling-up process. We will synthesize methodologies, research outputs, and process lessons across CRP locations for application in similar systems globally.

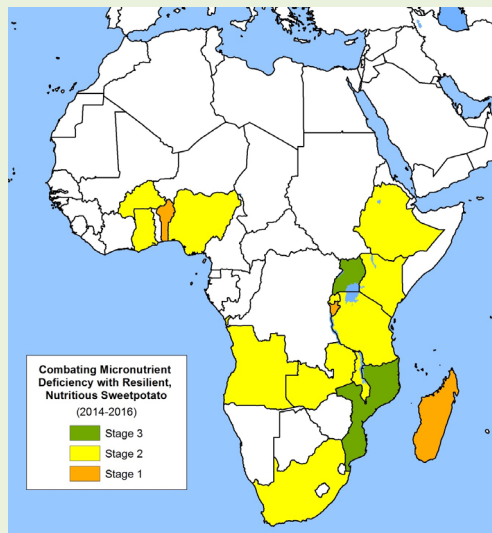


Figure 1a. 2014–2016

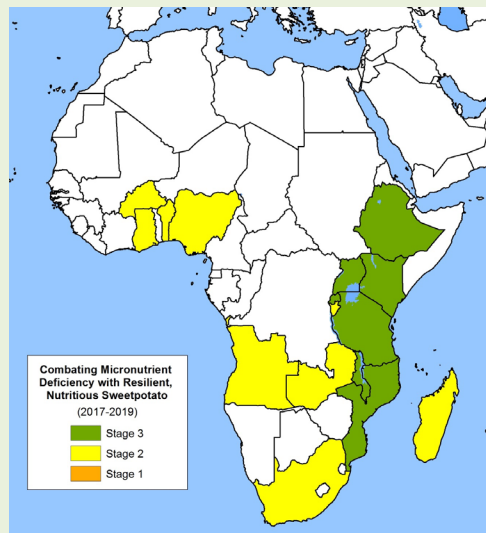


Figure 1b. 2017–2019

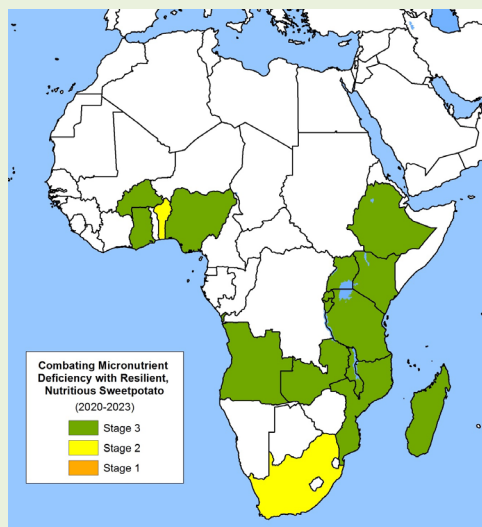


Figure 1c. 2020–2023

**Figure 1.** SO 1 target countries in SSA and their expected progression through the three implementation stages over the next 10 years (1a–1c). Note: a similar map will be elaborated for Asia during the first year of implementation.

## 6. Flagship and Linked Products

The core and flagship of this SO are resilient, nutritious OFSP varieties that are adapted to the local environment, perform well, and meet consumer taste preferences (Fig. 2). Locally important traits include virus and drought resistance, vine survival, high dry matter, low sugar, salinity tolerance, weevil resistance or avoidance, and early maturity. We will continue to use the sweetpotato genetic resource base by working with the CIP genebank and regional germplasm facilities. We will add unique sweetpotato landraces and other accessions to these genebanks as a way to expand the genetic foundation for future crop improvements in target countries. Flagship OFSP varieties, however, can only achieve broad impacts at scale if they are connected to several linked products. First-level research products are those that enable users from R&D sectors to use OFSP effectively, develop further specific products and services, and disseminate these to farmers and other stakeholders.



**Figure 2.** SO 1 flagship (at center) and linked products.

### 6.1 Linked products

1. **Accelerated breeding methods and tools.** Advances in breeding technology will be applied consistently to accelerate and improve the development of parent populations and nationally released varieties of biofortified OFSP and other nutritious sweetpotato. New discoveries generated under SO 4 could possibly be taken up in the future. National partners will adapt these methodologies and use parents from CIP's population development programs; linkages with seed systems and farmers demand will be strengthened.

2. **Seed systems approaches, technologies, and diagnostic tools.** We will develop innovative approaches to upgrading informal “seed systems” and commercially oriented systems whenever possible, in major OFSP value chains and with an emphasis on women’s involvement. For sustainable expansion of OFSP and other sweetpotato production, we will undertake operational research on incentive frameworks to initiate and scale-up market demand for quality planting materials under different value chain conditions. This effort will be supported by new technologies to enhance vine multiplication (e.g., “net tunnels”) and conservation (e.g., “sand, storage, and sprouting”). We will develop improved diagnostic tools for affordable and effective quality control in decentralized seed systems.
3. **Options for sustainable OFSP intensification.** We will enable both women and men farmers to realize the full production potential of OFSP in different agro-ecologies by developing and testing improved agronomic practices (e.g., small-scale irrigation for vine conservation, soil enhancement, and intercropping). Adapting to climate change effects in drier and flood-prone production zones will receive special attention. Where crop-livestock integration is important, we will develop sustainable options for use of dual-purpose OFSP varieties in animal feeds (fresh vines, silage, reject roots) and human nutrition, which will be carried out in conjunction with Dryland Systems and Humidtropics CRPs.
4. **Evidence base for nutrition and behavior change approaches.** An up-to-date evidence base, built in partnership with nutrition and social research institutions, will capture nutritional values and benefits and consumer acceptance of increasing numbers of OFSP varieties, including roots and leaves, and OFSP-based products. The evidence base will encompass diverse nutrition and food consumption scenarios, under different market and social circumstances, and will include evidence of changing behaviors of consumers, caregivers, farmers, and traders. The evidence base will provide data and guidance for policy dialogue, advocacy, and design of nutrition training and behavior change initiatives.
5. **Models and technologies for upgrading OFSP value chains.** We will develop process models, technologies, and implementation tools for integrating OFSP into multiple value chains, ranging from community-based nutrition/agriculture and school-feeding programs to higher-value urban market chains for bakery products and healthy-choice snack food. We will pay close attention to the organoleptic acceptability of an increasing range of sweetpotato products in different market and dietary contexts. The technical and organizational tools we develop will enable stakeholders to better manage the perishability of OFSP roots and position OFSP as a healthy food for all in the market place and create new options for more diversified utilization of sweetpotato.
6. **Partnership models and policy options for going to scale.** Research on partnerships and policies that can support large-scale use of OFSP will generate organizational models and guidelines, metrics for measuring effectiveness and efficiency of scaling up agriculture–nutrition linkages, and evidence-based policy recommendations to support this expansion. These research products will inform policy, investment planning, and development forums on agriculture and nutrition at the national to global levels.

## 6.2 Support platforms

We will involve research partners, next-users, and, where appropriate, farmers in the creation of linked products. We will help improve their access to these products and strengthen their capacity to use them effectively and equitably by fostering linkages with agriculture and nutrition through an expanding network of “support platforms.” We will engage with regional research and nutrition initiatives that can provide training, technology dissemination, and knowledge management services to national OFSP campaigns.

## 7. Impact Pathway

Products	Research Outcomes (Next Users)	Development Outcomes (End Users)	Contributing to RTB IDOs
<b>Flagship: Candidate OFSP varieties</b>	NARS release and promote well-adapted, consumer-preferred OFSP varieties	Men and women producers access adequate quantities of quality planting material of preferred varieties in a timely manner.	Improved productivity in smallholder OFSP cropping systems (SLOs 1, 2, and 4)
<b>Accelerated breeding methods and tools</b>	NARS achieve faster varietal release through a client-oriented breeding program	Farmers adopt OFSP varieties for sustainable home consumption and sale.	
<b>Seed systems approaches, technologies, and diagnostic tools</b>	Public and private extension service providers promote appropriate, gender-responsive seed system tools and interventions	Vine multipliers equitably and sustainably provide quality OFSP vines and extension advice to farmers	
<b>Options for sustainable intensification of OFSP</b>	Public and private extension service providers promote adapted OFSP technologies for sustainable systems intensification	Women and men producers integrate OFSP into mixed farming systems to enhance sustainability	Increased and stable access to food commodities by rural and urban poor (SLOs 1, 2)
<b>Evidence base for nutrition and behavior change approaches</b>	Health, education, agriculture, and private sectors implement appropriate, gender-responsive strategies to promote consumption of OFSP and vitamin A-rich foods	Food providers and institutional stakeholders incorporate OFSP and other vitamin A-rich foods in meals, especially targeting vulnerable household members	Increased consumption of OFSP and other vitamin A-rich foods, especially by the poor and nutritionally vulnerable women and children (SLOs 2, 3)
<b>Models and technologies for upgrading OFSP value chains</b>	NGOs and private sector promote appropriate options for equitable, sustainable OFSP value chain interventions	Value chain actors exploit new and pro-poor market opportunities for OFSP products, and urban consumers have access to a range of OFSP-based products	Increased and more gender-equitable income for poor producers in OFSP value chains (SLOs 2, 3)
<b>Partnership models and policy options for going to scale</b>	Development forums, policy dialogues, and advocacy campaigns consider and adopt partnership models and policy recommendations	Policy makers, investors, and program designers mainstream food-based approaches including OFSP	Enabling policy environment supporting development and use of pro-poor and gender-inclusive OFSP technologies (SLOs 1, 2, 3, and 4)

## 8. Research Outcomes and Indicators

SO 1 Research Outcomes	Indicators
NARS release and promote well-adapted, consumer-preferred OFSP varieties	<ul style="list-style-type: none"> <li>No. of OFSP varieties released</li> <li>Genetic gain achieved in these varieties</li> </ul>
NARS achieve faster varietal release through a client-oriented breeding program	<ul style="list-style-type: none"> <li>Reduction in duration of breeding and release process by NARS</li> </ul>
Public and private extension service providers promote and implement appropriate, gender-responsive seed system tools and interventions	<ul style="list-style-type: none"> <li>No. of seed system innovations actively promoted by country</li> <li>No. of seed providers</li> <li>No. of seed multipliers adopting tools and interventions</li> <li>No. of women seed multipliers</li> <li>Quantity of seed produced or areas covered by clean seed</li> <li>Quality score of self-preserved seed</li> </ul>
Public and private extension service providers promote adapted OFSP technologies for sustainable systems intensification	<ul style="list-style-type: none"> <li>No. of crop and system intensification options actively promoted by country</li> <li>No. of extension providers promoting sustainable crop and system intensification options</li> </ul>
Health, education, agriculture, and commercial sectors implement appropriate, gender-responsive strategies to promote consumption of OFSP and vitamin A-rich foods	<ul style="list-style-type: none"> <li>No. of gender-responsive strategies implemented</li> <li>No. of partners promoting these strategies</li> <li>No. and sex of recipients of promotions</li> </ul>
NGOs and private sector promote and implement appropriate options for equitable, sustainable OFSP value chain interventions	<ul style="list-style-type: none"> <li>No. of OFSP value chain innovations implemented</li> <li>No. of OFSP-related private enterprises and NGOs implementing</li> </ul>
Development forums, policy dialogues, and advocacy campaigns consider and adopt partnership models and policy recommendations	<ul style="list-style-type: none"> <li>No. of OFSP-oriented partnership models and policy recommendations adopted</li> <li>Increase in the level of funding</li> </ul>

## 9. Development Outcomes and Indicators

IDO	Indicators in 2023
1. Improved productivity in pro-poor RTB food systems (SLOs 1, 2, and 4)	1.1 OFSP on-farm yield increased by at least 50% in 2.5 million rural HH using quality planting material in Africa (16 countries), Asia (4 countries), and the Caribbean (1 country). (NB: Data will be disaggregated by agro-ecology, per capita HH wealth index, and sex of HH head.)
2. Increased and stable access to food commodities by rural and urban poor (SLOs 2, 3)	2.1 Aggregate OFSP production increased by 60% in target districts in each target country.
3. Improved diet quality of nutritionally vulnerable populations, especially women and children (SLO 3)	3.1 Nutritional status measured by diet diversity indices of all HH members (particularly of children under 5 and women of reproductive age) of 2.5 million HH in all African, Asian, and Caribbean target countries increased by at least 20%. 3.2 50% of children under 5 of 2.5 million HH in all African, Asian, and Caribbean target countries consume OFSP, or other vitamin A source when not available, at least twice a week. 3.3 50% of women of reproductive age of 2.5 million HH in all African, Asian, and Caribbean target countries increase their intake of vitamin A-rich food by 40%.
4. Increased and more gender-equitable income for poor participants in RTB value chains (SLOs 1, 2)	4.1 In 10 years, OFSP revenue increased by at least 15% through increased and diversified sales (food, feed, and vines) for at least 15% of 2.5 HH in targeted countries of Africa, Asia, and the Caribbean. (NB: Data will be disaggregated by per capita HH wealth index and sex of HH head.)
5. More effective policies supporting development and use of pro-poor and gender-inclusive RTB technologies developed and adopted by agricultural organizations, national governments, and international bodies (SLOs 1, 2)	5.1 At least one policy change supportive of OFSP interventions in each target country (e.g., inclusion of OFSP in national nutrition strategies and action plans, inclusion of OFSP in national research priorities for roots and tubers). 5.2 At least one government-led project/program implementing OFSP and other food-based approaches in each target country. 5.3 The number of rural HH using quality OFSP planting material in African, Asian, and Caribbean target countries increased by 12.5 million.

## 10. Gender Dimension

Gender is a key factor for achieving OFSP impacts on nutrition and income, and this SO will prioritize gender in research design and monitoring. As women and children are most at risk of VAD, impacts on their health must be optimized. Men, who often determine access and use of resources for agriculture and health, also have nutritional needs. In developing research outputs, we will determine gender-specific preferences in variety selection and improved agronomic practices and set specific gender and age targets in all components of the value chain. At least every two years, we will conduct focused quantitative and qualitative gender research to provide feedback to researchers and implementation agents on how each gender in different wealth categories is being affected. We will use this feedback to determine whether adjustments need to be made to ensure that women's status or resource access is not worsened and can be further improved. All research and assessment systems will use specific gender-responsive indicators and

promote participatory action research modalities to ensure that women, children, and men can understand the changes they are experiencing and provide feedback.

## 11. Partnership Strategy

Partnerships at the international, national, and regional levels are critical for achieving the SO’s ambitious outcome targets. We will strategically select and engage in partnerships to ensure they can catalyze wider support for SO 1 implementation across the three implementation stages. Working from our current partnership base in target countries, regions, and globally, we will seek agreements with a selected “like-minded” partners who can complement CIP’s research role to help deliver R&D outcomes. Technical criteria for partner selection will include their track record of scaling up agricultural technologies and nutrition interventions and their ability to implement up-to-date approaches and methodologies for nutrition-sensitive agriculture. In addition, we will take into account pragmatic criteria such as operational capacity and local networks in key scaling-up countries, and strong linkages with policy platforms, private sector associations, and donor forums. We will test several partnership models at each SO implementation stage, consciously seeking to improve our capacity for partnering, both technically and administratively. Innovative approaches will be explored to engage with rural youth and bring them on board as implementing partners.

We can build on a strong foundation of current partnerships. In SSA, we will continue to develop our already strong linkages with regional and national platforms under the CAADP and FARA. We will seek to strengthen our partnerships with civil society and the private sector. In Asia, partnerships at national and subnational levels are critical, as exemplified in our current work in Bangladesh and India. In Haiti, national and international efforts for disaster relief and child nutrition will be the context for partnerships. In all cases, bringing ARIs and independent impact assessment providers into these partnerships will be a key task to ensure quality and credibility of SO 1 delivery. Table 2 illustrates our current partnerships and how we see these developing as we pursue SO implementation.

**Table 2.** Selected current partners and their roles

Partners	Current Role	Expected Future Role
Scaling-up Nutrition	High-level policy and technical support to most OFSP target countries in SSA and Asia	In target countries, strengthen contribution of public sector to OFSP development outcomes
CAADP	Assist countries with their investment plans, including for OFSP	Include, and fund, OFSP in country investment plans in SSA
FARA	In East and Central Africa, OFSP technology dissemination; NARS capacity strengthening	Host/support OFSP support platforms and knowledge hubs; policy advocacy
CRS, PATH, Save the Children, CARE, LANSA, Concern	In SSA, disseminate nutrition knowledge and technologies	Disseminate knowledge and technologies at large scale in SSA and Asia
Commercial food enterprises	Sina Enterprises (Rwanda) producing OFSP biscuit on a commercial scale	Large-scale processing of OFSP products in SSA
CIP-CCCAP	Research support for sweetpotato processing and use as an animal feed	Capacity strengthening and technology exchange within Asia and with SSA

CRS = Catholic Relief Services; LANSA = Leveraging Agriculture for Nutrition in South Asia

## Delivering SO 1 in Malawi

### Development challenge and targets

Of Malawi's 16.7 million people, 12.5 million live in smallholder farming HH; more than 7.5 million of these live below the poverty line. Undernutrition is very high: 800,000 children under five are stunted and 1 million suffer from VAD. SO 1 sets out to combat micronutrient deficiency in Malawi through nutritious sweetpotato, starting with improving diet quality and crop incomes among 250,000 smallholder farming HH through OFSP by 2023. This target includes an estimated 375,000 children under five and 250,000 women of reproductive age. Indirectly, further dissemination of sweetpotato through government extension and NGOs will reach an additional 1.25 million new OFSP farmers, equivalent to about 30% of smallholder farming HH. Implementation will start from our current intervention districts, mainly in the Southern Region, and spread to additional locations (Table 1).

**Table 1.** Target districts and HH in Malawi reached by CIP-led projects (and linked partner projects)

Time Period	Southern Region	Central Region	Northern Region	HH Reached Directly (indirectly)
Current status	Chikwawa, Phalombe, Mulanje, Zomba (Balaka, Thyolo, Nsanje, Machinga)	Dedza (Lilongwe, Salima, Dowa, Kasungu)	(Mzimba)	70,000 (n/a)
2014–2016	Chikwawa, Phalombe, Mulanje, Zomba (Balaka, Thyolo, Nsanje, Machinga)	Dedza, Salima, Lilongwe, Mchinji, Ntcheu (Dowa, Kasungu)	(Mzimba)	100,000 (500,000)
2017–2019	Chikwawa, Phalombe, Mulanje, Zomba (Balaka, Thyolo, Nsanje, Machinga)	Dedza, Salima, Lilongwe, Mchinji, Ntcheu (Dowa, Kasungu)	Karonga (Mzimba)	150,000 (750,000)
2020–2022	Chikwawa, Phalombe, Mulanje, Zomba (Balaka, Thyolo, Nsanje, Machinga)	Dedza, Salima, Lilongwe, Mchinji, Ntcheu (Dowa, Kasungu)	Karonga, Mzimba, Chitipa	250,000 (1,250,000)

### Sweetpotato in Malawi

Maize takes up over 80% of land under smallholder cultivation in Malawi. Sweetpotato, with cassava, is an important complementary crop for about 3 million smallholders producing 1.4 million MT on 178,000 ha. Average landholdings in Malawi have fallen to under 0.8 ha. Sweetpotato's high productivity is an important advantage for providing calories as well as micronutrients from very limited land. Malawi's uni-modal rainfall pattern requires most of the country to plant sweetpotato in November–December and harvest in March–April. A second, "dry season" crop is produced in wetlands or irrigated fields between May and October, though these are small areas out of the reach of the poor.

In good years Malawi is self-sufficient in maize, yet food security is frequently at risk locally and nationally. Sweetpotato enhances food security of smallholder farms through more dependable yields across good and bad years in a greater range of agro-ecologies, including on more marginal lands important for the poor. OFSP varieties can provide vitamin A through roots and leaves to millions of rural poor already producing sweetpotato. In the long run, expanded production of resilient, nutritious sweetpotato will help reduce the dependency on maize and the need for expensive maize input and market support systems. In recent policies, the Government of Malawi prioritizes crop diversification and related investments in infrastructure and services. The Agriculture Sector-wide Approach (2011–2015), spearheaded by the Ministry of Agriculture and Food Security (MAFS), includes increased productivity and production of sweetpotato and OFSP

specifically as a strategic objective, supported by increased investments in research, technical, and advisory services. Consultations for Malawi’s new CAADP Investment Plan have further validated this strategy; government and donor support is expected to continue. Likewise, Malawi’s National Nutrition Policy and Strategic Plan, supported by the Scaling Up Nutrition movement, promotes a multisectoral approach to reducing child undernutrition and includes production and consumption of micronutrient-rich crops. CIP is working closely with MAFS and the Department for Nutrition, HIV and AIDS (DNHA) to contribute evidence for policy development and to help build the technical capacity of research and extension services at district level.

### CIP’s targeted approach

To realize the potential of sweetpotato and achieve our strategic targets in Malawi, we are scaling up our integrated Agriculture-Nutrition-Market approach to create virtuous cycles of increased supply and demand for nutritious sweetpotato. Over the past four years, we have enabled over 70,000 HH to grow OFSP, using a three-tiered vine multiplication system. The approach links farmers to quality planting materials produced by local vine multipliers that in turn are connected to disease-free foundation seed of three improved OFSP varieties at Bvumbwe Research Station of the Department of Agricultural Research Services (DARS). We have paid close attention to gender differences in access to resources, markets, and services, and in decision making at HH and community levels. We have worked with both women and men to ensure that nutritional and income outcomes are being achieved for all target populations. Our survey data have been carefully disaggregated by sex, and a specific qualitative gender assessment has been carried in 2013 to guide the further scaling-up of our OFSP work in Malawi.

We plan to expand this program at all levels. Responding to a wider spectrum of farmer and consumer demand, DARS will develop and release new OFSP varieties derived from Malawi populations and from germplasm received from Mozambique through the subregional sweetpotato support platform. Foundation material and multiplication plots will be established in all seven DARS research stations countrywide, and more than 2,000 new local vine multipliers will be trained and equipped to operate profitable seed businesses. Staff from Department of Agricultural Extension Services (DAES) and NGOs will be trained to support farmers in OFSP production and utilization in 12 districts. Adaptive research will help improve productivity of OFSP in agro-ecologies and socioeconomic contexts of importance to the poor through improved intercropping and rotations, water use, and pest management. We will continue to complement this agricultural work through demand creation and behavior change programs led by community and district nutrition personnel from government and NGOs that will strengthen use and consumption of OFSP and other nutritious foods. We will engage more vigorously with the private sector, starting with Universal Industries Ltd., to upgrade sweetpotato value chains for fresh roots and leaves as well as for processed products to help meet the growing demand for nutritious foods among the urban poor. Table 2 summarizes the milestones of scaling-up OFSP in Malawi over the next 10 years.

**Table 2.** SO1 Malawi Milestones (HH are direct CIP project beneficiaries)

	Current Status	2014–2016	2017–2019	2020–2023
Households growing and consuming OFSP	70,000	100,000	150,000	250,000
Crop income increase through OFSP	n/a	Increase of 20%	Increase of 20%	Increase of 20%
OFSP varieties released and available	3	7	12	20
DARS stations maintaining foundation seed	1	4	7	7
DVMs operating profitably	150	400	1,200	2,500
Area under OFSP (ha)	n/a	17,500	25,000	50,000

These milestones reflect key outcome targets as we will expand our work in Malawi in three stages. Figure 1 illustrates, in a simplified linear format, how we will move our research outputs towards achieving the nutrition and income impacts this SO aspires to. This impact pathway requires strong partnerships and continued feedback from research users to learn and adjust and co-create the next wave of technologies and management practices.

**Figure 1.** Impact Pathway for Malawi

Products	Research outcomes (Next-Users)	Development outcomes (End-Users)	Contributing to RTB IDOs
Flagship: Resilient, nutritious OFSP varieties	DARS release and promote 20 new OFSP varieties by 2023	At least 1.25 million HH plant improved OFSP varieties, with equitable results for men and women farmers.	Improved productivity in smallholder OFSP cropping systems (SLOs 1, 2, and 4)
Accelerated breeding methods and tools	DARS expands OFSP breeding facilities countrywide and trains staff in accelerated methods		
Seed systems approaches, technologies, and diagnostic tools	All 7 DARS stations have OFSP multiplication fields; at least 2,500 DVMs trained, 50% of them women		
Options for sustainable intensification of OFSP	DAES and NGOs promote OFSP in all agro-ecological zones, together with improved intercropping, soil, water, and pest management	At least 1.25 million women and men producers integrate OFSP into mixed farming systems to enhance sustainability	Increased and stable access to food commodities by rural & urban poor (SLOs 1, 2)
Evidence base for nutrition and behavior change approaches	DNHA and NGOs implement community-level nutrition and behavior change programs and regularly monitor outcomes across at least 12 districts	At least 250,000 HH with children under 5 years increase their regular intake of OFSP and other vitamin A-rich foods	Increased consumption of OFSP and other vitamin A-rich foods, especially by the poor and nutritionally vulnerable women and children (SLOs 2, 3)
Models and technologies for upgrading OFSP value chains	Universal Industries Ltd. and other commercial agro-processors produce and market new products with OFSP as a major ingredient. At least 10,000 smallholder farmers linked into these value chains	At least 5 new products containing OFSP as a main ingredient are available in urban and rural markets. Weekly markets for fresh OFSP roots and leaves expand in 12 districts.	Increased and more gender-equitable income for poor producers in OFSP value chains (SLO 2, 3)
Partnership models and policy options for going to scale	MAFS and DNHA adopt lessons and models from scaling-up of OFSP into sectorial programs.	CAADP Country Investment Plan and National Nutrition Strategy prioritize nutrition-sensitive agricultural investments, including biofortified sweetpotato	Enabling policy environment supporting development and use of pro-poor and gender inclusive OFSP technologies (SLO 1, 2, 3 and 4)

## Partnership strategy

We are pursuing a two-pronged partnership strategy to reach direct and indirect beneficiaries (Table 3). We work with *implementing partners* on joint projects and programs to deliver the integrated Agriculture-Nutrition-Market approach. We engage with *linked partners* by connecting them to OFSP vine multipliers, extension services, or other elements of this approach so that they can promote these technologies and methodologies in their own programs. The first-level partnerships will reach 250,000 direct beneficiary HH, the second-level partnerships an additional 1.25 million indirect beneficiary HH. We will deepen our collaboration with Government of Malawi by supporting DARS and DAES to implement the expansion of sweetpotato research and production in all regions of the country and by providing high-quality evidence for national policy and investment planning. Support from our current donors, Irish Aid and DFID, is secured to 2018. We are discussing with USAID and the European Union Delegation about further support to cover additional districts.

**Table 3.** CIP Partners in Malawi

CIP Partners in Malawi	
<i>Government of Malawi</i>	DARS, DAES, MAFS, DNHA
<i>Implementing partners</i>	CADECOM, Concern Universal, Millennium Villages Project, Universal Industries Ltd.
<i>Linked partners</i>	Farmers Union of Malawi, FAO, WFP, CRS, World Vision, Africare, Save the Children, Total Land Care, Emmanuel International
<i>Current donors</i>	Irish Aid, DFID
<i>Prospective donors</i>	USAID, EU

**ANNEX 1.1. SO 1 Targets by country (HH reached by 2023)**

Country	CIP Food Security Index Score (Rank)	Number of Children under 5 Years with VAD ('000s)	HH Reached by 2023	Sweetpotato Production (MT/year)	Sweetpotato Production (MT/ha)
Angola	40.8 (12)	1,486	116,000	689,000	6.5
Benin		637	68,000	56,000	4.5
Burkina Faso	45.0 (20)	1,456	77,000	72,000	13.8
Burundi	38.3 (8)	520	520,000	838,000	6.9
Ethiopia	27.8 (1)	4,909	200,000	409,000	8.8
Ghana	57.1 (37)	1,249	456,000	91,000	1.7
Kenya	44.6 (18)	2,320	340,000	769,000	11.3
Madagascar	36.5 (4)	1,118	372,000	874,000	7.3
Malawi	37.3 (6)	1,332	1,483,000	1,146,000	16.5
Mozambique	39.1 (9)	1,295	990,000	388,000	7.3
Nigeria	44.7 (19)	10,579	775,000	1,578,000	2.9
Rwanda	48.1 (26)	792	1,241,000	872,000	7.3
South Africa	65.1 (66)	1,237	14,000	46,000	3.2
Tanzania	43.1 (16)	2,794	1,450,000	960,000	3.8
Uganda	49.5 (28)	2,376	1,850,000	2,591,000	4.6
Zambia	32.8 (2)	1,008	235,000	138,000	16.9
Africa subtotal			10,187,000	11,517,000	
Bangladesh	40.5 (11)	3,374	1,250,000	303,066	9.8
India - Odisha	47.2 (24)	2,247	375,000	422,007	8.8
India - West Bengal	47.2 (24)	4,893	820,000	232,633	10.3
India - Uttar Pradesh	47.2 (24)	10,690	1,780,000	235,837	12.6
Indonesia - Papua	60.6 (44)	51	6,000	19,873	10.0
Indonesia - Papua Barat	60.6 (44)	13	22,000	346,966	9.9
Papua New Guinea		302	85,000	601,189	4.8
Asia subtotal			4,338,000	2,161,570	
Haiti	37.2 (5)	277	110,000	242,846	3.7
Caribbean subtotal			110,000	242,846	
<b>TOTAL</b>			<b>14,635,000</b>		

# SO 2 Enhancing Food Security in Asia through the Intensification of Local Cereal-based Systems with Early-Maturing Agile Potato Varieties

## 1. Summary of the Strategic Objective

We will improve systems productivity and farm incomes of at least seven million HH in targeted Asian countries over the next 10 years. These improvements will be achieved through development and use of early-maturing agile potato varieties and thereby enhancing food security and providing an additional source of income. (By “agile” we mean varieties that can fit into windows currently left fallow in the different cereal-based systems of Asia and display the robustness derived from the intended desirable traits.) We will develop the necessary early-maturing varieties with traits resistant to biotic and abiotic stress, including those required by the market and processors, as well as those preferred for home consumption. Responding to strong regional and national demand for better adapted potato varieties and more nutritious foods, we will develop new, early, and extremely early multipurpose potato varieties that are locally adapted and robust. We will help our partners scale up the use of research products for accelerated breeding, improved seed delivery, diversification of value chains, and ecological management practices. We will establish strategic partnerships for going to scale and couple this process with outcome research to assess cost-effectiveness, ensuring a pro-poor focus and gender inclusiveness. We are mindful of inherent risks in agricultural intensification. Therefore, our integrative, interdisciplinary approach to research for development will contribute to the analysis and design of ecologically intensive, sustainable agricultural production systems involving potato in Asia. This SO will contribute to six IDOs and all four of the CGIAR’s SLOs.

## 2. Strategic Objective

We will improve systems productivity and farm incomes of at least seven million HH in the Asian countries of China, Bangladesh, India, Vietnam, Pakistan, Nepal, and Central Asia over the next 10 years. We will accomplish this through development and use of early-maturing agile potato varieties. This SO will enhance food security and create an additional source of income.

## 3. Development Challenge

Asia, with the predicted highest level of global population growth in the 21st century, faces a tremendous food security challenge to feed its people. Climate change and a loss of arable land to urbanization exacerbate the problem. The quality of arable land is degrading due to over-intensification of monocropping, misuse of pesticides, and soil salination caused from frequent droughts. Economic and social exclusion, largely due to gender, caste, and ethnic discrimination, intensifies the problems of poverty and malnutrition. Asia also has the highest concentration of

poverty worldwide. This is combined with high malnutrition rates among women and children under five, leading to high levels of infant and maternal morbidity and mortality. Asian economies, farming systems, and diets are highly dependent on a small number of commodities—in particular rice and wheat. These are internationally traded food commodities subject to market fluctuations. These have led to severe spikes in the price of food in recent years, further increasing food vulnerability of the poor and related social unrest. Poor populations also continue to experience nutrition vulnerability due to monotonous, low micronutrient diets and the relatively low economic value of cereals.

Adoption of strategies is urgently needed to address food and nutrition insecurity in low-income countries. Diversification of farming systems is a strategy already being pursued by several Asian countries to increase economic and nutritional value and help ease the strain of food price inflation, especially in times of economic crises. Of particular importance will be the sustainable intensification of existing systems with nutritious, versatile, and high-value crops that are less susceptible to the vagaries of international trade. Potato is a high-value food security crop. It can be adapted to a wide range of cropping systems in subtropical, temperate, and highland environments to help low-income consumers cushion the impact of food price inflation and achieve higher income levels from on-farm and added-value options. Potato cultivation in the region, however, is unevenly distributed: China and India alone account for about 79% of the area as well as of production. Shortage of good quality seed has been recognized as one of the most important factors limiting potato production in Asia.

### **Institutional and sector constraints to wide-scale adoption of potato in Asia**

Poor public investment in scientific research of those Asian countries that are near the bottom of the economic and human resource index (below 0.03% in some incidences) has helped perpetuate a cycle of poverty. This is a challenge for individual institutions to break. The private sector also plays a key role in the scaling-up of improved varieties and techniques. Yet it often does not contribute due to its extreme weakness in many countries (i.e., Central Asia) and the lack of suitable regulatory services (credit, insurance, trade policies, etc.) that would facilitate its active participation. One of the aspects that make the value chain disarticulated is a poorly developed processing sector that could operate in preventing gluts and stabilizing market prices. The yield gap between the potential farm yield of potato and the actual average farm yield ranges up to 60% in some Asian countries due to the unavailability of quality seed of farmers' choice and locally adapted varieties. Many countries cannot develop their own sustainable seed program based on locally developed varieties due to high dependency on imported seed and lack of trained manpower and infrastructure.

Another major constraint is the presence in some countries of rigid certification schemes, too often copied from developed countries and unrealistic under local circumstances. In other countries, strongly centralized seed production schemes inherited from Soviet economies are led by extremely weak NARS that prevent private initiatives becoming successful. In Central Asia, phytosanitary regulations are not consistent with international standards as diseases of economic importance are not considered at the national level. In this sense, a lack of coordination among different Asian countries and presence of a transboundary, unofficial seed trade exchange allow the trade of poor-quality seed potatoes, which become a source of dissemination of many pests and diseases of economic importance (potato tuber moth, wart, Potato spindle tuber viroid, etc.). Postharvest knowledge (storage, marketing information) is also inadequate because of the limited participation of the private sector, which could be the driver for change and progress.

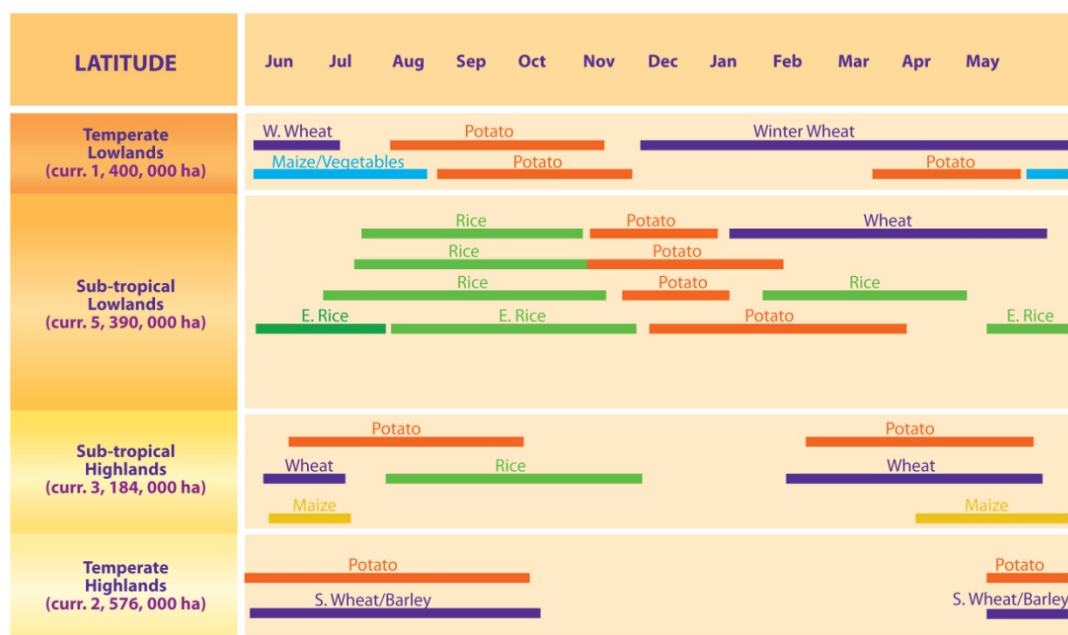
Finally, there is also a strong varietal preference by producers, consumers, and industries. This means that the research sector faces a major challenge to build acceptance for more nutritious and profitable varieties; substantial investment is required to achieve this goal. Availability of new varieties with more prospect of added value for farmers can decrease the yield gap considerably. Linkage between public and private sectors is needed for developing region-specific potato varieties.

## 4. CIP’s Targeted Response

A 70- to 90-day potato resistant to heat and viruses and with good processing quality is a profitable and nutritious complement to low-income cereals in lowland and highlands of South China, North Vietnam, Bangladesh, India, and the plains of Nepal and East Pakistan (Table 1). In Central Asia, the crop offers a valid alternative to fallow between two consecutive wheat crops, thus creating huge opportunities for potato cultivation. CIP offers elite, tropically adapted bred populations and “candidate potato varieties” with short growing seasons of 70–80 days in subtropical climates and 90–100 days in temperate ones. These varieties are tolerant to high temperatures and resistant to major virus diseases. They can bring new areas under potato cultivation in cereal-based systems and increase overall food productivity. Figure 1 displays how the potato fits into the cereal-based growing season by latitude.

**Table 1.** The agile potato: strengthening food security in diverse Asian agro-ecosystems

Systems	System Characteristics	Relevance for Food Security	Major Locations	Required Varietal Characteristics	Additional Benefits
Lowlands (focus of SO 2)	Cereal-based systems with short fallows appropriate for intensification	Low returns from cereals with potato a profitable and nutritious complement	S. China, N. Vietnam, India, Bangladesh, plains of Nepal, East Pakistan	70- to 90-day, high dry matter, processing quality, heat tolerance, virus resistance	Input to processing industry
Temperate	Potato as alternative to fallow between two consecutive winter wheat crops, in the lowlands  In the highlands, potato is an alternative to spring wheat/barley	Low returns from cereals supplemented by a more profitable and nutritious crop	N. China, Central Asian Republics and Caucasus, Korean peninsula, Mongolia	90- to 100-day potato resistant to viruses and tolerant to heat, drought, and salinity	Possibility of contribution to processing industry in the future and seed supply to lowlands
Highlands	Variable, with potato as a staple and cash crop in mixed farming systems	Potato as major food and income source in poverty “hotspots” and marginalized populations	Nepal, Northeast India, Bhutan, S. China, N.W. Vietnam, E. Indonesia, Philippines	High yield, late blight (LB) resistance, drought tolerance, biofortification with iron and zinc	Quality seed supply to lowland areas



**Figure 1.** . Growing season by latitude for potato within a cereal-based cropping system

Short-duration, drought-tolerant potato will give flexibility in planting and harvesting time without putting pressure on scarce land and water resources. In the Asia-Pacific region, potato is grown on about 7.3 million ha, producing about 121.7 million MT of potatoes with an average productivity of 16.49 MT/ha. The contribution of the Asia-Pacific region to the world area and production of potato is 39.3% and 37.7%, respectively.

The research on the agile potato will consider the study of sustainable cultivation practices and the environmental impact of introducing the potato on cereal-based cropping systems of Asia. Trade-off analysis in terms of labor, nutrients, water, and other input use will be measured to assess the beneficial impact on the four key elements of food security: food’s availability, accessibility, utilization, and vulnerability.

CIP’s 40 years of experience operating in Asia will be key to empowering the poor for sustainable gains and better income from agriculture. Expertise includes linking farmers with markets, value chain assessment, integrated crop management (ICM), systems analysis, natural resource management, and phytosanitary and logistic aspects of exchange of advanced breeding materials. CIP can adapt experience in participatory variety selection (PVS) and farmer field schools (FFS) that will accelerate fast adoption of varieties and technologies for increasing farmer incomes. Our work spans collaborative research, policy and advocacy, and on-the-ground delivery, making the Center unique as a bridge between upstream and downstream research. CIP’s understanding of diverse systems, combined with its established networking presence, can help develop and adapt technologies and practices to smallholder farmers, especially poor and female agricultural workers.

Through networking and an adequate study of value chains it would be possible to identify gaps, bottlenecks, and opportunities and discover causes of price volatility that makes potato uneconomical in certain markets due to overproduction. This can be resolved through the establishment of regional trade to harmonize market exchanges and abolish trade barriers that may occur occasionally to protect local production.

## 5. Alignment

### 5.1 Global and regional frameworks

One of the major challenges in almost all of Asia is the absence of any overarching regional political and trade bodies to act as a collaborative advocacy platform. A lack of political will and extensive mistrust are principal constraints to the progress of regional cooperation in Central and South Asia. Existing regional collaborative institutions such as the South Asian Association for Regional Cooperation, the Asia-Pacific Association of Agricultural Research Institutions, and the Central Asia and the Caucasus Association of Agricultural Research Institutions remain weak. By contrast, Southeast Asia boasts a range of collaborative bodies (e.g., the *Economic and Social Commission for Asia and the Pacific*) with whom CIP does and will continue to work.

Population growth, changing food habits, and growing demand for processed foods are driving the expansion of agricultural trade in the region. Yet agricultural trade in Asia accounts for only 21% of global agricultural trade and 8.5% of inter-regional agricultural trade in South Asia.<sup>1</sup> This suggests potential for growth, but advocacy will be required on trade facilitation for agricultural products. At present, tariff equivalent trade costs can be as high as 200% in South and Central Asia and are one of the major impediments to agricultural growth in the region. Efforts to enhance the potato value chain need substantial levels of public and private investment in the sector, infrastructural improvements, and initiatives to support and coordinate activities along the chain. Any program of this nature will have to contain a strong advocacy component to influence key policy makers to move potato and other root crops from the periphery to the core of food security.

An important step towards food security is the inclusion of potato as a food security crop in the national plans of China, India, and Bangladesh, creating political will and an enabling planning framework for expansion. The Second Phase of Central Asian Countries Initiative for Land Management addresses land degradation and increased productivity of land resources in Central Asia with a focus on potato as a food security crop. Climate change will have a serious impact on fragile environments of Central and South Asia, with a yield decrease by 30% from now to next mid-century, due mainly to higher temperatures that will lead to greater water demand for agriculture. As a heat-tolerant, low water consumption crop, potato is ideally adapted to alleviate some of the impacts from climate change. Asia is the most disaster-afflicted region in the world, accounting for about 89% of people affected by disasters worldwide. Potato is increasingly being recognized as a disaster mitigation crop, further solidifying its role in overall food security.

### 5.2 National frameworks and country targeting

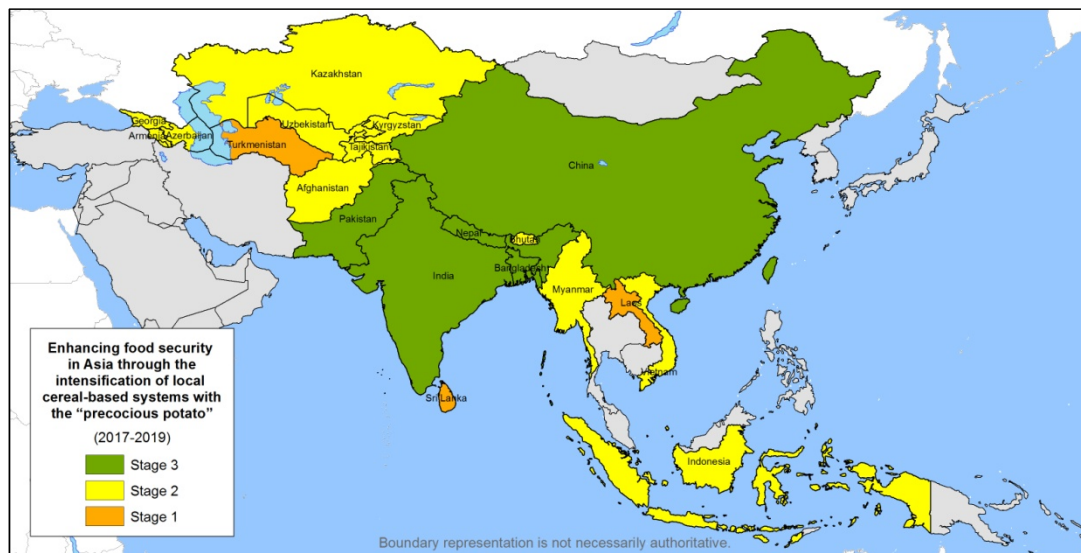
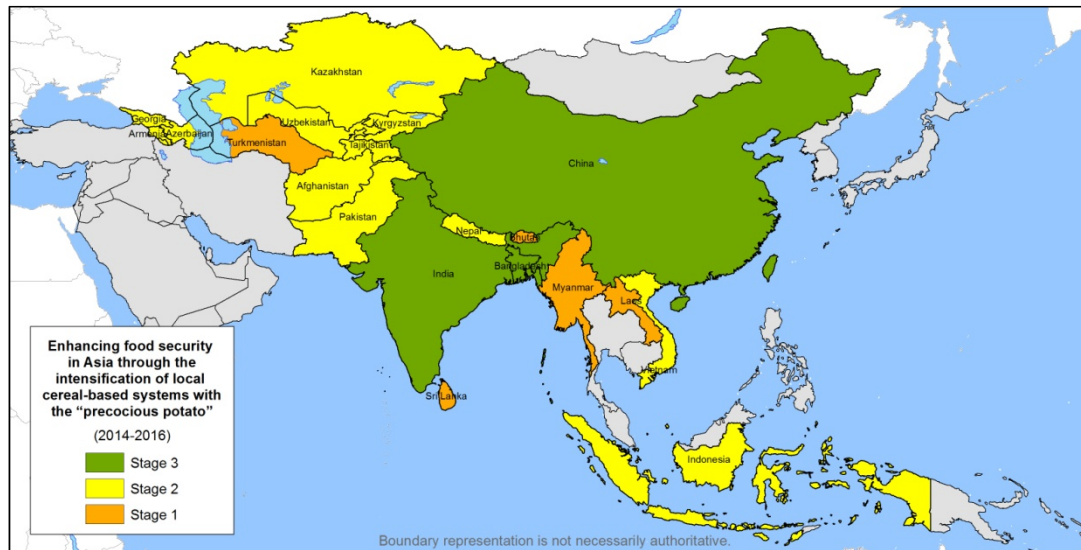
CIP's mode of engagement in these countries will change over time as national programs develop their capacities and research partnerships mature. Supporting this process, CIP will continue to play a science leadership role, though the focus will shift from formative to strategic research. We differentiate between three stages of engagement, corresponding to the status of program development as measured by numbers of HH reached:

- **Stage 1:** Strong public and private sectors, trained manpower, and sufficient infrastructure and resources combined with the existing and potential density of population to reach the number of predicted households.
- **Stage 2:** Limited action public and private sectors; lack of trained manpower, infrastructure, and resources but with high-potential arable land.
- **Stage 3:** Political instability; limited action public sector; and lack of private sector, trained manpower, infrastructure, and resources.

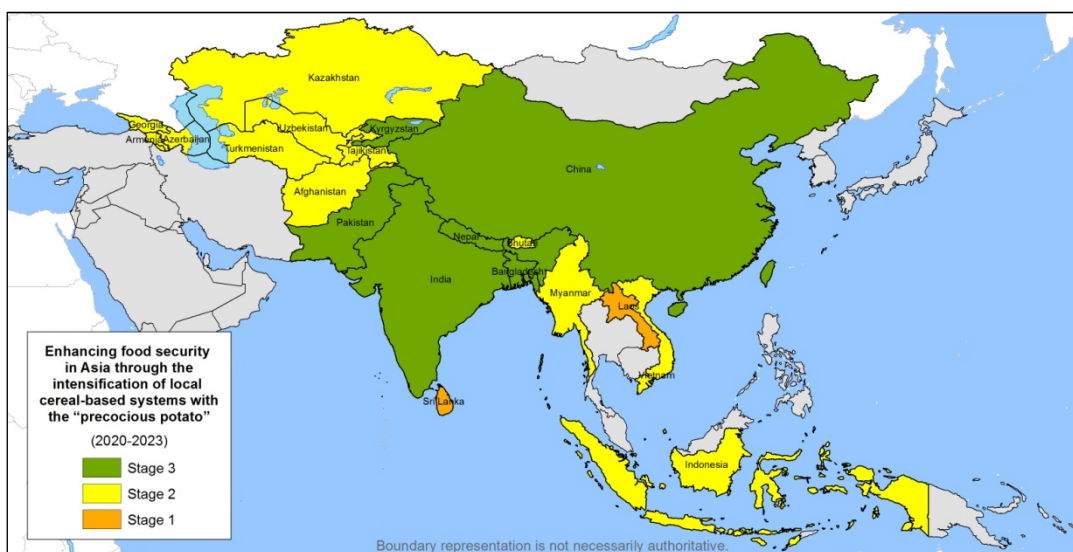
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<sup>1</sup> World Bank. 2010. "South Asia's Challenges in Trade Integration and Growth." <http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/SOUTHASIAEXT/EXTSARREGTOPINTECOTRA/0,,contentMDK:20313405~menuPK:579454~pagePK:34004173~piPK:34003707~theSitePK:579448,00.html>

This SO targets countries (Fig. 2) where cereal-based cropping systems can be sustainably intensified through incorporation of early-maturing potato varieties into short fallow periods such as Bangladesh, India, China, Uzbekistan, Tajikistan, and Kyrgyzstan. Other variables will be relevant for assessing the potential of the agile potato to contribute to increased food security and poverty reduction, in particular Nepal, Tajikistan, Bhutan, Myanmar, and Laos. For the work on small highland countries such as Nepal and Bhutan, interventions will be coordinated between SO 2 and SO 5 teams. For example, several food security indicators are being used as part of a global mapping and targeting exercise that will be considered.<sup>2</sup> Increasingly, CIP is working at state and district levels to develop successful models that can be taken to scale through convergence with local and national government plans. Country profiling will improve the knowledge about particular countries, their national food security frameworks, and their policy and institutional environments that may enable or impede achievement of these goals.



<sup>2</sup> Using indicators for food availability, food access, and food use along with potato consumption and yield at a national level to support expansion. This will be coupled with indices on political will, corruption, and stability, in addition to gender, donor, and poverty mapping. The targeting exercise will weight indicators for particular SOs to reach a ranking of countries for this SO and others.



**Figure 2.** SO 2 target countries in Asia and their expected progression through the three implementation stages over the next 10 years.

**Table 2.** Target countries according to the stages of implementation

Time Period	Stage 1 (<10,000 HH)	Stage 2 (<200,000 HH)	Stage 3 (>200,000 HH)
Current status	Laos, Myanmar, Bhutan, Sri Lanka, Turkmenistan	Kyrgyzstan, Uzbekistan, Kazakhstan, Nepal, Pakistan, Afghanistan, Indonesia, Tajikistan, Vietnam, Azerbaijan, Georgia, Armenia	China, India, Bangladesh
2014–2016	Laos, Turkmenistan, Myanmar, Bhutan, Sri Lanka	Kyrgyzstan, Uzbekistan, Kazakhstan, Nepal, Pakistan, Afghanistan, Indonesia, Tajikistan, Vietnam, Azerbaijan, Georgia, Armenia	China, India, Bangladesh
2017–2019	Laos, Turkmenistan, Sri Lanka	Kyrgyzstan, Uzbekistan, Kazakhstan, Afghanistan, Armenia, Myanmar, Bhutan, Georgia, Azerbaijan, Vietnam, Indonesia, Tajikistan, Pakistan	China, India, Bangladesh, Nepal
2020–2023	Laos, Sri Lanka	Uzbekistan, Kazakhstan, Afghanistan, Armenia, Myanmar, Bhutan, Georgia, Azerbaijan, Vietnam, Indonesia, Tajikistan, Turkmenistan, Pakistan, Kyrgyzstan	China, India, Bangladesh, Nepal

**Note:** The change of stage in a country will depend on the results of the proof-of-concept interventions (Stages 1 and 2). For countries already in Stage 3, a strategy for transferring responsibilities to national partners will be developed and implemented in the period 2020–2013.

### 5.3 SRF and CRPs

This SO will contribute primarily to the CGIAR SLOs on reduced rural poverty and improved food security. It will contribute to the SLO on improved nutrition and health, especially in highland areas, with the deployment of biofortified potato varieties.

SO 2 is most closely aligned with RTB, led by CIP; specifically Theme 2 (development of varieties with higher, more stable yield and added value), Theme 5 (developing tools for more productive,

ecologically robust cropping systems), Theme 6 (improving postharvest management), and Theme 7 (partnerships for impact). This SO has been designed as one of the new RTB delivery flagships and is thus in line with the reorganization of RTB. The SO will work closely with the RTB Gender group to develop gender indicators and implement gender integration research. This SO will contribute to Dryland Systems CRP through its alignment with the IDOs that aim to create conditions for more resilient livelihoods for vulnerable households in marginal areas and with target geographies. Development of input and output potato value chains is an important part of SO 2; methodological collaboration with PIM CRP has already begun. As biofortified potato varieties begin to become available in the target countries, especially for highland production systems, we expect collaboration with A4NH CRP on nutrition value chains linked to these varieties. New levels and combinations of needed traits will be achieved and delivered in collaboration with the RTB discovery flagship, next-generation breeding systems, and with SOs/POs 3 and 4.

## 6. Flagship and Linked Products

The core and flagship of this SO are on the development of agile potato varieties (70–90 days) that will fit into the cereal-based systems of the subtropical and temperate lowlands, thus diversifying and intensifying cropping systems that are otherwise based on cereal monocropping and/or fallow (Fig. 2). The secondary focus will be on medium and early-potato varieties grown in the highlands to enhance food security and to ensure a constant and regular supply of healthy seed to the lowlands systems. In the lowlands, agile potato varieties will compete with imported early seed varieties that are already available on the market. In Central Asia and the Caucasus, we estimate that 95% of the varieties grown are imported—many are early or mid-early (90–100 days). Resilient, competitive potato varieties incorporated into diverse cropping systems of subtropical lowland, highland, and temperate regions. New, early, and medium duration varieties resistant to abiotic (heat and drought) and biotic (virus, LB) stresses with specific postharvest use and management qualities will address current producers’ and market needs as well as food security for vulnerable households.

### 6.1 Linked products



**Figure 2.**  
SO 2 flagship  
(at center) and  
linked products.

1. **Accelerated breeding methods and tools.** Advances in breeding technology will be primarily to develop agile potato varieties for the cereal-based systems of the lowlands. Other cropping systems may benefit as well. Precision phenotyping for constraints such as virus diseases, heat and drought stresses, earliness, and day-neutrality will enable resilient and agile potato varieties to be developed. Standardized data collection and exchange will facilitate decision making. Genome-wide association studies will increase resolution on breeding value and accelerating gains for single and multiple traits.
2. **Options for demand expansion.** Create awareness/advocate for change in diets and food habits to stimulate consumption and sales and assure farmers' remunerative price for their potatoes. Options for effective and inclusive market chains will improve access to food and minimize food waste. Given increasing importation of processed potatoes from North America to Asia, evidence would suggest that there are both demand and potential to develop more indigenous processing varieties. Asia's cyclical problem of overproduction can be eased by diversification in the use of potato. This strategy will sustain an increase in potato area and yields and can help stabilize potato prices. Throughout Asia, potato is grown mainly for the fresh market, but the potential market for processed potatoes raises new prospects for income generation. Potato chips (crisps), French fries, and flakes are the products with the most potential for Asian markets. For all these products, potatoes should have high dry matter (> 20%), low reducing sugars (< 50 mg/100 g), low sucrose (< 150 mg/100 g), and low phenols (< 50 mg/100 g) of fresh weight in addition to the physical characteristics like shape and color for chipping. The processing sector in Asia is currently small—predominantly in India and China—with only approximately 6% of potatoes processed across the region.

Public private partnership (PPP) chains are required for contract farming and buy-back mechanisms to enhance processing of potatoes and assure income of farmers and buffer years of overproduction. An intense training program will upgrade farmers' skills to bring them to the processing requirements through improved technology options that support agricultural diversification and strengthened rural institutions engaged in market value chains. In the pro-poor SO 2, 95% of the beneficiaries will be marginal and small farmers in the region. The availability of quality seed of processing varieties developed will enhance the processing of potatoes from today's 6% to 10% in the next five years.

Value chain studies should commence with market analysis to assess demand to avoid overproduction in addition to investigating (1) the effects of promoting potato and local recipes as a nutritious food, (2) the opportunities for regional trade of seed and ware potatoes, and (3) whether the effects of introducing the agile potato on the increased amount of potatoes available on the local market would open research opportunities on postharvest and processing.

3. **Fast track systems for effective variety identification and release.** GIS and crop modeling will be applied to support decisions for variety testing and recommendation. The benefits of PVS approaches to accelerate the release and acceptance of new varieties by multiple stakeholders will produce evidence to influence the decision making of local and central authorities. Regional networking and data management will facilitate the exchange of information and material. Regional hubs with diagnostic capacities will receive material and distribute candidate varieties. Release authorities will be able to use data from other countries and participatory processes.
4. **Strategies for ecological intensification of farming system with potato.** Research on nutrient cycling, water harvest, sustainable soil, and pest management will contribute to resilient landscapes and increasing crop productivity. Technology development, education, and policy will engage in a systems approach to production and resource management. The dynamics of major biotic and abiotic constraints will be described and baselines quantified for future impact assessment. Standardized quantitative phenotyping of new

varieties will enable the subsequent verification of improvements in sustainability of systems by mapping increased levels of resistance in adopted varieties.

5. **Strategies for going to scale.** SO 2 will continue to work and build the capacity of traditional longstanding national partners, NARS, farmers associations, and NGOs and create regional training hubs in India and Central Asia (and potentially Russia). However, this SO will go to scale only through formulation of more complex and wider reaching partnership structures that involve closer convergence with national government food security plans. In addition, increasing engagement with the private sector and R&D agencies in processing and seed production and ware supplies will be essential, both to drive demand and create supply in addition to strengthening value chains and public health promotion. More innovation will be required in mass and community media communication, given limited budgets to engage with traditional electronic media, such as television and radio, coupled with low penetration of the Internet with targeted beneficiaries. Female farmers should be engaged at the outset both in project design and targeting, and the evaluation and dissemination if change at the HH level is to be both replicable and sustainable. Scale-up and -out can only be ensured by an adequate and improved supply of quality seed of the proposed new dual varieties and by promoting better on-farm practices.

#### **Case Study 1: An example of CIP's competitive advantage—Cooperation-88**

Cooperation-88 is a widely adapted and high-yielding potato variety with high levels of resistance to the primary diseases affecting potato: late blight that causes explosive epidemics and viruses that erode productivity through continued degeneration of planting material. Its production is providing economic benefits to the poor in Asia estimated at US \$192 million a year in 2010.<sup>3</sup> Meeting the demands of both fresh potato and chipping markets, C-88 has stimulated growth in the processing industry and ware potato value chains. Linking SO 2 with the Genebank (SO 6), C-88 traces back to the collection, conservation, and characterization of potato germplasm. It was developed through capacity building, collaborative breeding, and evaluation by CIP and NARS of Asia. Although China has its own breeding program, it is driven to improve disease resistance in its commercial varieties. Inclusion of CIP-bred germplasm in C-88 has broadened the genetic base of potato in China and diminished production risks associated with late blight. Grown on about 400,000 ha in five provinces of southwestern China, C-88 is currently one of the most widely grown potato varieties in the world. Its footprint is steadily increasing. New earlier-maturing dual-purpose varieties with productivity, utilization, and protection traits like those of C-88 are expected to help diversify incomes and diets through sustainable intensification of cereal-based systems in vast regions such as the Indo-Gangeic Plains.

<sup>3</sup> Robinson, J., and C.S. Srinivasan. 2013. Case studies on the impact of germplasm collection, conservation, characterization and evaluation (GCCCE) in the CGIAR. Report for the CGIAR Standing Panel on Impact. <http://impact.cgiar.org/sites/default/files/images/GCCCE2013.pdf>

## 7. Impact Pathway

Products	Research outcomes (Next Users)	First Level Development Outcomes (End Users)	Contributing to RTB IDOs
<b>Flagship: Agile, resilient, and precocious potato varieties</b>	NARS release and promote well-adapted, biodiverse, and consumer-preferred resilient potato varieties	Women and men farmers incorporate productive, biodiverse, resistant, and efficient potato varieties into sustainable and profitable farming systems	IDO 2: Increased and stable access to food commodities by rural and urban poor (SLOs 1, 2)
<b>Accelerated breeding methods and tools</b>	NARS and ARLs use superior progenitors, improved populations, and new tools and schemes to source new traits and trait combinations	Farmers achieve better yields and better quality potatoes with fewer inputs	
<b>Options for demand creation: traditional use and value chains</b>	Potato boards, retailers, processors, and cold store owners promote consumption of safe, nutritious potato products	Consumers show increased demand for a range of healthy potato products	IDO 3: Increased and more gender-equitable income for poor participants in RTB value chains (SLOs 2, 3)
<b>Fast track systems for effective variety identification and release</b>	Authorities include in-country and regional multilocational and participatory trial data and men and women farmers/consumers assessments in variety release decisions	Through gender-inclusive involvement in varietal evaluation, farmers have more rapid access to new, preferred varieties with improved levels of micronutrients	IDO 7: Enabling policy environment supporting development and use of pro-poor and gender-inclusive RTB technologies (SLOs 1, 2, 3, and 4)
<b>Strategies for ecological intensification of farming systems with potato</b>	NARS and partners introduce cultivation methods and management practices that reduce crop losses and environmental risks under intensification	Farmers incorporate potatoes into more productive cropping systems in a sustainable manner	IDO 1: Improved productivity in smallholder RTB cropping systems (SLOs 1, 2, and 4)
<b>Strategies for going to scale</b>	Development actors, private sector, policy makers, extension organizations, and donors use and promote resilient varieties in sustainable ware and seed potato value chains	Large-scale incorporation of new, high-yielding, high-quality potato varieties into farming and food systems in Asia	IDO 4: Increased consumption of safe and nutritious foods by the poor, especially among nutritionally vulnerable women and children (SLOs 2, 3)

## 8. Research Outcomes and Indicators

SO 2 Research Outcomes	Indicators
NARS release and promote well-adapted, biodiverse, consumer-preferred resilient potato varieties	2% of potato area annually covered by the new agile varieties with a gender breakdown of who has access to preferred varieties
NARS and ARIs use superior progenitors, improved populations, and new tools and schemes to source new traits and trait combinations	NARS and ARIs release locally adapted, new varieties annually
Potato boards, retailers, processors, and cold store owners promote consumption of safe, nutritious potato products	Potato consumption increases by 2% annually
Authorities include in-country and regional multilocational and participatory trial data and men and women farmers/consumers assessments in variety release decisions	Release of new varieties and technologies accelerated by involving stakeholders
NARS and partners introduce cultivation methods and management practices that reduce crop losses (ware and seed) and environmental risks under intensification	Crop losses reduced to 5% thanks to improved techniques and diversified potato use
Development actors, private sector, policy makers, extension organizations, and donors use and promote resilient varieties in sustainable ware and seed potato value chains	Potato assumes role of strategic food security crop and its importance promoted in value chains
Public and private extension service providers promote alternative sources, techniques, tools, storage methods, and interventions for provision of quality seed	Farmers start planting locally produced quality seed
Rising demand of starch for commercial use in Asia explored	Research indicates the potential for overproduction for consumption and therefore leading to the use of varieties with a secondary use as a source of starch

## 9. Development Outcomes and Indicators

IDs	Indicators in 2023
1. Improved productivity in pro-poor RTB food systems (SLOs 1, 2, and 4)	<p><b>1.1</b> By introducing agile potato varieties in their cereal-based cropping systems, the total crop output (aggregation of individual crop outputs) of 205,000 poor HH in China and 260,000 poor HH in the other nine targeted Asian countries increased by 8%</p> <p><i>(NB: Data will be disaggregated by country.)</i></p>
2. Increased and stable access to food commodities by rural and urban poor (SLOs 2, 3)	<p><b>2.1</b> Potato production in China and the other nine selected Asian countries increased by 12% due to the introduction of agile potato varieties in 300,000 ha of cereal-based systems</p> <p><i>(NB: Data will be disaggregated by country.)</i></p>
4. Increased and more gender-equitable income for poor participants in RTB value chains (SLOs 1, 2)	<p><b>4.1</b> 87,000 poor rural HH in three Asian countries increase total farm revenue between \$58/year (Bangladesh), \$115/year (Nepal), and \$330/year (West Bengal, India) from marketing new potato varieties, earning between 0.03 and 0.18 additional dollars a day for each HH member</p> <p><i>(NB: Data will be disaggregated by sex of HH head and of HH member.)</i></p>
5. More effective policies supporting development and use of pro-poor and gender-inclusive RTB technologies developed and adopted by agricultural organizations, national governments, and international bodies (SLOs 1, 2)	<p><b>5.1</b> At least xx% of target countries (list of countries) included potato as relevant crop in their national plans for food security.</p> <p><b>5.2</b> At least x regional initiative promoting potatoes as security crop in Asia.</p> <p><i>(NB: Indicators and specific target countries will be defined and identified.)</i></p>
7. Improved ecosystem services for enhanced food system stability and sustaining novel genetic diversity for future use (SLOs 2, 4)	<p><b>7.1</b> <i>(NB: An indicator will be defined to measure improvement in system resilience and stability by introducing agile potato varieties. The crop diversity index could be used as parameter.)</i></p>

## 10. Gender Dimension

The extensive male outward migration as an economic coping strategy—up to 50% of GDP in countries such as Tajikistan and Nepal are now through remittances—has led to the “feminization” of agriculture in all the target countries. This leads to lower educational opportunities for women as they become overburdened with agricultural labor as well as the care economy, disempowering them further. Rural women provide on average 70–80% of manual agricultural labor across Asia,<sup>4</sup> from storage and seed sorting to planting, harvesting, and marketing. Yet the importance of their work receives scant recognition, due largely to traditionally strong patriarchal societies across the region. Here, women’s role has faced increasing disempowerment as evidenced by the slide of both South and Central Asia downwards on the UNDP Gender Inequality Index.<sup>5</sup> Women and girls

<sup>4</sup> The World Bank. 2013. World Development Indicators: Employment by sector.

<sup>5</sup> UNDP. 2012. GII Gender Inequality Index. <http://hdr.undp.org/en/statistics/gii>

are overrepresented among those who are food-insecure: worldwide, an estimated 60% of undernourished people are female.<sup>6</sup>

This SO will include gender-responsive approaches to ensure that women are fully engaged from the outset in PVS, seed system development, and potato value chains. It will also ensure their access to information related to newly developed technologies. To transform the current undervalued role of women in rural communities towards greater empowerment, status, and economic control over assets, we will seek partners to act as both social mobilizers of women to address educational and health needs in addition to access to rural credit. The health and safety of rural female farmers are often at risk due to exposure to dangerous and unhealthy conditions, including extreme temperatures and the unregulated use of pesticides. It is necessary to review, rationalize, and communicate policies and best practices to ensure better working conditions for women. Orientation of educational and extension materials and campaigns targeting women can help ensure awareness and empower women to seek and create healthier working conditions. Gender inequality will be addressed through capacity building and the disaggregation of gender-sensitive technologies and practices in addition to rigorous targeting and gender-sensitive evaluation. Labor inputs will be monitored to evaluate potato as a labor-intensive crop that may add extra work to female farmers in the case of increased potato production from increased yield and variety and the intensification of labor due to rotation cropping.

## 11. Partnership Strategy

Partnerships will become increasingly complex and tripartite between government, private sector, and civil society to enable convergence with national plans and to reach scale. CIP does not have the inherent soft skills in partnership construction and relationship management, so some internal capacity building will have to be addressed to enhance these skills and to develop more robust frameworks on the ethical auditing of potential partners. CIP would work with its mandated and traditional partners, identifying strong NARS (India, China, Russia, Turkey, S. Korea, Philippines) to build sustainable capacity at a regional level. NARS with these strengths would take a leadership role in helping weaker institutions build both technical and institutional capacity. CIP will provide additional technical support and act as a broker to protect the interests of weaker institutions.

We will select partners based on compatibility with CIP's mission and goal, local operational strength, and reputation. We will add partners to bring core competences into the partnerships that CIP does not have in-house, and to leverage resources (intellectual capital, financial, and in-kind support) to stimulate innovation and scale. Multiple stakeholder consultation and a rights-based approach will assume greater importance to reflect both the requirements and inputs in addition to capitalizing on local knowledge of targeted beneficiaries (e.g., women and poor rural farmers). CIP will need to work more closely with local academic research partners to build and sustain capacity in upstream research and with the media to promote downstream public messages for user groups and profiling of the work to attract additional funding and partners. Value chain perspective will be an important dimension of the partnership strategy, to ensure involvement of relevant actors and stakeholders for linking farmers with markets. FoodSTART has developed and field-tested value chain approaches in Asia, which could be useful in identifying and facilitating essential partnerships for market-oriented potato innovations (see proposed research in SO 5).

In markets where there is a distinct lack of private sector activity (e.g., Nepal, Tajikistan), CIP would have to partner with the private sector to create alternative markets to strengthen supply chain linkages and address rural livelihoods in more innovative ways, in addition to working with partners to provide access to credit and micro-insurance for poor end producers. In target countries where civil society and media are weak, such as Uzbekistan, we will have to forge more

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<sup>6</sup> Ross, Miriam. 8 March 2012. "555 million women go hungry worldwide". World Development Movement. <http://www.wdm.org.uk/food-and-hunger/555-million-women-go-hungry-worldwide>

innovative partnerships to address this imbalance in going to scale. Table 3 illustrates our current partnerships and how we see these developing as we pursue SO implementation.

In the context of this SO, CCCAP's geographic focus will be East and Southeast Asia, with a strong organizational and programmatic link with East, Southeast Asia and the Pacific. The agro-ecosystem in China's southern region is similar to that of other Southeast Asian countries such as Vietnam, Laos, Myanmar, and Indonesia. The yield gap for potato production varies across the region due to a series of limiting factors. These include poor seed quality, use of varieties susceptible to and/or poor management of late blight (LB) and other disease and insect pests, inadequate management practices for water and soil, and inappropriate agronomic practices. The challenge of increasing potato production in the region becomes even more daunting in the context of intensifying climate change. China is already playing a leading role in economic development in general in East and Southeast Asia, and this includes the potato sector.

**Germplasm and evaluation.** CIP-related varieties will be shared and tested in China and then other countries. China's agro-ecosystem and human resources provide an excellent platform for evaluating germplasm for both high and lowland ecosystems, and for identifying resistance to several biotic (virus, LB) and abiotic (drought) constraints.

**Production management and technologies, including drought mitigation and IPM technology.** China has many different production techniques in lowland areas that will be shared and evaluated.

**Seed-related experience.** CIP has developed valuable seed-related experience in China using rapid multiplication techniques, which could be shared with countries in the region.

**Processing.** Potato value-chain research will be conducted and lessons and technologies will be shared within the region. Availability of early-maturing varieties of processing potato will lead to market development, which in turn will help boost demand.

**Capacity building and training.** These efforts will be done through international workshops, conferences, academia, research, and awareness events with the public and our stakeholders to add value in implementing SOs laid out the SCP. With the combination of China's strong human-ecosystems and know-how and anticipated new R&D facilities, CCCAP is in a position to contribute by:

- Developing an R&D community of practice to strengthen regional research in potato and sweetpotato.
- Providing capacity building and training in various aspects of potato and sweetpotato R&D, value-chain, postharvest techniques, and others, to promote favorable potato industry development policies and public awareness.
- Leveraging strong potato and sweetpotato R&D partners and development organizations in the region, including those in China, for win-win collaborations in areas such as research infrastructure, research services, capacity-building technologies (research, value chains, postharvest, processing, etc.)

**Policy advocacy and scale-up.** In partnership with others, CCCAP will participate in policy advocacy for promoting scale-up and demand. Several options are available: develop/hire new competencies within CCCAP, leverage other CGIAR Center capabilities, partner with other Chinese organizations, or a combination of these.

**Table 3.** Selected current partners and their roles

Partner	Current Role	Expanded Role
National governments, multilateral agencies (FAO, IFAD, ADB, WTO, UNFCCC), R&D private sector, and academic research institutes	Promoting national food policies	Advocacy for early varietal release and roll-out of the agile potato as a national feeding strategy and for climate change proofing
CGIAR	CGIAR partners in Consortium and CRP Dryland Systems activities	<ul style="list-style-type: none"> <li>• Funding upstream and systems research, Dryland Systems CRP, and facilitate technology transfer and scale-up</li> <li>• Solving food vulnerability and improving nutrition and livelihood</li> </ul>
Private sector (e.g., Technituber Ltd., BRAC/ PROSHIKA, DAE, Lijiang Bofu Agricultural Development Company Ltd., etc.)	Partners interested in disseminating interesting results of research (products and technology)	<ul style="list-style-type: none"> <li>• Multiply advanced clones, varieties, and variety testing and development</li> <li>• Capacity building in crop management, agronomy, and precision agriculture</li> </ul>
Water users associations, farmers associations, CACILM, supported by IFAD/GIZ	Other partners for scaling up products and technology	<ul style="list-style-type: none"> <li>• Diffusing improved potato varieties and water-saving technologies</li> <li>• Applying partial root-zone drying technique</li> <li>• Diffusing high dry matter potato varieties</li> <li>• Improving land resources productivity</li> </ul>

**Note:** CACILM = Central Asian Countries Initiative for Land Management

### Delivering SO2 in Bangladesh – Case study

**Improving livelihoods of potato farmers in Bangladesh through introduction of improved technology of potato production, with special emphasis on quality seed potato production and introducing best technologies in local farming system.** Potato is the third-largest food crop in Bangladesh (after rice and wheat), with an area of 0.44 million ha and yields of 8 million MT in 2012–2013. Owing to its prolific production potato can play a significant role in ensuring food security in Bangladesh because it can help widen the food supply base and thereby help minimize the risk of serious food shortages. In its attempts to diversify food habits, the government has encouraged potato consumption to reduce pressure on cereals, especially on rice. Therefore, potato is becoming an important food crop for ensuring food security and improving livelihoods in Bangladesh. The area under potato has increased remarkably in the last 20 years due to its increased production and source of income in Bangladesh (Table 4).

**Table 4.** Area, production and yield of potato in Bangladesh for last 10 years

Year	Area (million ha)	Production (million MT)	Yield (MT/ha)	Yield increase/decrease from previous year (%)
2003-04	0.367	5.31	14.47	5.77
2004-05	0.403	5.95	14.76	2.00
2005-06	0.373	5.38	14.42	(-) 2.30
2006-07	0.377	5.40	14.32	(-) 0.69
2007-08	0.520	7.80	15.00	4.75
2008-09	0.460	6.74	14.57	(-) 2.87
2009-10	0.472	8.50	18.00	23.54
2010-11	0.460	8.326	18.10	0.56
2011-12	0.430	8.20	19.07	5.36
2012-13	0.440	8.60	19.55	2.52

In Bangladesh, fewer than 10% of potato farmers are using quality seed potato at a high cost from government, NGO, and private sectors providers. More than 90% do not have access to certified quality seed potatoes due to high seed cost. CIP introduced informal seed systems in Bangladesh in 1998 in Northern Bangladesh. With the introduction of high-yielding variety potatoes and informal seed system, per hectare yield increased to 70% within 12 years. CIP has given more emphasis on quality seed potato production at farm level in the southern region of the country in last three years. As potato storage facilities in the Southern region are lacking, CIP introduced home storage and “coolbot” technology to research the value addition of cold storage for small farmers of to store seed potato. CIP also launched a pilot program for processing and utilizing potatoes by women farmers in the south, leading to the development of private entrepreneurs.

### **Research and scaling-up approach**

CIP has given more emphasis on the development of biotic and abiotic stress-tolerant potato varieties in Bangladesh. CIP, through participatory trials in collaboration with NARS (BARI), is supplying elite clones for development of varieties that are LB, virus, salt, and heat tolerant. CIP and BARI developed and released one LB-resistant variety in 2013 and included promotion and dissemination of this variety to farmers.

To achieve the target CIP has organized a manpower development program specifically for the training of young scientists on potato breeding, quality control of seed production, and data management. Milestones for SO 2 activities and targets in Bangladesh are shown in Table 5.

**Table 5.** SO 2 Bangladesh Milestones (HH are direct CIP project beneficiaries)

	<b>Current Status</b>	<b>2014–2016</b>	<b>2017–2019</b>	<b>2020–2023</b>
Households growing and utilizing quality potato seed in South Bangladesh	2,000	3,000	5,000	7,500
Crop income increase through potato		Increase 10%	Increase 15%	Increase 20%
Potato varieties released and available (from CIP clones)	7	10	12	14
Breeder Seed Production Center, station maintaining breeder and foundations seeds (CIP materials)	6 MT	25 MT	125 MT	600 MT
Total area under potato (ha)	0.44 million	0.50 million	0.55 million	0.60 million

# SO 3 Improving Livelihoods of Potato Farmers in Africa by Tackling Deteriorated Seed Quality through an Integrated Approach

## 1. Summary of the Strategic Objective

The overall goal of SO 3 is to significantly increase potato productivity and improve the livelihoods of at least 600,000 smallholder farmers by the use of high-quality seed of robust, market-preferred and biofortified varieties. Through multiplier effects, SO 3 expects to impact three million HH. SO 3 aims to improve quality and access to seed potato tubers (herein referred to as seed) of improved varieties in SSA by combining rapid multiplication technologies (RMTs) with decentralized seed production and on-farm seed maintenance in an integrated approach. A key element of the approach is involving the private sector and creating entrepreneurial opportunities for young and female farmers, which eventually leads to a supply of quality seed at an affordable cost to smallholder farmers.

## 2. Strategic Objective

As a result of SO 3's interventions, within 10 years at least 600,000 smallholder HH in SSA will increase their potato yields by 50% and HH incomes by at least US \$800/ha per season. SO 3 will facilitate innovative business arrangements at key points along the potato value chain that increase access to quality seed. Women and men will benefit from multiplying and using quality seed potato. Through multiplier effects, SO 3 expects to impact three million HH.

## 3. Development Challenge

Agriculture is the economic base for smallholders in most SSA countries. Yet smallholder farmers in mid-elevations and highlands often have limited options for increasing their incomes in agricultural subsectors. Potato is an ideal crop to mitigate this challenge. It thrives in mid- to high-altitude regions, yields more calories per unit area with a short growing cycle, and is nutritious.<sup>1</sup> These qualities make potato an important food security and cash crop for smallholder farmers with limited options. However, yields in SSA range from 6 to 10 MT/ha, far below attainable yields of 25–35 MT/ha and the 2010 global average of 17.4 MT/ha.<sup>2</sup> Demand is increasing for potato in SSA, but the trend is to increase the area under production rather than tackle productivity constraints (yields). This is unsustainable, given the threat to forested areas in mid- and high-altitude regions. Although the solution is to increase productivity, the major bottleneck is limited access to quality seed of suitable varieties, which reduces yields, food availability, and farmers' incomes. The health status of seed defines the potential yield of the potato crop. Typically, farmers

<sup>1</sup> Litaladio, N.B., and Castaldi, L. 2009. Potato: The hidden treasure. *J. Food Comp. Anal.* 22: 491–493.

<sup>2</sup> FAOSTAT. 2010.

often use unmarketable ware potato for planting that is generally of low quality and sourced from their own fields or markets. As a result, diseases have accumulated and spread in farmer-saved seed stocks. Farmers' lack of knowledge to select quality seed is compounded by limited access to varieties with robust traits (such as drought, heat, and disease tolerance and/or biofortified with essential micronutrients, specifically iron and zinc), lack of knowledge of good agricultural practices for potato, and minimal capacity to store. And although seed certification standards exist, most national policies do not recognize more practical quality standards, such as Quality Declared Planting Material (QDPM). This further limits access to quality seed.<sup>3</sup> Policy advocacy for more practical quality standards is required at national levels.

#### 4. CIP's Targeted Response

Breeding for adaptive and disease-resistant traits is at the core of CIP's activities, with an inventory of thousands of germplasm accessions that possess demanded traits, such as resistance to diverse diseases (i.e., LB and various viruses), drought and heat tolerance, and high levels of iron and zinc. But farmers' inability to access quality seed of those varieties undermines all investments and innovations in breeding for new varieties. CIP has proven experience in integrating RMTs that can reduce the number of specialized multiplications from five to three generations under the "3G" approach (pioneered under a three-year USAID-funded project), which further integrates decentralized multiplication, on-farm seed maintenance, and capacity building.<sup>4</sup> Through the 3G approach, CIP helped develop rapid seed multiplication systems in Ethiopia, Kenya, Rwanda, Tanzania, and Uganda, with more recent expansion into Angola, Malawi, and Mozambique. Key to the success of the 3G approach was targeted, strategic partnering between the private and public sectors along all stages of the seed value chain.

The private sector's continued investment in seed potato production is increasing due to high demand for seed and opportunities along the seed value chain. But this involvement is still minimal and seed systems, if they are to be sustainable, need the private sector to become more involved. CIP will exploit this largely untapped potential, creating entrepreneurial opportunities for all levels along the seed value chain, with a special focus on women and youth farmers.

##### **Potato's fit in farming systems**

The hilly, fertile terrain of East, Central, West, and Southern Africa—from Ethiopia to the north down to Mozambique on the coastal south, from the volcanic highland regions of the Democratic Republic of the Congo, Burundi, and Rwanda, to the highland plateaus of West Africa in Cameroon and Nigeria, is home to more than six million smallholder potato farmers. High altitudes, a temperate climate, and generally dependable rains make for near ideal growing conditions for potato—one of the few cash crops available to small-scale farmers throughout these regions. Cropping cycles, however, differ between the region: two or more distinct cycles in East, Central and West Africa, only one growing cycle in Southern Africa. Potato farmers here commonly practice mixed farming that involves crops (maize, legumes, vegetables, and sometimes tea, wheat, or barley) and livestock on average landholding sizes of usually less than 2 ha. As population rises, landholdings shrink and pressure mounts to increase productivity and boost farm incomes. Highland farmers have few choices for cash crops other than potato; consequently, they repeatedly plant potato on the same site. This allows diseases to build up and yields to decrease. Troubling, however, is that farmers are meeting the growing demand for potato by expanding the areas under production, not by improving productivity (yields per hectare). As agriculture continues to encroach onto non-farmland, forested mid- and high-altitude regions are

<sup>3</sup> Fajardo, J., Litaladio, N., Larinde, L., Rosell, C., Barker, I., Roca, W., and Chujoy, E., 2010. Quality declared planting material—Protocols and standards for vegetatively propagated crops. FAO Plant Production and Protection Paper 195. Rome. 126 p.

<sup>4</sup> International Potato Center. 2011. *Roadmap for investment in the seed potato value chain in eastern Africa*. Lima, Peru. 27 p. [http://cipotato.org/research/potato-in-east-africa/cip\\_roadmap-final.pdf](http://cipotato.org/research/potato-in-east-africa/cip_roadmap-final.pdf)

lost, with consequential threats to the carbon sinks that these forests represent and, in many cases, to wildlife habitats and biodiversity. Critical to improving potato production and productivity is greater supply and access to high-quality seed potato, alongside improvements in plant nutrition, disease management, and postharvest management.

As farm sizes shrink, there is strong pressure to increase farm incomes as a way to offset the loss in acreage.<sup>5,6,7</sup> Meanwhile potatoes are considered the main cash crop in these regions.<sup>8,9</sup> Farmers in SSA tend to grow potatoes in very close rotations or even, in some cases, in mono-cropping. They basically have few alternatives of other high-value cash crops, inadequate knowledge of good agricultural practices, and low yields, reducing their incomes even further.<sup>10, 11</sup> As a consequence, farmers are experiencing detrimental effects on soil fertility, farm viability, and reduced yields. Moreover, by depending on the performance of a handful of crops farmers face higher risks of complete crop failures. These are caused by specific abiotic and biotic stress conditions, chiefly the build-up of crop-specific soilborne pest and diseases.<sup>12, 13, 14, 15</sup> CIP recently found in a survey conducted in Kenya, Rwanda, and Uganda that about 15–25% of potato farmers do not practice crop rotation at all; whereas another 20–40% have only one crop in between potatoes.<sup>16</sup> Muthoni and Kabira (2010) showed in trials at KARI Tigoni Station that widened crop rotations and organic fertilization improved soil characteristics and yield after a relatively short time.<sup>17</sup> Crop diversification in terms of time and space is one of the major agronomic measures of integrated management to reduce risks of disease spread to increase nutrient-use efficiency in low-input systems, and to minimize the dependence from external inputs such as synthetic nitrogen fertilizers by the integration of legume crops.<sup>18</sup>

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<sup>5</sup> Shepherd, K.D., Soule, M.J., 1998. Soil fertility management in west Kenya: dynamic simulation of productivity, profitability and sustainability at different resource endowment levels. *Agriculture Ecosystems and Environment* 71 (1–3), 131–145.

<sup>6</sup> Thornton, P.K., Kristjanson, P.M., Thorne, P.J., 2003. Measuring the potential impacts of improved food–feed crops: methods for ex ante assessment. *Field Crops Research* 84 (1–2), 199–212.

<sup>7</sup> Waithaka, M.M., Thornton, P.K., Herrero, M., Shepherd, K.D., Stoorvogel, J.J., Salasya, B., Ndiwa, N., Bekele, N., Croucher, M., Karanja, S., Bolutink, H., 2005. System Prototyping and Impact Assessment for Sustainable Alternatives in Mixed Farming Systems in High-Potential Areas of Eastern Africa. Final Program Report to the Ecoregional Fund to Support Methodological Initiatives.

<sup>8</sup> Kaguongo, W. 2009. Baseline study on farmers willingness to pay for high quality seed. Funded by GTZ, Kenya, project report

<sup>9</sup> Obado J. 2010: 3G Baseline Report for Kenya, Rwanda and Uganda in the USAID funded project: Tackling the food price crisis in Eastern and Central Africa with the humble potato: Enhanced productivity and uptake through the “3G” revolution. March 2010, unpublished

<sup>10</sup> Gildemacher PR, Maina P, Nyongesa M, Kinyae P, Gebremedhin W, Lema Y, Damene B, Shiferaw T, Kakuhenzire R, Kashaija I, Musoke C, Mudioppe J, Kahiu I, Ortiz O (2009) Participatory analysis of the potato knowledge and information system in Ethiopia, Kenya and Uganda. In: Sanginga PC, Waters-Bayer A, Kaaria S, Njuki J, Wettasinha C (eds) *Innovation Africa: enriching farmers’ livelihoods*. Earthscan, London, pp 153–167

<sup>11</sup> Schulte-Geldermann, E., Gildemacher, P.R., Struik, P.C., 2012: Improving seed health and seed performance by positive selection in three Kenyan potato varieties. *Am. J. Pot Res* (2012) 89:429–437

<sup>12</sup> Turkensteen LJ (1987) Survey of diseases and pests in Africa: fungal and bacterial diseases. *Acta Hort* 213:151–159

<sup>13</sup> Low JW (1997) Potato in southwest Uganda: threats to sustainable production. *Afr Crop Sci J* 5:395–412

<sup>14</sup> Lemaga B, Kakuhenzire R, Kassa B, Ewell P, Priou S (2005) Integrated control of potato bacterial wilt in eastern Africa: the experience of African highlands initiative. In: Allen C, Prior P, Hayward A (eds.). *Bacterial wilt disease and the *Ralstonia solanacearum* species complex*. American Phytopathological Society, St Paul, pp 145–157

<sup>15</sup> Gildemacher PR, Maina P, Nyongesa M, Kinyae P, Gebremedhin W, Lema Y, Damene B, Shiferaw T, Kakuhenzire R, Kashaija I, Musoke C, Mudioppe J, Kahiu I, Ortiz O (2009) Participatory analysis of the potato knowledge and information system in Ethiopia, Kenya and Uganda. In: Sanginga PC, Waters-Bayer A, Kaaria S, Njuki J, Wettasinha C (eds) *Innovation Africa: enriching farmers’ livelihoods*. Earthscan, London, pp 153–167

<sup>16</sup> CIP 2009–2011: Project baseline and impact studies conducted in Ethiopia, Kenya, Rwanda and Uganda, unpublished

<sup>17</sup> Muthoni J and Kabira JN (2010). Effects of crop rotation on soil macronutrient content and pH in potato producing areas in Kenya: A case study of KARI Tigoni station. *J. Soil Sci. Environ. Manage*, 1:227–233.

<sup>18</sup> Østergård H., M. R. Finckh, L. Fontaine, I. Goldringer, S. P. Hoard, K. Kristensen, E. T. Lammerts van Bueren, F. Mascher, L. Munki and M.S Wolfe, 2009. Time for a shift in crop production: embracing complexity through diversity at all levels. *J Sci Food Agric* 89: 1439–1445

## 5. Alignment

### 5.1 Global and regional frameworks

At the global level, SO 3 aligns strongly with the provisional SDGs of poverty eradication, food security and nutrition, sustainable agriculture, and employment. SO 3 further aligns with two of the four FAO food security pillars: food availability and food access and stability/vulnerability. At the regional level, this SO aligns with the CAADP<sup>19</sup> Pillars III (food supply and hunger) and IV (agricultural research, technology dissemination, and adoption).

### 5.2 National frameworks and country targeting

SO 3 intends to target 13 SSA countries where potato is important for mid-altitude and highland farmers (Table 1, Fig. 1) based on seven criteria:

- National policy highlights potato as a priority crop for investment
- CIP's experience and involvement in these countries
- Presence of effective current and potential partners
- Institutional context (e.g., effective NARs, effective phytosanitary control schemes)
- Potato area (hectares) currently under production
- Number of potato farmers
- Potential to reach high numbers of beneficiaries.

SO 3 differentiates and describes three phases of engagement, corresponding to the status of program development as measured by numbers of HH reached: (1) Stage 1 (pilot phase), (2) Stage 2 (assessment), and (3) Stage 3 (going to scale). The basis for selecting pilot-phase countries is the potential for impact and proof of concept. Entry points and exit strategies will be defined in the upcoming respective project implementation plans.

**Table 1.** SO 3 focus countries and 10-year progression through SO 3 implementation

Phase	Stage 1 (<10,000 HH*)	Stage 2 (<100,000 HH)	Stage 3 (>100,000 HH)
Current status	Mozambique, Rwanda, Uganda, Tanzania	Ethiopia, Kenya, Malawi,	
2014–2016	Burundi, Cameroon, Madagascar, Nigeria, Democratic Republic of Congo (DRC)	Malawi, Mozambique, Tanzania, Uganda, Rwanda	Ethiopia, Kenya, Rwanda
2017–2019	Cameroon, DRC, Madagascar, Nigeria,	Burundi, Malawi, Mozambique	Ethiopia, Kenya, Rwanda, Tanzania, Uganda
2020–2023		Burundi, Cameroon, DRC, Madagascar, Mozambique, Nigeria	Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda

\* Targeted number of HH with improved access to quality seed.

<sup>19</sup> <http://www.nepad-caadp.net/>

### 5.3 SRF and CRPs

SO 3 directly aligns with the four SLOs of CGIAR’s SRF and is fully aligned with the RTB CRP. Particularly relevant for SO 3 are RTB’s cross-crops projects on understanding planting material degeneration and on developing a conceptual framework to analyze and guide seed interventions, which will provide scientific knowledge to improve implementation of SO 3 activities. The need to strengthen seed systems has also been included in Humidtropics CRP, which will be looking at the seed system at production system level.

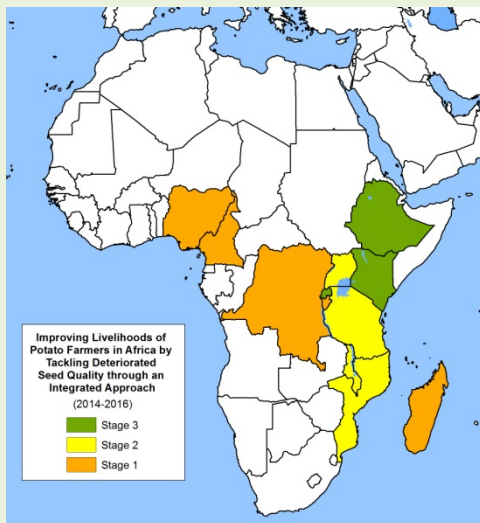


Figure 1a. 2014–2016.

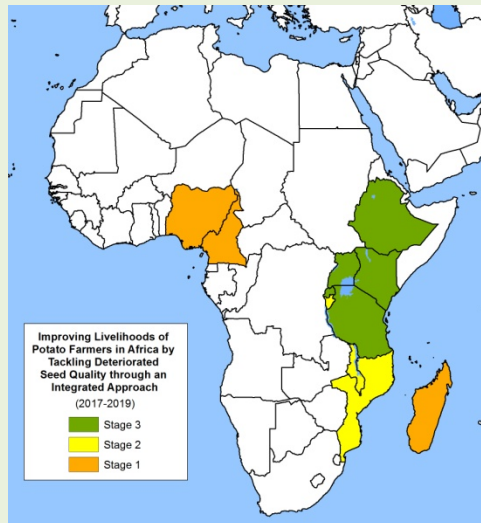


Figure 1b. 2017–2019.

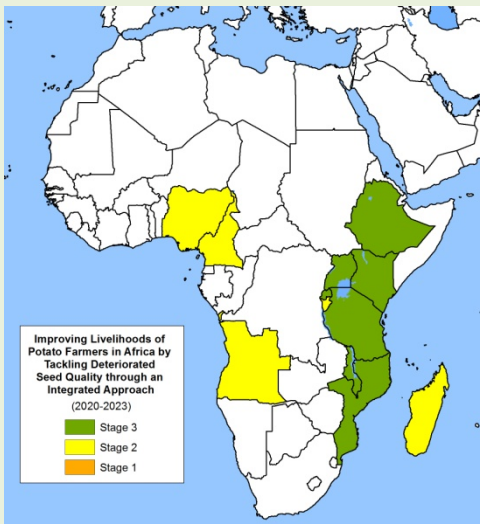
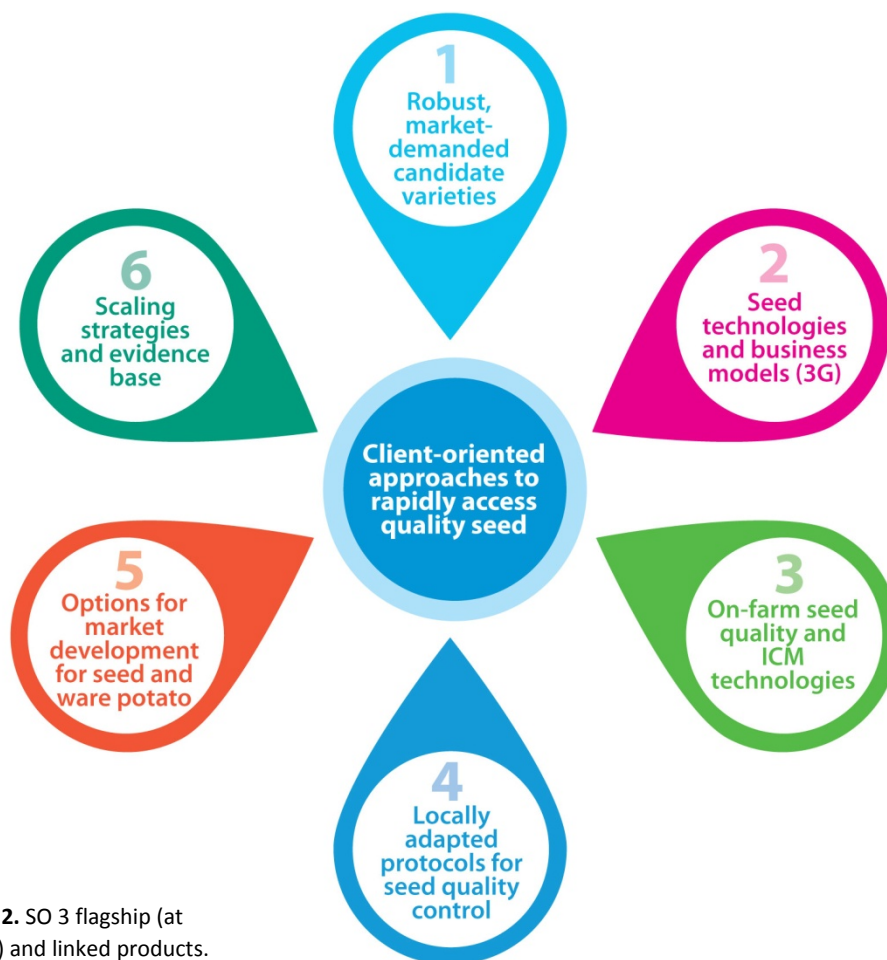


Figure 1c. 2020–2023.

**Figure 1.** SO 3 target countries in SSA and their expected progression through the three implementation stages over the next 10 years.

## 6. Flagship Product and Linked Products

The core of this SO is client-oriented (i.e., small-scale potato farmers in SSA) approaches to rapidly access quality seed (Fig. 2). SO 3 will integrate specialized, early-generation seed production with decentralized multiplication and on-farm seed maintenance. This will accelerate much-needed access to and adoption of varieties possessing in-demand traits through an efficient seed system.



**Figure 2.** SO 3 flagship (at center) and linked products.

### 6.1 Linked products

- 1. Robust, market-demanded candidate varieties.** Increase potato-breeding efficiency and delivery, for population improvement and variety development against major biotic and abiotic stresses with user-preferred table, processing, and nutritional qualities, taking into consideration special needs of vulnerable groups in SSA. Research themes include producing and disseminating large numbers of advanced clones (e.g., through seed directories), engaging farmers and breeding companies in the selection process, conducting genotype-by-environment evaluations to help identify markers for trait selection, and addressing intellectual property (IP) issues.
- 2. Seed technologies and business models (3G).** Targets specialized and decentralized seed multipliers. Adaptive research on and implementation of RMTs for in-vitro,

minituber, and field generation seed categories, and equitable business models to stimulate the seed sector through PPPs, including socioeconomic and cost-benefit analyses.

3. **On-farm seed quality and ICM technologies.** Targets adaptive research on technologies for on-farm seed quality management (positive/negative selection, small seed-plot technique, improved storage, etc.), ICM (control of major pests and diseases, postharvest management, etc.), and postharvest storage for seed and ware potato producers. Improving and maintaining soil fertility will receive special emphasis. Research on modeling seed degeneration, pest and disease epidemiology, and yield gaps carried out in association with RTB will provide scientific basis to improve current ICM technologies.
4. **Locally adapted protocols for seed quality control.** Research and evidence-based advocacy actions for adapting and implementing (1) protocols for seed quality control, such as QDPM, to be used at national or regional levels to complement regulations of formal seed standards; (2) affordable disease diagnostic techniques; and (3) risk studies monitoring the introduction of new pests and diseases.
5. **Options for market development for seed and ware potato.** The focus here is on (1) studies of current and shifting user preferences and demands along potato value chains to address changing food habits, and (2) activities to increase the use of seed and ware potato through identifying, adapting, implementing, and documenting effective methodologies to raise awareness of the value of potato, quality seed, and improved varieties. Participatory organoleptic panels are key to supporting adoption of improved varieties and better target specific markets. These activities will draw upon successful interventions from other RTB or similar crops (e.g., sweetpotato) and regions (e.g., Latin America<sup>20</sup>), and seek partnerships with food technology experts.
6. **Scaling strategies and evidence base.** Testing and implementing methodologies to generate innovations on large-scale production and use of quality seed, as well as on effective linkages among value chain actors, paying special attention to private companies. We will identify, document, and promote replicable and scalable methodologies to reach new areas and users with suitable varieties. Close linkages are expected with seven CRPs, particularly RTB and Humidtropics. Close interactions and knowledge exchange are expected with four SOs, especially SO 1 (Combating vitamin A deficiency with resilient, nutritious sweetpotato) and SO 2 (Enhancing food security in Asia through the intensification of local cereal-based systems with the agile potato). Both have strong seed components that can benefit from experiences and methodologies developed within SO 3.

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<sup>20</sup> Devaux, A., Ordinola, M., and Horton, D. (eds.). 2011. *Innovation for Development: The Papa Andina Experience*. International Potato Center, Lima, Peru. pp. 431.

## 7. Impact Pathway

Products	Research Outcomes (Next Users)	First Level Development Outcomes (End Users)	Contributing to RTB IDOs
<b>Flagship: Client-oriented approaches to rapidly access quality seed</b>	Next users improve seed interventions by adapting models to their conditions	Ware potato farmers increase the use of high-quality seed of robust varieties	IDO 1: Improved productivity in smallholder RTB cropping systems (SLOs 1, 2 and 4)
<b>Robust, market-demanded candidate varieties</b>	Farmers, breeders, NARS, and private sector actors breed, release, and promote varieties using participatory approaches	Ware potato farmers have faster access to robust varieties	IDO 2: Increased and stable access to food commodities by rural and urban poor (SLOs 1, 2)
<b>Seed technologies and business models</b>	Public and private seed producers increase production and sales of in-vitro, minituber and early field seed generation categories using improved RMTs and diagnostic technologies	Seed multipliers, especially decentralized, selling affordable high-quality seed	IDO 2: Increased and stable access to food commodities by rural and urban poor (SLOs 1, 2)
<b>On-farm seed quality and ICM technologies</b>	GOs, NGOs, universities, CBOs, producer organizations, and private sector actors support appropriate on-farm seed maintenance and ICM techniques to add value to seed and ware potato	Ware potato farmers balance seed replacement and on-farm maintenance of quality seed cost effectively	IDO 3: Increased and more gender-equitable income for vulnerable participants in RTB value chains (SLOs 2, 3)
		Ware potato farmers increase return of seed purchases through the use of ICM technologies	
<b>Locally adapted protocols for seed quality control</b>	Regulatory and extension agencies implement appropriate quality control standards and use affordable diagnostics methods to facilitate production of large volumes of high-quality seed and ensure safe seed trade	Seed multipliers, traders, and ware potato farmers have access to seed of guaranteed quality at local, national, and regional levels timely and cost effectively	IDO 7: Enabling policy environment supporting development and use of accessible and gender-inclusive RTB technologies (SLOs 1, 2, 3, and 4)
<b>Options for demand creation with seed and ware potato</b>	GOs, NGOs, universities, CBOs, producer organizations, and private sector actors use marketing tools to increase potato consumption and high-quality seed use of robust varieties	Consumers increase potato consumption and purchases based on perception of potato as a nutritious food	IDO 4: Increased consumption of safe and nutritious foods by the poor especially among nutritionally vulnerable women and children (SLOs 2, 3)
<b>Scaling strategies and evidence base</b>	GOs, NGOs, and donors adopt and promote best practices and approaches for wide-scale uptake of high-quality seed and robust varieties through efficient partnerships	Large number of ware potato farmers in vast areas produce and sell substantial volumes of potato through the use of quality seed and robust varieties	IDO2: Increased and stable access to food commodities by rural and urban poor (SLOs 1, 2)
			IDO3: Increased and more gender-equitable income for poor participants in RTB value chains (SLOs 2, 3)

## 8. Research Outcomes and Indicators

Research Outcomes	Indicators
Next-users improve seed interventions by adapting and using models to their conditions	<ul style="list-style-type: none"> <li>• SO 3 flagship iteratively improved and documented using a conceptual framework developed in association with RTB</li> <li>• SO 3 flagship measured through rigorous studies at pilot, assessment, and going-to-scale phases</li> </ul>
Farmer breeders, NARS, and private sector actors breed, release, and promote varieties using participatory approaches	<ul style="list-style-type: none"> <li>• At least 10 pro-poor varieties released by private sector and/or NARS in the intervention countries</li> </ul>
Public and private specialized actors increase production and sales of in-vitro, minituber, and early field seed generation categories using improved RMTs and diagnostics technologies	<ul style="list-style-type: none"> <li>• Equitable business models to stimulate the seed sector through PPPs validated and documented</li> <li>• At least two RMTs adapted to local conditions and validated with partners in respective target countries</li> <li>• Agriculture-related private firms engage in minituber production with a capacity of at least 5 million/year</li> <li>• Availability of certified seed increases 2-, 5-, and 10-fold in Stages 1, 2, and 3 countries, respectively</li> <li>• Seed companies and agro-input dealers involved in seed sales and distribution</li> </ul>
GOs, NGOs, universities, community-based organizations (CBOs), producers organizations, and private sector actors support appropriate on-farm seed maintenance and ICM techniques to add value to seed and ware potato	<ul style="list-style-type: none"> <li>• In association with RTB, seed degeneration rate estimated under different conditions and on-farm seed techniques adjusted accordingly</li> <li>• ICM techniques improved by using basic epidemiological studies of key pests and diseases</li> <li>• Number of techniques for on-farm seed management and ICM promoted and routinely used by next users interventions</li> </ul>
Regulatory and extension agencies implement appropriate quality control standards and use affordable diagnostic methods to facilitate production of large volumes of high-quality seed and ensure safe seed trade	<ul style="list-style-type: none"> <li>• Efficiency and effectiveness of QDPM documented</li> <li>• Number of standards for potato seed certification and quality declared seed production adapted to local conditions</li> <li>• Number of detection techniques for key pathogens validated and used by partners</li> </ul>
GOs, NGOs, universities, CBOs, producers organizations, and private sector actors use marketing tools to increase potato consumption and high-quality seed use of pro-poor varieties	<ul style="list-style-type: none"> <li>• User preferences and demands in potato value chain identified and documented</li> <li>• Number of methodologies to raise awareness of the value of potato and quality seed tested and documented</li> </ul>
GOs, NGOs, and donors adopt and promote best practices and approaches for wide-scale uptake of high-quality seed and pro-poor varieties, through efficient partnerships	<ul style="list-style-type: none"> <li>• Number of methodologies to promote use of quality seed in large areas and facilitate collective action tested and documented</li> <li>• Good practices for up-scaling seed interventions documented</li> </ul>

## 9. Development Outcomes and Indicators

IDOs	Indicators in 2023
<p><b>1.</b> Improved productivity in pro-poor RTB food systems (SLOs 1, 2, and 4)<sup>†</sup></p>	<p><b>1.1</b> Potato yield of at least 600,000 ware potato farmer HH planting clean seed in SSA (East and Central Africa—400,000; Southern Africa—150,000; and West Africa—50,000) increased by 50% (or 5 MT/ha)</p> <p><b>1.2</b> Potato yields of at least 200,000 ware potato farmer HH (East and Central Africa—120,000; Southern Africa—50,000; and West Africa—30,000) increased by 30% (or 3 MT/ha) through adapted techniques for on-farm seed management</p>
<p><b>2.</b> Increased and stable access to food commodities by rural and urban poor (SLOs 2, 3)</p>	<p><b>2.1</b> National potato production increased by at least 5% in at least 6 of the 13 priority SSA countries, due to increased area productivity</p>
<p><b>4.</b> Increased and more gender-equitable income for poor participants in RTB value chains* (SLO 1, 2)</p>	<p><b>4.1</b> Potato income of 600,000 farmer HH using adapted gender-sensitive techniques for on-farm seed management in SSA (East and Central Africa—400,000; Southern Africa—150,000; and West Africa—50,000) increased by at least 10%</p> <p><b>4.2</b> The profit of at least 2,500 decentralized seed multipliers, in particular youth and women entrepreneurs, increased by 25% (or US \$300/ha) in SSA targeted regions: East and Central Africa—1,800; Southern Africa—500; and West Africa—200</p> <p><b>4.3</b> Potato income of at least 200,000 vulnerable potato farmer HH, across priority countries, increased by 20% by applying technologies to improve farm saved seed qualities</p> <p><i>(NB: All increases will be measured against baseline Information obtained at the start of respective country interventions within SCP's timeframe.)</i></p>
<p><b>5.</b> More effective policies supporting development and use of pro-poor and gender inclusive RTB technologies developed and adopted by agricultural organizations, national governments and international bodies (SLO 1, 2)</p>	<p><b>5.1</b> Established schemes for seed quality control, such as QDPM and formal certification, in at least five countries: Ethiopia, Malawi, Rwanda, Tanzania, and Uganda</p> <p><b>5.2</b> Tripled production of certified seed and quality declared seed in at least eight of the priority countries, from baseline information obtained at the start of respective country interventions within SCP's timeframe</p> <p><b>5.3</b> Improved and adapted standards (for both certified and on-farm seed management) for quality seed production defined in national regulations in at least six priority countries</p>

\* Where applicable, indicators will be disaggregated by gender. SO 3 targets at least 30% women beneficiaries, with an ultimate goal of equitable representation between genders for each indicator.

† SLO 1: Reduction in rural poverty; SLO 2: Increase in food security; SLO 3: Improving nutrition and health; SLO 4: Sustainable management of natural resources.

## 10. Gender Dimension

Because women have a prominent role in seed production, we will take every measure to ensure that they are involved in and benefit from multiplying and using quality seed. The 3G project demonstrated that women farmers were more likely to adopt and continue using the 3G approach than were men: of the 35 men and 22 women farmers in Kenya who participated, 20 of the women farmers are still engaged in seed production, whereas only 18 of the men are. CIP will ensure that women are informed of our activities and are able to participate (e.g., by holding any trainings during times when women are able to attend).

The linked products of the flagship imply managing relatively more processes than the traditional seed selection and multiplication process. There is a need to better understand equity effects and dynamics of the seed business on the autonomy and workload of women in production and access to market decisions. The factors responsible for gender disparities in the adoption or impact of new technologies need to be identified, and efforts are needed to ensure that women participate in the evaluation and adoption of improved methods to multiply seed. Partner selection will recognize their different perspectives on gender and youth components (see below). Special attention will be given to provide new business opportunities to women and youth. We will strongly encourage women to participate in enterprise associations. Promotion and marketing along the potato value chain will consider specific preferences and demands of women and youth.

## 11. Partnership Strategy

Engaging partners along all levels of potato value chains is essential to complement CIP's expertise, to scale up, and to provide outreach to the hundreds of thousands of beneficiaries. Furthermore, partnerships are key to raising awareness of the benefits of using quality seed, selecting suitable varieties, and consuming biofortified potato. SO 3 will take advantage of lasting partnerships established during previous interventions, especially the 3G project. CIP has developed a network of public and private partners along all levels of the seed and ware potato value chains. We have strong relationships with NARS in the countries where CIP works (Ethiopia, Kenya, Malawi, Mozambique, Rwanda, and Tanzania); with the private sector (i.e., Syngenta, Bayer, and Universal Industries); and large-scale, commercial farms such as Solargrow, Kisima, and Mtanga farms. As well, we have forged linkages with support agencies, such as Root Capital (a finance institution) and the International Fertiliser Development Center, and NGOs, such as the Syngenta Foundation, the Irish Potato Coalition (a consortium of NGOs and science and business partners), and the CIAT-Soils group for integrated farm system-level research and implementation.

We will select future partners as our activities expand along the value chain, with specific attention to the private sector. CIP will focus on expanding our private sector partnerships, with much attention given to women and youth farmers. We will target new private sector players through stakeholder and informal meetings. Sustainability and our exit strategy depend on partnerships. It is the private sector that serves as the key players in the potato value chain and that will carry on the scaling-up process well after CIP has moved on to other activities. Table 2 illustrates our current partnerships and how we see these developing as we implement SO 3.

Entire seed potato production system in the target countries has traditionally been the sole responsibility of national programs, and the systems have largely been operating under limited human capacity and facilities and without a quality control system. Through our past and current projects, CIP has laid the groundwork to develop functional seed systems in the targeted countries. Working with existing and developing new partnerships are key to scale-up and out previous initiatives to accelerate farmer adoption of quality seed through proven technologies and dissemination approaches. Strategies to reach our target number of farmers with quality seed include scaling up and out of decentralized seed production, an extensive awareness-building campaign, distribution in small seed packages to increase accessibility to quality seed, and training

farmers to maintain seed quality on farm. To ensure that our strategies are successful, we will increase private sector involvement along all levels of the seed value chain to complement public sector capacity to produce quality seed.

**Table 2.** Selected current partners and their roles

Partner or Player	Anticipated Linked Product Contribution
Farmer groups/associations, lead farmers	<ul style="list-style-type: none"> <li>• Seed technologies and business models (3G)</li> <li>• On-farm seed quality and ICM technologies</li> </ul>
ARIs, national research institutes, extension services	<ul style="list-style-type: none"> <li>• Robust, market-demanded candidate varieties</li> <li>• Locally adapted protocols for seed quality control</li> </ul>
Extension services	<ul style="list-style-type: none"> <li>• On-farm seed quality and ICM technologies</li> </ul>
Private sector, SMEs, and cooperatives, seed companies, agro-input dealer networks	<ul style="list-style-type: none"> <li>• Options for demand creation with seed and ware potato</li> <li>• Scaling strategies and evidence base</li> </ul>
NGOs, CBOs (FIPS-Africa, CRS), MoA	<ul style="list-style-type: none"> <li>• On-farm seed quality and ICM technologies</li> <li>• Options for demand creation with seed and ware potato</li> </ul>
National Potato Council	<ul style="list-style-type: none"> <li>• Options for demand creation with seed and ware potato</li> </ul>
Input and credit providers, input insurance schemes	<ul style="list-style-type: none"> <li>• Options for demand creation with seed and ware potato</li> <li>• Scaling strategies and evidence base</li> </ul>
Regulatory agencies, regional, and subregional organizations	<ul style="list-style-type: none"> <li>• Seed technologies and business models (3G)</li> <li>• Locally adapted protocols for seed quality control</li> </ul>
Syngenta	<ul style="list-style-type: none"> <li>• Options for demand creation with seed and ware potato</li> </ul>
International Fertiliser Development Center	<ul style="list-style-type: none"> <li>• On-farm seed quality and ICM technologies</li> <li>• Options for demand creation with seed and ware potato</li> </ul>
Root Capital	<ul style="list-style-type: none"> <li>• Seed technologies and business models (3G)</li> </ul>
M-Farm	<ul style="list-style-type: none"> <li>• Options for demand creation with seed and ware potato</li> </ul>
CIAT–Soils	<ul style="list-style-type: none"> <li>• On-farm seed quality and ICM technologies</li> </ul>

**Note:** SMEs = small and medium enterprises; FIPS = Farm Input Promotions; CRS = Catholic Relief Services; MoA = Ministry of Agriculture

\* Specific partners depend on country, project, and current status of seed multiplication and potato production. Further considerations are private sector involvement and political will and support. Partners involved will remain throughout the span of any intervention. It is the intensity of partnerships that will change as countries progress along phases of the SO. For example, research activities/partners will dominate phase 1 for proof of concept and will move toward a convening role in phases 2 and 3. Partners from the commercial seed sector increase their involvement significantly from phase 1 to 3 and eventually will dominate the seed value chain.

## Delivering SO 3 in Ethiopia

### Development challenge

In Ethiopia, close to 1 million HH (6 million people) annually produce approximately 1 million MT of potatoes on 164,000 ha. The total area suitable for potato production is 7 million ha, so there is massive potential for growth. The main potato-producing districts are Amhara (42%), Oromia (32%), Southern Nations, Nationalities and Peoples Region (SNNPR, 22%), and Tigray (2%). Average yields of 8 MT/ha are far less than attainable yields of greater than 25 MT/ha. This gap highlights a significant opportunity to increase productivity and overall production.

### Key features of the Ethiopian seed potato industry

While dominated by the regional ARI, the private sector is beginning to invest in specialized production of early generation seed. The current capacity to produce minitubers is expanding, with annual production of approximately 370,000 minitubers, of which 120,000 are produced by Solagrow PLC, the only private seed company engaged in minituber production and field multiplication of early generation seed. Farmer groups and seed producer cooperatives in Oromia, SNNPR, and Tigray produce the bulk of *quality* seed, and collectively produce approximately 6,000 MT/year. Being located in traditional seed-producing areas, the cooperatives produce seed in a highly decentralized manner to reduce the spread of disease and limit transport costs. Many are developing their business skills so as to evolve into regular enterprises. A system of 789 diffuse light stores (DLS) located over 17 woredas (districts) can store as much as 5,111 MT of seed.

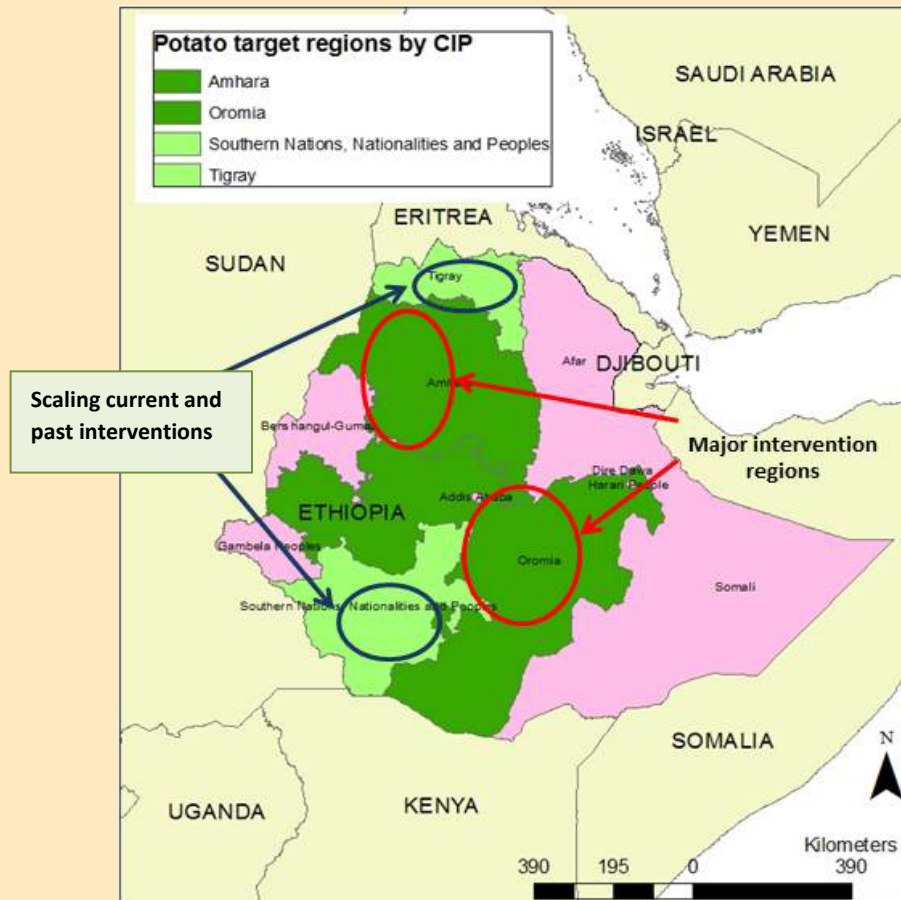
In the absence of official, functioning seed certification schemes for potato, an informal seed inspection scheme for the production of quality seed potato is being piloted in Ethiopia. The scheme builds on the FAO/CIP concept of producing QDPM. The QDPM concept has now been recognized by the Ethiopian seed legislation as an option to increase the availability of quality seed. The system operates at two levels: (1) the seed producer cooperative level that inspect their own fields, and (2) a woredas-level committee composed of district agriculture research and extension bodies and representatives from seed producer cooperatives of the woreda who inspect fields within the woreda. Our experience has shown that farmers using QDPM seed are achieving yields of 25–30 MT/ha, demonstrating that seed producers practicing positive and negative selection are able to maintain seed quality. Additionally, seed multiplication occurs at high altitudes, where aphid and subsequent virus pressures are very low. Research has shown that minor viral diseases are present in the seed but at extremely low frequencies. The ongoing initiative piloted by CIP in eight woredas will generate first experiences that will be further refined prior to incorporation into the seed legislation.

### CIP experience and past interventions in Ethiopia

Since 2008, CIP, in close collaboration with Ethiopian government organizations and NGO partners, and with funding from USAID, the Common Fund for Commodities, and the Austrian Development Agency, has worked to address key seed potato constraints. Our current and past interventions target Oromia, SNNPR, and Tigray regions and focus on supporting production and dissemination of quality planting material of high-yielding, disease-resistant varieties through (1) capacity building along all levels of the seed value chain, (2) rehabilitating RMT facilities (tissue culture laboratories, aeroponics, and hydroponics), (3) establishing seed producer cooperatives, (4) linking seed producer cooperatives to input (minitubers, chemicals) and output (seed, ware) markets, (5) piloting a QDPM system, and (6) supporting research at M.Sc. levels.

## Intervention plan: intervention scope and areas

Interventions will benefit at least 250,000 HH in the potato-producing regions of Ethiopia: Amhara, Oromia, SNNPR, and Tigray, and aims to increase the amount of quality seed available at least fivefold. Given the importance of the crop in the Amhara region, and limited past interventions in the potato sector, SO 3 will prioritize its interventions in this region and intensify and expand recent interventions in the other three regions.



The intervention areas address all levels of the seed value chain in Ethiopia, from production of in-vitro plantlets to marketing seed potato. Regional ARIs (ARARI in Amhara, ORARI in Oromia, SARI in SNNPR, and TARI in Tigray) will be supported to increase their rapid seed multiplication capacities. In partnership with ARARI, this entails strengthening production capabilities for disease-free minitubers by rehabilitating the existing tissue culture laboratory and constructing sand hydroponics facilities and screen houses. In partnership with ORARI, SARI, and TARI we will continue to provide material and technical backstopping to existing RMT facilities and construct further sand hydroponic and aeroponic facilities where required. Additionally, the intervention will target massive private sector investment in early seed generation production and provide those with technical backstopping. Identifying decentralized seed multipliers and organizing into seed producer cooperatives will continue in all intervention regions, particularly in Amhara. Training on technical and business skills, along with linking seed producer cooperatives to input markets such as minituber producers, will facilitate decentralized seed production and increase accessibility to quality seed. To maintain seed quality and improve market access, we will continue to invest in seed storage facilities for seed potato (DLS) and minitubers (cold stores). To maintain seed quality, we will continue to validate and strengthen QDPM systems. Raising

awareness of the benefits associated with using quality seed through demonstrations, advertising, and the like among all stakeholders (traders, ware growers, policy makers) will continue to increase demand. To support the seed value chain, we will encourage establishing regional-level potato boards to provide market information for seed and ware potato growers, establish a seed repository system, and advocacy. Human capacity building and technical backstopping in science, seed regulation, seed production systems, farmers agronomic skills, and others are **key** for a sustainable success of the intervention

**Scaling out interventions**

Through our past and current projects, CIP has laid the groundwork to support the production and distribution of quality seed in Ethiopia. SO 3 will scale activities in SNNPR and Tigray and expand to Amhara and Oromia. Key to our success is our lasting partnerships with public and private sectors in Ethiopia. As noted above, our key partners include regional ARIs who are largely responsible for early-generation seed production and high-level technical backstopping of specialized private multipliers; the Bureau of Agriculture and NGOs who are largely responsible for capacity building, extension, and seed dissemination; seed producer cooperatives and farmer groups for decentralized seed multiplication; and institutes such as the IFDC and CIAT-Soils to support programs to improve production. Increasing private sector investment further in seed production is paramount to our exit strategy.

**Business-Enabling Environment: Strengths and weaknesses of the potato sector in Ethiopia**

Business-Enabling Environment: Strengths and Weaknesses of the Potato Sector in Ethiopia	
<i>Strengths</i>	<ol style="list-style-type: none"> <li>1. Increased availability of quality seed is a priority in national Growth and Transformation Plan</li> <li>2. Dense national network of microcredit and saving institutions</li> <li>3. Government organizations, ARIs and NGOs active in seed production and distribution</li> <li>4. Decentralized, commercially oriented farmer seed producer groups operational</li> <li>5. QDPM concept recognized in revised Seed Proclamation</li> </ol>
<i>Weaknesses</i>	<ol style="list-style-type: none"> <li>1. Distribution of seeds of unknown health status</li> <li>2. Few commercial, large-scale seed enterprises</li> <li>3. Private sector investment hampered by government over-regulation</li> <li>4. Farmers lack access to price information</li> </ol>

Outputs	Outcomes				Impact
	Next Users	Next Users	End Users	End Users	Impact
<b>Suitable for early generation RMTs are developed for public and private sector seed growers</b>	Triple capacity for minituber production of existing public and private seed multipliers in RMTs produce minitubers	Improved profitability of seed multiplication triggers private sector investment in seed production improved at suitable seed production sites	Availability of early generation quality seed tripled for further decentralized multiplication		
<b>Evidence-based seed quality control and disease-monitoring schemes and policies</b>	NARS and regulatory agencies have the capacity for diagnostics and control of seed-borne diseases, and establish regular disease control schemes for multiplication of early generation seed	NARS and regulatory agencies have the capacity to monitor tuber-borne pest and pathogens and develop plans to significantly reduce disease spread through seed trade	More and affordable seed made available with guaranteed quality		
<b>Interactive platforms of seed value chain actors jointly produce national plan</b>	Improved communication and trust among value chain actors and with a client orientation	Provision of credit and other complementary inputs to overcome constraints to adoption of improved seed production methods		Enhanced availability of potato for consumption	Higher farm incomes
<b>Directory of seed demand, supply, and prices using ICT</b>	Functioning market for quality seed of all categories with transparent information and reduced transaction costs	Public and private potential stakeholders invest more in potato seed business based on reliable information			Improved food security
<b>Evidence-based advocacy to address policy constraints to improved seed production and use</b>	More favorable operating environment for seed enterprises	Increased market size for quality seed and enhanced profitability of seed production and distribution enterprises			
<b>Capacity development for business and technical management by decentralized seed multipliers and small seed producers cooperatives and empowerment of women in business</b>	Decentralized entrepreneurial seed producer seed cooperatives established	Effective links between decentralized seed producer cooperatives to producers of early generation seed and other input and output markets are established	Farmers are able to make appropriate decisions to replace seed in a timely manner	More profitable potato cropping with higher prices for market-preferred cultivars	

Outputs	Outcomes				Impact
	Next Users	Next Users	End Users	End Users	Impact
<b>Locally adapted protocols for seed quality control</b>	Adoption of QDPM quality standards with identified seed cooperatives guarantees quality seed production and seed traceability	Seed cooperatives and extensionists are using low-cost, easy-to-use disease diagnostic tools	Ware potato farmers have access to quality seed and are able to trace it back to the producer		
<b>Improved seed storage methods</b>	Establishment of appropriate seed storage capacity (DLS, ambient cold storage, etc.) with seed producers cooperatives	Increased capacity of decentralized seed producer cooperatives on postharvest seed handling and storage			
<b>Technological options and decision-making tool for stewardship of quality seed by farmers with different resource endowments</b>	Farmers and field multipliers become more efficient through more timely multiplication and optimal management	Farmer support and extension organizations providing appropriate advice about seed use and replacement	Farmers are able to make appropriate decisions to replace seed in a timely manner	More profitable potato cropping with higher prices for market-preferred cultivars	
<b>Awareness creation through demonstration plots of improved seed quality with preferred and new robust varieties</b>	More demand for quality seed of preferred and new varieties from ware producers		More rapid adoption of new varieties with market-favored characteristics and improved resistance and agronomic traits	Higher yield potential of potato varieties	
<b>Information from end users about improved and market-preferred varieties used to plan seed production cycles by enterprises efficiently</b>	Improved and preferred new varieties included in production cycles of seed enterprises		Improved access to market-demanded, disease-resistant varieties		
<b>Technological options and decision-making tools to improve farmers' agronomic practices</b>	Farmers and extensionists are using calibrated user-friendly decision support tools for improved disease management by smallholders	Improve understanding of farmers' decisions and preferences to design sustainable farming systems and improve technology uptake	Farmers are able to make appropriate agronomic decisions		

**ANNEX 3.1:** Selected countries from SSA for implementing Strategic Objective 3

Country	Potato as a Priority Crop <sup>a</sup>	CIP's Experience <sup>a</sup>	Effective Partners <sup>a</sup>	Institutional Context <sup>a</sup>	Potato Area (ha x 1,000) <sup>b</sup>	Potato Farmers (x 1,000) <sup>b</sup>	Potential Adopters (%) <sup>c</sup>	Potential No. of Beneficiaries (x 1,000) <sup>d</sup>
Burundi	2	2	3	3	15	110	30	33
Cameroon	2	2	2	3	60	240	20	50
DRC	2	1	2	2	30	150	20	30
Ethiopia	4	4	4	4	164	1,000	40	400
Kenya	4	5	4	4	152	800	60	480
Madagascar	2	1	2	2	45	160	25	40
Malawi	3	4	4	3	60	300	40	120
Mozambique	3	4	3	3	18	50	40	20
Nigeria	2	2	2	2	260	600	25	150
Rwanda	5	4	4	4	150	1,000	60	600
Tanzania	3	4	3	3	170	330	20	70
Uganda	3	4	3	3	102	480	30	144
<b>Total</b>					<b>13,21</b>	<b>5,644</b>		<b>2,146</b>

<sup>a</sup> 1–5 (poor–excellent)

<sup>b</sup> Based on information from surveys conducted by CIP (baseline and end line studies from the Willingness to Pay, 3G, and CFC projects) and country profiles.

<sup>c</sup> Adoption is considered successful if farmers buy quality seed at least once every five seasons and if they use at least one of the technologies to maintain the quality of their own seed and produce quality ware potatoes (positive/negative selection; small seed-plot technique; ICM to produce quality potatoes and manage key pests and diseases; improved storage).

<sup>d</sup> Potato farmers X potential no. of potato adopters/100.

# SO 4 Accelerating the Discovery of Game-changing Solutions for Enhancing Food Security

## 1. Summary

In this SO, we envisage building on the foundation of knowledge already generated by CIP as well as recent evolving discoveries in genetics, molecular biology, genomics, bioinformatics, nanotechnology, plant-pathogen interactions, disease control, developmental biology, and cellular biology to facilitate multidisciplinary approaches to achieve five game-changing solutions. Two of them represent potentially massive productivity gains through the use of the most elite germplasm and the introduction of multiple genes: (1) a potato with durable resistance to diseases and (2) a sweetpotato with pest resistances. The next three game-changing solutions are (3) expanding the cultivation of potato toward warmer and drier land, (4) next generation of pathogen diagnostics, and (5) new true potato seed technology. These efforts build on “discovery” research that aims at reaching a proof-of-concept (PoC) stage in these game-changing solutions after which new SOs will be developed. Collectively, such solutions will position CIP with new flagship products well into the next decade. SO 4 will play a role in prospecting new discoveries in science to add new game-changing solutions to the list if supported by sufficient scientific evidence.

## 2. Strategic Objective

By 2018, the PoC for breakthrough products will be established at the experimental level for at least one game-changing solution (e.g., disease-free potato). By 2023, at least one intermediate product will be tested at the farmer level to demonstrate its potential for quantum leaps in potato or sweetpotato productivity, nutrition, agronomic practices, and the delivery of value-added traits.

## 3. Development Challenge

The world’s population is projected to reach 9.2 billion by 2050. Owing to increased population, increasing income levels, and accompanying dietary shifts, the FAO projects that it will be necessary to increase food production by 70%.<sup>1</sup> Intensifying climate change, emerging pests and diseases, and other unknowns from an increasingly dynamic planet will create myriad challenges in the coming decades. The precise impact of these challenges remains uncertain, so agility in discovering and delivering solutions is critical. As highlighted in a recent study, it is already clear that the genetic gain by conventional breeding approaches alone will not feed the world.<sup>2</sup> This SO focuses on products that will be needed to feed the planet by 2050 by overcoming major

<sup>1</sup> Alexandratos, N., and Bruinsma, J. 2012. World Agriculture towards 2030/2050: the 2012 Revision. ESA Working Paper N°. 12-03. Agricultural Development and Economics Division, FAO of the United Nations, Rome.

<sup>2</sup> Ray, D. K., Mueller, N. D., West, P. C., and Foley, J. A. 2013. Yield trends are insufficient to double global crop production by 2050. *PLOS ONE* 8: e66428.

productivity limitations, reducing product losses, and expanding the area under cultivation as recommended in the study. Displacement of area under cultivation by urbanization is also driving the need for crop varieties with broader adaptability to fit in different kinds of agriculture, including intensive, constrained-space agriculture, precision agriculture, peri-urban vegetable systems, vertical agriculture, and others.

Examples of challenges include increased crop vulnerability due to climate change; shifting location where crops are grown; improved nutritional quality; the need to use increasingly scarce inputs more efficiently (pest/diseases, water- and nutrient-use efficiency); and better, faster, more efficient delivery systems for genetic gains and adaptive traits. Some of these problems have been intractable. And, while others have conventional solutions, incremental stepwise progress is no longer sufficient. It is imperative that innovative, accelerated, and greater resource-efficient approaches are discovered for developing and delivering solutions to the bottlenecks in productivity and distribution of value-added elite varieties of potato and sweetpotato. Envisaged through a window of 5–40 years, the game-changing solutions that we describe undeniably represent not only high risk but high return on research as well.

#### 4. CIP's Targeted Response

CIP's unique combination of assets positions it to be the leader in providing solutions to challenges facing potato and sweetpotato production in developing countries. CIP's genebank houses the greatest genetic diversity in both the primary and secondary gene pool for potato and sweetpotato (see SO 6). This diversity is the underpinning for future genetic and potential crop management gains. Exploiting these assets through multidisciplinary teams highlights the expertise in CIP research programs for the development and delivery of crop gains through a global network of local, regional, national, and international partnerships. ARIs and the private sector are key partners to access the new knowledge and technologies needed to realize these game-changing solutions (see Section 10. Partnership Strategy). One example where the use of germplasm from the genebank will be key in this SO is in the development of the durable and extreme resistance to LB disease using resistance genes from several wild potato species, including *Solanum bulbocastanum*, *S. venturii*, and *S. paucissectum*. Another example is the New Potato Seed, where the uses of known self-compatible genes from wild species such as *S. chacoense* lead to inbred lines that promise to reap the benefits of hybrid seed technology.

Crop improvement remains the heart of CIP core competencies, but it needs a multidisciplinary approach to maximize its future impact. Unique breeding populations have been developed for both crops from diverse germplasm derived from existing varieties, landraces, and original genetic stocks that take advantage of contributions from wild species. Conventional breeding has solid bases at CIP; but, inherent to the genetic complexity of our crops, progress is slow. Pre-breeding, capturing alleles, and QTL from wild populations is one approach that will help speed the pace of progress. Complementary to these efforts, genomics and biotechnologies have revolutionized agriculture. CIP is well placed to make use of these in crop improvement, in the field of pest surveillance and diagnostics, control of diseases, remote sensing, and soil microbiology. CIP can transfer genes without sexual recombination or edit genomes by site-specific mutagenesis, and use DNA markers to identify the rare but superior genotypes. CIP's modeling capability in relating phenotypic expression of QTL under different environmental conditions can generate new knowledge needed by biotechnologists and breeders to accelerate the process for generating expected solutions.

#### 5. Alignment

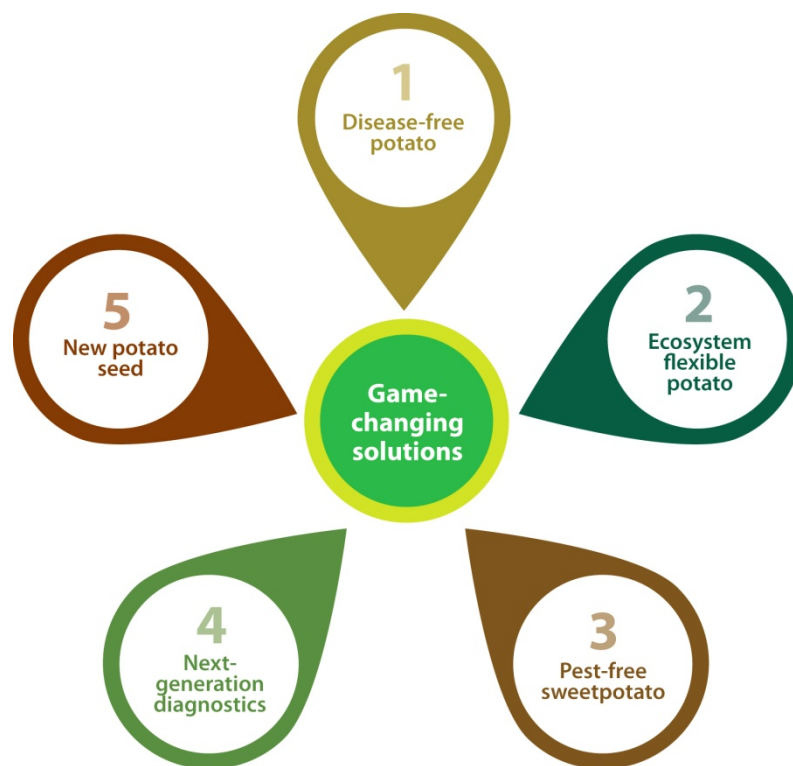
Unlike previous SOs operating mostly within a development framework where alignment to national, regional, and international priorities is fundamental, the game-changing solutions are almost by definition not specifically aligned with one particular framework. Most are solutions to global problems that can be delivered wherever potato and sweetpotato are grown (except

perhaps for the pest-free sweetpotato, which is aligned with the SSA regional priorities for sustainable production of sweetpotato). The target regions with major expected impact are SSA and Asia.

General areas of alignment include:

- The SDGs' objective on new technologies and futuristic solutions
- RTB Theme 2 (accelerating the development and selection of varieties with higher, more stable yield and added value) and Theme 3 (managing priority pests and diseases)
- CRPs: CCCAFS, Humidtropics, and Dryland Systems
- Biotechnology policy and biosafety frameworks in the African and Asian countries
- National, regional, and international phytosanitary and genetic resources frameworks for germplasm exchange.

## 6. Game-Changing Solutions



**Figure 1.** SO 4 flagship (at center) and linked products.

We define here game-changing solutions as research outputs responding to a major agricultural problem and delivered as a novel technology with great potential for significant impact on food security. Taken together, these game-changing solutions are the future flagship product for either the other SOs or new ones to come (Fig. 1). We envisage five game-changing solutions that rely on enabling technologies, knowledge, new policies, CIP capacities, and partner expertise. Many of the technologies used to develop the inventions and linked outputs are protected by IP rights. Hundreds of such technologies enter into play to develop these game-changing solutions. We access these proprietary technologies regularly for “research purposes only” because the outcome of the research is not a product ready for deployment. In all cases, we avoid accessing

proprietary technology that would impose restrictions that would transgress CGIAR's Intellectual Asset principles.

### 1. Disease-free Potato

This game-changing solution will be tailored to contain the most important disease resistances according to local context, needs, and regulatory environments (Table 1). Improvement of potatoes' LB resistance has long been one of the most important research areas at CIP because of the high potential impact that the resistant varieties can have. LB causes major damage in potato worldwide, with an estimated annual cost of €10 billion in developing countries.<sup>3</sup> Fungicide use to control LB is still the norm in potato production even with the most resistant cultivars. An LB-free potato is envisaged as the first game-changing solution and will result from combining technologies conferring durable resistance by multiple broad spectrum *R* genes from related *Solanum* species and/or RNAi-mediated engineered resistance. Research on pathology, disease modeling, and innovative crop management practice have long been essential parts of CIP's research portfolio, and disease-free potato builds on this body of knowledge. The LB-free potato will first be tested in Africa using also the advanced biotechnology facilities at Biosciences eastern and central Africa (BecA) and at the National Agricultural Research Organization (NARO) in Uganda. National programs increasingly request potato varieties with combined disease resistance. After LB, potato virus Y (PVY) and bacterial wilt (BW) will be considered as these are the next most important diseases of potato and a permanent threat to seed production. Building on previous work, the *Ryadg* gene-conferring resistance to all known PVY strains is being cloned from *Solanum andigena* and, once ready, will be transferred to the LB-resistant potato. Our research on BW resistance has identified sources with some tolerance; complete resistance has yet to be found. The global losses for potato due to BW are estimated around €730 million per year, and the disease is expanding to new areas.<sup>4</sup> Innovative research is needed to study the mechanisms of *Ralstonia solanacearum* pathogenicity and virulence, which will enable durable resistance to BW to be developed. Genomics using next-generation technologies is essential for such study resulting in generation of "big data," with high requirements for bioinformatics capacities and data analysis skills. These are the areas where the collaborative research with ARIs becomes essential to ensure access to the latest state-of-art technologies and facilities. Because most of these strategies are based on transgenic technologies, improving transformation of farmer-preferred varieties and developing biosafety and stewardship frameworks for these products are essential to success. Once the PoC is ready, the technology may enter in the product development phase and use delivery systems of SO 2 and SO 3.

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<sup>3</sup> Haverkort, A. J., Struik, P. C., Visser, R. G. F., and Jacobsen, E. 2009. Applied biotechnology to combat late blight in potato caused by *Phytophthora infestans*. Spec. Issue Bioexploit Exploit. Nat. Plant Divers. Pestic.-Free Prod. *Food* 52: 249–264.

<sup>4</sup> Elphinstone, J. G., Allen, C., Prior, P., and Hayward, A. C. (eds.). 2005. The current bacterial wilt situation: a global overview. *Bacterial wilt disease and the Ralstonia solanacearum species complex*. St. Paul, MN: APS Press, 9–28.

**Table 1.** Research outputs leading to disease-free potato

Disease-free Potato		
Extreme resistance to LB	Extreme resistance to virus	Resistance to BW
Transgenic or cisgenic events with <i>R</i> genes from <i>Solanum</i> spp.: <i>RB</i> or <i>Rpi-blb1</i> , <i>Rpi-blb2</i> , <i>Rpi-vnt1</i> , <i>Rpi-pcs</i>	LB-free events with <i>R</i> genes from <i>Solanum andigena</i> Ryadg (PVY resistance)	Transgenic events with PAMH gene
Stacked events with <i>R</i> genes and RNAi-mediated resistance	LB-free events with <i>R</i> genes from <i>Solanum</i> spp.: <i>Rladg</i> (PLRV resistance), <i>Rx</i> (PVX resistance)	Pathogenicity and virulence determinants of <i>R. solanacearum</i> characterized
<b>Pathogen modeling and monitoring tools developed</b>		
<b>High-quality phenotyping used</b>		
<b>Genomics tools to exploit genetic resources developed</b>		
<b>Improved potato transformation technologies developed</b>		
<b>Biosafety and stewardship plans developed and applied in regional context</b>		
<b>Socioeconomic and biophysical modeling for ex-ante impact assessment</b>		

## 2. Ecosystem-flexible potato

This game-changing solution will combine diverse traits that allow potato cultivation to be extended to the lowland tropics and temperate regions, an “old” potato-breeding objective (Table 2). These traits will build on previous successes of CIP’s lowland tropical potato program, adding on early bulking; capacity of tuberization under high night temperatures (above 24°C); tolerance to heat and drought; modulating the short-day dependence of tuberization; and resistance to LB, virus, and BW. In many regions where potato is already cultivated, expansion of the cultivated area is constrained by the temperature sensitivity of potato as well as the dependency of potato on short-day conditions. Several breakthroughs have been achieved that pave the way to develop this innovation. Complex gene networks are being discovered when potato plants respond to moderately elevated temperatures.<sup>5</sup> Tuberization signals and genes that can be manipulated to promote tuberization under higher temperatures and long-day conditions have been discovered.<sup>6</sup> Breakthroughs in rice give hope that deeper roots may result in triple yields during droughts.<sup>7</sup> In addition, genetic resources (including wild potatoes originating from the humid tropics) and new technologies such as genome sequencing will be used to identify genes conferring traits for tolerance/resistance to the challenges listed above and will be combined with novel crop management practices to maximize the yield potential. These will be used in conjunction with high-quality and high-throughput field phenotyping of cultivars to identify those that are productive in the lowland tropics. Ex-ante impact assessment using biophysical and socioeconomic modeling will help to guide future investment in scaling-up flagships and linked products similar to SO 2 and SO 3.

<sup>5</sup> Hancock, R. D., Morris, W. L., Ducreux, L. J., Morris, J. A., Usman, M., Verrall, S. R., and Taylor, M. A. 2013. Physiological, biochemical and molecular responses of the potato (*Solanum tuberosum* L.) plant to moderately elevated temperature. *Plant, cell & environment*. doi: 10.1111/pce.12168.

<sup>6</sup> Kloosterman, B., Abelenda, J. A., Gomez, M. D. M. C., Oortwijn, M., de Boer, J. M., Kowitwanich, K., and Bachem, C. W. 2013. Naturally occurring allele diversity allows potato cultivation in northern latitudes. *Nature* 495: 246–250.

<sup>7</sup> Uga, Yusaku, Kazuhiko Sugimoto, Satoshi Ogawa, Jagadish Rane, Manabu Ishitani, Naho Hara, Yuka Kitomi, et al. 2013. Control of root system architecture by DEEPER ROOTING 1 increases rice yield under drought conditions. *Nature genetics* doi:10.1038/ng. 2725.

**Table 2.** Research outputs leading to ecosystem-flexible potato

Ecosystem-Flexible Potato	
Day length independent tuberization	Drought and heat tolerant
Allelic variants of <i>StCDF1</i> gene documented	Gene networks to promote tuberization under higher temperatures characterized
Genome editing events of the short-day– dependent <i>StCDF1</i> gene to allow for tuberization in long days	Deeper rooting (gene)
<b>Innovative and high-quality phenotyping used</b>	
<b>Genomic tools to exploit genetic resources developed</b>	
<b>Stacking on disease-free potato by crossing/transformation technologies</b>	
<b>Biosafety and stewardship plans developed and applied in regional context</b>	
<b>Socioeconomic and biophysical modeling for ex-ante impact assessment</b>	

### 3. Pest-free sweetpotato

This game-changing solution (Table 3) will be developed in the context of local needs and regulatory requirements. Virus diseases and weevils are the major constraints to sweetpotato cultivation worldwide, resulting in estimated yield losses of 20–100%.<sup>8</sup> Two intermediate flagship products with extreme resistance to weevils and viruses will be produced through RNAi technology,<sup>9</sup> and will also include Cry protein-mediated resistance to weevil<sup>10</sup> and/or novel combinations of alleles of endogenous genes improving the efficiency of RNAi. Improving transformation technologies will be paramount to speeding up the PoC since it still takes a year to produce transgenic events from only a handful of varieties. As in the case of the disease-free potato, it will be essential to develop the frameworks for biosafety and stewardship. The advent of genomics tools offers new options for exploiting potential sources of resistance to viruses and weevils in cultivated germplasm as well as wild species. The pest-free sweetpotato will initially have a focus on Africa, where these problems are having the most severe impacts, in collaboration with ARIs and the private sector, but also with a prominent role for BecA and NARO-Uganda for product development and testing. This will ensure that local capacity is also developed with the issues of biosafety and stewardship. When successful, this technology will be appropriate to any other part of the world as they address global pests. Adaptation of the technology for different Asian countries at the CCCAP is envisioned as the next step. This will be part of an ex-ante impact assessment using modeling. Success of this invention, however, will depend not only on technical issues but also on policy environments (e.g., labeling or traceability requirements) of the target regions, and policy advocacy activities should be anticipated if policy problems are foreseen.

<sup>8</sup> Kiiza, B., Mwanga, R. O. M., Kitembo, L., Kreuze, J., Labarta, R., and Ghislain, M. 2009. Analysis of economic implications of biotech sweetpotato in the Great Lakes Region to control weevil and virus disease damage. Uganda Country Report.

<sup>9</sup> Kreuze, J. F., Klein, I. S., Untiveros Lázaro, M., Cuellar Chuquiuri, W. J., Lajo Morgan, G., Cipriani Mejía, P. G., Ghislain, M., and Valkonen, J. P. T. 2008. RNA silencing-mediated resistance to a crinivirus (Closteroviridae) in cultivated sweetpotato (*Ipomoea batatas* L.) and development of sweetpotato virus disease following co-infection with a potyvirus. *Mol Plant Pathol* 9: 589–598.

<sup>10</sup> Ekobu, M., Solera, M., Kyamanywa, S., Mwanga, R. O. M., Odongo, B., Ghislain, M., and Moar, W. J. 2010. Toxicity of Seven *Bacillus thuringiensis* Cry Proteins Against *Cylas puncticollis* and *Cylas brunneus* (Coleoptera: Brentidae) Using a Novel Artificial Diet. *Journal of Economic Entomology* 103: 1493–1502.

**Table 3.** Research outputs leading to pest-free sweetpotato

Pest-Free Sweetpotato	
Extreme weevil resistance	Extreme virus resistance
Transgenic events with Cry protein-mediated resistance	Transgenic events with RNAi mediated resistance
Explore dsRNA affecting weevil larvae and develop corresponding transgenic events	Explore and identify candidate genes for resistance to viruses using genomics tools
<b>Disease and insect modeling tools developed</b>	
<b>Genomic tools to exploit genetic resources developed</b>	
<b>Improving sweetpotato transformation technologies</b>	
<b>Biosafety and stewardship plans developed and applied in regional context</b>	
<b>Socioeconomic and biophysical modeling for ex-ante impact assessment</b>	

#### 4. Next-generation diagnostics

Degeneration due to viral infection is perhaps the biggest contributor to yield loss in clonally propagated crops across the globe. In addition to other pathogens, the international—and even sometimes national—distribution of germplasm is hampered by presence of viruses. Hence, the diagnosis and elimination of virus infections are the major bottleneck in rapid international distribution of vegetatively multiplied crops, including potato and sweetpotato, severely limiting impact from global conservation and breeding efforts. On the other hand, diseases such as BW and LB continue to inflict enormous losses and rapidly evade control by resistance or pesticides in potato. The ability to diagnose existing and novel pathogen genotypes with ability to overcome resistances is critical to understanding pathogen dynamics and designing adequate resistance strategies. Modern diagnostic techniques (Table 4) such as small RNA sequencing and assembly (SRSA) have enabled rapid and universal sequence-based identification of all viruses, including novel ones, in a single test. Applicable on in-vitro plants as well as on plants collected in fields, SRSA will be validated as a universal virus identification tool to reduce the time and cost for virus indexing by fivefold as compared to the current situation. In addition, single-tube micro-arrays for detection of all pathogens for potato and sweetpotato will be developed for use at national or regional distribution hubs. Such arrays can also be “formatted” to identify critical genotypes and used for pathogen monitoring and mapping. We will also develop LAMP (loop mediated isothermal amplification) assays for the relevant viruses, which will be combined into microfluidics-based multiplex assays for rapid, cheap, and highly sensitive field-level diagnostics. Smart-phone applications will be developed for diagnostic support and enabled to read results from microfluidics LAMP and tube-arrays. Linked to a central server mapping data on pathogen distribution, this tool will provide for rapid risk assessment and advice. Whereas collaboration with various ARIs is essential to develop the technology, the private sector is expected to play an important role in dissemination of these new diagnostics tools. Establishing sound PPPs will be critical to ensure further technology development and distribution to end-users.

**Table 4.** Research outputs leading to next-generation diagnostics

Next-Generation Diagnostics	
Knowledge	Prototypes
Global potato and sweetpotato crop viromes determined and disease relationships understood	Web-enabled central pathogen distribution and risk assessment database
Diagnostic field protocols developed for germplasm evaluation, testing in seed certification schemes, and pathogen surveillance	Microfluidic multiplex LAMP system for rapid, cheap, and highly sensitive field diagnostics Tube-arrays system for all viruses of potato and sweetpotato Smart-phone applications for diagnostic support, risk assessment, and reporting of LAMP and tube-array results
SRSA validated to replace biological indexing	New protocols and policies for institutional and international use

## 5. New potato seed

Potato cultivars are heterozygous and thus each true potato seed (TPS) obtained from sexual recombination will develop into a unique plant different from the parent cultivar. This represents a major biological bottleneck in production of agricultural applications that has, among other factors, limited the success of CIP's previous TPS programs. CIP has tremendous experience with traditional TPS breeding, production, and management. However, this flagship will concentrate on TPS production through novel approaches that include the production of inbred lines for the capture of heterosis through the production of hybrid TPS and the development of apomictic systems for TPS (Table 5), which will build on and further characterize in-depth naturally occurring 2n gamete production and haploid induction system in potato. The game-changing trait of this product resides in its phenomenal multiplication rate (1 to 7 for tuber seed vs. 1 to 1,000+ for botanical seeds), new trait combinations including heterosis, and the fact that it is a notably pro-poor technology.<sup>11</sup> One invention embraces hybrid technology that has proven extremely successful in grain crops. Diploid breeding to exploit hybrid technology relates to the production of inbred lines resulting from cycles of selfing and selection using diverse diploid potato landraces, self-compatibility systems such as the *Sli* gene from *Solanum chacoense*, and hybrids between wild species and *Phureja* clones. These inbred lines are crossed to produce hybrid TPS selected for heterosis and new combinations of traits. A first-stage PoC has been developed and a spin-off company of the Wageningen University, Solynta, is pioneering hybrid technology in potato.<sup>12</sup> Numerous challenges certainly exist: will such diploid hybrid potato yield as much as a tetraploid, and does it matter? Complementary to the hybrid TPS research will be research into the production of an apomictic system in potato as demonstrated in meiotic mutants of *Arabidopsis thaliana*.<sup>13</sup> For the production of this flagship, either elite tetraploid potato varieties would be mutagenized by non-GMO-regulated technologies or by the identification of natural apomictic systems in potato. As soon as some of these challenges are resolved, modeling will be used for ex-ante estimation of adoption and impact, which will guide further development steps as well as the desirable PPPs to ensure reaching all farmers.

<sup>11</sup> Almekinders, C. J. M., Chujoy, E., and Thiele, G. 2009. The use of true potato seed as pro-poor technology: the efforts of an international agricultural research institute to innovating potato production. *Potato Research* 52(4): 275–293.

<sup>12</sup> Lindhout, P., Meijer, D., Schotte, Th., Hutten, R. C. B., Visser, R. G. F., and van Eck, H. J. 2011. Towards F1 hybrid seed potato breeding. *Potato Research* 54: 301–312.

<sup>13</sup> Marimuthu, M. P. A., Jolivet, S., Ravi, M., Pereira, L., Davda, J. N., Cromer, L., Wang, L., Nogué, F., Chan, S. W. L., Siddiqi, Imr., and Mercier, R. 2011. Synthetic clonal reproduction through seeds. *Science* 331: 876.

**Table 5.** Research outputs leading to new potato seed

New Potato Seed	
Hybrid technology	Apomixis
Breeding scheme for diploid inbred line selection	Genome editing to mutagenize genes and alleles
Functional loci for reproductive and agronomic traits	Dihaploid inducer for genome elimination
Inbred lines developments from wide germplasm sources	Apomictic tetraploid variety
Evaluation of heterosis, trait combination such as <i>R</i> genes, and environmental stress tolerance genes	Identification of natural apomictic systems in potato
<b>Genomic tools to exploit genome sequences</b>	
<b>Accelerated diploid breeding across regions</b>	
<b>Seed modeling and ex-ante impact assessment</b>	

## 7. Impact Pathway

Product	Research Outcomes (Next Users)	Development Outcomes (End Users)	Contributing to RTB IDOs
Framework/methods for accelerating the discovery of solutions	Breeders and scientists from CGIAR, NARS, and ARIS use the breakthroughs to speed up the development and deployment of varieties with new traits and to better manage pests and diseases	NARS-released potato and sweetpotato varieties with game-changing traits reach farmers more rapidly and a larger pool of options is available to them for facing uncertain future conditions	Improved productivity in pro-poor RTB cropping systems  RTB cropping systems with reduced risk of disease and higher resilience to climate shocks
Game-changing breakthrough solutions to challenges (resistance to pest and diseases, tolerance to abiotic stresses, next-generation diagnostics, and new breeding and seed strategies)		Farmers have access to better varieties to solve recalcitrant problems, adopt these varieties and have higher, more stable yields, thus reducing vulnerability and risk	

## 8. Research Outcomes and Indicators

Research Outcomes	Indicators
<p><b>Disease-free potato:</b> Research scientists from CGIAR, NARS, and ARIs use new disease resistance genes with PoC to improve new potato varieties</p>	At least one peer-reviewed publication and one confined field trials demonstrating PoC for durable resistance to disease within 5 years
<p><b>Ecosystem-flexible potato:</b> Breeders and research scientists from CGIAR, NARS, and ARIs use new modified genes and germplasm with PoC to expand potato cultivation area in their region</p>	At least one peer-reviewed publication demonstrating PoC for tuberization under heat (>24°C) and/or breaking short-day dependency of Andigena varieties; and one field or laboratory trial demonstrating adaptation to warmer nights and higher latitudes in 5 years
<p><b>Pest-free sweetpotato:</b> Research scientists from CGIAR, NARS, and ARIs use new weevil and virus resistance genes with PoC to improve new sweetpotato varieties</p>	At least one peer-reviewed publication and one confined field trial demonstrating PoC for resistance to weevils and/or viruses within 5 years
<p><b>Next-generation diagnostics:</b> Breeders and genebank scientists from CGIAR, NARS, and ARIs use new prototypes with PoC to improve efficiency and speed of germplasm exchange and better monitor and predict risks of diseases</p>	At least two peer-reviewed publications, two prototype technologies, and one workshop to demonstrate PoC for rapid diagnostics within 5 years
<p><b>New potato seed:</b> Breeders and seed specialists from CGIAR, NARS, and ARIs use diploid inbred lines for testing suitable combination for desired purpose in their regions</p>	At least one peer-reviewed publication, and one field trial demonstrating PoC for inbred line development, heterosis, and/or apomixis and successful trait combination within the next 10 years

## 9. Gender Dimension

The ex-ante impact assessment of the game-changing solutions will include gender considerations. The traits targeted so far are main constraints for potato and sweetpotato production and as such gender-neutral. With sex disaggregated surveys, however, we may learn that men and women may prefer different traits and future research prioritization should take this into account. For the current traits in the pipeline, some clear benefits that benefit both men and women can be pointed out. With the disease-free potato we aim to reduce the exposure to chemicals of most susceptible members of the household. New potato seeds will provide accessibility to seed in remote areas; reduced workload of women tasked to keep, transport, and plant potato seeds; job creation for specialized women farmers; and higher income for female-headed households. Through the pest-free sweetpotato, we anticipate more healthy food available for households and increased use of OFSP varieties.

## 10. Partnership Strategy

Game-changing solutions are critically dependent on establishing sound partnerships with both ARIs and next-users. In many instances, partners listed in Table 6 have developed technology for other crops, and CIP will engage them through this SO to apply the innovations to potatoes and sweetpotatoes. ARIs have competitive advantages in technology discovery and development as

well as intellectual assets that CIP can access on the basis of global access to the resource-poor in developing countries. Next-users need to be engaged as early as justified in the process—from technology discovery to development—in order to tailor it to the proper physical and social environment where such innovation could eventually take place. Together with partners, we anticipate developing and strengthening our capacity to carry out some of the research at CIP-HQ, CIP-BecA, and the CCCAP.

Advanced research facilities and human resources will be located in China over a period of years. The CCCAP will become a center of excellence for CIP’s upstream research, leading to the discovery and delivery of game-changing solutions. This will be “blue-sky” R&D, with an emphasis on research not yet available in China—biotechnology such as genomic-assisted breeding, crop modeling, pathogen-chips diagnostics, phenomics—and other technologies like satellite imaging.

**Multistakeholder partnerships between NARIs, ARIs, and private sector: Bringing LAMP to a field-useable format:** LAMP technology is promising as a sensitive and cheap diagnostic tool appropriate for field use due to its high sensitivity and isothermal reaction. However, to bring LAMP to a viable field diagnostic tool to support research and phytosanitation, a range of issues need to be tackled: robust assay design, simple sample extraction methods, running the reaction (using sodium acetate heat packs), interpreting the results, reducing cost, and supplying the final product. To address these challenges we are collaborating with the Food and Agricultural Research Agency (FERA, UK) to develop custom LAMP assays for major sweetpotato viruses as well as simplified field extraction protocols. CIP has contributed by providing sequence data of sweetpotato viruses from the African continent through surveys in collaboration with various NARIs (e.g., Mikocheni Agricultural Research Institute, Tanzania) and next-generation sequencing in collaboration with Boyce Thomson Institute (US). The same samples are used for validating the assays in collaboration with NARIs in Africa. To bring down costs and simplify the handling procedure, we will be partnering with scientists at the University of Wisconsin who have developed a new microfluidic device (QuickChip: highly portable, plugs into a smartphone, and designed to be operable in resource-limited environments with minimal training), which reduce reagent volume and allow easy multiplexing of different assays.

Whereas solutions have and are being developed for each individual step that should enable an appropriate and easy-to-use field diagnostic tests, they still need to be compiled into a suitable “kit.” They would now require a dedicated product development and validation effort, taking into account sensitivity/specificity/cost and ease of use. For such a kit to become widely and sustainably usable, both hardware and consumables need to be easily and cheaply available in African countries, which is currently a major bottleneck for use of molecular biology techniques on the African continent. To achieve this we will approach Optigene (a private company producing and marketing LAMP reagents and equipment worldwide), negotiating availability at appropriate prices for African countries in exchange for permission to commercialize components developed by FERA/CIP, and perhaps collaboration in validation of equipment and tests in the field.

### **Unique advantages of the CCCAP for SO 4**

Human resources in biotechnology have significantly increased the number of PhD scientists thanks to attractive government incentive programs. These are pioneering the emergence of the next generation of Chinese scientists who do not necessarily need to go abroad to obtain competitive degrees and cutting-edge knowledge.

Tremendous operational capacity in universities and institutes exists that goes well beyond the reach of international agricultural research centers. This is coupled with a biochemistry and biotechnology industry locally producing the bulk of reagents, chemicals, products, and disposable items required on an ongoing basis for such research.

A network of geneticists and breeders who have collaborated with CIP scientists ensures a strong interest and willingness to collaborate in making incremental progress in the science of our two main crops.

### **Planned CCCAP contributions to SO4**

Structural, functional genomics and gene discovery in potato can accelerate the discovery of genes/alleles of interest to breeding. New R-genes to combat LB and virus diseases will help the development of varieties with extreme and durable resistance to diseases.

High-throughput phenotyping for relevant priority traits in potato, heat and drought tolerance, and root development can be semi-automated and scaled-up to improve the power of genome-wide association studies. These are needed to develop more environmentally friendly potato varieties.

Sweetpotato sequencing efforts face technical challenges posed by its hexaploid and highly heterozygous nature. The CCCAP could pioneer the development of solutions for genome sequencing of heterozygous polyploidy crops.

Biotechnology associated with novel methods of genetic modification could be used for PoC for gene function, and development of potato varieties, including novel properties from the inclusion of mutations or positive alleles by non-GM-regulated technologies.

Basic and applied research for TPS production (apomictic and/or hybrid potato seeds) that would revolutionize the logistics associated with seed production, transport, and planting.

Finally, to the extent biotechnology (e.g., GMO techniques) will be used for these game-changing solutions, a concerted government policy advocacy program, in loose coalition or partnership with other interested organizations throughout the region but especially in China, will be necessary.

**Table 6.** Selected current partners and their roles

Partners	Current Role	Expected Future Role
<b>ARIs:</b> Sainsbury Lab (UK), James Hutton Institute (UK), Wageningen University and Research Center (NL), INRA Versailles (FR), SLU (SW), IRD (FR), Ghent University (BE), Cornell University (US), Michigan State University (US), Donald Danforth Plant Science Center (US), Vulciani Centre (IL), Beijing Genomics Institute, UC Davis, Food and Environment Research Agency (UK), Boyce Thomson Institute (US)	Isolation and exchange of R genes for LB and PVY resistance <i>Phytophthora infestans</i> population studies in SSA	<b>Disease-free potato:</b> improvement of durability of LB and virus resistance through biotechnology or gene technology; improvement of durability of LB resistance through pathogen monitoring
	Genotype by sequencing, genomic selection	<b>Ecosystem-flexible potato:</b> resistance to BW disease through programmed hypersensitive reaction
	RNAi for weevil resistance	<b>Pest-free sweetpotato:</b> biotechnology and biosafety capacity, risk assessment, RNAi testing
	Sequencing and virome assembly and development of LAMP and tube-arrays	<b>Next-generation diagnostics:</b> prototype development, development custom assays
	Potato genomics resources	<b>New potato seeds:</b> development of apomictic variety
<b>Private Sector:</b> Solynta (NL), Venganza (US), Optigene (future: UK)	Development of inbred line strategy	<b>New potato seeds:</b> development of inbred lines
	Advanced technology providers	<b>Disease-free potato and pest-protected sweetpotato:</b> RNAi technology
	Diffusion of technologies	<b>Next-generation diagnostics:</b> diagnostic tools commercialization
<b>NARS:</b> Chinese universities, BGI genomic center (China), NARO (Uganda)	Collaborative research on LB resistance and sweetpotato resistance to pests and diseases	<b>Ecosystem-flexible potato:</b> development of technologies and testing of prototype products through the CCCAP
		<b>Disease-free potato and pest-protected sweetpotato:</b> confined field trials of GM events
		<b>Next-generation diagnostics:</b> epidemiology, sampling, needs assessment
<b>CGIAR partners:</b> Bioversity, CIAT, IITA, BecA-ILRI	Platform to use genomics tools, and transformation facilities	<b>Disease-free potato:</b> genetic transformation for LB and virus resistance
		<b>Pest-protected sweetpotato:</b> genetic transformation and efficacy testing for resistance against weevils and virus disease
		<b>Ecosystem-flexible potato:</b> BW resistance, methodologies for genomic tools for polyploids
		<b>Next-generation diagnostics:</b> epidemiology, development of methodologies



# SO 5

## Addressing the Food Security Challenge through Roots and Tubers: Transforming Vulnerability to Resilience

### 1. Summary

Food security is the most recent addition to CGIAR's new SLOs. As in the case of national governments such as the People's Republic of China, this has been largely precipitated by recent crises in food prices, which has underlined the reality of a crisis in global food security. Within the food security paradigm proposed by FAO, the dimension that has been least explored or operationalized is vulnerability. This is understood as change in food availability, food access, and food utilization brought about by socioeconomic or environmental stresses and shocks. This SO seeks to operationalize the dynamic concept of food vulnerability in the context of agricultural R&D. To operationalize the concept and develop a framework for food vulnerability analysis and the design of resilience interventions, this SO uses a process model known as the pro-poor R&D cycle (discussed in the Introduction to the SCP). This was developed by CIP about eight years ago to help move from a linear transfer model of agricultural technology development to an impact-oriented, feedback-sensitive model that contributes to a more focused, food security-sensitive research agenda. The SO analyzes food vulnerability and assesses and designs intervention research to reduce vulnerability through the five stages of the cycle that are also the linked products: targeting, characterization, needs and opportunity assessment, intervention research design, new approaches for going to scale, and novel approaches to impact assessment. The model also includes crosscutting products related to gender, partnerships, capacity development, and M&E and learning. SO 5 will focus interventions in the Andes and in Asia. However, in the midterm, and following advances in the PoC, these system-level approaches will be applied to the many vulnerable systems confronted by CIP's program in SSA.

### 2. Strategic Objective

By 2018, a set of systems- and social science-based frameworks, methods, and tools will have been developed and PoCs concluded for the analysis and mitigation of food vulnerability in stressed environments where roots and tuber crops (RTCs) are key system components. Food vulnerability is understood as change in food availability, food access, and food utilization brought about by socioeconomic or environmental stresses and shocks. Vulnerability introduces the notion of uncertainty into food security. This SO will seek to identify "hotspots" of food vulnerability in farming and food systems where RTCs are important, analyze sources of uncertainty, identify the current responses by agricultural populations, and design and implement interventions to reduce food vulnerability and strengthen the resilience of these systems.

### 3. Development Challenge

The four major development challenges that the newly reformed CGIAR aims to tackle as part of its SRF concern reducing rural poverty, improving food security, improving nutrition and health, and managing natural resources sustainably. Poverty reduction has been at the heart of CGIAR's mission since its founding, and sustainable natural resource management was added as a main pillar about 20 years ago. In the last 10 years, the role of agriculture in improving nutrition and health, especially of young children and fertile women, has also assumed greater priority. However, the explicit goal of improving food security has become included as a major challenge for CGIAR only recently.

This has also followed changing trends among national governments in prioritizing food security, and for the same reason: the increasing instability of food prices in world markets that is affecting countries' capacity to ensure adequate food supplies for their populations. China, which has introduced food security into its 12th five-year plan, may not reach that goal. CIP's collaborative program with the Chinese government, the CCCAP, is developing its strategy to support this national effort.

A widely accepted definition of food security<sup>1</sup> states, "When all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." The concept includes four dimensions:

- **Availability** of food at different scales, which CGIAR has been already addressing for many years through improvements in crop productivity.
- **Access** to food at different scales, which has also been indirectly addressed through attention to postharvest technologies and improvements in value chains and income.
- **Utilization** of food at different scales, involving the ability of HH or larger populations to select culturally appropriate food and to consume and physiologically absorb its nutrient content. With increasing attention to end-user preferences and the bioavailability of micronutrients, we are beginning to better address the issue of food utilization. But there remain many issues to be confronted, especially in relation to adding value to locally preferred varieties and using crop mixtures and food combinations to enhance bioavailability.
- **Stability/vulnerability** of food, which relates to the physical, environmental, economic, social, and health risks affecting the availability, access, and utilization of food over time.

This last aspect of food security is probably the least elaborated of the four dimensions in generalized use of the concept. Traditionally, it has been most closely associated with forecasting possible supply shocks, but vulnerability related to food access and utilization has been sidelined.<sup>2</sup> It is also the weakest area in CGIAR's treatment of the food security concept, although vulnerability has been studied in relation to poverty and as part of the sustainable livelihoods approach (SLA).<sup>3</sup>

Yet understanding the vulnerability of food availability, access, and utilization is crucial. A vulnerability focus is explicitly dynamic and forward-looking, recognizing the essentially uncertain condition of food security. It is not simply a snapshot of current food security outcomes; rather, it looks at their future incidence. Hence, it enables us to look at food insecurity *ex ante*, rather than examining it as an *ex-post* outcome.<sup>4</sup> The concept of resilience and how it can be strengthened in

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<sup>1</sup> First World Food Summit. 1996. [http://www.fao.org/wfs/index\\_en.htm](http://www.fao.org/wfs/index_en.htm)

<sup>2</sup> Løvendal, Christian Romer, Marco Knowles, and Naoko Horii. 2004. Understanding Vulnerability to Food Insecurity. Lessons from Vulnerable Livelihood Profiling. ESA Working Paper No. 04-18. Agricultural and Development Economics Division, FAO.

<sup>3</sup> For example, Adato, Michelle, Meinzen-Dick, and Ruth Suseela. 2003. Assessing the impact of agricultural research on poverty and livelihoods. *Quarterly Journal of International Agriculture* 42(2): 149–167.

<sup>4</sup> Scaramozzino, Pasquale, 2006. Measuring Vulnerability to Food Insecurity. ESA Working Paper No. 06-12, FAO, Rome. <http://www.fao.org/es/esa>

practical terms through enhancing the absorptive, adaptive, and transformative capacity the poor is key for reducing vulnerability.<sup>5</sup>

Operationalizing the reduction of food vulnerability is the major challenge of this SO that will ultimately contribute to improved food security. The approach taken is to use a process model known as the pro-poor R&D cycle to undertake meta-research on different phases of the R&D cycle with a food vulnerability lens. The model is impact oriented and feedback sensitive. The refinements and improved operationalization will contribute to a more focused, food security-sensitive research agenda in the other SOs. It also recognizes the need for flexibility to take projects to scale, measure their impacts, and use their lessons to adjust research activities and priorities. The model has five stages (targeting, characterization, needs and opportunity assessment, targeted research, going to scale, and impact assessment) organized in a continuous cycle with each step informing the development of the next. Further details of these five stages are provided below.

The challenge of food vulnerability looms particularly large in one type of agro-ecology widely distributed in Latin America, Africa, and Asia: tropical mountain agricultural systems often associated with ethnic minority populations and economic marginality, subject to difficult terrain, extreme weather events, highly dependent on RTCs, and in some cases with difficult access to markets.<sup>6</sup> These locations represent some of the most intense poverty hotspots on Earth, with high levels of malnutrition and debilitating levels of migration. There is an urgent need to better understand the dynamics of food vulnerability in such systems in order to strengthen food security. They will be one priority geographical focus of this SO.

But there are other environments that we will also examine with a food vulnerability lens. These include disaster-prone lowlands in South and Southeast Asia, often with a rich resource base but subject to flooding or cyclones or both. It also includes certain island populations in Southeast Asia, the Pacific, and the Caribbean, which also harness RTCs as part of coastal food security and livelihood strategies in coastal communities. These environments are often more highly dependent on RTCs, but also vulnerable to extreme climate and the future effects of climate change.

Overall, SO 5 seeks to better understand and overcome the vulnerability issues unique to each, and common across, diverse sweetpotato and potato agro-ecologies. And although the focus will be in Latin America and Asia, further intervention sites could be added in SSA in the midterm, following advances in the PoC of the approaches.

#### 4. CIP's Targeted Response

The Andes and FoodSTART sites in Asia are ideal learning spaces for generating lessons on food vulnerability and resilience. FoodSTART has elaborated a food security framework that gives prominent attention to vulnerability and the framework has guided application of the General Assessment Methodology (GAM) for characterizing the role of RTCs in food security in the Asia region (see Table 1 providing an abbreviated view of the framework<sup>7</sup>). It has also made major progress in translating research findings into usable products for large-scale development. In the Andes, CIP has a solid track record of both biophysical and social research in the region with a strong focus on systems. These include use of complex systems science in agricultural and natural resource contexts, climate-agriculture interactions, predictive modeling, participatory GIS, evaluation of biofortified crops and food-based solutions to nutrition, and in-situ conservation of

<sup>5</sup> Von Grebmer, K., Headey, D., Olofinbiyi, T., Wiesmann, D., Fritschel, Yin, S., and Yohannes, Y. (eds.). 2013. Global Hunger Index, the challenge of hunger: building resilience to achieve food and nutrition security. Welt Hunger Hilfe, International Food Policy Research Institute (IFPRI), Concern Worldwide, Bonn/Washington/Dublin.

<sup>6</sup> Jodha, N. S. 1997. Mountain Agriculture. In Messerli, B., and J. D. Ives, Mountains of the world: a global priority. Parthenon Publishing Group, UK.

<sup>7</sup> <http://asia.ifad.org/web/foodstart/resources/>

crop genetic resources. Most of these areas of research have involved interdisciplinary collaboration; many have included innovation in participatory methods. This intellectual capital also includes important contributions to innovation systems thinking, the development, maintenance, and monitoring of multi-actor networks and partnerships with diverse sectors (health, education, agriculture, private sector, value chain), and social learning through South–South knowledge sharing. This work has led to the generation of rich regional databases. Such intellectual capital constitutes the basis for understanding trends in the region and for sharing experiences with other regions.

To operationalize the food security framework, FoodSTART has adapted a process model (the pro-poor R&D cycle; see Fig. 1 in Introduction and accompanying text). CIP sought to move from the dominant, linear, science-driven paradigm, which generated research outputs and handed them over to partners, toward a more targeted and balanced, demand-and-supply-driven paradigm. This process model offers an excellent basis for addressing the new focus on food security and especially the dynamic aspects of vulnerability and resilience of food availability, access, and utilization. Through SO 5, CIP will use the intellectual capital described above to refine and strengthen use of the process model to operationalize the food security framework, with emphasis on understanding and addressing food vulnerability.

**Table 1.** RTC food security framework (abbreviated from FoodSTART brief, Concept and Methods Series N°. 1, 2013<sup>7</sup>)

		COMPONENTS	SOURCE OF VULNERABILITY
FOOD AVAILABILITY	Individual/intra-household	Assets—Human: knowledge, skills Assets—Financial Health and nutrition status	Future and unexpected changes in family circumstances (e.g., more children, aging, increased care-giving, illness, AIDS )
	Household farm	Assets—Land, water, soils, biodiversity Assets—Infrastructure, equipment, production inputs, productivity and farm production, and marketing choices	Climate variability, extreme weather events with natural resources degradation Pest and disease outbreaks Reduced access to finance
	Community/ focus site	Assets: Social and kinship networks, trust Level of surplus, RTC prices in local vs. other markets	Increased trading of RTC produce/ products to external markets, reducing local food use. Peace/order issues
	Province/state	Provincial policies (and implementation of national policies) for agri-food sector relevant to RTCs	Growth of non-food industries using RTCs as raw material (and policies to promote this); natural disasters
	Nation	National food balance. National food prices—food stocks, market speculation. Agro- and food sector policies, implications for RTC production/utilization	National market price fluctuations for RTCs and grains. Speculation Climate variability, extreme weather Policies on land allocation (staple biofuel)

		COMPONENTS	SOURCE OF VULNERABILITY
FOOD ACCESS	Individual/ intra- household	Remittance, off-farm employment Allocation of RTC and other foods among HH members Control of resources by gender, age, etc.	Future and unexpected changes in family circumstance (more children, aged, sickness), reducing income and increasing food/nutritional needs
	Household farm	Quantity and seasonality of on-farm RTC and other crop production. Storage and/or processing. Diversity on-farm	Reduced crop diversity and increased dependence on one/few crops or products for income (risk of market price declines)
	Community/ focus site	Local food prices. Purchasing capacity of non-farm households. Market/market information access	Lack of links of urban HH with rural producers Growing costs of rural-urban transport
	Province/ state	Food prices, quality standards Purchasing power of urban population Market access—road and transport Communications infrastructure	General economic climate and shocks – income vs. food prices
	Nation	Food prices, quality standards Purchasing power of urban population Food market chain integration	General economic climate and shocks – income vs. national/international food prices
FOOD UTILIZATION	Individual/ intra- household	Food consumption patterns of individuals Nutrient intake of HH members Nutritional status and deficits by gender	Nutritional deficiencies due to differential food allocation/consumption by gender, age, and literacy level
	Household farm	RTC and other food purchase, storage, handling, preparation, and consumption Nutritional knowledge education HH water and sanitation (hygiene)	Nutritional deficiencies due to shocks/future trends, poor nutritional knowledge/education Lack of water and sanitation, poor hygiene
	Province/ state	Investment in nutritional promotional/educational campaigns. Situation of agriculture-health linkages	
	Nation	Nutritional and health sector policies, nutrient supplementation, fortification of key foods, school feeding programs	

To operationalize the food security framework, FoodSTART has adapted a process model (the pro-poor R&D cycle; see Fig. 1 in Introduction and accompanying text). CIP sought to move from the dominant, linear, science-driven paradigm, which generated research outputs and handed them over to partners, toward a more targeted and balanced, demand-and-supply-driven paradigm. This process model offers an excellent basis for addressing the new focus on food security and especially the dynamic aspects of vulnerability and resilience of food availability, access, and utilization. Through SO 5, CIP will use the intellectual capital described above to refine and strengthen use of the process model to operationalize the food security framework, with emphasis on understanding and addressing food vulnerability.

## 5. Alignment

### 5.1 Global and regional frameworks

At the global level, SO 5 is in line with the new SDGs, particularly G5: ensure food security and good nutrition. It will also contribute to G1 on poverty eradication and G9 on managing natural resource assets sustainably. SO 5 will contribute to the development outcome targets of the R&D SOs, particularly SO 1 and SO 2, and pursue integration with systems CRP's (Humidtropics, CCAFS). At global and regional levels it is aligned with FAO's approach and framework for food security (including the four dimensions of availability, access, utilization, and stability/vulnerability). There also is a close correspondence with the Food Security Learning Framework<sup>8</sup> (FSLF) developed by FAO, the Bill and Melinda Gates Foundation, DFID, IFPRI, IFAD, OECD, USAID, UKAID, MCC, WFP, and the World Bank, as SO 5 will promote M&E harmonizing to make temporal and spatial comparisons of food security indicators feasible. This identifies eight development themes that contribute to the different dimensions of food security through different pathways. SO 5 has the chance to contribute to all eight:

- Improved livelihoods
- Increased resilience of vulnerable populations
- Improved research, innovation, and commercialization for agriculture and nutrition
- Expanded markets and value chains
- Improved policies and institutions for food security
- Enhanced nutrition and dietary quality
- Enhanced management of natural resources and adaptation to climate change
- Improved gender equality and women's empowerment.

SO 5 is also aligned with the comprehensive Food Security and Vulnerability Analysis<sup>9</sup> of the WFP. We will benefit from its baseline survey results that provide an in-depth picture of the food security situation and the vulnerability of households in different locations. At the regional level, this SO is aligned with the Inter-American Institute for Cooperation in Agriculture and its Strategy for Technical Cooperation in Food Security, with emphasis on family agriculture for increasing food availability and nutrition as well as policy dissemination.

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<sup>8</sup> FAO, B&MGF, DFID, IFPRI, IFAD, OECD, USAID, UKAID, MCC, WFP, and the World Bank. 2013. The Food Security Learning Framework. [http://www.ifad.org/hfs/tools/hfs/fs\\_frameworkpub/foodsecurity.pdf](http://www.ifad.org/hfs/tools/hfs/fs_frameworkpub/foodsecurity.pdf)

<sup>9</sup> United Nations World Food Programme (WFP). 2009. Comprehensive Food Security & Vulnerability Analysis (CFSVA) Guidelines. Rome, Italy. <http://www.wfp.org/content/comprehensive-food-security-and-vulnerability-analysis-cfsva-guidelines-first-edition>

## 5.2 National frameworks and country targeting

Although the focus of this SO is global, we will be grounding research in regional and national learning spaces, especially in selected countries of Asia and in the Andes. Therefore, regional and national food security policies are important, both as objects of characterization and needs assessment research, but also as elements of alignment in strategies for going to scale. Countries in the Andes, for example, have taken action in four main policy areas: (1) smallholder agriculture and rural development, (2) social protection and food, (3) nutritional health assistance, and (4) education and training in health and nutrition. Understanding the contribution of these policies to reducing vulnerability (characterization) and to identifying constraints to their implementation and opportunities for SO 5 to help overcome constraints through alignment (needs and opportunities assessment) will be an integral part of learning.

Because the Andes and Asia are the major learning spaces for this SO, country targeting in the two regions is both a subject of study (research in the targeting stage of the pro-poor R&D cycle; see section 6) and a pragmatic need. Country selection for practical research will be based on both salient issues in food security and especially vulnerability, but also pragmatic issues of research potential, on the basis that research sites do not always need to coincide with development need. It is essential that the logistics and context of research favor the production of results that can then be applied in high-priority locations. Thus in the Andes the following mix of pragmatic and food security-based criteria have been applied:

- Potato as a priority crop in national policies
- Importance of potato and sweetpotato biodiversity
- CIP's experience and presence
- Partnerships with public and private sectors and civil society
- Food security and malnutrition levels
- Potential impact
- Favorable institutional context to operate.

## 5.3 SRF, CRPs, and other SOs

As mentioned above in Section 3, SO 5 is primarily aimed at contributing to the food security SLO in the SRF.

This SO is also related to several CRPs. RTB is the most important, with the expectation that SO 5 will contribute to improved research capacity in targeting, assessment methodologies, partnership analysis, gender, and impact assessment. It will also provide inputs to Humidtropics, through work on systems thinking and its relationship to food security; to PIM, through methods for going to scale, especially related to value chains; to A4NH, through expected contributions to nutrition value chains and biofortification; and to CCAFS, through research on relationship between climate change scenarios and understanding of vulnerability. This SO links with SO 1 because of sweetpotato's potential to serve vulnerable farmers in marginal and disaster-prone environments, with SO 2 through its interest to contribute to improved potato production and use in constrained environments, and with SO 3 because of the importance of the concept of food and seed security.

## 6. Flagship and Linked Products

Framework for food vulnerability analysis and resilience interventions in RTB-significant farming and food systems (Fig. 1).



Figure 1. Framework for food vulnerability analysis and resilience intervention.

### 6.1 Linked products

The linked products elaborate methods, tools, and approaches for food vulnerability analysis and interventions leading to increased food resilience at different steps in the pro-poor R&D cycle. The following paragraphs describe these products, the state of the art, and critical gaps. Specific examples of the different products are then given in Boxes 1–4.

1. **Methods for targeting at multiple scales.** At the macro-scale, we will explore the use and limits of national data for a range of indicators contributing to a Food Security Index, with particular attention to indicators for food vulnerability. At subnational level we will adopt a dual approach, using existing data and country priorities for food vulnerability targeting and using a modeling approach for developing future scenarios under climate change. Within each of the target countries, a fine-grained subnational targeting will be conducted to identify target areas where a high incidence of food insecurity overlaps with RTC production and consumption and with social and economic marginality a further criteria. This approach has already been validated by CIP’s FoodSTART project. IssAndes has elaborated a mapping method to overlay poverty and malnutrition data with potato production at district level, incorporating other key variables such as access and distance to markets using infrastructure maps. As a result of subnational targeting, focus sites will be identified within each country. Targeting will also be refined through modeling of future

scenarios under climate change, which will generate predictions of the impact of trends and shocks on agro-ecosystems and food supply and on food systems and access. Intelligence provided by models will be downscaled and validated towards informing different kinds of communities—from decision makers to development agents.

#### *State of the art*

- Macro-level targeting using mostly national data sources for indicators as part of a food security and food vulnerability index.
- Multistage, multimethod food security targeting developed by CIP's FoodSTART and IssAndes projects, including geo-referenced information at subnational level, critical analysis of official national food security indicators, and taking advantage of secondary data available on food insecurity and vulnerability through specific programs (e.g., from WFP in the Andes).
- Down-scalable climate change and sweetpotato/potato growth models developed through CIP's participation in CCAFS.

#### *Critical gaps*

- How can targeting methodologies be refined to make them scalable and replicable in specific socio-geographical contexts beyond target sites? This might include adaptation of “vulnerability profiling,” which has been used in urban assessments<sup>10</sup> and also institutional targeting, identifying presence of potential partners such as IFAD investment projects or WFP activities that will contribute to going to scale.
- What are the system shifts that will occur as a consequence of climate change and how will RTC production systems look 30 years from now?

## **2. Tools for characterization of targeted farming and food systems and vulnerability trends.**

Characterization will be undertaken in targeted sites through adapting the GAM developed by FoodSTART into a tool that also characterizes vulnerability of food availability, access, and utilization over time, and across individual, HH, community, regional, and national levels. This framework characterizes the systems based on (1) production and livelihoods systems, including markets, (2) nutrition and health profiles, (3) food intake over time, and (4) knowledge actors/networks and policy and institutional landscapes. Scoping studies will be first conducted for a preliminary understanding of current food availability (production, seasonality), food access (incomes, markets, and value chains), food utilization (cuisine, processing), food vulnerability (stability, resilience), gender aspects, and safety networks, followed by more detailed characterization via surveys and FGDs.

#### *State of the art*

- GAM adapted for vulnerability characterization, validated, and shared for its application with partners in LAC and Asia.
- Data from production and nutrition baseline studies already available from IssAndes in the Andes will be used to develop and strengthen the GAM.

#### *Critical gaps*

- What kind of tools are needed to characterize the uncertainties of food security in a dynamic environmental and socioeconomic context (the vulnerability context)?
- What are the key indicators that define and characterize the agro-ecosystems and food systems?
- What is the key “minimum data set” for characterizing current food security and food vulnerability, along with sweetpotato's and potato's role and contribution? Can these be

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<sup>10</sup> For example, Parikh, J., Jindal, P., and Sandal, G. 2013. Climate Resilient Urban Development. Vulnerability profiles of 20 Indian Cities. COE-IRADe, 2013.

specified for types of agricultural systems in which the two crops are associated with, such as tropical mountain agro-ecosystems or disaster-prone lowlands?

- How do we understand the agri-food systems of marginal people in vulnerable environments in terms of diet, nutrition, and health? What are the parameters to understand the system?
3. **Needs and opportunity assessments (NOAs) for specific thematic areas of the vulnerability context.** GAM will identify key thematic areas where more detailed assessments are carried out into aspects of food vulnerability. The needs assessments will focus on the vulnerability dimension of food stability of agricultural systems and food supply, access through entitlements in the food system, and biophysical and cultural use and consumption. The opportunities assessment will also be guided by the different dimensions of food security and will examine value chain development, including attention to food quality and consumer preferences, nutrition improvement, and use of genetic and system diversity for enhanced environmental and economic sustainability. These will include the interaction between economic opportunities offered by new crop-related value chains and the effect this has on the resilience of cropping systems (increase or reduction of diversity, cultivation in less sustainable locations, etc.). Gender dimensions will be prioritized in the NOAs. As an outcome of the assessment phase the need for different research interventions will be identified.

#### *State of the art*

- On the basis of results of the GAM, NOAs identify pathways from food vulnerability to food resilience.
- On the basis of the GAM, opportunities are identified for support to national frameworks and policies that support food security.
- The NOAs will complement needs assessment studies already implemented in the Andes that will be shared with partners.
- Methodological framework and guidelines for thematic studies will be developed, as developed and piloted in FoodSTART.

#### *Critical gaps*

- Tools and methods for profiling food vulnerability over time in relation to different food security dimensions and at different scales.
- How can marginal peoples be truly empowered to take full advantage of opportunities to build greater food resilience?
- Participatory decision-support tools for stakeholders to prioritize needs and opportunities for more resilient agri-food systems.
- How can the food security learning framework be used to analyze RTC systems in terms of vulnerability and identify appropriate interventions to increased resilience?

4. **Participatory action research to reduce food vulnerability and build system resilience.** On the basis of the targeting, characterization, and NOAs, methods for participatory trialing of technologies and/or socio-ecological practices as well as the application of new knowledge will be undertaken. Specific interventions will depend on the outcomes of the assessments. But it is expected that they will be strongly focused on reducing food vulnerability arising through agro-ecological and/or food system stresses and shocks. Research agendas will be tailored and adaptive and based on bottom-up decision-making processes involving local stakeholders, especially marginalized groups. Likely research interventions directly into food systems may include training and empowerment of farmer business schools, also linked to new food processing opportunities (Box 1), the participatory evaluation of

nutritious varieties (Box 2), evaluation of nutrition education, and promotion approaches and improved storage options. Action research into agro-ecosystems may include agricultural modeling for alternative climate change scenarios and examining ways to strengthen agro-ecosystem services in general and enhance the contribution of biodiversity management to system resilience in particular.

#### **Potential state of the art interventions**

- Validation of the business school methodology for improving resilience in food access.
- Validation of introduction of biofortified crops into farming and food systems in the Andes and in Asia for more resilient food utilization.
- Identification of high-potential cropping systems for different climate change scenarios.
- Biodiversity management and other ecosystem services options to strengthen agro-ecosystem resilience.

#### **Critical gaps**

- Understanding tradeoffs between value chain development and the contribution of agriculture to ecosystem resilience.
- How can the more immediate needs from the local perspective be balanced and combined with long-term research processes towards sustainability and resilience building?

#### **Box 1. Farmer business schools in Asia: how new business opportunities enhance food access**

On the basis of FoodSTART's initial scoping study in 2010, the Philippines Cordillera highlands region has been targeted as among the project focus sites in promoting RTCs' contribution to food security and livelihood development. The initial challenge FoodSTART sought to address was to strengthen farmers' entrepreneurial capacity as they seek to participate in dynamic agricultural value chains in the Cordillera. Thus the idea of farmers business schools (FBS) was born. FBS is a participatory action learning approach supporting farmers' participation in agricultural value chains. Through the FBS, participating farmers (30 groups, 700 individuals) in the Cordillera are working to achieve three key outcomes: development of market-driven product innovations, establishing and expanding linkages with markets both locally and regionally, and generating new and additional profits through increased volume and sales of their products.

#### **Box 2. Participatory varietal selection in Latin America: how nutritious varieties transform indigenous highland communities**

In 2009 Anali Janampa, a young Quechua agronomy student from Lircay (Huancavelica, Peru) would never have anticipated that her leadership role as a young woman in decentralized participatory varietal selection (PVS) would lead to the formal release of the new potato variety *Kawsay* (meaning "life"). The locally selected new variety has a high iron content, thereby contributing to reducing stunting among children in Peru's indigenous highland communities. More than 350 women and men from Huancavelica's extreme poverty pockets were directly involved in the selection of the new variety from a total of 20 clones of CIP's B1C5 using the "Mother & Baby" trial design. Women participated in on-farm trials, taste tests, and urban consumer panels. Even before its formal release by Peru's national program (INIA), the variety is already grown and adopted by hundreds of smallholders (> 200 ha) who are making good profit selling the new variety. The favorable decision for variety release by INIA was achieved in four years (a process that frequently takes more than 10). Key factors for success included (1) youth and women engagement from the start, (2) rapid seed multiplication, (3)

involvement of multiple actors with complementary roles (including municipalities, NGOs, universities, development projects), and (4) the use of a semi-structured research design promoted by CIP. Four years after her initial involvement, Anali has become a woman leader in her region advocating food-based approaches to improved nutrition.

**Box 3.** FoodSTART in Asia: going to scale with RTCs interventions through the pro-poor R&D cycle

FoodSTART is a 4-year (2011–2015) research-for-development project within CIP’s new orientation towards the role of sweetpotato and potato in food security. FoodSTART promotes the enhanced contribution of RTCs for more diverse and sustainable agri-food systems in Asia-Pacific. FoodSTART has a regionwide scope with focus sites for action research in five countries: Bangladesh, China, India, Indonesia, and Philippines.

The FoodSTART project is financed through an IFAD grant. It is designed to pro-actively work with IFAD’s large-scale investment programs in Asia-Pacific, with the latter serving as intermediate user and partnership platform for up-scaling and institutionalization.<sup>11</sup> FoodSTART aims to (1) identify main geographic areas where RTCs are produced and consumed by the poor, (2) characterize existing systems for production and utilization of RTCs, (3) examine drivers of demand for RTCs in rural and urban markets, (4) assess value chains where small producers are linked to large-scale processing industries, and (5) explore RTCs of local importance besides potato and sweetpotato. The project uses the pro-poor R&D framework to structure and guide its R&D activities, which is an example of how SO 5 could move to implementation phase.

**Targeting for Impact.** During its pre-project phase, CIP and IFAD jointly undertook a *regional scoping exercise* to examine potential roles of RTCs in Asia-Pacific, and to identify preliminary geographic targets for FoodSTART. It involved consolidation and review of secondary information, key informant interviews, and stakeholder consultation meetings. As a result, seven subnational focus sites were prioritized: southwest China, eastern Indonesia, northern Philippines, north and eastern India, and southern Bangladesh. A key aspect of targeting was the review of in-country food security frameworks to better understand the indicators and resulting food security targets of national/subnational governments.

**Characterization.** Upon project start-up, FoodSTART conducted a *general assessment study* on RTCs for food security, at focus-site level. It sought to (1) characterize household and community food systems and role of RTCs; (2) assess food availability, access, and utilization, including gender dimensions; (3) identify vulnerability factors for RTCs-food systems—particularly climate change, and (4) map knowledge actors/ networks relevant to RTCs-food systems. The multimethod study consisted of community participatory rapid appraisals, household questionnaire interviews, and food intake assessments. These were supplemented by participatory GIS to map RTC production with poverty and malnutrition. Research findings helped characterize home-use and market-oriented RTC systems, the direct and indirect (i.e., via cash income) roles of RTCs in food security, and the specific RTCs’ focus per site.

**NOAs.** Having targeted and characterized the focus sites, the next step was to identify needs and opportunities in RTCs-for-food security R&D. On the basis of general assessment results, thematic studies were undertaken to further probe diversity and nutrition, value chain, and

<sup>11</sup> CIP Newsletter, December 2013: <http://cipotato.org/resources/publications/cip-newsletter/cip-newsletter-december-2013>

consumption and product quality. Thematic studies draw upon specialized methodologies from relevant scientific disciplines (e.g., genetic diversity mapping, market and economic analysis, and nutrition assessment of crops/cultivars). The combined results of general assessment and thematic studies served as basis for joint stakeholder prioritization of needs and opportunities, and for identification of proposed innovations. R&D interventions were consequently recommended for household nutrition improvement and value chain development.

**Participatory action research.** Since then, FoodSTART has engaged in collaborative research and development actions to address the key needs and opportunities in target focus sites. Pilot-scale, proof-of-concept research activities focused on potential innovations ranging from technological (e.g. crop production), institutional (e.g. micro-enterprise development), policy (e.g. standards for support service provision) and commercial (e.g. product promotion and market testing). Through all these FoodSTART has pro-actively facilitated uptake of research outputs.

**Going to scale.** A distinct feature of FoodSTART's R&D strategy is using large-scale development projects as partnership platforms for up-scaling and out-scaling of innovations. FoodSTART collaborates with nine IFAD investment projects that collectively represent agricultural development financing of over US \$500 million. FoodSTART's goal is to work with these projects to achieve their aims and objectives by mobilizing their financial and other resources towards increased RTC investment—in each focus site and on a wider scale. FoodSTART partnership with IFAD investment projects across sites and countries are currently at different stages of planning and implementation, based on progress in formulating shared R&D targets and priorities and in introducing operational mechanisms for field-level action.

**The Philippine case.** FoodSTART's R&D implementation, including partnership with IFAD investment projects, is most advanced in the Philippines. The key enabling factors include (1) a new national food security policy has officially declared sweetpotato, cassava, and bananas among the five official staple crops in the country; (2) RTCs are a primary priority NARS commodity; (3) RTCs are multipurpose crops in the Philippines (from staple to high-value cash crops); (4) FoodSTART forged partnership with a \$65 million IFAD investment project whose R&D agenda and targets closely match RTCs-for-food security; and (5) FoodSTART's core project team is based at the CIP Philippines office facilitating regular and intensive interaction.

**Box 4.** IssAndes in Ecuador: the case of Food Security through the Innovation for Food Security project in the Andes

Innovation for Food Security and Sovereignty in the los Andes (IssAndes) is a 42-month (2011–2014) research-for-development project that responds to the causes of malnutrition in the Andes. CIP, in collaboration with agriculture, nutrition, and health R&D partners, is promoting an innovative and concerted approach of food and nutrition security that looks at the food and agriculture linkages to nutrition. The potato crop is the backbone of the diet of the rural population in the high Andes. So the project focuses its efforts on the potato-based food systems of the region where poor and vulnerable smallholders predominate.

This project focuses on the innovation and integration of three principal areas that contribute to improving food and nutrition security: (1) food production systems, specifically the use of nutrient-rich potato varieties (with higher iron and zinc contents), including native potatoes, to enhance production and nutrition, but also including raising small animals and

horticulture production, depending on the local context in each of the countries; (2) income generation through increased production of market-attractive products (e.g., nutritive native potatoes are in demand for Peruvian gastronomy) to enable the purchase of nutrient-rich foods available in the market; and (3) enhancing nutrition education and behavior change communication programs for appropriate selection and use of foods within the family. This is done with the local production and health institutions and services, with strategies and messages designed according to the local nutritional needs, context, and opportunities, results of the formative research and baseline surveys in each focus site and country. These three components together lead to improved dietary diversity and nutrition, especially for the most vulnerable groups: infants and young children and women. Gender is addressed through all of the components. Influencing local, national, and regional policy is another critical component of the project.

An important aspect of the project is the regional focus. Owing to the many similarities in the food production systems and nutritional deficiencies across these high altitude populations of the Andes, the concepts, interventions, methodologies, and evaluations are coordinated and similar, with local adaptations as determined by the context. It is implemented in Bolivia, Ecuador, Peru.

**Targeting for Impact.** Target areas in Ecuador were selected using GIS tools to combine data of potato area, accessibility to markets, poverty and malnutrition. As a result, two composite indexes of poverty and potato production were identified. Each index was categorized into terciles (low, medium, high) and the combination of them resulted in nine possible outcomes (from low potato and low poverty, to high potato and high poverty). The resulting map was complemented with information about institutional presence of potential partners. Finally, expert opinion was used to select target areas that combined high potato production, high poverty and strong institutional presence. Nineteen parishes in 5 cantons located in the central highland provinces of Chimborazo, Cotopaxi and Tungurahua were targeted for intervention.

**Characterization and NoAs.** Nutrition, production, and socioeconomic baseline studies were implemented to characterize the focus sites. Characterization relied on profiles for nutrition and health, food systems and consumption, production systems, livelihood systems, knowledge and actor's networks, potato diversity, and nutritional characterization that were developed through the use of socioeconomic surveys; 24-hour recall survey; actor mapping; and morphological, nutritional, and molecular characterization. The baseline studies contributed to the detailed characterization of the cropping and food systems in the focus sites, taking into account specific gender-sensitive variables. A participatory prioritization of local needs in terms of food availability, access, utilization, and vulnerability was conducted with local stakeholders. The needs assessment involved data from national food security surveys that were discussed and analyzed in planning meeting to define matching opportunities. The opportunity assessment included value chain opportunities and analysis, nutrition and genetic diversity, consumer preferences, and product qualities.

**Research, policies and capacities.** As an outcome of the characterization and assessment phase, the need for different research outputs, policies, and capacity strengthening were identified. The research agenda was informed by both the short- and the longer-term needs and opportunities defined through characterization and assessment.

IssAndes has not yet reached the phase of going to scale, but critical M&E and learning with stakeholders at national and regional levels are continuously applied to ensure that scalable approaches and lessons can be systematized and shared in the Andean region and in a broader context. Examples from other CIP projects implemented in the Andes, such as Papa Andina, indicate that it is possible to generate outcomes and impacts by working with participatory innovation processes (see references in footnotes 12 and 18).

5. **Methods for going to scale through partnerships and dissemination platforms.** Although elaboration of appropriate partnerships will be a key contributor to increased food resilience at all stages of the R&D cycle (see section 7.2), it is particularly important for going to scale. This requires engagement with new types of development partners. The SO will systematize and refine models for these kinds of partnerships developed by FoodSTART in Asia and IssAndes in Latin America. It will also examine the experiences of partnerships within SPHI in SSA. Dissemination platforms have a long history of elaboration and innovation in Latin America through Papa Andina<sup>12</sup> and IssAndes.<sup>13</sup> These experiences will be tested in Asian locations. Policy analysis and dialogue will be crucial for going to scale, and we will build on experiences of different CIP programs in LAC, SSA, and in Asia (Papa Andina, SASHA, Urban Harvest, and FoodSTART).

#### *State of the art*

- Refinement and validation in new settings (other parts of Asia and LAC) of the development partnership model elaborated by FoodSTART.
- Refinement and validation in other locations of the dissemination platform approach pioneered by Papa Andina and IssAndes.

#### *Critical gaps*

- Aligning the interests of different stakeholders in agro-ecosystems and food systems (researchers, international development agencies, public and private sectors) to achieve partnerships for going to scale with food resilience interventions.
- How can actors working on food-based approaches to nutrition, health provision, and emergency relief streamline their agendas?

6. **Refined food security impact assessment tools.** Appropriate methods and metrics will be developed, tested, and adapted to measure the impact of selected interventions on food and nutrition security. This includes case-study research on the HH-level impact of selected policies. Approaches will recognize both direct impacts of interventions aimed at improving nutritional status of targeted populations (e.g., via promoting production and consumption of nutrient-dense varieties) as well as impacts on food security and health via indirect impact pathways (e.g., effects of increased incomes from sales of cash crops on dietary availability and quality). The impact analysis will follow a well defined seven-step process:

- Select interventions of interest from set of available cases.
- Identify impact pathways by which interventions intend to increase food security.
- Select appropriate food security indicators of interest for each intervention.
- Collect production and nutritional baselines at the HH level.
- Monitor evolution of key indicators during intervention timeline.
- Assess impacts of the end of the intervention, including intra-household allocation of food security outcomes.
- Analyze results and feedback to improve design of future interventions.

#### *State of the art*

- Methods to analyze production and food security data at HH level available.

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<sup>12</sup> Devaux, A., Horton, D., Velasco, C., Thiele, G., Lopez, G., Bernet, T., Reinoso, I., and Ordinola, M. 2009. Collective action for value chain innovation in the Andes. *Food Policy* 34: 31–38.

<sup>13</sup> IssAndes, Innovation for Food Security and Sovereignty in the Andes. Lima, Peru. <http://cipotato.org/resources/publications/brochure/issandes-brochure-english>

- Experimental designs of interventions to control for impacts of interest have been developed.
- Existing key partnerships with advanced research institutions and nutritional experts to ensure adequate assessment of impacts in food security.

**Critical gaps**

- What are the appropriate tools and methods for cost-effective impact assessment of food security interventions?
- What are the most robust food security indicators to measure changes from RTC systems vulnerability to resilience?
- How does foreseen impact differ from true impact post-intervention? What can we learn from different impact pathways to achieve food security?

## 7. Impact Pathway

Products	Research Outcomes (Next Users)	IDOs
Flagship: Framework for food vulnerability analysis and resilience interventions in RTB-significant farming and food systems	CIP and RTB integrate refined methods and tools of R&D cycle to address food security and vulnerability more effectively	Increased and stable access to food commodities by rural and urban poor (SLOs 2, 3)
Methods for targeting at multiple scales	Research managers across RTB, in NARIs, and among other partners use FS index as part of intervention design	Increased and more gender-equitable income for poor participants in RTB value chains (SLOs 1, 2)
	Modelers in RTB and other CRPs use vulnerability modeling techniques in relation to climate change	
	NARS planners revise subnational targeting procedures based on new targeting methods	Improved diet quality of nutritionally vulnerable populations, especially women and children (SLO 3)
Tools for characterization of targeted farming and food systems and vulnerability trends	RTB and NARI researchers use improved GAM and other tools for analysis of socio-ecological and institutional aspects of food vulnerability	
NOAs methodology for thematic areas of the vulnerability context	RTB, NARI, and other researchers adapt descriptive and modeling tools for NOAs to profile vulnerability over time and identify options for increased resilience	Improved ecosystem services for enhanced food system stability and sustaining novel genetic diversity for future use (SLOs 2, 4)
Participatory action research methods and tools to reduce food vulnerability and build system resilience	RTB, NARI, and other partners implement research actions to strengthen food system and agro-ecosystem resilience using validated methods and tools	
Methods for going to scale through partnerships and dissemination platforms	SO and RTB teams pilot new R&D partnership model and dissemination platforms in new locations	More effective policies supporting development and use of pro-poor and gender-inclusive RTB technologies developed and adopted by agricultural organizations, national governments, and international bodies (SLOs 1, 2)
Refined food security impact assessment tools	SO, RTB, and NARS social scientists apply cost-effective tools and methods to assess impact of food security interventions	
	CIP's IA team pioneer use of robust FS indicators to measure change from system vulnerability to resilience	

The products and research outcomes SO 5 will directly contribute to the delivery of development outcomes in other SOs, particularly SO 1 and SO 2, and also the development outcomes of partners (e.g., system-related CRPs such as Dryland Systems and Humidtropics) or large development interventions by institutions such as IFAD. First, development contributions will be made through the demand-driven and targeted incorporation of potato and sweetpotato as a critical systems component. Particularly where there is demonstrated potential for these crops to directly contribute to food availability by filling gaps in terms of seasonality or total production output, nutrition quality in terms of coverage of micronutrient intake, income generation through inclusive market chains that contribute to income generation, and/or reduced food system vulnerability through increased yield stability and system robustness. Second, SO 5 will contribute to the sustainable intensification of potato and sweetpotato systems through more adapted and climate smart management of farming systems through appropriated input use, nutrient cycling, cropping calendars, and rotation design. Third, the role and comparative advantages of potato—and particularly sweetpotato—as emergency crops will be strengthened through targeted responses to shock in partnerships with relief agent partners.

## 8. Research Outcomes

SO 5 Research Outcomes	Indicators (5 years)
CIP and RTB integrate improved methods and tools of R&D cycle to more effectively address food security and vulnerability	<ul style="list-style-type: none"> <li>• At least one high-profile publication on measuring and predicting food security and vulnerability</li> <li>• Number of uses of R&amp;D cycle model for project planning, assessment, and development of indicators</li> <li>• Number of SO and RTB flagships in which food vulnerability and food resilience are explicit parts of assessment and intervention</li> </ul>
Research managers across RTB, in NARIs, and among other partners use FSV index as part of intervention design	<ul style="list-style-type: none"> <li>• Publication on FSV index and indicators</li> <li>• Number of SO and RTB projects using FSV index for priority setting and targeting</li> <li>• Number of partner organizations using FSV index</li> </ul>
Modelers in RTB and other CRPs use vulnerability modeling techniques in relation to climate change	<ul style="list-style-type: none"> <li>• Calibrated models for testing vulnerability pathways in relation to RTB crop performance under different climate change scenarios</li> <li>• Number of journal publications on application of models</li> </ul>
NARS planners revise subnational targeting procedures based on new targeting methods	<ul style="list-style-type: none"> <li>• At least one publication on subnational targeting methodology</li> <li>• Numbers of changes in national data collection methods as a result of collaborative targeting efforts</li> </ul>
RTB and NARI researchers use improved GAM and other tools for analysis of socio-ecological and institutional aspects of food vulnerability	<ul style="list-style-type: none"> <li>• Numbers of SOs, RTB projects, and organizations using improved GAM</li> <li>• Number projects/organizations using novel tools to measure uncertainty of food availability, access, and utilization</li> <li>• Number of applications of GAM for profiling</li> <li>• Use of GAM to characterize policy and institutional aspects of food vulnerability</li> </ul>
RTB, NARI, and other researchers adapt descriptive and modeling tools for NOAs to profile vulnerability over time and identify options for increased resilience	<ul style="list-style-type: none"> <li>• At least two publications on descriptive and modeling tools for NOA</li> <li>• Number of gender-responsive NOAs undertaken in relation to different dimensions of food security</li> </ul>

SO 5 Research Outcomes	Indicators (5 years)
RTB, NARI, and other partners implement research actions to strengthen food systems and agro-ecosystem resilience using validated methods and tools	<ul style="list-style-type: none"> <li>Number of research activities undertaken by SOs, RTB, and/or other partners to measure change in level of food vulnerability through action research interventions</li> <li>Number of tradeoff studies carried out on positive and negative effects of value chain development on ecosystem resilience</li> </ul>
CIP SO and RTB teams pilot new R&D partnership model and dissemination platforms in new locations	<ul style="list-style-type: none"> <li>Number of new R&amp;D partnerships models introduced into SOs, RTB projects, and by partners, especially in LAC</li> <li>Number of new dissemination platforms established in Asia</li> </ul>
SO, RTB, and NARS social scientists apply cost-effective tools and methods to assess impact of food security interventions	<ul style="list-style-type: none"> <li>Number of ex-ante and ex-post impact assessments of food security interventions</li> <li>Number of applications of indicators measuring change of levels of vulnerability of RTC systems</li> </ul>

## 9. Gender Dimension

Constraints on women’s agency and access to resources have been shown to adversely affect attainment of development outcomes, including food security.<sup>14</sup> Nevertheless, despite this evidence, there are relatively few studies that focus on understanding how improved gender equality and women’s empowerment impact on food security. Focusing on potato- and sweetpotato-based food systems in LAC and Asia, gender research will be integrated into the different stages of the pro-poor R&D cycle. Macro-targeting will include a measure of gender inequality from UNDP,<sup>15</sup> and finer-grained targeting will also look for sex-disaggregated indicators of participation in production, markets, and the like. Under characterization staff involved in SO 5 will also participate in a large-scale, cross-CRP study of the relationship between gender norms and agency and agricultural innovation.<sup>16</sup> NOAs will also be gender responsive, and some kinds of targeted research interventions will seek transformative development outcomes.

### *State of the art*

- Tools for gender analysis (role, constraints, and opportunities) and to improve gender equality in value chain intervention tested in SSA and LAC in potato and sweetpotato food systems (OMCA methodologies), and lessons learned available.
- Qualitative methods for understanding the relationship between gender norms and agency and agricultural and natural resource management innovation.
- Studies and tools for field analysis of the correlation between gender and nutrition and gender and food developed in IssAndes project, complementing the production and nutrition baseline assessment of the project.
- Evaluation of value chain governance model and role of women in FBS and enterprise and their results in term of inclusiveness of value chain realized in LAC and in Asia.

<sup>14</sup> FAO. 2011. The State of Food and Agriculture 2010-2011. Women in Agriculture: Closing the gender gap for development. FAO, Rome.

<sup>15</sup> <http://hdrstats.undp.org/en/indicators/68606.html>

<sup>16</sup> More information can be found at <http://gender-ag-research-network.cgxchange.org/gender-norms-study-group>

### *Critical gaps*

- What are the most effective approaches and critical factors in agricultural and nutritional intervention that permit allow improved gender equality and women’s empowerment (decision making power, access and control over benefit, time use, agricultural productivity, leadership)?
- Are programs that emphasize gender empowerment more effective in reducing poverty and reaching food security? What are the causal relations and impact pathways that can be identified in specific case studies?

## 10. Partnerships Strategy

SO 5 will take advantage of existing CIP partners and networks in LAC and Asia and look to develop new ones for responding to the specific research needs of this SO (see section 9). Novel partnership strategies need to be developed with GO and international NGO (INGO) partnerships, especially with development partners for going to scale. INGOs are addressing food security issues at large scale with bottom-up approaches. They would be interested in coordinating and complementing their efforts with international research organizations, especially where there is targeting of food vulnerability, which as noted above, has so far achieved relatively limited traction. GOs now have access to more resources for R&D programs. Access to regional and global research networks would give an added value to their initiatives. Research will be conducted in collaboration/partnership with development partners (across NGO, public, and private sectors if possible). Such research could take advantage of their experience in vulnerability analysis and interventions, and collaborate with their field staff to develop and validate methods, so that the results of the SO are obtained, and methods/tools developed and validated, within the constraints and limitations of large-scale development efforts.

This program will require implementing partnerships at different scales and involve different partnership arrangements, depending on the type of linked products involved:

- **Partnerships with ARIs** will be important in strengthening targeting approaches, especially the development of a global FSV index and for modeling. We will also seek collaboration with ARIs around methods for probabilistic and predictive assessments of food vulnerability over time, as part of characterization. Within the research stage, we would seek collaboration on use of ecosystem services, especially biodiversity management, for strengthening ecosystem resilience and food supply. Potential partners are universities, specialized centers, at the international level, and in the region looking for South–South collaboration with organizations with unique research capacities in FSV and also in potato-based production and food systems.
- **Partnership with development organizations** (including GOs and NGOs with expertise in the areas of agriculture, credit, health, nutrition, and vulnerability analysis) will be developed. We will build on modes of working with these types of organizations for going to scale in Asia, LAC, and Africa. We also envisage opportunities in participatory evaluation of technologies, and in strengthening socio-ecological practices.
- **Policy advocacy partnership.** Many authors have argued for vulnerability-led approaches to adaptation so as to contextualize how climate change affects livelihoods, and to explain that successful adaptation depends upon not only exposure and sensitivity to climate change, but also adaptive capacity and an enabling institutional and policy environment. Thus local adaptive capacity requires higher level enabling support. Recent analysis by IFPRI and FAO are explicit in describing the necessary enabling conditions, such as access to markets for new crops and national policy that prioritizes food security and agricultural extension.

Partnerships with agricultural knowledge, information, and development public and private actors at national and regional levels should be developed. This effort would seek to link research, education, information and development, and enabling innovation. Facilitation of learning alliance with these actors should allow sharing experiences and developing messages and policies for decision makers and donors. A collaborative strategy with the private sector will be defined that will compare commercial arrangements with social marketing and corporate social responsibility approaches.

**Table 2.** Examples of selected partners and their roles

Partners	Current role	Expected future role
<b>ARIs:</b>		
<b>Wageningen University (NL)</b>	Innovation platforms (seed systems)	Institutional analysis, partnerships
<b>Institute of Development Studies Sussex University (UK)</b>	Resilience research	Food vulnerability, socio-ecological systems, methods and metrics to measure vulnerability
<b>World Food Programme (global)</b>	Vulnerability and malnutrition analysis	Shared approaches and actions, learning from relief
<b>McGill Institute for Global Food Security (CA)</b>	Nutrition	Bioavailability studies with Fe and Zn enriched potato varieties
<b>Private Sector:</b>		
<b>International Zinc Association</b>	Agronomic micronutrient fortification through fertilization in wheat and rice	Research on micronutrient fortification through fertilization in RTCs
<b>Chef associations and gastronomic schools (Andes)</b>	Promotion of RTC consumption	Promotion of RTC consumption and biodiverse value chains
<b>Processing firms (Andes, China, Indonesia, Philippines)</b>	Processing of chips, French fries and novelty food products	Promotion of biodiverse value chains
<b>Specialty shops and restaurants for RTCs (Indonesia, Philippines)</b>	Facilitating value chain development for health and wellness sector	Promotion of RTC consumption
<b>NARDS:</b>		
<b>Agricultural universities, National Agricultural Research Institutes (NARIs), RTC research centers—for example, INIAs in LAC; Indian Council of Agricultural Research (IN); Bangladesh Agricultural Research Institute; Provincial academies of agricultural science, (China); PhilRootcrops (PH); BALITSA (ID)</b>	Characterization, NOAs	Idem
<b>Specialized food security/nutrition research organizations (e.g., Instituto de Investigación Nutricional (PE); BRAC RED, Health Divisions (BD); Food and Nutrition Research Institute (PH); National Institute of Nutrition (IN)</b>	Food intake, consumption, nutrition studies, nutrition education	Consumption and nutrition patterns and habits,

Partners	Current role	Expected future role
<b>Public sector development projects and agencies (e.g., Depts. of Trade, Agriculture (PH); Ministry of Tribal Affairs (IN); MINAG (PE); MSP, EC, international development organizations and agencies working with national development programs)</b>	Lead agencies for investment projects in value chain development and poverty alleviation	Partners in going to scale
<b>Regional organizations/networks:</b>		
<b>Comunidad Andina de Naciones (CAN)</b>	Advocacy, social learning	Up- and out-scaling
<b>Inter-American Institute for Cooperation on Agriculture (IICA)</b>	Advocacy, social learning	Up and out-scaling
<b>SICTA Network</b>	Capacity building	Up and out-scaling
<b>NGO's:</b>		
<b>Acción Contra el Hambre (PE)</b>	Pilot testing of intervention portfolios	Idem, participatory research, up- and out-scaling
<b>BRAC (BA)</b>	Pilot testing of intervention portfolios	Idem, participatory research, up- and out-scaling
<b>Daarut Tauhid (ID)</b>	Pilot testing of intervention portfolios	Idem, participatory research, up- and out-scaling
<b>MSSRF (IN)</b>	Pilot testing of intervention portfolios	Idem, participatory research, up- and out-scaling
<b>World Vision (global)</b>	Pilot testing of intervention portfolios	Idem, participatory research, up- and out-scaling
<b>CARE (global)</b>	Pilot testing of intervention portfolios	Idem, participatory research, up- and out-scaling
<b>CRP &amp; CGIAR partners:</b>		
<b>CCAFS, PIM, AAS</b>	Collaboration on piloting	Application and going to scale of system approaches
<b>CIAT, Bioversity, IITA, World Fish, World Agroforestry Center</b>	Collaboration on piloting	Application and going to scale of system approaches

## 11. Capacity Development

As noted in the Introduction, in its new approach to capacity development, CIP will need to develop its own skills and ability to deal with diverse and changing capacity needs within the organization and among partner organizations. These capacities include:

- Systems thinking to accommodate impact pathways and relevant value chains.
- Change management skills to facilitate organizational and systemic learning towards managing for results (outcomes and impact).
- *Action learning* skills to align individual action to collective action at organization and system levels.

- *Partnership management* skills to enhance collective action between public and private sectors along respective value chains to achieve expected outcomes and impact.
- *Adult learning* skills to facilitate rural innovations for social change and development.

Many of these skills are closely linked to different linked products of SO 5. In relation to systems thinking, there is a need to socialize the process model that will guide the operationalization of this SO, namely the pro-poor R&D cycle. Whereas many scientists are familiar with particular stages of the cycle, it is vital that there is a general understanding of the whole project cycle. Systems thinking goes well beyond that of course, and will be especially important in understanding the way that stresses and shocks affecting the food and farming systems result in changes in food availability, access, and utilization (i.e., levels of vulnerability). Action learning skills, adult learning, and social learning are essential components of the kinds of research interventions that will be evaluated in SO 5 (illustrated above in Boxes 2 and 3). To strengthen our capacity to go to scale with innovations, we need new sets of partnership diagnosis and management skills.

## 12. Monitoring & Evaluation and Learning

The development and testing of a participatory, responsive M&E system will be an important part of the work of this SO and will be closely linked to social learning.

M&E will require metrics that allow us to track progress along the impact pathway. Indicators need to be sensitive to non-financial aspects of change and to be both inclusive and self-reflexive among partners involved in implementation. We will therefore draw on work undertaken by CIP programs in Latin America involving participatory impact pathway analysis<sup>17</sup> of technology innovation, including the use of Participatory Market Chain Analysis.<sup>18</sup> This work has already explored the development of indicators for both monitoring and evaluation. This will continue, especially the development of indicators of food vulnerability and resilience. The development of this M&E system will contribute to RTB, which is also in the process of developing a new outcome metrics as part of RBM.<sup>19</sup>

M&E in SO 5 will be about a new type of learning to achieve outcomes and impacts at scale. In the Introduction, we described the need for identifying different kinds of social spaces where opportunities exist to enable interventions to grow or where obstacles need to be removed. One of these spaces involves social learning, processing knowledge about what works and what does not work in scaling up. This learning covers several areas, such as change management, cross-sectoral collaboration, the socializing of individual action to collective purposes, and the use of adult learning skills to engage those who feel left behind in change processes. These M&E and learning processes will cut right across the pro-poor R&D cycle.

<sup>17</sup> Douthwaite, B., Alvarez, B. S., Cook, S., Davies, R., George, P., Howell, J., Mackay, R., and Rubiano, J. 2007. Participatory Impact Pathways Analysis: a practical application of program theory in research-for-development. *Canadian Journal of Program Evaluation* 22(2): 127–159.

<sup>18</sup> Douglas Horton, Emma Rotondo, Rodrigo Paz Ybarnegaray, Guy Hareau, Andre Devaux, and Graham Thiele. 2011. Lapses, infidelities, and creative adaptations: Lessons from evaluation of a participatory market development approach in the Andes. *Evaluation and Program Planning* 39: 28–41.

<sup>19</sup> Alvarez, Sophie, Bucheli, Brenda, Delgado, Raul, Maldonado, Luis, Paz, Rodrigo, Pozo, Antonio, Rotondo, Emma, and Thiele, Graham. 2008. Guía de Alcances e Impactos de as Metodologías participativas sobre la Innovación Rural. Cambio Andino/International Potato Center, Lima, Peru.

# SO 6 Conserving Diversity for the Future: the CIP Genebank

## 1. Summary of the Genebank

Genebanks are like an insurance policy for the future of agriculture: they conserve the diversity of plant species, offer resources for breeding crop varieties, provide food solutions in times of disaster, and safeguard food supplies for future generations.<sup>1</sup> Genebanks also conserve genetic adaptations proven useful in one species that may someday prove invaluable to others in dealing with future challenges such as climate change.

The genebank is central to the success of all other SOs. It supports and enables the expedient use of diverse genetic building blocks and associated information to ensure global productivity of healthy, abundant, and secure food. It facilitates the rapid, efficient, and impact-oriented release of strategically placed CIP innovations and products by the conservation and use of the rich global biodiversity of potato (*Solanum* section *Petota*) and sweetpotato (*Ipomoea* spp.). Our collection of Andean root and tuber crops (ARTCs) comprises oca (*Oxalis tuberosa*), ulluco (*Ullucus tuberosus*), mashua (*Tropaeolum tuberosum*), achira (*Cannus edulis*), yacon (*Smallanthus sonchifolius*), arracacha (*Arracacia xanthorrhiza*), ahipa (*Pachyrhizus ahipa*), maca (*Lepidium meyenii*), and mauka (*Mirabilis expansa*).

The CIP genebank holds a total of 21,038<sup>2</sup> accessions made up of 10,343 potato accessions (4,354 cultivated, 2,507 wild, and 3,482 breeding lines); 8,149 sweetpotato accessions (6,420 cultivated, 1,179 wild, and 550 breeding lines); and 2,546 ARTC accessions (2,019 cultivated, 497 wild, and 30 breeding lines). These collections serve as a model for global and national genebanks through innovative research, advanced public database designs, and interactive genomic use of the collections. Genomic fingerprinting allows scientists to identify the diversity of these accessions rapidly and conclusively. Similarly, complete characterization of every accession provides an assessment of diversity and use through genetic and phenotypic correlations.

The capture, generation, discovery, and compilation of trait-associated information will greatly aid in food security in a changing environment through disease and insect resistance as well as drought, cold, and heat tolerance. Use of next-generation sequencing (such as genotype-by-sequencing) will lay the ground work and baseline information needed to facilitate the identification of genes, QTLs, and the development of marker-aided selection options to better mine and use the diversity in the collections.

The genebank will enhance the conservation and availability of valuable diversity through further rationalizing of global national collections, facilitating the use of germplasm currently not under the International Treaty for Plant Genetic Resources for Food and Agriculture (PGRFA), strategic collecting to supplement the collection, and the building of on-farm conservation through partnerships with farmers for in-situ conservation. Through collaborations with technology

<sup>1</sup> Hawtin, G. C., and J. Chérfas. 2003. Plant genebanks: Food Security. *ActionBioScience*. [www.actionbioscience.org/biodiversity/hawtin\\_cherfas.html](http://www.actionbioscience.org/biodiversity/hawtin_cherfas.html)

<sup>2</sup> Data as of October 1, 2013. Collection numbers reported in the past have often been a subset of the collections consisting of accessions that were only PGRFA, only in vitro, or only available for distribution (identity verified and phytosanitary clean). The numbers reported in this plan represent the **total** active collections preserved by the CIP genebank regardless of the category or biological status.

developers, breeders, researchers, NARS, NGOs, farmers, and other users, CIP's genebank will maintain its world-class reputation for excellence, transparency, expertise, and germplasm to sustain global food productivity and security into the next century. Unique in-situ programs, such as Ruta Condor and Parque de la Papa, help reinforce the conservation of the diversity of these crops and crop wild relatives (CWR) while investing in the livelihoods of indigenous farmers.

## 2. Strategic Objective

The CIP genebank serves as a model for the innovative, research-driven development and delivery of plant genetic diversity and associated information and tools. We envisage a number of "smart" initiatives in the next five years that will shape the genebank's strategic direction and contribution to global researchers. DNA fingerprinting of the collections begins in 2014, and will serve as a quality check of the in-vitro collection by also genotyping the original material before it is phased out over the next five years. We will ensure that herbarium specimens are prepared to document this very important original material. By 2018 DNA fingerprints will be available to provide the tools needed to develop trait-by-genetic marker correlations in all accessions. Use of the collection (samples distributed) and associated information (visits to the genebank webpage) to secure food supply and availability will be doubled through a number of initiatives and discovery research efforts.

Second, the genebank will compile by 2018 in a publicly assessable database all known traits associated with accessions by working with partners who have generated these data but may not have the data in an accession-associated or public format. In keeping with the genebank's role as a vital research resource, CIP will develop progressive and interactive databases and catalogs to accelerate information exchange.

Third, efficiencies are needed to allow the evolution of databases, cryobanking methodologies, phytosanitary cleaning, microtuber development, genomics capacities, monitoring of in-situ sites, and other activities. Changes in strategic directions of collection management will be made. In five years we will reduce by 75% the number of field and greenhouse plants and tubers (retaining only samples of the core collections), which are very costly to maintain.

Import permit requirements, often excessive and unnecessary, can delay the shipment and use of valuable germplasm. Phytosanitary cleaning of plant material is necessary to meet these requirements, but current cleaning technologies greatly delay the release of germplasm by a year or more. Thus, a priority for the genebank by 2018 will be to shorten to six months or less the phytosanitary cleaning of routine cultures by streamlining the testing process, using other methodologies for cleaning and detection, and increasing the cleaning throughput.

## 3. Development Challenge

Unchecked population growth will continue to be the major challenge in the 21st century. Unsustainable growth is destroying both environmental habitats and plant diversity, essential to providing farmers with new varieties, at unpredicted rates<sup>3</sup> that far outstrip available conservation resources.<sup>4</sup> Even the release of new improved commercial varieties, which are adopted in large numbers by farmers due to indisputable benefits and whose development *depends* on plant diversity, *displaces* such diversity. Contributing factors also include political and social unrest, natural disasters, and climate change. These physical, measurable, yet often unpredictable influences in the loss of diversity make the need to double food production in the next 20 years

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<sup>3</sup> Li, D-Z., and Pritchard, H. 2009. The science and economics of *ex-situ* plant conservation. *Trends in Plant Science* 14(11): 614–621.

<sup>4</sup> Myers, N. et al. 2000. Biodiversity hotspots for conservation priorities. *Nature* 404: 853–858.

that much more difficult. And it has to be done on the same land area as is currently used for food production.

Obvious targets for breeders include the environmental threats of drought, heat, flood, and cold tolerance. Land traditionally used for potato cultivation is now unsuitable for that purpose due to insect and disease pressures from warming climates, forcing potato cultivation to move to elevations as much as 100 meters higher in the past few decades. This is especially devastating to smallholder potato farmers—the primary potato producers across the developing world. They rely on centuries-old varieties and farming practices and may be unable to move to higher elevations. Coupled with shifting climates, increasing population, and poor farming practices, land once productive is either being taken out of farming by human encroachment or languishing in productivity due to worsening soils. In the next 20 years we will need to supply not just food but *nutritious* food that can be grown and harvested in previously unsuitable environments. Gradual warming of the planet intensifies the immediate demand on plant breeders for sustaining and increasing food productivity.

Genebanks are also critical after disasters, whether natural or man-made. The national genebanks in Rwanda and Afghanistan were looted during wars, and no locally adapted seed (including potatoes and sweetpotatoes<sup>5</sup>) was left for farmers to start the rebuilding process. In both countries, other genebanks holding material from these countries repatriated accessions to start the rebuilding process.<sup>5</sup> In late 2004 a tsunami inundated rice-growing areas in Asia with saltwater, raising the salinity to levels unsuitable for existing varieties to withstand. In a search of the collection of over 100,000 rice accessions maintained by the International Rice Research Institute, cultivars were found suitable for growing in these high salinity areas.<sup>6</sup> The CIP genebank has similarly shipped potato accessions to Haiti in the aftermath of the devastating 2010 earthquake. Working with Parque de la Papa in Peru, the genebank repatriated disease-free potato varieties collected from the region in the past yet no longer grown in the valley.

FAO's Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture<sup>7</sup> lists approximately 1,750 individual ex-situ genebanks worldwide holding approximately 7.4 million accessions. Although this number is large and the *unique* accessions held by genebanks are only 25–30% of this number, the growth is phenomenal as it is estimated there were only 54 genebanks worldwide at the end of the 1970s. The report went on to highlight several core challenges to PGRFA worldwide. For example, PGRFA are essential raw materials for helping farmers respond to climate change, and loss of PGRFA has reduced options for the agricultural sector. Better communication, collaboration, and partnerships are needed among institutions dealing with PGRFA management—from conservation to plant breeding. However, there is a huge need to support and strengthen the genebanks in developing countries by building capacity in such areas as cleaning accessions of diseases, establishing national sustainable support systems (infrastructure, funding, legislation, databases), training of staff, and implementing best genebank practices.

The genetic diversity of landraces and CWR is threatened. Worldwide concern is growing over the need for in-situ sites for conserving and monitoring changes in PGRFA. Research needs include knowledge of how these genetic resources can contribute to enhanced nutrition, income generation, and sustainability of farmers' livelihoods. Complementary to this research will be the documentation and understanding of the temporal and spatial dynamics of diversity conserved in situ, all of which are well imbedded in the research carried out under RTB.

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<sup>5</sup> Starvation Threatens Rwanda. "Seeds of Hope" Program to Restore its Crippled Agriculture. 1995. CGIAR Press Release <http://hdl.handle.net/10947/1311>

<sup>6</sup> CGIAR Consortium partners with Global Crop Diversity Trust to revitalize genebanks. January 31, 2013. <http://www.cgiar.org/consortium-news/cgiar-consortium-partners-with-global-crop-diversity-trust-to-revitalize-genebanks/>

<sup>7</sup> Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture. 2010. Commission on Genetic Resources for Food and Agriculture, Food and Agriculture Organization of the United Nations (FAO), Rome. <http://www.fao.org/agriculture/seed/sow2>

## 4. CIP's Targeted Response

CIP's unique contribution is the knowledge and know-how held by the CIP community of breeders, researchers, curators, and technicians. A hallmark of CIP's work is the interaction with smallholder farmers in potato-growing regions, including initiatives like Ruta Condor for in-situ conservation and improving the livelihoods of indigenous farmers. Nowhere in the world is there a genebank or organization with a larger or more diverse collection of potato, sweetpotato, and ARTC germplasm. And although this collection is available globally, CIP physically holds the accessions and grows them out every year. We have first-hand institutional knowledge on their use, related information, the expertise, and associated knowledge about the collection that can only be attained by hands-on work. CIP's breeders and researchers have unfettered access to the curators whose knowledge of the collection is unparalleled and therefore are better positioned to capitalize on its use. This targeted response is a key enabling factor that will allow CIP to be successful in accomplishing all of its SOs.

The challenge to feed the world in 2025 and beyond will have to look at not only food productivity but also at enhanced nutritional content and other benefits, especially for smallholder poor farmers and farmer communities throughout the developing world. OFSP is an excellent example where the diversity in the genebank has and will continue to be used for biofortification and products with added nutritional content. The genebank holds numerous accessions of OFSP and purple-fleshed sweetpotato containing enhanced contents of vitamin A, antioxidants, and other important vitamins and energy sources. Leaves from the purple-fleshed sweetpotato are also purple and can be used as an antioxidant source. Native potatoes are rich in vitamin C: some estimate that consumption of a medium-sized tuber can provide 50% of the recommended adult vitamin C.<sup>8</sup> ARTCs are another collection with huge nutritional potential. Although starch is the major nutritional constituent in most ARTCs, yacon stores fructooligo-saccharides in place of starch, making this crop valuable for diabetics as well as for reducing cholesterol and triglyceride levels, enhancing calcium assimilation, and strengthening the immune system. Maca and mashua are abundant in the anticancer-related isothiocyanates. Some mashua cultivars contain antioxidant levels higher than blueberry cultivars.<sup>7</sup>

A final example of the utility of CIP's targeted response is the Ruta Condor program (see Box below). Genebank and CIP scientists are working with indigenous communities stretching along the Andean highlands from Venezuela to Argentina to establish in-situ sites for conservation and long-term monitoring of landraces and CWR and to repatriate disease-free, local landrace material to smallholders. This program in dynamic conservation is set up to directly benefit the indigenous farmers through increased productivity, technology transfer, training, and participatory research. Parque de la Papa, the pilot project launched in conjunction with the Association for Nature and Sustainable Development, helps support the cultivation of more than 600 varieties by over 1,200 families among the six communities that make up the Parque. More than 400 regional native potato varieties have been returned successfully to the area. In exchange, CIP has received over 300 varieties back for inclusion into the genebank. By honoring the cultural heritage and social structures of these communities, CIP continues to build win-win partnerships with smallholder indigenous communities and establish long-term monitoring programs for plant genetic resources.

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<sup>8</sup> Roca, W. et al. 2007. Indigenous Andean Root and Tuber Crops New Foods for the New Millennium. *Chronica Hort.* 47(4): 13–19.

## La Ruta del Condor

La Ruta del Condor (Route of the Condor) is a project to restore and conserve the genetic diversity of native potato species in situ in the high Andes, where native potatoes originated. The Route of the Condor follows the ancient Inca Empire trading roads that crisscross and run the length of the Andes. It covers a network of microcenters that are cultural and biological hotspots, including principal hotspots of native potato diversity.

Highland communities frequently lose all or part of their crops to natural disasters or political events. In the case of native potatoes, this means that they also lose next year's planting materials. For more than a decade, CIP has repatriated virus-free native potato varieties from the CIP genebank in Lima back to the communities suffering these biodiversity losses. The repatriation program began with requests from four Andean communities a decade ago. Since then, CIP scientists, farmers, and local partners have repatriated over 4,600 samples of more than 1,200 varieties of native potato in 41 locations. That is, over 25% of the native potatoes in the CIP ex-situ genebank in Lima have been repatriated to their original custodians.

### **The pilot project: Pisac Potato Park (Parque de la Papa)**

In a special partnership with the farmer conservationists of Písaq and the NGO *Asociación ANDES*, since 2005 CIP has provided technical support for the cultivation of almost 1,200 varieties of native potatoes in what is now known as the Pisac Potato Park. The 1,200 families of the six communities that make up the Park collected more than 600 local potato varieties, which were then complemented by over 400 varieties from the CIP genebank. Complementary training on clean seed production and best agronomy practices is also provided.

The goal is to extend and adapt this pilot project to a chain of native potato biodiversity hotspots along the Ruta Condor, from Mérida in Venezuela to Jujuy in Argentina.



## 5. Alignment

The CIP genebank is well aligned with regional, national, and global frameworks involving the conservation and use of plant genetic resources. On the international level, the genebank is collaboratively engaged with other CGIAR genebanks and the GCDT in supporting the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) and aiding in the evolution of this Treaty. Genebank staff members represent CIP at the Peruvian National Biopiracy Committee as well as participate in other national committees dealing with plant genetic resources. The genebank is actively engaged with *Asociación ANDES*, an NGO working directly with communities to enhance communities' livelihood and provide tools to grow, prosper, and sustain.

## 5.1 Global and regional frameworks

The Convention of Biological Diversity (CBD) was unveiled at the United Nations Conference for Environment and Development (the Rio Earth Summit) in June 1992. It introduced a remarkable phase for the conservation, sustainable use, and fair and equitable sharing of benefits from the use of genetic resources.<sup>9</sup> In the past 20 years the CBD has been the driving force in the regulation, management of, and limitations on the use of genetic resources by individual countries.<sup>10</sup> At the Tenth Conference of the Parties in Nagoya in 2010, the issue of access and benefit was discussed. They reiterated the core requirements of party nations: access, fair, and equitable sharing of benefits, traditional knowledge associated with genetic resources, and compliance.<sup>11</sup>

The most relevant legislation to arise from the CBD for the genebanks is the ITPGRFA, a legally binding treaty whose goals are the conservation, access, benefit sharing, farmers rights, and sustainable use of PGRFA.<sup>12</sup> <sup>13</sup> The ITPGRFA came into force in June 2004 and established a multilateral system for the facilitated access of 35 crop genera and 29 forage species, collectively referred to as Annex 1 crops. These crops and others since designated as PGRFA are distributed under the terms of a standard material transfer agreement. Terms of access and benefit sharing are defined in the ITPGRFA, and it is clearly aligned with and serves as an important tool for the Nagoya protocols. The GCDT and the CGIAR genebanks have signed formal agreements with the Governing Body of the ITPGRFA to uphold and abide by its terms.

## 5.2 National frameworks and country targeting

The CBD firmly established that the country of origin had sovereignty over the genetic resources within its borders. In many cases this has led countries or regions to implement legislation of their own covering the use of material acquired since 29 December 1993, when the CBD came into force. An example is the *Decision 391 of the Andean Community on a Common Regime on Access to Genetic Resources* (Reglamento 391) by Venezuela, Colombia, Ecuador, Peru, and Bolivia in 1996.<sup>14</sup> Reglamento 391 has become an important international law and policy in the access to genetic resources, including indigenous knowledge and IP. Other national legislations beyond Reglamento 391 continue to evolve, highlighting the need for the genebank to remain actively engaged in the national, regional, and international conversations.

## 5.3 SRF and CRPs

The CIP genebank programs are key to meeting current and future CGIAR SRFs as all programs of this SO contribute to reducing poverty, increasing food security, improving nutrition, and protecting natural resources. The genebank will work with partners to provide the genetic building blocks that farmers, researchers, and others need to overcome challenges from increased population growth, changing land use, limited water, shifting insect and disease pressures, deteriorating soil quality, climate change, and other global issues. The support of the SRFs is highlighted by in-situ programs where the genebank will play a major role in the complementary

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<sup>9</sup> See <http://www.cbd.int/>

<sup>10</sup> Kursar, T. A. 2011. What are the Implications of the Nagoya Protocol for Research on Biodiversity? *BioScience* 61(4): 256–257.

<sup>11</sup> Medaglia, J. C., et al. 2012. Overview of National and Regional Measures on Access to Genetic Resources and Benefit Sharing Challenges and Opportunities in Implementing the Nagoya Protocol. Study for the Centre for International and Sustainable Development Law.

[http://cisdl.org/biodiversity-biosafety/public/CISDL\\_Overview\\_of\\_ABS\\_Measures\\_2nd\\_Ed.pdf](http://cisdl.org/biodiversity-biosafety/public/CISDL_Overview_of_ABS_Measures_2nd_Ed.pdf)

<sup>12</sup> <http://www.planttreaty.org>

<sup>13</sup> Briefing of the Second High-Level Round Table on the International Treaty on Plant Genetic Resources for food and Agriculture. 2012. International Institute for Sustainable Development. <http://www.usd.ca/uncsd/rio20/itpgrfa/>

<sup>14</sup> Muller, M. R. 2000. Regulating Bio Prospecting and Protecting Indigenous Knowledge in the Andean Community: Decision 391 and its Overall Impacts to the Region. Summary of the UNCTAD Expert Meeting on Systems and National Experiences for Protecting Traditional Knowledge, Innovations and Practices.

[http://r0.unctad.org/trade\\_env/docs/ruiz.pdf](http://r0.unctad.org/trade_env/docs/ruiz.pdf)

conservation of plant genetic resources through in-situ and ex-situ conservation and the understanding, monitoring, and distribution of the unique genetic components conserved. The in-situ/ex-situ programs demonstrate clearly where, through interactive conservation, natural resources are conserved. They also illustrate how the livelihoods of poor farmers are enriched by increased technology transfer, know-how, and empowerment to provide value-added, nutritious, and secure products for the market place. Work with Parque de la Papa to set up a self-sustaining native seed potato program for other communities in the Southern Andes is a good example of the future success of such programs.

The CIP genebank represents CIP in the Genebank CRP and the resulting close community and partnership between the 11 CGIAR genebanks and the GCDT. This unique partnership operates through the management by the Trust of consortium funds for the long-term maintenance of CGIAR in-trust PGRFA collections. In the management of the Genebank CRP, the GCDT works with the genebanks to provide security, oversight, increased efficiency, and long-term funding for routine maintenance and distribution of the collections. The Trust is committed to building its endowment from at present the roughly \$150 million<sup>15</sup> to over \$500 million. This will allow it to assume the funding of routine maintenance of the genebanks, freeing up Window 1 funds for other activities.

The GCDT also recognizes that there are needs not covered by the Genebank CRP and offers one-off funding as possible for some of these. Projects not covered by the Genebank CRP that CIP's genebank is currently partnering with the GCDT to accomplish include development of methods and standards for a robust cryobank, backing up of two key global collections (the national Philippine sweetpotato collection and the potato collection from Parque de la Papa), and the testing of the application of GRIN-Global for complementing the genebank and CIP corporate databases for accession data management. Other one-off funds offered by the GCDT include funds for targeted collecting trips and partnership-building activities.

The relationship between the CIP genebank, the Genebank CRP, and RTB is progressing, particularly in the conservation of breeding material that is not covered by the Genebank CRP. This collaboration has strengthened the partnership between the breeders and the genebank to characterize, evaluate, identify, and document on an accession basis traits important for facilitating future use of the germplasm. Further projects under SO 6 include the testing of new genomic technologies (such as genotype by sequencing and deep sequencing) and assessing the application of these technologies in genotyping diverse germplasm and the detection of pathogens of quarantine importance.

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<sup>15</sup> As of September 2013.

## 6. Flagship and Linked Products



**Figure 1.** Genebank flagship (at center) and linked products.

The genebank’s specific objective contains three flagship products—the World Potato Collection, the World Sweetpotato Collection, and CIP’s collection of ARTCs, emerging from the three main collections held by the genebank (Fig. 1). These flagship products will raise the CIP genebank to new standards of global recognition defined by excellence in germplasm accessibility and data management; worldwide coordination of the global resources held in other genebanks for crops represented by these flagship products; and provide measurable impact on the livelihoods of smallholders by innovative, in-situ dynamic, and interactive conservation strategies. These flagship products will further draw on CIP’s expertise in genetic resources management, research, breeding, and sustainable land-use management in partnership with the other CIP SOs to substantially increase the use, knowledge, and benefits of these collections globally.

### 6.1 Linked products

The development of the Potato World Collection and the Sweetpotato World Collection flagship products will encompass linking, coordinating, partnering, and collaborating with all other CIP SOs; CIP-HQ and regional programs; national, regional, and international entities involved with access and benefit sharing of PGRFA; and global genebanks and the gene-banking community.

6. **Genebank and distribution management.** Building stronger, more responsive user-oriented collection management strategies includes (1) conserving and making available a greater range of diversity through collection and acquisition, (2) streamlining phytosanitary cleaning to speed up the process of getting valuable and needed germplasm to the smallholders in developing countries, (3) grouping accessions into sets for facilitated and increased use, and (4) more efficient capture of user information.

7. **Information management and database.** We will advance public informatics platforms for the dissemination of accession- and collections-specific information by developing or advancing customer-friendly tools. Such tools include (1) facilitating access to accession-based information through online searchable.pdf catalogues with pictures and associated information for all accessions in the genebank on a single page for easy reference; (2) enhancing germplasm selection specific to users' needs through increased use of dynamic, category-specific germplasm grouping tools such as CIP's International Nurseries program; and (3) continual updating of the online ordering system to refine click-and-order technologies. Database design will clearly play a major role in user interface. Designs will recurrently be enhanced to facilitate in-house and external access to information through data management systems such as GRIN-global<sup>16</sup> and through transparent, user-friendly, and web-based public portals such as Genesys.<sup>17</sup>
8. **CIP breeding, regional programs, and offices.** Through constant incorporation of advances and the two-way interexchange with regional programs in SSA, China, and Southeast Asia, facilitation of pre-breeding efforts, conservation and use of materials, and accession-specific information and knowledge, the World Collection networks will be the portal for dissemination of the latest information.
9. **Accession-specific DNA fingerprinting and trait associations.** Efforts ongoing in the Potato and Sweetpotato World Collections will deliver the footing to tie all other collections together by providing technology transfer, know-how, and facilitated interactive access to DNA fingerprints to aid in genebank management (duplicate identification, identify verification, diversity studies) and the association of markers to traits of interest.
10. **National, regional, and international legislation and treaties.** Unraveling and understanding the complicated web of ever-changing regional and international legislation governing PGRFA and other material in the global collections are ongoing tasks of critical importance to the development of the World Collections.
11. **Rationalizing national collections into a World Collection network.** At the heart of the World Collections' strategy is the global harmonization of the potato and sweetpotato collections. This harmonization will be done by a coordinated global effort. First, we will identify the major collections and work with these collections one-by-one to facilitate the identification through DNA fingerprinting of collection uniqueness. Second, we will work with the genebanks to ensure that phytosanitary clean material is backed-up to prevent loss of diversity already in conservation and is returned to the original collection to ensure that these national collections have clean material to distribute.
12. **CIP Strategic Objectives.** Providing the needed tools, partnering, and collaborations for the rapid achievement of the CIP SOs is paramount to their success, as they will catapult the global attention of benefits derived from PGRFA. This will increasingly raise awareness to further the incentives for other genebanks to be part of the World Collections. Areas where the genebank can support the SOs include:
  - **Combating Vitamin A Deficiency with Resilient, Nutritious OFSP (SO 1):** preserving and making available the genetic diversity that provides important traits in African sweetpotato production, including virus and drought resistance, vine survival, high dry matter, low sugar, salinity tolerance, weevil resistance or avoidance, early maturing, as well as high beta-carotene (vitamin A), antioxidant content, and other traits important for biofortification products.

<sup>16</sup> GRIN-Global, developed jointly by the GCDT, USDA-ARS, and Bioversity International, is a flexible, easy-to-use global plant genetic resource information management system that will constitute the keystone for an efficient and effective global network of genebanks to permanently safeguard plant genetic resources vital to global food security, and to encourage the use of these resources by researchers, breeders, and farmer-producers.  
[http://www.grin-global.org/index.php/Main\\_Page](http://www.grin-global.org/index.php/Main_Page).

<sup>17</sup> Genesys is a global portal to information about PGRFA and serves as a gateway from which germplasm accessions from genebanks around the world can be easily found and ordered. <http://www.genesys-pgr.org/>.

- **Enhancing Food Security in Asia through the Intensification of Local Cereal-based Systems with Early-Maturing Agile Potato Varieties (SO 2):** preserving the diversity needed for short-cycle (70–90 day) potato varieties that are heat, drought, virus, and bacteria tolerant; contain high micronutrients (iron, zinc, beta-carotene) and vitamin C content; and have good postharvest processing characteristics and quality features suitable for the Asian pallet.
  - **Improving Livelihoods of Potato Farmers in Africa by Tackling Deteriorated Seed Quality through an Integrated Approach (SO 3):** providing know-how for large-scale in-vitro multiplication, microtuber technology, and phytosanitary clean, diverse material-containing traits. This allows for rapid bulk-up of early-maturing as well as short- and long-dormancy potato in SSA resistant to major biotic (LB, BW, and viruses) and abiotic stresses with user-preferred table and processing qualities.
  - **Accelerating the Discovery of Game-Changing Solutions for Enhancing Food Security (SO 4):** providing this longer-term objective with the critical rich diversity of novel genes, alleles, and allelic combinations from potato, sweetpotato, and ARTCs. These will be used to develop flagship products that include *R* genes for disease and virus resistance; multiple stacked resistances for a weevil- and virus-resistant, pesticide-free potato; genes that allow tuberization at high night temperatures; pre-breeding and diversity that allow the development of inbred lines from hybrids with enhanced heterosis; and even elusive apomictic genes.
  - **Addressing the Food Security Challenge through Roots and Tubers: Transforming Vulnerability to Resilience (SO 5):** the genebank will play a pivotal role in this SO through its vast diverse collection of cultivars from potato, sweetpotato, and ARTCs, which are largely untested in many regions and markets. Although the cultivars make for an off-the-shelf ready source of materials, the huge diversity in the wild species offers novel traits that may exploit much needed niche markets for sustenance farming. Ex- and in-situ linkages to enhance the resilience of farming systems will be a focus in centers of crop origin.
13. **Interactive in-situ conservation to benefit poor farmers.** Conservation of genetic diversity through in- and ex-situ strategies are complementary, not distinct conservation strategies. Hence a world collection strategy must include well-formed components of both. One aim is to characterize and quantify conservation benefits that add to resilience, including year-round nutrient provision, yield stability, and ongoing evolution as an adaptive mechanism. Research activities will include studies on the interaction between cultivated and wild potato diversity, the role of diversity in smallholder diets, timeline-series monitoring of landrace and cultivar diversity, and studies on the role of institutions provisioning (including repatriation) planting materials.
14. **Crop Wild Relatives.** At the crux of all crop genetic diversity lies the CWR of these crops as they have evolved to endure a multitude of stresses and insults. Thus they contain the genetic constituents and gene combinations to enable survival and tolerance of the major challenges faced by agriculture in the use of the cultivated relatives of these crops. The conservation of CWR and their availability to breeding programs provide the foundation for future crop improvement.

## 7. Impact Pathways

Products	Research Outcomes (Next Users)	First Level Development Outcomes (End Users)	Intermediate Development Outcomes (End Users)
<b>Information management and database</b>	Breeders and researchers from NARS, universities, CGIAR, and other research institutes use information to select germplasm	New traits and genetic/phenotypic correlations are discovered, breeding lines are developed, and this information is deposited back in the database to increase future value of individual accessions	Researchers and breeders use new information to develop varieties to help farmers
<b>CIP breeding, regional programs and offices</b>	Breeders and researchers from within CIP use information and materials for selection of accessions for study	New varieties and breeding lines are developed with novel/useful traits	Smallhold farmers have improved material for increased productivity and income
<b>Accession-specific DNA fingerprinting and trait associations</b>	DNA fingerprinting and initial trait associations provide breeders and researchers with a new tool to mine the CIP genebank accessions	New associations are continually developed, which adds more value to accessions, increases use of the database, and further benefits and accelerates the development of new cultivars	Novel and new material is available to NARS partners and ultimately farmers for testing and implementation
<b>National, regional, and international legislation and treaties</b>	CIP has information on pending and enacted legislation affecting the use of genetic resources	CIP partners (GCDT, other genebanks) can access information on legislation which could have broader impact beyond Peru	CIP and users of CIP genetic resources stay compliant with national, regional, and international legislation on the use of plant genetic resources
<b>Rationalizing national collections into a World Collection network</b>	NARS and national programs with genebanks add value through association with CIP accessions and enhanced characterization of their material	Material from global national genebanks is securely backed-up and phytosanitary clean material is returned to the genebank for distribution and use within the country	Farmers and breeders in these developing countries with genebanks have access to phytosanitary clean material improving productivity and breeding success
<b>CIP Strategic Objectives</b>	Genebank materials with known traits and genetic associations to these traits are available for current and next-generation products for the SOs	CIP researchers, breeders, and regional offices have more material available with traits needed for success of SOs	Farmers see benefits from the CIP SOs
<b>Interactive in-situ conservation strategies to benefit poor farmers</b>	Indigenous farmer communities have support and knowhow to maintain their traditional farming practices and associated flora	"Natural" farming preserves are maintained, allowing traditional knowledge to be retained and benefit other smallhold farmers	The global research and breeding communities benefit by the on-farm conservation of traditional varieties, associated flora, traditional smallhold farms, and the potential dynamic in-situ evolution of crops
<b>Crop Wild Relatives</b>	Breeders and researchers from NARS, universities, CGIAR, and other research institutes have exotic material to select and use directly or for use in developing prebreeding material	Novel or new alleles/gene combinations are available for use in the development of new breeding lines or varieties	NARS have new plant material available with novel traits to test and distribute to farmers
<b>Genebank and distribution management</b>	Genebank is streamlined, efficient, and more responsive to users of genebank material. Genebank personnel benefit as well from less stress and greater ease in procedures period	Breeders and researchers from NARS, universities, CGIAR, and other research institutes have a greater selection of accessions available and can access these accessions more rapidly	New varieties are available and delivered to NARS partners more rapidly, allowing faster gain from improvements

## 8. Research Outcomes

Research Outcome	Indicators (5 years)
Breeders and researchers from NARS, universities, CGIAR (including CIP-HQ and regional offices), and other ARIs have a greater selection of accessions available (including exotic materials) and can access these accessions more rapidly. This facilitates the discovery of new traits, genetic-phenotypic correlations, and the development of new breeding lines more efficiently.	<ul style="list-style-type: none"> <li>• CIP trait data are tied to genebank accessions in a public database</li> <li>• Release of routine varieties and germplasm from the genebank within 6 months of introduction/ release from quarantine</li> <li>• GRIN-Global is assessed and beneficial components operational</li> <li>• Genetic fingerprints available for all accessions in the Potato and Sweetpotato World Collections</li> </ul>
CIP staff, researchers, and partners have access to information on pending and enacted legislation affecting the use and distribution of genetic resources and associated information to aid in the decision making of genetic resources collection, conservation, and use.	<ul style="list-style-type: none"> <li>• Links to texts for pending and enacted legislation and relevant reviews on genetic resources are available through a web portal</li> <li>• Genebank personnel actively participating and representing CIP at the Governing Body meetings for the IP</li> </ul>
Genebank managers from NARS add value to their collection through use of CIP information; securely back-up their accessions; and obtain phytosanitary clean materials back to their genebanks for distribution and use within the country/region.	<ul style="list-style-type: none"> <li>• At least three NARS genebanks participate in the fingerprinting and comparison of collections</li> <li>• 100% of accessions received from NARS partners are cleaned and available to return to partners within 12 months of release from quarantine</li> <li>• A minimum of one national genebank collection is safety backed-up at CIP annually</li> </ul>
Indigenous farmer communities have support and know-how to maintain their traditional farming practices and associated flora, resulting in improved in-situ conservation of landraces and CWR.	<ul style="list-style-type: none"> <li>• At least 5 in-situ sites established for long-term monitoring of diversity in the Andes</li> <li>• CIP has pre-breeding lines available incorporating valuable traits from wild germplasm</li> </ul>
CIP genebank uses information and technologies to be more responsive to users, reduce costs, and increase efficiency of genebank functions.	<ul style="list-style-type: none"> <li>• 25% of CIP potato collection backed up in cryopreservation off site internationally</li> <li>• 100% of active collection identity verified as true-to-type</li> <li>• 75% of collection phytosanitary clean</li> <li>• Doubling of use of genebank web pages</li> <li>• ISO standards are maintained</li> </ul>

## 9. Gender Dimension

CIP's genebank will work actively to increase the livelihoods of men, women, and families of smallholder poor farmers. We will use gender-responsive methodologies to include and involve women in the planning and management of all in-situ activities and efforts performed for and by the communities. We will also engage partners to help in the effort to ensure the empowerment and equal opportunity for women (who often keep their communities' seed) through knowledge generation, education, data collection, project planning, management, and credit for

accomplishments. Within the genebank, we will continue to promote gender equality and opportunities to allow women to advance in science and leadership roles.

One important partner in our gender-responsiveness is RTB, and we will follow the gender-responsive objectives set forth in their Gender strategy.<sup>18</sup> We will develop a strong gender understanding of indigenous knowledge and include this in the conservation and use of genetic resources (RTB Theme 1), be sensitive to gender-specific preferences for traits and their consequences in varietal use (RTB Theme 2), and improve access to quality genebank materials with gender-specific delivery systems as appropriate (RTB Theme 4). We will also strive to communicate in a gender-neutral fashion and make special effort to ensure that women are included in our communications strategies.

## 10. Partnership Strategy

With the development and secure conservation of the potato, sweetpotato, and ARTC collections, partnerships will be important assets to success. Partnerships at all levels are key to providing complete information (characterization, evaluation, passport, and genetics in a user-friendly public database) on each accessions. This effort leads to the use of the genetic resources collections that in turn increase the livelihood of poor smallholder farmers. They then complete the loop by providing feedback information on that accession.

Key to this SO's strategy is the partnership and outreach with the CIP regional programs and offices. This partnership will be key in the identification of global collections in need of backing-up of the collections to ensure their security and availability for future generations. Through these CIP regional partners, the genebank will facilitate the transfer of unique accessions from these collections to CIP to ensure long-term conservation of the collections in addition to providing the global genebanks with pathogen-free material for enhanced regional distribution and use. The participation of the CIP regional programs in the genebank program has been minimal. Yet through SO 6, this partnership will be enhanced and built to provide technology transfer, know-how, and support for long-term sustainable conservation of valuable regional germplasm in the regions.

Partnerships with genebanks, breeders, NARS, ARIs, farming communities, NGOs, and regulatory bodies provide the underpinning for a network that ensures the secure preservation and use of global genetic resources for the benefit of humanity. CIP's genebank will strengthen partnerships and seek out new collaborations to share and broaden the global understanding of the importance of preservation and use of diverse genetic resources. The relationship between CIP's genebank, breeding programs, and national and international entities is key to acquiring, conserving, and providing genetic resources globally. As an example, the dynamic conservation activities undertaken by the genebank highlight the complementary relationship between the in-situ environments and the ex-situ conservation through instruments such as repatriation of material free of diseases of phytosanitary importance and bi-cultural community partnerships, particularly where they benefit women farmers. Interactive conservation is the genebank's frontline defense against global climate change. Specific examples include work with community genebanks in San Jose de Aymara and repatriation with Parque de la Papa, where the impact of our work has revived cultural and social celebrations surrounding the cultivation of potatoes. Other major efforts relying on close, efficient, and trusting partnerships include the rationalization of the Potato and Sweetpotato World Collections with national genebanks throughout the world, and working with national, regional, and international entities to increase understanding and provide input for legislation and policies concerning the use and conservation of plant genetic resources.

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<sup>18</sup> CGIAR Research Program on Roots, Tubers and Bananas-RTB. 2013. Gender Strategy. [http://library.cgiar.org/bitstream/handle/10947/2630/Consortium\\_Gender\\_Strategy.pdf?sequence=4](http://library.cgiar.org/bitstream/handle/10947/2630/Consortium_Gender_Strategy.pdf?sequence=4)



## Introduction

The new SOs represent an evolutionary path for the organization. They expand CIP's work along the development continuum from upstream research to developing stronger interactions with uptake pathways and hence downstream development impacts. These R&D SOs, together with the strengthening of the CIP strategic research encompassed in SOs 4–6, present new operational corporate challenges. Thus the corporate objectives (COs) must also evolve to complement and maximize the impact of the SOs. The initiatives that follow ensure that global systems will professionally link, enable, empower, and decentralize decision making across the organization. They create an environment that will allow CIP to move with agility into the new environments identified by the SOs while maintaining our core competencies.

The SOs presented in the earlier chapters enable CIP to facilitate agricultural development and deliver on CGIAR's SLOs by continuing to raise the quality of CIP science: the relevance and effectiveness of programs. CGIAR is also required to demonstrate value for money through its RBM framework. This necessitates continuing to raise the quality of CIP's management, organizational structures, financial management, knowledge management, and communications, to grow and strengthen the Center. These challenges look to the staffing and career development of CIP's personnel, the efficiency and economy of its operations, and the ability to influence CIP's investors and partners.

For these reasons, this chapter develops the five CIP COs: CO 1: Growing Together, centered on human resources (HR) and staff development; CO 2: Expanding Organizational Capacity through enhanced program and project management; (3) CO 3: Financial Stewardship for efficiency and economy of operations, influencing CIP's investors and both national and international partners; CO 4: A Strategic Approach to CIP's Marketing, Branding, and Business Development. The chapter closes reverting to the key investment in staff relating to CO 5: Safety, Health, and Environmental Sustainability.

The foundation of CIP's COs is rooted in over 40 years of the Center's operations. CIP's organizational value of excellence was strengthened over the last three years through a focus on 12 distinct areas of operations. On a macro-level, the focus was on setting concrete project management processes, putting in place a sound organizational structure and planning process, and implementing corporate management processes and procedures for all of CIP. As a result, CIP became more harmonized with other CGIAR Centers and the new RTB CRP.

Operationally, CIP, alongside two other Centers, led the way for the CGIAR System-wide implementation of the One Corporate System (OCS), an Enterprise Resource Planner (ERP) harmonized with other CGIAR Centers. During the first wave of the implementation CIP was the first Center to implement the timesheet and project costing and billing modules of the system. CIP is sharing the design of these modules with the second and third wave of the OCS implementing Centers in order to fully harmonize the use of the system across the CGIAR System. CIP has recently upgraded the IT infrastructure and capabilities across the Lima campus through the unified communications projects. Concurrently, CIP reenergized its internal and external communications efforts to support these corporate initiatives while maintaining CIP's research reputation externally. Furthermore, efforts to enhance CIP's grants and contracts capabilities through improved partnership agreements, streamlined legal approvals, and implementation of IP policies, among others were pursued. Progress was also made in harmonizing the procurement

process throughout the organization. Infrastructure improvements were started on the Lima campus, including the completion of a new warehouse.

Two efforts were advanced to build an outstanding talent pool and to ensure that the places where CIP works are safe and secure. CIP launched an organization-wide Talent Management (TM) process to all staff that included annual work plans, performance appraisals, staff development and learning initiatives, creation of a new salary structure at a global standard, an enhanced recruitment process, and succession planning. In line with CIP's commitment to staff diversity, the gender ratios continued to improve through 2012. Moreover, the fostering of a health and safety culture began that aspired to ensure that all CIP staff were aware that everyone is responsible for his/her own health and safety and that of fellow workers, and that supervisors carry the same responsibility for staff under their charge. This includes ensuring that staff are aware of and compliant with guidelines contained in the new global health and safety manual.

The new COs will also be enhanced through greater collaboration between CGIAR Centers and the CRPs. The main thrust of the current collaboration is through OCS, which is mainly focused on accounting, budgeting, HR, procurement, and time allocation. This system is being implemented by 10 Centers; CIP has taken a lead in the development of this ERP—particularly the time allocation system and the project costing and billing areas. CIP was the second Center to go live with this system and will continue to benefit from each Center's shared experiences. Beyond OCS, CIP is also working with CGIAR's Shared Service Unit on shared services, which includes procurement, library journals, IT software, health and safety guidelines, risk and security, and knowledge management. CIP is also collaborating with CGIAR in practice areas like corporate services, HR, legal and contracts, knowledge management (KM), communications, IT services, intellectual assets, and research programs. These practice areas each have shared services components that allow CIP to expand its organizational capacity beyond its ability and resources to do it alone. Management realizes that by collaborating in various areas across the whole CGIAR Consortium CIP will be able to achieve its SCP.

The five COs discussed below represent opportunities that will facilitate and reinforce the implementation of the new SOs. These are areas that CIP must address above and beyond those corporate functions and systems that it already has in place. Once implemented, these initiatives will allow CIP to increase revenue growth and expand the skill sets of CIP researchers and management to support new these new activities. They will also position CIP to partner effectively, to collaborate both inside and outside CGIAR, enhance its ability to work globally in the developing world from a Lima-based headquarters, and to improve the ability to manage larger and more complex projects. These COs will be designed to promote the success of the SOs.

## **CO 1: Growing Together**

### **1.1 Summary**

CIP's employees are our greatest asset. The new SCP requires CIP to make optimum use of this asset to expand along the R&D continuum. The growth needed to implement the SOs requires CIP to bring together a diverse range of talent and ensure that this talent is dedicated, empowered, and fully supported by our organization. Over the last two years CIP began the process of building a strong TM program to promote performance management, professional development, and succession planning. Over the next five years CIP will focus on assembling a diverse workforce that brings new development and scientific technical expertise into the organization by recruiting the next generation of talented women and men and allow them to collaborate and create a more food-secure world. CIP will empower staff through clear lines of responsibility and accountability that decentralize decision making and levels of authority. CIP will build on the TM program to retain, train, and reward current staff to further strengthen our institutional values and achieve the SOs. Optimizing CIP's relationship with CGIAR is critical to the success of this CO. CIP must take advantage of shared services opportunities such as the postdoctoral initiative, salary

standardization, harmonized HR reporting, and staff categorization. All of these will help CIP take advantage of the HR economies of scale available through our sister Centers.

CO 1 is built around three principal areas of emphasis and objectives, each with its set of deliverables (Table 1):

- **Next generation of researchers and professionals.** CIP will establish a program to recruit the next generation of talented researchers and development professionals. Our approach will be gender balanced to ensure a steady stream of innovative thinking and provide the Center with key skills for the future.
- **Empowering staff and decision making.** CIP will refine organizational structures, policies and procedures, and level of authority to ensure that all staff are fully empowered to make decisions at the appropriate levels through the organization.
- **Talent management.** CIP will build on the current TM program to strengthen a culture of performance management and professional development.

## 1.2 Next generation of researchers and professionals

The five-year SCP is driving a reevaluation of staff needs across the organization. As CIP expands along the R&D continuum, so too must the skills of the staff. To avert attrition due to age and to acquire staff with skills in upstream research and downstream development, CIP must focus the next five years on recruiting this next generation of researchers and development professionals to lead CIP for the next 20 years. We will achieve this by creating a new recruiting program to attract young researchers, especially female scientists, into the organization. Recruiting alone as one medium-sized center will not allow CIP to bring in the talent necessary to achieve our plan; therefore, CIP will work with other Centers to promote and recruit across CGIAR. CIP will create an enhanced support system for PhD and masters-level students. To meet the needs of rapid start-up projects based on scaling up of innovative technologies, CIP will create a recruiting system that begins at the proposal development stage and brings talented professionals into a network for CIP to engage with on an ongoing basis.

**CIP must develop programs to engage younger scientists and attract them to its mission and vision.** We will create an outreach program that actively networks with a new generation of scientists in all fields of research while creating programs to further develop young researchers already here. This effort will be in conjunction with other Centers to make sure that we are attracting the best and brightest to CGIAR and offering them not only a career at one Center but also a diverse career across the Consortium. A major priority of many donors is engaging women in agriculture. This engagement is usually focused on beneficiaries living in poverty. And while CIP designs strategies to engage with women in the agricultural setting, it must find ways to engage more women at scientific and professional levels. Diversity, in all its forms, increases creativity and innovation; it improves decision making by providing different perspectives on problems. Over the next five-year cycle CIP will devise programs to develop women scientists at all levels of the organization. Our outreach programs will include a gender balance approach to ensure that we are recruiting and maintaining the best personnel.

**To recruit world-class researchers CIP will create programs to assist PhD and masters-level students in both developing and developed economies.** CIP must extend its network to ensure that as scientists begin their training they are aware of the value and benefits of working with CIP and within CGIAR. CIP will work with the Consortium on their postdoctoral program that is being established for the whole Consortium. Once these students work as part of CIP's mission and vision, they will become future employees or allies to the Center and its mission.

**High-potential prospective staff members from outside must be sold on the value and culture of CIP.** Recruiting talented staff is an active process and engages scientists and development professionals on many platforms and by many different staff. To attract the best and the brightest, every current and past staff member must become an ambassador for CIP and its mission. We will

create this new network by engaging staff on multiple platforms and keep active the relationships that are formed. CIP's new SOs also call for a more robust recruiting process that starts at the proposal development stage and is active throughout the life of the project. Donors now expect rapid start-up teams to hit the ground running. To do this, staff must be in place immediately following the award of a project.

### **1.3 Empowering staff and decision making**

Employees reach their highest potential when they are empowered to achieve the goals and objectives of the organization. CIP's growth over the last five years has expanded its ability to ensure sound decision making at all levels of the organization. The next five years will further push the boundaries of effective and efficient decision making by the design, communication, and implementation of enhanced policies, procedures, and levels of authority to support the SOs.

**Successful organizations must find ways to align their organizational design to reflect all aspects of their current strategy.** The best organizational structures eliminate bureaucracy, simplify working environments, promote cooperation and exchange of ideas, align talented staff into critical positions, and establish processes for seamless knowledge sharing. CIP will promote an organizational structure that will foster interdisciplinary working relationships and cross cultivation/pollination of ideas throughout its scientific programs and across CRPs. CIP will review its organizational design to ensure that the strategy is aligned to the most appropriate structure to allow for the optimal growth of the organization.

**Properly designed policies and procedures empower employees and establish a clear framework on which to operate.** Policies and procedures that are appropriately designed, understood, communicated, and followed are the basis for a well-functioning organization and an empowered workforce. Employees who feel that they are part of management's decision making feel more motivated to comply with and promote organizational systems. CIP will ensure that appropriate policies are discussed at senior levels of the organization so that managers and supervisors feel part of the decision making and better understand the reasons behind changes. We will enhance systems to fully communicate policies and procedural changes and the rationale behind the changes to facilitate full compliance by the workforce.

**Establishing appropriate levels of authority for management creates the foundation for innovative thinking.** Staff who clearly understand the roles and responsibilities of their position will have a more positive impact because they are freed to concentrate on their roles and innovate within that framework. Clearly defined levels of authority also allow the organization to simplify and become less bureaucratic. With clear levels of authority, staff also understand the roles of their peers, thus ending duplication of effort and frustration with tasks left unattended due to miscommunication.

### **1.4 Talent management**

The development of existing staff is a key focus for the next five years to sustain long-term organizational growth. The main focus is to fortify the existing TM program while adding incremental components to the program as organizational capacity grows. CIP must develop programs to engage our staff and recommit them to CIP's mission and vision. CIP will build on the current TM program to strengthen a culture of performance management, professional development, and succession planning.

**Challenging employees to perform at their highest level is instrumental in achieving the SCP.** The TM program creates processes for employees to evaluate their performance over the course of the year. These tools and processes are supplemented by a career development and succession planning structure that rewards an RBM culture. Though the basic foundation has been created in the TM program, incremental improvements must be implemented in years to come. CIP will build greater transparency into the process, including a clearer path for promotions and career advancement based on concrete achievements, peer review, and evaluations. We will monitor

the market to ensure that our TM program stays competitive with both the public and private sectors while ensuring internal equity.

**Professional development is an essential tool for retaining, training, and rewarding staff while creating CIP's future leaders.** Development of the resources to accommodate both young and mid-career scientist and professional staff is challenging. Mid-career staff require assistance with emerging technologies, and younger staff need programs to assist in management and strategic topics. To respond to this challenge, CIP will work in conjunction with other CGIAR Centers to transform itself into a learning organization where staff eagerly seek new skills and training and adopt new technologies to work more efficiently and deliver greater results. CIP will seek out training opportunities and technologies that are used by other Centers or develop them together.

CIP will reinforce positive leadership behaviors, engender a culture of M&E and learning, and adopt an organization-wide program management model. We will take advantage of new learning models to accelerate core competency development. We will create a mentoring and leadership program to develop the next generation of leaders. Researchers and professionals will be offered ongoing training in emerging technologies so that the Center continues to innovate.

Successful succession planning within CIP is the internal gauge to ensure that other aspects of the TM program are working. When key positions have clear succession plans in place over the short and long term, it will indicate that CIP has proper recruiting, performance management, and professional development in place to ensure CIP's continuity. To make this happen, we must expand upon our succession planning initiative by growing its pool of future leaders, whether internally or externally. We need to both identify high-achieving individuals and seek to augment this pool with potential leaders from other organizations. We will create processes to review and evaluate current staff with both managers and people teams, to design succession planning charts across all levels of the Center and look for potentially partner Centers willing to participate in shared succession planning sessions.

**Table 1.** Deliverables

CO	Area of Emphasis	Deliverable
Growing Together	Next generation of researcher and professional	<ul style="list-style-type: none"> <li>• Three outreach programs designed and implemented to attract young scientists to CIP</li> <li>• Increase gender equity within the organization to 50% of females in management</li> <li>• Join CGIAR Consortium postdoctoral program and recruit 10 new post-docs per year</li> <li>• Implement new recruiting software</li> <li>• Join two new recruiting services connected to R&amp;D</li> </ul>
	Empowering staff and decision making	<ul style="list-style-type: none"> <li>• Create communities of practice</li> <li>• Review policies annually</li> <li>• Define levels of authority for all key positions</li> <li>• Create leadership and supervisory training</li> </ul>
	Talent management	<ul style="list-style-type: none"> <li>• Create succession plans for all key positions</li> <li>• Include in the performance evaluation the RBM metrics of the SOs and RTB</li> <li>• Training programs will include 75% staff participation</li> <li>• Create a mentoring program</li> </ul>

## CO 2: Expanding Organizational Capacity

### 2.1 Summary

The six new SOs require new thinking and skills to propel CIP forward successfully. They will stretch the organization as it expands along the R&D continuum both up and down the impact pathway. To meet these new demands CIP must grow the capacity of the organization to support this expansion. CIP aims to become an innovative and reliable investment partner to donors, partners, and stakeholders, in support of its SOs. This will be achieved through internal capacity strengthening and collaboration with other CGIAR Centers to bring the best practices from across the Consortium into CIP's operating environment.

CIP will apply strategic program management and sound project implementation by strengthening institutional project management capacity to achieve sustainable and responsible growth. Donors and the international scientific community increasingly recognize the importance of data management and knowledge sharing as a means to optimize impact. CIP will maximize its position as a major producer of International Public Goods to ensure maximum global access for all intellectual assets produced. Intellectual assets management, knowledge-sharing strategies, and learning processes will be formulated and developed at the project level and connected to all levels of the organization.

CO 2 is built around these two principal initiatives (see Table 2 for CO 2 deliverables):

- **Program and project management.** CIP will focus its efforts around program and project management capacity building to respond to increased donor demands for cost-effective results.
- **Knowledge management.** CIP recognizes management of knowledge as a strategic priority. We are committed to develop KM strategy in order to consolidate an institutional KM culture; to promote organizational learning; and to realize the greatest value out of the products, lessons, and best practices that result from its R&D activities.

### 2.2 Program and project management

To grow and deliver impact in line with our donor expectations, CIP will improve its program and project management capacities across the organization. The project life-cycle model is the perfect framework for this effort and needs to be implemented in a decentralized and externally focused fashion. Project management efforts will be articulated around project portfolios within the different SOs.

#### **Effective and efficient program and project management is a requirement for all R&D projects.**

The current industry trend is to adapt traditional project management methodologies to R&D. CIP has followed this trend in that more than 65 staff members have already received formal training in project management. The strengthening of the project management culture is necessary because both the new CRPs and bilateral projects are now “projectized” and require the same level of oversight and management. CIP will develop a formal project management office within the organization to further standardize and replicate project management throughout the organization. This office will work with all research leaders to make sure that their projects are running smoothly on time, within scope, and within the budget.

#### **Project management thrives when the processes and tools are standardized across the Center.**

To gain the greatest efficiency from a project management system, standardized training must be implemented for the learning to spread throughout the organization. Operating and communicating in the same project management language will be achieved through consolidation and standardization of project management systems and process. These new standards will consist of recognized approaches to project management, techniques, and tools. These will be used to plan, monitor, and control R&D projects and the support systems and technologies to enhance program output, outcome, IDOs, and other indicators established in the CRPs to track

project success. OCS forms the foundation as a major tool but must be complemented with other tools like Microsoft Project to complete the picture. CIP proposes initiating a project management community of practice in CGIAR in the context of results-oriented research and CRPs in order to develop a standard of practice and to standardize processes from which all Centers and CRPs can benefit.

**Training and capacity building will support project management success.** The cultural change needed to support a project management environment requires a commitment to training and capacity building, especially of the new generation of researchers and project implementers or managers, as well as supporting units. CIP will use outside organizations to provide training programs on new processes, standards, systems, and tools created in collaboration with CIP. We will segment the targeted population to achieve a higher degree of specialization in project management capacities of research projects and development projects. CIP will tie performance appraisals and career development to incentives around project and program management.

### 2.3 Knowledge Management

CIP is aligned with CGIAR's Consortium Office Data and Knowledge Management Strategy as reflected in its three-year plan, but will go beyond these foundational efforts. CIP will work through the Knowledge Management Community of Practice at the Consortium to focus on four parallel work streams: the data and document delivery pipelines; knowledge capturing, social sharing, and learning processes and tools; people and culture; and the technology platforms.

**Data and document delivery pipelines.** On the basis of the CGIAR's principles, policies, and guidelines, CIP will adapt its internal processes to fully operationalize the new Intellectual Assets and open access policies. These, together with the right set of quality standards and controls, will constitute the framework and the foundation to manage the processes of the data and document delivery pipelines: data and document collection, archiving, curation, sharing, and reuse. Systems will be in place to guarantee accessibility and fitness for purpose.

**Knowledge capturing, social sharing, and learning.** Aside from developing the capacity to capture and store valuable research data and information, CIP will roll out a first set of processes and methods to capture knowledge and connect people to this knowledge. Social sharing of knowledge and learning must take place throughout the organization to ensure that cross-collaboration and closer connections are created between department, regions, and SOs. CIP will continue to participate and offer to lead on the CGIAR's effort to implement a Consortium-wide SharePoint platform. This platform will encourage cross-project learning, best practice transfer, and after-action reviews. Case studies will constitute the first set of initiatives. CIP will also create communities of practice across the organization that will work to bring social learning to the forefront to ensure that CIP is connecting processes, methods, tools, and technology platforms across the organization.

Considering the importance of social interaction for information and knowledge exchange, CIP will continue to promote active participation in these communities of practice, will strengthen the internal "Seminar Series," and will implement a "Knowledge Café and Resource Center" as a new and fresh platform for informal and formal scientific and intellectual interaction and organizational learning.

**People and culture.** Consolidating the effort of existing KM initiatives and building a robust internal CIP KM team to properly accompany and capitalize on the system-wide plan are essential. This team will lead the Center through the cultural change required for KM to blossom and will operationalize this change. It will be built by starting with a more strategic use of existing resources and gradually complemented with additional technical and specialized skills acquired through collaboration on KM with other CGIAR Centers. Training, capacity building, and the right set of incentives will consolidate a KM culture at CIP and throughout the Consortium.

**Platforms and tools.** Technology enables KM. CIP will automate critical processes whenever possible, and will leverage and expand on existing technology platforms that have proven to be

efficient and effective at the CGIAR level or in the international science community. Short-term priorities will focus on quick wins such as data- and document-sharing platforms that maximize immediate and long-term benefits.

**Table 2.** Deliverables

CO	Area of Emphasis	Deliverable
Expanding Organizational Capacity	Program and project management	<ul style="list-style-type: none"> <li>• Create a new project management office that will coordinate projects across the organization</li> <li>• Train 200 staff members on project management</li> <li>• Implement formal annual project reviews</li> <li>• Implement new collaborative tools including SharePoint and Microsoft Project</li> <li>• Create a project management community of practice</li> </ul>
	Knowledge management	<ul style="list-style-type: none"> <li>• Implement recommendations from CGIAR on KM</li> <li>• Lead implementation of SharePoint in CGIAR</li> <li>• Establish communities of practice</li> <li>• Create a Knowledge Café and Resource Center in Lima</li> </ul>

## CO 3: Financial Stewardship

### 3.1 Summary

CIP has experienced steady revenue growth over the last five years due to increases in funding for both CRPs and traditional bilateral projects. The portfolio growth necessary to achieve the next SCP requires further revenue expansion across the organization. In the short term, revenue growth will continue through the expansion of the CRPs and the scaling-up efforts of SO 1. In the medium term, it is necessary to support scaling-up technologies beyond SO 1 and the search for the next flagship products. Organizational growth must happen in parallel with the adoption of more sophisticated financial management strategies across the organization. This includes a stronger financial management systems, performance management tied to return on investments (ROI), and focused resource allocations.

CO 3 is built around three principal areas of emphasis and objectives (see Table 3):

- **Financial Management Systems.** CIP’s expansion along the R&D continuum increases its obligation to ensure sound financial stewardship for a growing portfolio.
- **Performance Management.** A metrics-driven, results-oriented culture is essential to meet CIP’s new challenges.
- **Focusing Resources.** CIP recognizes that to successfully achieve the growth envisaged by the SOs, it must prioritize resources to focus research and operations on achieving global food security.

### 3.2 Financial stewardship

CIP must continue to find innovative solutions to support financial management decisions at all levels of the organization, starting at the grassroots project level and expanding up through the country, regional, and global levels. Real-time financial analysis and reporting is a goal of this effort. Larger and more diverse research projects funded by multiple sources require that CIP has a flexible financial management system. The key areas of focus to achieve these goals are an innovative ERP accounting system, financial training, and financial policies and procedures.

**The anchor of a sound financial management system is an innovative ERP accounting system.** CIP’s use of the OCS ERP ensures that the financial management systems have a robust engine to

generate sound financial decisions. This cloud-based system will maintain CIP's presence on the cutting edge of integrated financial management systems within CGIAR, as it allows for access anywhere in the world to real-time financial reporting. CIP will continue to develop the functionalities of the OCS and share these innovations with other Centers to ensure that future management needs are incorporated into the system. CIP will also continue to lead the innovative uses of OCS, whether through timesheets and project costing and billing or integration of countries offices into the system. This leadership will benefit future Centers preparing to implement OCS.

**OCS is a decision-making and management tool in the toolbox of the staff, researchers, and senior management.** To ensure that this new system is the power of financial management, systematic training must take place to make sure that all staff know and understand its abilities. Staff will be trained and prepared to use a stronger and more powerful system and the reports that assist in CIP's day-to-day business. Training in financial management will be extended to lead researchers and project managers as well as accounting and finance personnel. Increasing the fiduciary responsibility of leaders across the flagship products and the organization is critical for future success. The training necessary for the full use of OCS requires resources dedicated for the training of staff in Lima and around the world. This will not be accomplished by CIP alone. A collaborative effort to train and improve the tools set provided by OCS is organized by the 10 Centers participating in this effort.

**An organization must have a foundation rooted in modern policies and procedures designed to complement its systems and the strategy.** CIP must adapt many of its policies and processes to the changing global realities to ensure that what was originally designed for the home office in Lima is applicable to the global environment. As CIP grows during the next five years, it must recognize that policies and procedures designed for a medium-sized organization require review and alignment for larger projects spanning multiple countries and continents. Furthermore, CIP will adjust policies and procedures to account for an expanded donor base and to meet requirements to comply with the new terms and conditions of bilateral projects and more complicated accounting conditions. CIP will further develop baseline policies that can be adapted to adhere to local laws and customs of the countries where CIP works. These policies and procedures will support a decentralized decision-making authority and increase effectiveness and efficiency of the process.

### 3.3 Performance management

The donor community is looking for innovation and impact on a quicker basis. Agricultural research centers are being challenged to move science and technology through the research pipeline as efficiently and effectively as possible. Therefore, a metrics-driven, results-oriented performance management culture is essential to meet the challenges presented by the new SOs. Efficiency and productivity in the use of resources will be enhanced through a more rigorous approach to research management that will follow recommendations from CGIAR on RBM. A focus on ROI, research pipeline management, and a more business-like approach to research management ensures the success of the SOs.

**Having the greatest impact for our beneficiaries in the long run will determine our success.** Many donors are looking at how their funds are used as a way to determine both potential opportunities and project success. As CIP implements its new SOs, we must focus on a number of metrics to measure our input efficiency and success in using donor funding. CIP will follow the metrics established through CRP RBM. One metric to measure the input efficiency is to calculate the total cost of the intervention per beneficiary. This will allow CIP to ensure that we are maximizing use of donor funds. Another metric is the actual ROI based on the calculation of the economic return for the beneficiaries using the donor's investment. CIP will continue to review other metrics that can take into account the long-term return on ROIs, the effects of investments on gender, and the quality of the internal rate of return. These financial metrics will complement traditional research and project indicators that measure agricultural success. CIP will use these

financial metrics to evaluate project proposals and ongoing projects to align with the CRPs and the RBM program.

**Efficient and effective management of the flagship and linked products along the research pipeline is essential for performance evaluation.** As more donors begin working with the private sector on R&D projects, they recognize the difference between the private and public sectors in how each group manages its research pipelines. CIP will respond to the requirement for performance evaluations and establish a more rigorous review of the research pipeline. CIP will create stage-gate reviews of the performance from both a technical and financial standpoint. These reviews will help manage the flagship and linked products and ensure that the Center is focused on the most promising results. These stage-gate reviews will use new metrics that track the financial and scientific results, taking into account both the long- and short-term requirements of a balanced portfolio of research.

**Launching a new model of research management is essential to ensure that CIP is competitive into the 21st century.** The balance between public and private research is beginning to grey as more donors require greater accountability for their donations. The need to review the management practices of the Center is essential to increase productivity and efficiency. CIP will require business plans for new substantive investments, including a rigorous performance management plan to monitor progress. CIP will look to attract young scientists who already understand these requirements. CIP will roll out training programs to support these tools to ensure that staff can manage to these new standards. CGIAR's OCS, which allows us to link accounting, HR, procurement, budgeting, grants and contracts, research, and project management functions into one system, will help us implement these new performance management practices.

### 3.4 Focusing resources

CIP recognizes that to achieve the growth envisaged in the SOs successfully, it must prioritize resources to focus research and operations on achieving global food security. A keen focus on maximizing ROI will provide the guiding light toward effective and efficient management and resource allocation. The key areas to ensure maximizing of ROI include a focus on flagship products, new funding models to support basic science, and the efficient management of indirect costs through shared services and full cost recovery.

**CIP must find new funding models to support the basic science that will create the flagships of tomorrow.** The Center's "core funding" was the backbone of the basic science of the organization. As CGIAR's funding model changes, so too must CIP change the way it funds its basic science. The majority of basic science funding is through the CRPs. CIP will augment this funding with new dynamic funding from other sources to ensure innovation, exploring models that are already used in other CGIAR Centers to pursue new funding opportunities. One of these models is to build pockets of funding into the projects related to more impact-focused activities. Another model is to develop third-party entities that will funnel funds back to CIP to support the core mission. CIP will explore all possible funding sources to ensure that future flagships are funded today.

**The adoption of clearer, more flexible, and results-oriented sets of operational processes will allow for the more effective use of indirect funds.** The traditional view of the Center as a self-contained "city-state" must give way to evaluating services based on value for money and examination of all non-core functions to ensure competitiveness. CIP has already established strong full-costing standards and will look to rationalize costs further by designing proposals that capture increases in the operational effectiveness of our resources. CIP will continue to lead the way in the creation of new shared services across CGIAR, beginning with the OCS. The need to operate as a true consortium is paramount to a more competitive CGIAR. We will continue to push in that direction.

Table 3. Deliverables

CO	Area of Emphasis	Deliverable
Financial Stewardship	Financial management systems	<ul style="list-style-type: none"> <li>• Implement phase two of OCS</li> <li>• Share innovations in OCS with other CGIAR Centers</li> <li>• Train all accounting and project leaders to fully use OCS</li> <li>• Train project leaders on basic accounting and financial principles</li> <li>• Create new financial policies that incorporate the new OCS system</li> </ul>
	Performance management	<ul style="list-style-type: none"> <li>• Use metrics from the CRP RBM system</li> <li>• Create additional institutionally based metrics</li> <li>• Create stage-gate reviews of project and research performance</li> <li>• Institutionalize performance management plans</li> </ul>
	Focusing resources	<ul style="list-style-type: none"> <li>• Review methods for funding basic research</li> <li>• Prioritize internal resource allocation to SOs</li> <li>• Reduce the indirect rate to 15%</li> </ul>

## CO 4: A Strategic Approach to CIP’s Marketing, Branding, and Business Development

### 4.1 Summary

The new SOs provide CIP with new marketing programs, and an opportunity to craft powerful brand messages and transmit them to the audiences with which they will have the maximum impact. To do this CIP will develop a comprehensive marketing and branding strategy to exploit our strengths. This strategy will align target audiences with CIP the institution, each strategic objective and CRP, the projects that CIP administers, and the products that result from each of them. Recognition of these layers and acting upon them deliberately will help ensure that CIP’s success stories reach the appropriate audiences in a timely fashion. The main audiences include donors, partners (including the scientific community), and beneficiaries. Support for these efforts must be included in project budgets in the proposal stage.

CO 4 will focus on four principal areas of emphasis (see Table for CO 4 deliverables):

- **Business development.** CIP will build a robust business development capacity to capitalize on new business opportunities and ways to engage with traditional and nontraditional donors and partners.
- **Structured marketing.** CIP will market itself—the institution, the new SOs/CRPs, projects, and products. Through this approach CIP can effectively exploit the opportunities inherent in each tier and tie it to an audience’s expressed need. Marketing will be prioritized by return on customer investment.
- **Messaging matrix.** CIP will dedicate resources toward identifying key audience information needs and develop messages for each SO based on these needs for each marketing tier.
- **Communication toolkit.** CIP will develop strategic branding, publications, and media initiatives to convey messages to each audience.

### 4.2 Business development

New business development (NBD) is an area that goes hand in hand with the new SOs. If CIP desires to scale out the technologies and innovations along the impact pathway, it must strategically approach donors and partners. As the funding model has changed within CGIAR, so

too has the competition across R&D organizations. Therefore CIP must expand and coordinate NBD across the organization. It must both think strategically at the high levels of the organization and ensure that every employee knows how he/she contributes to business development. The country and regional offices will act as the ground floor for gathering intelligence and contacts, whereas Lima can provide the resources and multidisciplinary teams to develop the proposals. A sound new business development effort includes developing a strong donor base, targeting strategic partners to implement projects, and building an effective NBD team.

**The scaling-out of the flagship and linked products can only occur through the growth of the project portfolio.** CRPs will continue to be a critical funding source. But to secure growth and expand along the R&D continuum, we must expand the donor base and sources of funding. The current SCP challenges CIP to deliver results up the impact pathway—a move that opens up new sources of funding. New sources of funding that CIP will target over the next five years include development funding from traditional donors; development banks; donors from emerging economies, including the BRICs; philanthropy; and the private sector. Many of our traditional donors have multiple sources of funding and, and as CIP *with its development partners* begins delivering results on development impacts, it will be able to tap this new source of funding. Philanthropy can emerge as a source of funds for creative “discovery” research to feed the research pipeline in the long run, as well as for targeted capital campaigns. New sources of funding could come from approaching private sectors who by their very nature are profit oriented and could help CIP develop income-generating enterprises that could benefit our stakeholders. CIP will also capitalize on existing corporate social responsibility initiatives. For instance, the private sectors in the regions could support micro-enterprise project start-ups through loans or business planning and support. CIP will develop specific business plans at the country/regional level for each of these targeted new sources of funding.

CIP is uniquely positioned along the R&D continuum to play a strategic role as a broker or convener of stakeholders in the formation and building of effective partnerships. CIP’s unique contribution is in its holistic perspective, afforded by its understanding of the underlying principles in agricultural innovation and of the needs and context of next users and ultimately target beneficiaries. As part of its business development activities, CIP will formulate partnership plans at the project level to identify the partnership roles necessary to maximize impact. The partnership roles will include strategic relationships and networks to ensure scale-up, and project implementation roles to ensure scale-out. In addition, the plans will consider elements such as the application of participatory approaches to ensure project ownership, as well as the evaluation of capacity-building needs to ensure greater sustainability and reduced dependence on external interventions. Depending on the nature of project, CIP will engage upstream science and private industry commitments anchored in mutual objectives and accountability.

CIP’s goal is to optimize its institutional experience and establish itself in this essential role by effectively formulating, facilitating, and leveraging distinct actors along the continuum. In this role, CIP is well positioned to build a wide range of partnerships at the global, regional, and local levels with actors such as governments, research institutions, civil society, national programs, and the private sector.

**The backbone of the NBD process is strong leadership and flexible multidisciplinary teams.** A designated leader, empowered and supported by flexible multidisciplinary teams to identify and respond to opportunities, is critical to NBD. CIP will recruit an NBD leader who can assemble teams within CIP to develop country and regional plans to capture new business. CIP will expand the capacity of the current staff with training of researchers and project staff in intelligence gathering, marketing to donors, and proposal development. CIP will capitalize on the existing expertise and skills of researchers and build upon the existing business intelligence and fundraising capacity to have a formal NBD team. NBD is also the job of every member of CIP. Every interaction a potential donor or partner has with CIP is an opportunity deliver a message. A revitalized NBD effort will be communicated at all levels of the organization and across areas and regions to be effective and efficient.

### 4.3 Structured marketing

**Structured marketing segments CIP's marketing opportunities into tangible communications assets.** This tiered approach (explained above) presents opportunities that are overlapping and interrelated. Each tier must be able to stand on its own and benefits from the success of other tiers. For instance, the success of product marketing reflects positively on the institution, and institutional success will shine a positive light on the SOs.

An example of this tiered approach to marketing is the OFSP flagship. OFSP is a product that stakeholders can relate to and actually hold in their hands. It can be marketed specifically to beneficiaries, agricultural ministries, and donors. OFSP's success was incorporated into the marketing of the donor-related projects and the overall OFSP regional programs.

The marketing of the OFSP occurred on multiple levels. Because CIP developed the variety, the positive light that shined on OFSP reflected positively on CIP. With the development of SOs, more programs will be launched with distinct products. Both programs and products can be marketed to their respective audiences all under the auspices of the CIP. This multilayered approach allows CIP to segment audiences and deliver messages that each can relate to.

### 4.4 Messaging matrix

**A messaging matrix will align audiences with the appropriate messages.** Of critical importance to this effort is the reliance on research to ascertain the needs of each audience and how each expects to receive information. Each segment has distinct audiences; however, any single audience may benefit from hearing information from more than one or all segments. Identifying audiences by tier, therefore, is important since it helps target campaigns more efficiently. Audiences will also be prioritized by return on customer investment. CIP will analyze how its marketing dollars are spent to evaluate what impact marketing to a particular audience yields in terms of revenue. This information will help CIP prioritize its marketing efforts to maximize this return. In this way, CIP can support each SO's marketable strengths, an approach that will benefit the areas that are harder for donors to appreciate fully, such as upstream scientific research.

### 4.5 Communications toolkit

CIP will develop a new communications toolkit to exploit the new opportunities that emerge from this layered approach. Building upon its existing communications foundation, CIP will build strengths in branding, publications, and media to send our messages to our prioritized audiences.

**The CIP brand is at a state where it could easily be built upon.** CIP has a recognizable logo and brand within agricultural research circles. It is especially well known as the lead Center for RTB. CIP will work to maintain and strengthen its brand position to the world through RTB and within its traditional audiences who already have a favorable perception of the organization.

CIP's positioning outside of agricultural research circles is unclear. CIP must conduct research on the current level of brand awareness that it has in the agriculture and development arena and identify the brand qualities of successful players in this arena that could be emulated. CIP may subsequently rebrand itself based upon the results of this research.

Brand ambassadors are CIP employees who communicate directly to our audiences. To be successful this requires development of an internal marketing culture that will seep into personal interactions with key audiences at meetings and events, on CIP site visits, during NBD meetings, and any other personal interaction where CIP needs to be positively portrayed by its staff. This begins first by defining the roles of directors and senior managers. Eventually this will be rolled out to staff at-large through policies, training, and positive reinforcement through communications.

**CIP delegates will attend meetings and events that our target audiences do, and will have exhibits at select events.** A well-monitored CIP brand will be apparent in CIP presentations, exhibits, and literature to reinforce CIP's organizational sophistication. CIP will also do community outreach activities in locations where it has a research presence, starting in Lima. Finally, to reinforce CIP's thought leadership position, we will hold or partner with an organization to

organize a conference that brings together leaders in food security issues to discuss solutions to emerging issues, successes stories, and to network. To reinforce CIP's global reach, this conference should rotate through the regions where CIP has a presence. Such a conference could also promote CRPs and sister Centers. This will improve CIP's status as a research institution, thought leader, preferred partner, and an honest broker.

**CIP will continue to support its strong publication capability and expand capability into digital publications and infographics.** These enhancements will simplify CIP messages and attract and hold the attention of our audiences. In consideration of donor emphasis on impact, marketing publications will emphasize success stories reflecting improved socioeconomic status of CIP's target groups. This will increase in importance under the new SOs as we anticipate that more effort will be put into measuring and evaluating and potentially less into publishing in peer-reviewed journals. Marketing publications that emphasize CIP's success stories will fill this gap.

**For an organization like CIP, placement in well-regarded scientific journals is essential to maintain our scientific credibility in addition to sharing the results of our work with peers.** It is important to promote publications more aggressively to reinforce CIP's profile in the scientific community and to reinforce donor perceptions of CIP as a research institution with substantial contributions to the body of science. Communications in support of scientific publication will be prioritized to reinforce CIP's research foundations.

**CIP will develop strategic media priorities; network with journalists; and reinforce its position as a resource on food security, agriculture, economics, technology, and potato-related stories.** CIP will capitalize upon the good news that it generates and publicize it. CIP will recruit its scientists, social scientists, and leadership to blog about innovations and achievements; outside experts will be enlisted to blog on behalf of CIP. Arrangements will be made for CIP news to appear on the news feeds of peer institutions and science sites.

CIP's story placement capabilities span the range of sections in a traditional newspaper—from economics, lifestyle, and food, to science, technology, and general interest news. These linkages will be exploited to raise awareness of our good work. Moreover, each SO will have a corresponding media relations campaign, and regular announcements of success stories will be published in a timely fashion. Messaging and protocols will also be developed to respond to tough issues such as GMOs and obesity. A range of spokespeople will be trained on how to speak to media and manage media issues.

**CIP's web presence will become more robust and contemporary in the coming months and years.** We must promote our research expertise and development success regularly online. Our work should be actively pushed to key audiences through social networks. Staff will be empowered to contribute through blogs, photos, and videos, and share opinion and perspectives to position CIP as a thought leader with innovative solutions to complex food security problems. This effort will also display CIP's diversity of talent and expertise within the organization.

CIP's website must also become a KM portal and the first stop for researchers and others who want to mine data or discover research publications on potato, sweetpotato, and our ARTCs. CIP will work with the Consortium Office and other Centers to develop the KM portals that will lead CIP in the future.

Much of the success of CIP's online presence will depend upon the empowerment of the Center's thought leaders to share information and freely expound on their areas of expertise. More frequent updates about CIP's news and information on the web, cross-postings on social media sites, linkages to other institutions, and increased site visits will propel CIP's web presence to a respectable position among our peers and to audiences with which CIP has yet to engage.

Table 4. Deliverables

CO	Area of Emphasis	Deliverable
Strategic Approach to CIP's Brand Image and Marketing	Business development	<ul style="list-style-type: none"> <li>Target new funding sources from China State Council Leading Group on Poverty Alleviation, IFAD, World Bank, private sector, and philanthropy, USAID, development partners</li> <li>Improve the partnership-vetting processes</li> <li>Partner with five new development organizations to help the SOs go to scale</li> <li>Hire a new leader of the global NBD team</li> <li>Develop proposal teams and processes for proposal development</li> <li>Implement corporate social responsibility platform</li> </ul>
	Structured marketing	<ul style="list-style-type: none"> <li>Perform a brand audit</li> <li>Complete reputational research (CIP and peers)</li> </ul>
	Messaging matrix	<ul style="list-style-type: none"> <li>Complete an audience analysis</li> </ul>
	Communication toolkit	<ul style="list-style-type: none"> <li>Establish branding guidelines</li> <li>Train 200 brand ambassadors</li> <li>Host 2 agriculture and development conferences</li> <li>Create 4 media relations campaigns</li> <li>Create 2 thought leadership campaigns</li> </ul>

## CO 5: Safety, Health, and Environmental Sustainability

### 5.1 Summary

CIP recognizes that safety and health are fundamental to achieving our organizational goals and mission. CIP is committed to providing a safe work environment by creating and sustaining a strong safety culture based upon the concept of “safety—a habit for life.” CIP is creating a global standard of safety, health, and environment (SHE) that allows us to grow and decentralize responsibly while carefully managing all aspects of safety, including security risks associated with increased global expansion. We strive to maintain the highest standards to preserve our environment and protect and enhance the safety and health of our staff. As a result, these efforts can help retain staff, boost productivity, and pave the way for greater employee engagement.

CIP is increasing its safety and health awareness and defining its objectives in accordance with local laws and through a systematic approach for immediate implementation. We are achieving this through the formulation of an SHE framework, demonstrating CIP's global commitment to safety and health. CIP recognizes the importance of duty of care to its staff, and takes critical steps to ensure their health, safety, and well-being.

CIP believes that creating a safe and healthy workplace is a moral imperative. We are committed to environmental sustainability by conserving resources and reducing waste generation. We recognize that leadership commitment provides the motivating force and resources. Staff participation is an expression of commitment to safety and health protection. CIP also recognizes that it is part of CGIAR and sister Centers, which share the same challenges and commitments to the principles of SHE. CIP will collaborate with other Centers as appropriate to develop systems, tools, and processes and share all metrics for a better CGIAR.

CO 5 is built around three principal areas of emphasis and objectives; deliverables are shown in Table 5:

- **Safety.** CIP is committed to providing a safe workplace according to all local safety regulations by addressing risks involved at work. We will empower all staff to reduce risks through organized educational campaigns.
- **Health.** CIP will promote the achievement of a high standard of occupational health and injury management programs, while gaining commitment for a healthy and safe workplace.
- **Environment.** CIP will strive to become “green” by focusing on environmental conservation.

## 5.2 Safety

As CIP expands globally, the need for safety measures has increased. CIP is responsible for providing a safe work environment. By doing so, it commits to reducing and managing risks/dangers through the implementation of an SHE plan and safe practice procedures, including training and use of personal protective equipment.

**CIP’s duty of care is to safeguard each and every employee.** It includes developing a travel safety program that includes pre-briefings, immunization requirements, travel ID cards, and local briefings by location for staff on security issues. As one of the 15 CGIAR Centers across the world, we face political unrest and challenging workplace safety conditions. CIP will coordinate with member Centers to align our crisis management plans per location, medical evacuation plans and protocols, and emergency brigades as part of an emergency preparedness plan. CIP will work with the Consortium’s Shared Services Unit to collaborate on the development of security protocols around the world.

**CIP’s responsibility is to provide a safe work environment for all staff, free from hazards and complying with local regulations.** CIP will strengthen its safety protocols and risk maps by identifying job hazards and maintaining close monitoring in risk areas such as the laboratories, agricultural fields, and greenhouses. This includes enforcing safe work practice behaviors as indicated in relation to CIP’s Health and Safety manual. Health and safety in the workplace are about preventing work-related injury and disease, and designing an environment that promotes well-being for everyone at work. We recognize that knowledge is the key element in providing a safe work environment: if everyone knows the correct procedures, accidents and injuries can be minimized.

**Evaluation, metrics, and continuous improvement must be part and parcel of our safety culture.** We must develop safety management indicators linked to process hazard analysis, operating procedures, pre-startup safety reviews, and compliance audits. Accidents are usually caused by unsafe acts and/or unsafe conditions. We want to reduce our injuries to zero. A key activity is to identify hazards and correct unsafe acts through training and proactive behavior (employee participation). We will use the following indicators to benchmark our offices globally: corrective actions, employee participation, safety awards, incident/accident rates (i.e., lost time injury, first aid injury, and frequency rates). We recognize that accidents can only be eliminated by including and involving the staff and active leadership participation. We will move towards a culture of interdependence where everybody looks out for each other. CIP considers that evaluation and corrective action is crucial to ensuring continuous improvement. M&E of the SHE program will be done through annual audits and supervisor evaluations. The audit results will be shared throughout the respective areas at CIP so that the required corrective actions can be implemented immediately. These audits will help support CIP’s effort in maintaining the SHE program as a priority in all aspects of work.

## 5.3 Health

CIP cares for the health of its staff in relation to the safe practices at the workplace. In assessing the current situation, CIP has become proactive by implementing safety and health initiatives at HQ, focused on risk identification, safety education, and prevention programs (e.g., nutrition) related to occupational safety.

**Occupational health is CIP's priority.** Occupational health programs integrate medical surveillance and risk assessment to improve the occupational health of the staff. CIP has developed five occupational test protocols associated with certain job positions in HQ: laboratories, field workers, maintenance, drivers, and administrative. CIP will roll out the occupational health program globally. In addition, CIP will perform job hazard analyses (according to the chapter 16 of the Health and Safety Manual) to ensure a continuous improvement loop.

**Promoting good health and nutrition for mothers and children is at the heart of what we do.** CIP will promote nutrition programs (e.g., lectures on nutrition, good eating habits presentation, etc.). Additionally, CIP will deliver health-related training programs such as ergonomics and vaccination campaigns, throughout the organization in all locations to reinforce healthy behaviors.

## 5.4 Environment

**CIP will incorporate corporate environmental responsibility as a new organizational discipline.** Corporate environmental responsibility and sustainability are being adopted more and more by organizations and corporations at a global scale to protect our planet. We are committed to “being green” and will implement current technologies to achieve this goal.

CIP will begin by implementing the three main areas of environmental sustainability of reuse/recycle programs, natural resource conservation, and energy conservation. We will reduce our environmental footprint by raising awareness and carrying out training for promoting efficiencies in water usage, waste management, and energy consumption. Our goal is to achieve a 3% annual reduction in energy consumption to reach our goal of 10%.

CIP will accomplish this goal by incorporating environmental awareness into our daily business through key initiatives such as environmental responsibility programs to use our resources efficiently, minimizing waste, and reusing or recycling materials. Units will contribute to the confinement of batteries, recyclable trash separation, and promoting other ecological actions among our staff. Another initiative is to promote safe and sustainable management of chemicals and chemical waste, including CIP's management plan of hazardous waste generated from laboratory and field/greenhouse operations. The resource conservation regarding water and electricity will be possible through awareness programs. Moreover, the Good Agricultural Practices implemented in CIP's farming operations, including preparation of irrigation plans in all CIP farm stations to improve water efficiency, are reinforced by educational programs for staff on environmental protection and assessment of environmental impact from our agricultural stations. Finally, CIP can tap into CGIAR initiatives to reduce its carbon footprint through the efficient use of resources and minimizing carbon inputs. Our carbon-neutral efforts already are underway.

The success in achieving these goals will provide the basis for a strong safety culture at CIP globally. We want to foster the most engaged, health and safety-conscious staff, an environment where each employee will become ambassadors of research projects upholding the highest standards for safety and health and are environmentally conscious. This will help reduce incident and accident rates, employee turnover, absenteeism, and compensation costs. This strong safety culture will help CIP become a safe and environmentally responsible institution.

Table 5. Deliverables

CO	Area of Emphasis	Deliverable
Safety, Health, and Environmental Sustainability	Safety	<ul style="list-style-type: none"> <li>• Establish a duty of care policy</li> <li>• Establish a crisis management plan at <b>all</b> offices</li> <li>• Train 75% of staff on personal security and safety</li> <li>• Roll out the Health and Safety Manual to <b>all</b> offices</li> <li>• Develop metrics and audits to monitor progress</li> <li>• Roll out occupational health program globally</li> </ul>
	Health	<ul style="list-style-type: none"> <li>• Roll out occupational health program globally</li> <li>• Perform job hazard analyses</li> <li>• Create 4 nutrition and health campaigns promoting healthy lifestyles to staff</li> </ul>
	Environment	<ul style="list-style-type: none"> <li>• Promote global programs on reuse/recycle, natural resource conservation, and energy consumption</li> <li>• Perform energy audit of Lima</li> <li>• Achieve 3% annual energy reduction in Lima by up to 10% over 5 years</li> </ul>



The International Potato Center (known by its Spanish acronym CIP) is a research-for-development organization with a focus on potato, sweetpotato, and Andean roots and tubers. CIP is dedicated to delivering sustainable science-based solutions to the pressing world issues of hunger, poverty, gender equity, climate change and the preservation of our Earth's fragile biodiversity and natural resources.

[www.cipotato.org](http://www.cipotato.org)



CIP is a member of CGIAR.

CGIAR is a global agriculture research partnership for a food secure future. Its science is carried out by the 15 research centers who are members of the CGIAR Consortium in collaboration with hundreds of partner organizations.

[www.cgiar.org](http://www.cgiar.org)