Working title:
The Strategic Plan for Research of the International Potato Center 2006-2016

A roadmap of CIP's Strategy

Introduction **How we will get from our Vision to the Strategy**

Chapter 1 **What are our strategies for global science?**
- **Genetic resources**
- **Genetic enhancement and crop improvement**
- **Integrated crop management**
- **Natural resources management**
- **Innovation Systems**

Chapter 2 **How we connect our research to the Millennium Development Targets**

Chapter 3 **How we will keep a research for development focus and improve the livelihoods of the poor**

Chapters 4-7 **What we will do in the regions**
- **4 Latin America and the Caribbean**
- **5 Sub-Saharan Africa**
- **6 South, West and Central Asia**
- **7 East, Southeast Asia and the Pacific**

Chapter 8 **How we will position ourselves for future growth and to make an impact**

Each regional chapter has a standard set of headings

Context and trends
Targeting
Needs and opportunities
Research for development themes
- Reducing temporal and chronic hunger among poor communities
- Linking farmers to markets
- Facilitating sustainable intensification of potato and sweetpotato-based farming systems
- Improving access to safe and nutritious food
- Promoting sustainable use of biodiversity
- Developing sustainable and healthy horticulture in and around cities

Partnering for Impact
Impact assessment

Contents

Executive summary vi
Introduction: from Vision to Strategy ix
Chapter 1: Global science strategies 1
1.1 Genetic resources 2
1.1.1 Global context: the changing scenario for genetic resources 2
1.1.2 CIP context: positioning CIP genetic resources in the global scenario 3
1.1.3. Outlook 3
1.2 Genetic enhancement and crop improvement 4
1.2.1 Global context 4
1.2.2 CIP context 5
1.2.3 Outlook 6
1.3. Integrated crop management 9
1.3.1 Global context 9
1.3.2 CIP context 10
1.3.3 Outlook 10
1.3.3.1 Molecular and biological tools for understanding evolution of insect and pest populations 10
1.3.3.2 Crop modeling and GIS for analytical and predictive purposes 11
1.3.3.3 Ecosystems research for improving crop productivity and sustainability 11
1.3.3.4 Information, innovation and Information and Communications Technologies 12
1.4 Natural resources management 12
1.4.1 Global context 12
1.4.2 CIP context 13
1.4.3 Outlook 14
1.5 Innovation systems 14
1.5.1 Global context 14
1.5.2 CIP context 15
1.5.3. Outlook 18
1.5.3.1 Strengthening systems capacities 18
1.5.3.2 Policy 18
1.5.3.3 From international public goods to improvements in the livelihoods of the poor 19
1.6 Conclusion 19
Chapter 2: Pathways to Impact 20
2.1 Sustainable use of biodiversity 22
2.2 Reduce temporal and chronic hunger in vulnerable communities 22
2.3 Improve access to safe and nutritious food 22
2.4 Link farmers to markets 22
2.5 Sustainable intensification of potato- and sweetpotato-based farming systems 23
2.6 Sustainable and healthy horticulture in and around cities 23
2.7 Institutional learning for pro-poor change 23
Chapter 3: The Pro-poor Research for Development Cycle 24
3.1 Enhancing impact 24
3.2 CIP's research and development process 24

3.3 Stages of the Pro-poor R&D Cycle 25
3.3.1 Targeting 26
3.3.2 Needs and opportunities assessment 27
3.3.3 Research for development 27
3.3.4 Partnerships for Impact 28
3.3.5 Impact assessment 29
Chapter 4. The strategy for Latin America and the Caribbean 30
4.1 Context and trends 30
4.2 Targeting 33
4.3. Needs and opportunities 33
4.4 Research for development themes 34
4.4.1 Promoting sustainable use of biodiversity 34
4.4.2 Reducing temporal and chronic hunger among poor communities 35
4.4.3 Improving access to safe and nutritious food 35
4.4.4 Linking farmers to markets 35
4.4.5 Sustainable intensification of potato-based farming systems 36
4.4.6 Sustainable and healthy horticulture in and around cities 36
4.4.7 Institutional learning for pro-poor change 36
4.5 Partnerships for Impact 37
4.6 Impact Assessment 37
Chapter 5. The strategy for Sub-Saharan Africa 38
5.1. Context and trends 38
5.2 Targeting 41
5.3 Needs and opportunities 42
5.4 Research for development themes 46
5.4.1 Promoting sustainable use of biodiversity 46
5.4.2 Reducing temporal and chronic hunger among poor communities 46
5.4.3 Improving access to safe and nutritious food 47
5.4.4 Linking farmers to markets 47
5.4.5 Sustainable intensification of potato and sweetpotato-based farming systems 48
5.4.6 Sustainable and healthy horticulture in and around cities 48
5.4.7 Enhancing capacity for innovation 49
5.5 Partnerships for Impact 49
5.6 Impact assessment 50
Chapter 6. The strategy for South, West and Central Asia 52
6.1 Context and trends 52
6.2 Targeting 54
6.3. Needs and opportunities 55
6.4 Research for development themes 56
6.4.1 Reducing temporal and chronic hunger among poor communities 56
6.4.2 Improving the access to safe and nutritious food 56
6.4.3 Linking farmers to markets 56
6.4.4 Sustainable intensification of potato and sweetpotato-based farming systems 56
6.4.5 Sustainable and healthy horticulture in and around cities 57
6.4.6 Enhancing capacity for innovation 57
6.5 Partnerships for Impact 57
6.7 Impact assessment 58

Chapter 7. The strategy for East, Southeast Asia and the Pacific 59
7.1 Context and trends 59
7.2 Targeting 60
7.3 Needs and opportunities 61
7.3.1 Potato 62
7.3.2 Sweetpotato 64
7.4 Research for development themes 65
7.4.1 Promoting sustainable use of biodiversity 65
7.4.2 Reducing temporal and chronic hunger among poor communities 65
7.4.3 Improving access to safe and nutritious food 65
7.4.4 Linking farmers to markets 66
7.4.5 Sustainable intensification of potato and sweetpotato-based farming systems 66
7.4.6. Sustainable and healthy horticulture in and around cities 66
7.5 Partnerships for Impact 67
7.6 Impact assessment 68
Chapter 8. Positioning for growth and impact 69
8.1 Preserving the core and responding to challenges 69
8.2 Research excellence 70
8.3 Enabling and empowering 70
8.3.1 Capacity strengthening 70
8.3.2 Communication and public awareness 71
8.4 Comparative advantages in research 71
8.5 Key features of CIP's operations 71
8.5.1 Organizational structure 71
8.5.2 Staff diversity 72
8.5.3 Partnerships 72
8.5.4 Impact assessment 72
8.5.5 Knowledge management 72
8.5.6 Decentralization 72
8.6 Acquiring resources 73
Literature Consulted 75

Executive summary

The Strategy of the International Potato Center (CIP) sets out a program of research for the next 10 years that is aimed squarely at contributing to the achievement of selected targets of the Millennium Development Goals (MDGs).

The Strategy follows from CIP's Vision, published in 2004, which maps out the content of the Center's research and development activities in relation to the Center's mission and the context in which it operates. The MDGs guide CIP's research program, to ensure that the outputs of the work are translated into improvements in the livelihoods of the poor and so contribute to the MDGs. In addition to the specific well known goals, the MDGs also demand a larger space in our agenda for cross cutting issues such as gender considerations in technology development and in the workplace, closing the communications technology gap, capacity strengthening that empowers local decision making.

CIP's mandate crops are potato, sweetpotato and other Andean roots and tubers. In this strategic plan we introduce two new research areas. We take advantage of modern genomics to propose work more with other members of the solanaceous family and our experience hosting the CGIAR Systemwide Program Urban Harvest and issues of health and agriculture to propose a program on safe and healthy horticulture in and around cities.

CIP was founded as a crop improvement center based on the premise of beneficially utilizing the world collections of its mandate crops to make advances in crop improvement and crop protection. We refer to this as our core business. This strategic plan confirms our continuing dedication to this long term founding agenda while at the same time affirming our support for the role that CIP must play in a 21st century global agricultural innovation system.

CIP is a research institution with a global mandate. As such, CIP has a number of global research functions, specifically genetic resources, genetic enhancement and crop improvement, integrated crop management, natural resources management and innovation systems.

CIP's global strategy on genetic resources will be to conserve diversity to help farmers to grow more food on less land, directly support efforts to sustain farmers' traditional knowledge and customs in conservation and production, and safeguard and maintain the flow of genetic material around the world. CIP will acquire knowledge on the structure of diversity and the evolutionary and phylogenetic relationships of root and tuber crop biodiversity, improve integrated conservation approaches, and participate as an expert partner in the emerging Global Genetic Resources System.

In genetic enhancement and crop improvement, CIP will takes a crop focus on improving the productivity and quality of sweetpotato and potato varieties and enhancing capacity to adapt them to local needs and opportunities. Sweetpotato work will emphasize pro-vitamin A, starch accumulation and resistance to weevil; for potato, durable resistance to late blight and viruses – all in varieties that will meet farmers' and consumers' needs for production and use. Compelling new challenges

include tolerance to drought and heat stresses; improving agricultural systems; more nutritious food systems; and innovative solutions to critical, recalcitrant traits such as bacterial wilt of potato and sweetpotato virus disease complex. CIP will exploit the genetic similarities of the Solanaceae family to collaborate in crop improvement of selected high value vegetable members of this valuable plant family. CIP will continue to practice and contribute to quantitative genetics, and remain a center of excellence in breeding of vegetatively propagated crops.

CIP will focus its global agenda on integrated crop management on developing molecular and biological tools for understanding evolution of insect and pest populations, crop modeling and GIS, ecosystems research for improving crop productivity and sustainability, as well as innovation systems theory for crop management. We will expand our work on high value urban and peri-urban horticulture systems, focusing our integrative skills on issues of food safety and occupational health of urban farm families.

Natural resources management will complement germplasm research, aiming at increasing productivity while improving the sustainability and reducing the vulnerability of the rural poor. Work will include developing frameworks, tools and methods to identify research needs and opportunities for commodity and food systems research in representative geographic and agroecological target sites. It will also integrate interventions generated by CIP and other key partners in those sites. Research will also seek to develop and validate resilient systems, and to develop robust food systems.

CIP will use innovation systems thinking to conduct research that generates knowledge, and identify the processes, mechanisms and organizations that will apply and re-use research knowledge. Emphasis on strengthening systems capacities will allow the innovation systems approach to produce knowledge more efficiently and use it more effectively. CIP will also take advantage of its partnership programs to improve the articulation of the research processes with the development needs and engage in research to understand impact pathways related to CIP's outputs within the innovation systems framework. We will continue our contributions to sector analyses and policy that promotes sustained development.

The CIP Vision introduced an iterative research and development paradigm called the Pro-poor Research and Development (R&D) Cycle. This Cycle is a comprehensive framework for generating a focused research agenda, producing outputs and outcomes, and following through to tangible impact on the livelihoods of the poor.

The Cycle is a continuous iterative process with a number of clearly defined stages. Targeting exercises produced a global picture based on the geographical overlapping of different indicators such as poverty, hunger and mortality rates on to potato and sweetpotato distribution maps. This work allowed CIP to focus its efforts in the future on 36 countries in eight regions. This is followed by needs and opportunities assessment that allows for effective research for development, and the development of linkages and partnerships for scaling up and out the utilization of research outputs by users. Continuous assessment of impact at the different stages of the cycle ensure an influence on the MDGs. Effectively, CIP has redefined its role to be a ***research***

partner for development by adopting new ways of defining research priorities and finding innovative ways for interaction and intervention in its areas of operation.

CIP's Strategy implements the Pro-poor R&D Cycle through a number of research and development themes that are grounded in regional realities. Looking to respond to the MDGs, important global trends and conceptual shifts, CIP defined a series of key themes that create a logical connection between its research program and its contribution to the MDGs, in fact representing pathways to impact. These themes, which are fundamental to the content of the Strategy, are sustainable use of biodiversity; reducing temporal and chronic hunger in vulnerable communities; improving access to safe and nutritious food; linking farmers to markets; sustainable intensification of potato- and sweetpotato-based farming systems; sustainable and healthy horticulture in and around cities; and institutional learning for pro-poor change.

CIP is a global research institution that operates regionally, where most development work is done. The regions that CIP has defined are: Latin America and the Caribbean, Sub-Saharan Africa, South, West and Central Asia, and East and Southeast Asia and the Pacific. The common set of research themes will be pursued in each region. However, each region will have different requirements and priorities, which will be laid out in a series of regional strategies. For example, combating late blight through resistance breeding and integrated management will be a common activity across regions, but in Latin America and the Caribbean, there might be a focus on improving nutrition of Andean inhabitants and conserving the rich agrobiodiversity in native potatoes. A strategy for Sub-Saharan Africa will take into account the needs of two broad regional groups: eastern and southern Africa and West Africa. Specific activities might include cost-effective strategies for scaling-out orange-fleshed sweetpotato and breeding orange-fleshed sweetpotato to combat vitamin A deficiency and improve diet quality. The strategy for South, West and Central Asia might include sustainable production in the small hillside farms and innovative technology in multiple cropping systems, while in East, Southeast Asia and the Pacific emphasis might be placed on simple and affordable ways to extend the storage life of fresh roots.

Capacity strengthening, knowledge generation and communication and public awareness will be important activities assuring that CIP's outputs will be used by all possible interested stakeholders. CIP continues to pioneer effective utilization of research networks, seeking to refine this approach to partnering as an efficient method for organizing joint efforts with a regional or global focus when numerous research partners exist. Activities will also include impact assessment, which is an integral part of the Pro-poor R&D Cycle to inform and feed back information for improved iterations of the cycle.

Introduction: from Vision to Strategy

This paper sets out the research strategy of the International Potato Center (CIP) for the next 10 years. It builds on the CIP Vision[1], which resulted from extensive consultations with a wide group of stakeholders. The new Vision takes an extended look at the future and maps out the programmatic content of the Center's research and development activities in relation to the Center's mission and the context in which it operates. CIP's stakeholders agreed that the Millennium Development Goals (MDGs) should guide CIP's program. The MDGs are defined through targets. The vision affirmed our commitment to eight of them.

BOX

CIP'S Vision

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

BOX

Millennium Development Targets

Through its research and in collaboration with development partners CIP can contribute to:
MDT 1: reduce extreme poverty by half
MDT 2: reduce hunger by half
MDT 5: reduce the under five mortality rate by two thirds
MDT 6: reduce the maternal mortality ration by three-quarters
MDT 9: integrate principles of sustainable development and reverse the loss of environmental resources
MDT 11: improve the life of 100 million slum dwellers
MDT 13: the special needs of the least developed countries
MDT 18: make available the benefits of communications and information technologies

The CIP Vision set the scene for the preparation of this Strategy, and provides complementary information on many of the issues discussed here. The CIP Vision introduced an iterative research and development paradigm that we call the Pro-poor

[1] The citation for this and other literature consulted in the preparation of this document are listed in the final section.

Research and Development (R&D) Cycle. The Pro-poor Cycle is further developed in Chapter 3 as a methodological compass to ensure that all the Center's activities contribute to improving the livelihoods of the poor. The MDG framework focuses efforts on real people in real places.

At the time of the Vision exercise, we made first steps towards developing a Strategy. We realigned our research program into research divisions and partnership programs. Our research divisions are our concentrations of disciplinary expertise that we bring to focus on research challenges. Our partnership programs help us reach out to partners to assure that their priorities are recognized in the Center and our outputs become outcomes and eventually impacts. We also conducted an initial targeting exercise overlaying indicators of measures such as poverty, hunger and nutrition onto maps of potato and sweetpotato zones to identify priority countries and focal regions. That exercise identified 36 countries in eight regional groups that we consider priority geographical targets in our work to contribute to the MDGs. Those countries and regions are described in more detail in the regional chapters below.

The preparation of this document engaged stakeholders on several fronts. Participatory workshops involved CIP's staff at all levels in all regions to contribute ideas on corporate management, structure and priorities. We also polled our staff, collaborators and other stakeholders on potato and sweetpotato science needs and opportunities and we estimated possible impacts. A strategic planning team built on these consultations, following the guiding principles of the Vision document, to prepare a draft plan. This draft plan was subsequently validated with a key group of stakeholders and endorsed by CIP's Board of Directors.

As the UN and others observe, progress in reaching the MDGs is faltering through lack of investment. If the development community is serious in its commitment to the poor and disadvantaged, as a whole it needs to redouble its efforts. CIP has an important role to play in these efforts and hence this Strategy also plans for growth of the Center. CIP must preserve and consolidate its core scientific activities with potatoes and sweetpotato for which it has justifiably achieved world renown, but it also needs to do more to ensure that the outputs of this work are translated into improvements in the livelihoods of the poor and so to contributions to the MDGs. As this plan explains, achieving livelihood improvements in different thematic areas means going beyond more narrowly defined commodity boundaries that characterized our work in the previous 10 years.

This Strategy, while based on the MDGs, is grounded in regional realities. More local engagement and a clearer articulation of needs through the pro-poor R&D cycle will enhance the relevance of basic research and the generation of international public goods, which is a central feature of the work of a CGIAR center. The plan makes the Pro-poor R&D Cycle operational through a limited number of strategically defined research and development themes. Introduced in Chapter 1, these themes bring together the strongest combination of CIP's assets to address the MDGs.

This Strategy is targeted at a diverse audience. It is intended as an internal road map to guide CIP scientists as they develop tactical and operational plans. But it is also

intended for our partners and other stakeholders as we recognize that much of what we do will require collaboration with others.

We divide the plan into several parts. Chapter 1 highlights our global commitment and how we engage with the global scientific community. Chapters 2 and 3 show how we will keep a research for development focus. Finally we recognize the specificity of what we want to do at the regional level. Chapters 4-7 detail a series of regional strategic plans that provide more detailed road maps appropriate for local contexts.

We are aware that the world and our ideas are evolving rapidly, so that while this document proposes a 10-year planning horizon, inevitably some parts of it will require revision before the end of that period. The greatest value of this plan is in building consensus around a road map of where we want to go and in generating the commitment and momentum that we need to journey down the routes that are laid down and so contribute to improving the livelihoods of the world's poor.

Chapter 1: Global science strategies

1.1 Genetic resources 3
1.1.1 Global context: the changing scenario for genetic resources 4
1.1.2 CIP context: positioning CIP genetic resources in the global scenario 4
1.2 Genetic enhancement and crop improvement 6
1.2.1 Global context 6
1.2.2 CIP context 7
1.2.3 Outlook 7
1.3. Integrated crop management 9
1.3.1 Global context 9
1.3.2 CIP context 10
1.3.3 Outlook 10
1.4 Natural resources management 12
1.4.1 Global context 12
1.4.2 CIP context 13
1.4.3 Outlook 13
1.5 Innovation systems 14
1.5.1 Global context 14
1.5.2 CIP context 14
1.5.3. Outlook 16

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Page numbers to be updated

In 1971 CIP was founded as a crop improvement center based on the premise of beneficially utilizing the world collections of its mandate crops to make advances to solve globally significant problems with crop improvement and crop protection. Research fashions come and go and the original commodity productivity improvement focus may seem quaint today. However, as our research focus broadened beyond the crop and the field to include the farm, the agro-ecosystem, the farm family and the community, we retained our commitment to the plant and its protection. We greatly value our broadened agenda because it makes us a better informed institution about what might be real solutions for real priorities. However, our real comparative advantage as a partner and participant in the global agricultural innovation system is with the plant, its protection and our 35 years of institutional knowledge of where and how potato and sweetpotato systems in developing countries work.

We refer to this as our core business. This strategic plan confirms our continuing dedication to this long term founding agenda while at the same time affirming our support for the role that CIP must play in a 21st century global agricultural innovation system.

This chapter discusses a number of our global research functions, specifically genetic resources, genetic enhancement and crop improvement, integrated crop management, natural resources management and innovation systems.

In this Strategy we show how the results of our research reach MDG target groups. Those individuals live in particular places with particular circumstances. However,

despite this focus on people in places, some of the science we must do is best conducted on a global scale. CIP intends to fill the role of global provider of technologies that are not logical or economical for other providers with narrower mandates to confront.

Many of the tasks to be undertaken must be done in consortia, sharing expertise, facilities and knowledge. The technology supporting the science of molecular biology or genomics for example requires a substantial fixed laboratory infrastructure. We will seek collaborations with other actors in the global agriculture innovation system to effectively pursue our agenda. We will acquire and use modern information and communications technology with partners to facilitate data acquisition, analysis and sharing. We use this chapter to introduce this portion of our intended research agenda.

1.1 Genetic resources

1.1.1 Global context: the changing scenario for genetic resources

Three major external factors are influencing and re-shaping the way that potato, sweetpotato and other root and tuber crop genetic resources are accessed, conserved and exchanged. First, the new knowledge, methods and practices emerging from comparative biology, modern genetics and bioinformatics offer opportunities for better-informed management and more effective use of genetic resources; likewise the role of genebanks is evolving as providers not only of seeds or clonal material, but also specific traits, quantitative trait loci, alleles and DNA samples. Second, the International Treaty on Plant Genetic Resources for Food and Agriculture sets a legally binding framework based on the principles of the Convention on Biological Diversity (CBD), and brings new contract rules to the Future Harvest Centers by creating a multilateral system of facilitated access and benefit sharing. Third, other global trends influencing the changing scenario for genetic resources include:

(i) global climate change, threatening habitats and causing natural disasters, are expected to increase biodiversity losses in mountain ecosystems such as the Andes where, for example, wild potato endemisms are at risk. Enhancing genebanks' capacity will provide secured conservation to additional collected germplasm and sufficient fresh and healthy seed stocks for restoring crop diversity in farmers' fields;

(ii) the increased market penetration in biodiversity-rich areas tends to favor crop uniformity, this in turn might displace or erode local crops; but, on the other hand, market demand for diversified foods and niche products increases the role of genebanks as diversity providers;

(iii) urbanization can exacerbate migration to cities, increasing the need for *ex situ* conservation and for additional germplasm to meet food requirements in and around the cities;

(iv) increasing demand for healthy and nutritious food on the one hand, and natural resources conservation on the other, call for the identification of nutritional and health promoting variable attributes, and resource-saving efficiency traits in germplasm collections.

1.1.2 CIP context: positioning CIP genetic resources in the global scenario

Genetic resources form the core of the CIP research program. The Pro-poor R&D Cycle dynamically identifies needs and opportunities within research and development themes which in turn provide the pathways for operationalizing CIP's contribution to the MDGs. Priority needs and opportunities are translated into genetic resources contributions on knowledge, expertise, material and facilities. CIP is well positioned to carry out essential functions in genetic resources research for development. CIP's comparative advantages to fill this role include:

(i) its location in the major center of origin and diversity of potato, sweetpotato and other roots and tubers, and the fact that the germplasm CIP holds in-trust constitutes the world's most complete collection of genetic resources for these crops;
(ii) the commitment of the international community to CIP as custodian for the long-term conservation and worldwide availability of this material;
(iii) unique knowledge and information on these resources accumulated through decades of research.

1.1.3. Outlook

These comparative advantages endow CIP with the capacity to carry out global research functions on genetic resources such as:

(i) conserving diversity to help farmers to grow more food on less land, CIP contributes to protect fragile environments, reduce farmers' reliance on agrochemicals, save water and produce more nutritious and healthy food;
(ii) directly supporting efforts to sustain farmers' traditional knowledge and customs in conservation and production;
(iii) safeguarding and maintaining the flow of genetic material around the world;
(iv) using and diffusing the new scientific opportunities offered by modern genetics and comparative biology for acquiring knowledge on the structure of diversity, evolutionary and phylogenetic relationships of root and tuber crop biodiversity, and for improving and integrating conservation approaches;
(v) playing a scientific role in genetic resource policy and genebank management issues, as part of the emerging Global Genetic Resources System.

Precise and extensive phenotyping, i.e. characterization and evaluation of morphological, physiological, pathological and biochemical traits will continue to be a major role of CIP genebank. To do this more efficiently, CIP will strengthen high throughput phenotyping and genotyping capacities by adopting the technological opportunities offered by modern genetics and genomics. These capacities will allow CIP to conduct accurate description and measurement of diversity, determine the limits and gaps of collections, monitor endemisms, assess geneflows and erosion risks, discover allelic variation in its mandated germplasm and discover sources of new traits in related taxa, e.g. Solanaceae. CIP will also use sequence-based genetic markers and conduct and convene research on molecular approaches for pathogen detection and elimination.

CIP will carry out and convene conservation research, including cryopreservation and DNA banking, to enhance the effectiveness and safety of long-term conservation of potato, sweetpotato and other root and tubers. The research will include technical and economic assessment of conservation, dissemination and utilization processes.

In partnership, CIP will conduct targeted collecting missions in endemic, risk-prone areas of the Andes, Southeast Asia, the Pacific and Africa with high numbers of unique or endemic varieties that are at risk of being lost. There, CIP will also partner with local organizations to analyze farmers' managed diversity, assessing *in situ* erosion risk and designing mitigation strategies. In doing this, ethnobotanical and socioeconomic knowledge will be linked to modern biological information. Contributions to community-based conservation of cultivated potatoes, sweetpotatoes and other roots and tubers will receive further attention, especially in relation to on-farm utilization and market opportunities.

To increase the availability of potato, sweetpotato and other root and tuber germplasm with resistance to priority pests and diseases, and with improved quality, CIP will improve the efficiency of characterization and screening methods, and promote the diffusion of information and data worldwide.

In order to make germplasm with nutritional and health-promoting attributes available to partner research programs and other users of genetic resources, CIP will enhance links to related initiatives like the CGIAR Challenge Program on bio-fortification program and the Convention on Biological Diversity cross-cutting initiative on biodiversity for food and nutrition. To carry out this role, CIP will strengthen skills and facilities on high throughput phenotyping, e.g. biochemical screening for genetic variation of key micronutrient and health related factors in potato, sweetpotato and other roots and tuber germplasm.

CIP will also use up-to-date germplasm characterization and screening methods and tools for plant biomass distribution and resource-use efficiency; and will contribute, through research collaboration, to build NARS and other partners' capacities in genebank management, genetic resources conservation and characterization, and policy issues, including access and benefit sharing.

1.2 Genetic enhancement and crop improvement

1.2.1 Global context

Along with safeguarding genetic diversity of staple foods, genetic enhancement for crop improvement is at the heart of CIP's and the CGIAR mission. Plant breeding has made tremendous, direct contributions to the production of more and better food, but CIP's new Vision implies the need for additional characteristics in the varieties we develop, and expanded efforts to assure that their use, and related knowledge and technologies, lead to impact on the MDGs. At the same time, global trends, advances in science and technology, and contingent concerns from society affect what we do, how, and with whom we do it.

Adverse effects of climate change such as decreased water availability and increases in pest and vector populations are predicted to have the greatest impact in developing countries. Geographic information system (GIS)-assisted studies have shown that potato varieties will need greater tolerance to heat and drought, and sweetpotato will need tolerance to even more marginal soils. Globalization of trade and communications will influence supply and demand for agricultural products and may create new restrictions on intellectual property and genetic resources. Science spending to offset the impacts of these scenarios, however, presents a significant gap between those with and without access to technology. Chapter 5, on Sub-Saharan Africa, refers to this as the 'gene-gap', which low-productivity agriculture, slow diffusion of technology from abroad, high disease burdens, and a history of adverse geo-politics only aggravate.

The features of today's global science that are most influential on crop improvement are advances in molecular genetics and information sciences. Information and communications technology (ICT) offers greater connectivity among parties with diverse capacities and objectives.

Molecular genetics is changing our understanding of and ability to manipulate diversity within breeding programs. There is also considerable data linking molecular markers to genes for pest and disease resistance, and also to quantitative trait loci (QTL) that influence important agronomic characteristics. Recent developments in comparative genetics have also demonstrated the validity of exploiting genome information across species.

1.2.2 CIP context

CIP's current concentration takes a crop focus to improving the productivity and quality of sweetpotato and potato varieties and enhancing capacity to adapt them to local needs and opportunities. For sweetpotato we emphasize pro-vitamin A, starch accumulation and resistance to weevil; and for potato, durable resistance to late blight and viruses –all in varieties that will meet farmers' and consumers' needs for production and use. Compelling new challenges include tolerance to drought and heat stresses; varieties to fit the improvement of agricultural systems (including diversification, intensification, and better options for management of farmers' resources); more nutritious food systems; innovative solutions to critical, recalcitrant traits such as bacterial wilt of potato and sweetpotato virus disease complex. For the scientists keeping pace with the rapid generation, and sheer amount of information available to researchers, farmers and consumers is an additional challenge.

Foremost among CIP's assets for crop improvement are the in-trust germplasm collections and broadly based advanced potato and sweetpotato populations oriented to key agroecologies and constraints. We have unique and valuable genetic stocks including superior progenitors for clonal and true potato seed (TPS) breeding. Finally we also enjoy an extensive 'customer base' ready and capable of using appropriate new methods and technologies including improved varieties.

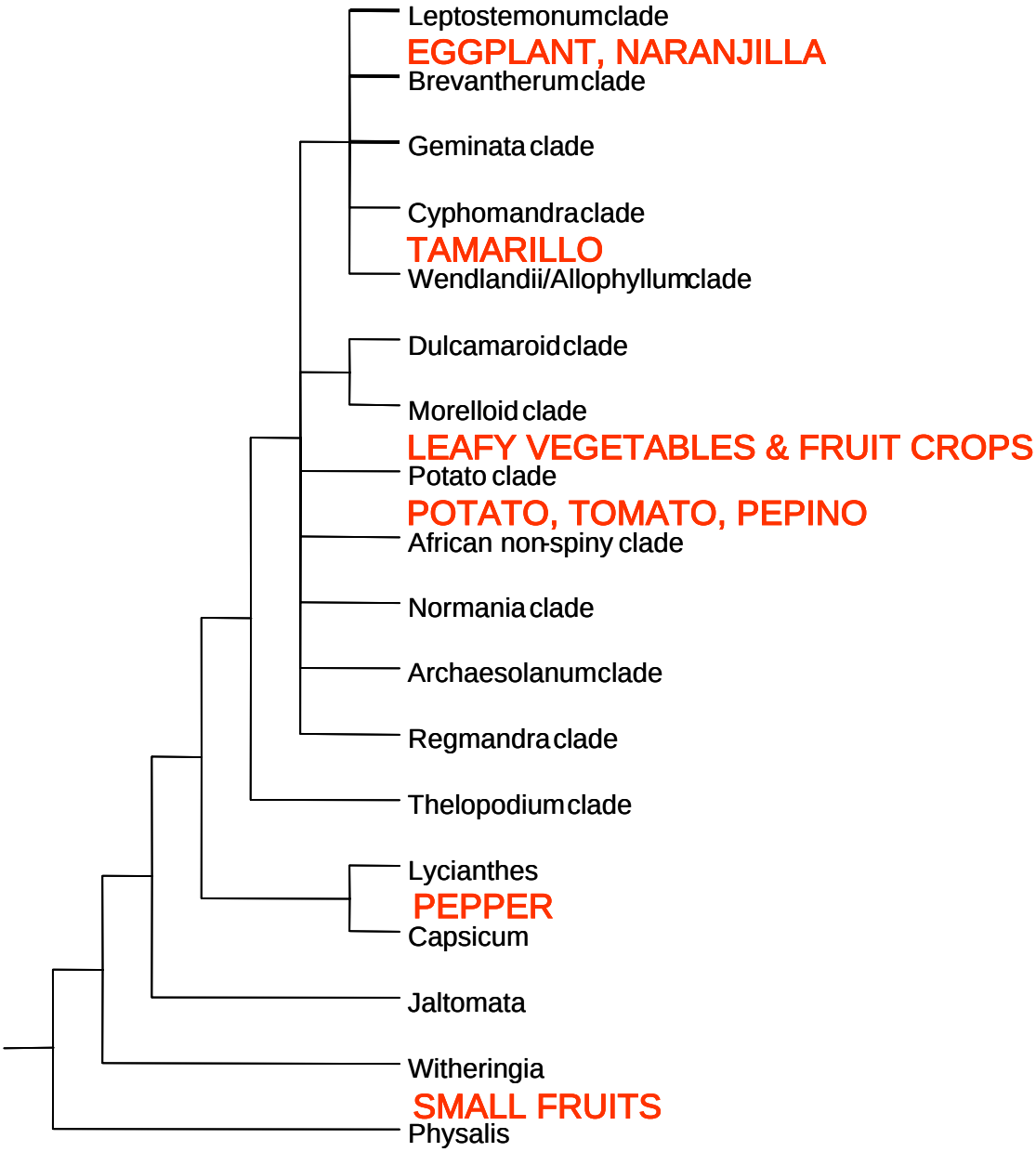
CIP will use and contribute to the development of modern tools of ICT for better partner outreach and responsiveness, 'real time' data analysis, and modeling and

simulation. This will assist predicting the consequences and performance of new genetic combinations in target environments and under distinct biotic and abiotic challenges.

1.2.3 Outlook

Genomics expands the realm of biological research from the study of unique loci, genes and proteins to the study of all genes and proteins. Whereas classical genetics and QTL mapping can be applied to the dissection of complex traits, functional genomics and metabolomics will facilitate the description and understanding of complex developmental, metabolic and physiological pathways and processes. In support of genomics, bioinformatics ranges from querying DNA sequence data to whole-cell modeling. It underlines several specific strategies for using genetic resources in genetic enhancement. Taking advantage of recent advances in genetics, genomics and comparative biology, CIP will continue to practice and contribute to knowledge of quantitative genetics, while applying new methods to monitor gene frequencies, dissect genetic traits, tag and track important loci, pyramid genes, and combine components and traits.

We will identify, develop and disseminate breeding products, technologies and know-how to improve food production, food security and rural livelihoods from root and tuber-based cropping systems in developing countries. We will do this by identifying and committing to a set of carefully weighed objectives and approaches that answer needs and use features of our crops for their direct improvement, systems enrichment and contingent knowledge generation.


Leptostemonum clade
EGGPLANT, NARANJILLA
Brevantherum clade
Geminata clade
Cyphomandra clade
TAMARILLO
Wendlandii/Allophyllum clade
Dulcamaroid clade
Morelloid clade
LEAFY VEGETABLES & FRUIT CROPS
Potato clade
POTATO, TOMATO, PEPINO
African non-spiny clade
Normania clade
Archaesolanum clade
Regmandra clade
Thelopodium clade
Lycianthes
PEPPER
Capsicum
Jaltomata
Witheringia
SMALL FRUITS
Physalis

BOX

The Solanaceae family

The potato is one of 2000 species in one of agriculture's most important plant families, the Solanaceae. This important plant group contains an outstanding array of adaptations, forms and functions, and has served man valiantly with food, drugs, employment and economic wealth since domestication from the wild. Although few of these species can be crossed sexually, discoveries from comparative genetic mapping and DNA sequencing have shown that this diversity rests on a common repertoire of genes, including conserved order in genomes and function in gene networks in response to challenges from the environment. These plants have in common many of the pests pathogens, and metabolic processes we seek to manage in agriculture. An expanded view of plants places not only potato but also sweetpotato in a single phylogenetic tribe demonstrating the degree to which genes and biological processes in these crops are shared by descent. While we now know that certain functions have been conserved across these wide genetic distances and evolutionary timeframes, some characteristics have also evolved in parallel in quite distant branches the family tree.

Exploitation of conserved order and function of genes will yield an overview of diversity that is not available or expressed in any one species. CIP will apply genomic and bioinformatics approaches, including comparative biology and genetics, with diversity and information in related taxa, to reveal and use new genes and new sources of needed traits in germplasm collections and breeding materials, taking advantage of platforms including the Generation Challenge Program and international consortia dedicated to genome sequencing.

CIP will develop new applications of valuable technology such as near infrared spectrophotometry to develop rapid screening methods that can help us gain time in programs designed to achieve genetic gains for crop improvement. We will expand our alliance with the Harvest Plus Challenge Program to bring such technology to bear not only on breeding of sweetpotato and potato, but to serve other crops as well.

CIP will develop and make available bio-diverse, safe, adapted and nutritious potato and sweetpotato varieties and associated tools and knowledge; and we will contribute to the development of capacity and policies that enhance the adoption of these new technologies. We will continue to practice and innovate on classical strategies for population improvement. However, we now have a wide range of tools and a new perspective on what happens in this process and we will apply these lessons to developing more robust products in shorter time frames. For example, CIP and its partners will innovate to improve breeding methods, seeking the best use of genes and gene pools, such as by exploiting heterosis and developing marker-assisted selection. CIP's strategy for genetic enhancement will

expand to consider cropping and food system synergies; shared biochemical pathways; co-hosts and shared responses to challenge in model and/or learning species. CIP will identify and develop value-added traits for products of the mandate crops linked to emerging markets; and apply mechanistic, genetic, phylogenomic approaches to understanding and enhancing resistance and nutritional traits. The program will identify and promote varietal components of better potato and sweetpotato cropping systems and stimulate biodiversity use through the development of potential economic and nutritional benefits from underutilized root/tuber crops.

CIP will apply and improve participatory, multi-stakeholder breeding and selection strategies with improved varieties for farmers, traders, processors and consumers, involving input and interaction with specialists in a range of complementary disciplines including nutrition, communication, product development, etc. to improve the fit and the delivery of breeding products.

Selective application of advances in genetic and information science and technology offer substantial pay-off to applied crop improvement, including the ability to make better choices of germplasm and gene sources for trait enhancement, increased precision in the design of better gene and trait combinations, reduced product development time, and enhanced predictability of performance. Implementation of the strategy will require institutional adaptations including human resource capacity with new skill sets, access to sophisticated facilities (variously, in house or via outsourcing), and new alliances with advanced institutions and the private sector.

CIP is and will remain a center of excellence in breeding of vegetatively propagated crops. We will continue to be a premier source for providing enabling genetic technologies, including candidate varieties with pro-poor characteristics, key genetic and genomic stocks and tools and efficient screening and phenotypic evaluation methods. In this context, the Center will develop and operate an expert lab for quality and nutrition analysis, and advance as an expert consumer of and communicator on relevant crop-related bioinformatics, and contributor to understanding of key processes of biology, production and quality of root and tuber crops,

1.3. Integrated crop management

1.3.1 Global context

As potato and sweetpotato moved from their centers of origin in Latin America, several pests and diseases moved with them and assumed global importance. Late blight (*Phytophthora infestans*), the fungus that caused the Irish potato famine 160 years ago is the world's most costly plant disease, with over six billion dollars spent on control or lost through reduced yields. The late blight fungus is changing and threatens to become more virulent. Sweetpotato weevil (*Cylas* spp.) eats more roots than farmers do in Sub-Saharan Africa. Plant viruses are constantly changing, creating new threats to potato and sweetpotato. Insufficient disease-free planting material is the constraint that has topped the list of farmer concerns since CIP began operating 35 years ago. These biotic constraints, combined with

soil fertility and drought, create a persistent yield gap that still is a priority to address. Only continued, focused, determined work can solve these problems.

1.3.2 CIP context

CIP knows where and why potato and sweetpotato constraints are important. Our decades of experience make us well positioned to provide science-based solutions for crop management. The majority of these constraints can be managed via a combination of appropriate plant cultivars and management strategies. CIP has experienced staff to conduct research and has also a unique position as liaison between advanced research institutions and NARS.

CIP will focus its global integrated crop management (ICM) science agenda on developing dynamic and holistic solutions grounded in deep understanding and fundamental knowledge of biophysical and biological processes, the development and application of modeling, and the design of principles for integration in technical and socioeconomic terms. New knowledge and information will be made available to NARS using suitable training strategies so that they can generate site or regional-specific crop management solutions. Integration will go beyond crop management, including ways to integrate farmer and scientific knowledge, livelihood systems, farming communities and institutions.

The overall aim will be the enhancement of potato and sweetpotato innovation systems. CIP is aware that there are distinct gender roles in potato and sweetpotato food systems and solutions to the development of those systems can have differential impacts on those gender roles. We will continuously monitor our research priorities, the implications of solutions and the potential for uptake with these considerations in mind.

1.3.3 Outlook

To face the challenges described below, the crop management-related research areas of CIP will need to grow in disciplinary terms and number of staff, in order to strengthen our work on crop and pest modeling, epidemiology, entomology, agroecology, and human behavioral sciences. Complementary to this global agenda we will need crop management specialists based in regional locations to support and validate global analyses and the transformation of science into practical applications.

1.3.3.1 Molecular and biological tools for understanding evolution of insect and pest populations

These tools will improve knowledge of pathogen ecology, disease epidemiology and infection processes in relationship with resistance mechanisms and biological and cultural control. Molecular and biological tools will also be useful for improving pathogen detection technologies in both plant and soil systems. They are essential tools for monitoring the detection and spread of known or new pathogens. Molecular tools will also be useful to understand host and pathogen interactions in relation to the environment and management practices and to study the dynamics of pathogen antagonists in the plant and soil. Crop management science will make use of resistant materials and inform breeding programs about the reactions of the materials to specific pest and pathogen

populations. Synergisms among pathogens, cross protection and the role of biochemical, molecular signaling and elicitors within the plants will be explored in close collaboration with breeding science. Molecular markers and fingerprinting technologies will be essential to understand the genetic variability of pathogens and insect pests, which will be used to design and contribute to global alert systems to inform stakeholders of threats resulting from detected and predicted changes in the genetic structure of pest and pathogen populations such as highly aggressive pathotypes. These tools will also be applied for determining the genetic variability of natural enemies such as entomopathogens and parasitoids that will improve their optimal use as biological control agents against pests.

1.3.3.2 Crop modeling and GIS for analytical and predictive purposes

For an institution with a global mandate working in many environments, modeling offers attractive efficiency gains over traditional experimental research methods. Our work in simulation will include the development of multiple trait and constraint modeling, and also cropping systems modeling in coordination with Natural Resources Management science. CIP will integrate process-based and analytical simulation models to predict the effects of stable resistance traits in plant cultivars derived from classical breeding or genetic engineering. Effects of host resistances and management interventions for major potato and sweetpotato pests and diseases will be integrated into validated crop simulation models. Multi-constraint simulation models will be linked with crop growth models to produce virtual field trials. Scenario testing will lead to identification of synergies and tradeoffs among ICM components, which will refine and add value to field validation trials. CIP will be at the forefront of a concerted effort to produce GIS-based maps of major pathogen and insect-pest distributions and make these maps available to stakeholders as decision support aids and to help identify emerging problems. CIP will apply knowledge of specific constraints to develop predictive models of seed quality under different scenarios. Predictive tools will be applied within specific socio-economic contexts to develop location specific and appropriate seed systems, spanning from formal, specialized systems to community-based, on-farm seed production. CIP's seed modeling work will rely on epidemiological knowledge of the main constraints, especially viruses for sweetpotato, and viruses and bacterial wilt for potato.

1.3.3.3 Ecosystems research for improving crop productivity and sustainability

This will be conducted to understand the interactions and relationships of organisms in agro-ecosystems. CIP will conclude an inventory of insect communities in potato and sweetpotato agro-ecosystems. Further, CIP will analyze plant-insect interactions and will assess the efficacy and contribution of antagonists in natural pest control. These investigations will be evaluated in relation to landscape fragmentation and farmers' practice, and their effects on functional diversity and the exchange of species among different habitats. This research will contribute to understanding and designing strategies to stabilize and self-regulate agro-ecosystems to counteract a range of pests and diseases, which will include and prioritize the use of biocontrol-based pest management strategies. For this, an overall understanding and analysis of the biology and ecology of pests' natural antagonists will be essential, including the assessment of their efficacy, and the development of systems for formulation and application.

The evaluation of communication and behavior of insects and the understanding of intra-specific communication within pest species (pheromones), as well as of pest migration capacities and spatial dispersal will be fundamental for developing innovative systems for effective pest management. CIP will use quantitative tools for risk assessment of management technologies in order to support decision-making for scaling-up and out suitable technologies.

1.3.3.4 Information, innovation and Information and Communications Technologies

CIP will make use of modern ICT to link databases of researchers from different locations in the world, so that information can be used for capacity building, planning research or for advising NARS on measures such as quarantine mechanisms or the need to change integrated pest management components according to the variability of pest or disease populations.

Advances in systems theory will be used to facilitate the transformation of information and knowledge into crop management components, which can be adopted by farmers and researchers or extension workers from NARS. Human behavioral sciences will be used to understand and facilitate innovation at individual, group and institutional level, identifying participatory research principles for crop management, identifying appropriate principles for wider adoption, and developing predictive tools for planning and decision-making oriented to scaling-up technologies and methodologies.

1.4 Natural resources management

1.4.1 Global context

Agricultural systems practiced by smallholders in countries where we will work are quite complex. Farm families utilize natural resources (water, soils and biodiversity) with a combination of various crops (potatoes, other root and tubers, cereals, forages), trees and livestock (ruminants and non-ruminants). They operate in systems that are constantly buffeted by biophysical, economic and political shocks. The capacity of the smallholder farm to absorb and recover from these shocks is a measure of its resilience. Resource mining and shrinking farm sizes reduce resilience.

Natural resources management (NRM) research in CIP complements germplasm conservation and crop improvement research, aiming at increasing productivity while improving the sustainability and reducing the vulnerability of the rural poor. NRM research develops frameworks, tools and methods for the identification of research needs and opportunities for commodity and food systems research in representative geographic and agroecological target sites. It also integrates and validates interventions generated by CIP and other key partners in those sites. Finally NRM research seeks to develop and validate resilient systems, thus contributing to the MDGs, specifically those related to sustainability of natural resource use and poverty and hunger reduction.

Providing science-based solutions to MDGs implies incorporating additional components, dynamic interactions, several scales and hierarchies to our research

agenda. In short, we must deal with complex systems. Multi-dimensional problems require skills from many areas and methods to account for their complexity. Research teams addressing the MDGs will need to expand their skills beyond traditional reductionist methods to the tools and methods developed by theoreticians and practitioners of the Complex Systems Science. This implies using measurement theory, the quantification of complexity through appropriate field measurements at different scales, understanding structure and causality, nonlinear modeling, information processing and computation.

Box

Complex Systems
In a Complex System, the interaction between the parts or sub-systems allows the emergence of global behavior that would not be anticipated from the behavior of components in isolation. Complex systems are being found and studied at a huge range of time and space scales from those of a single cell to the entire globe and involve processes ranging from physical or chemical alone to the intersection of biophysics and socio-economics. Complex systems have non-linear relationships among its elements, these relationships have positive and negative feedback loops, changes in the system can be irreversible, the systems are open, may be nested and have boundaries that are difficult to define. These characteristics apply well to smallholder farming systems in developing countries. Complex Systems Science emerged in the 1990 as a space for integrative holistic research
Ziemelis, K (2001) Complex systems-Nature Insight Review, Ziemelis Ed. *Nature* 410: 242-258.

Although the level of complexity is increasing, new tools and datasets, going from field to global spatial scales, are increasingly available. The challenge is how to effectively use data that were collected for different purposes to answer different hypotheses to respond to the questions addressed by CIP research in specific target areas. New protocols will be developed and tested, and new alliances formed.

1.4.2 CIP context

NRM research builds upon databases, knowledge, technologies and practices generated by genetic resources, germplasm enhancement and crop improvement, and integrated crop management research. Data, information and knowledge are being systematized into crop physiology-based models for improved targeting, ideotyping (designing model plants with desired traits), *ex ante* assessment of genotype-by-environment interaction outcomes, and yield forecasts under present conditions and expected environment changes.

CIP has the capacity for systems theory and analyses, especially in non-linear modeling. The Center has developed software based on multi-fractal theory that can facilitate the application of complex systems analyses to biological systems.

CIP is also using geospatial sciences for targeting exercises at different spatial and temporal scales and to assess *ex ante* the expected impact of external dynamics on the vulnerability of food systems. The experience gained includes expertise in the analysis across scales of biophysical and socioeconomic variables.

1.4.3 Outlook

CIP will acquire additional modeling capability to improve the quality and timing of its response to the needs of most vulnerable people. One of the most immediate needs is to combine crop physiology with genomics to improve tools that better assess GxE interactions. The objective is to use improved physiology models to predict gene-to-phenotype relationships. CIP will also acquire process and distribute high-resolution databases required for sub-national targeting. By linking the process-based models with geospatial data, CIP will assist national agencies improve the notoriously poor quality of national root crop statistics as well as their yield-forecasting capacity.

CIP will conduct complex systems analyses to search for the answers needed to develop robust food systems. This implies addressing issues of food availability, access and utilization. Similar tools and methods will be used to assess the vulnerability of targeted food systems to environmental change. CIP will also make sure that findings are translated into useful best practices to foster policy and management actions.

1.5 Innovation systems

1.5.1 Global context

The linear technology transfer paradigm, where CGIAR centers supply technology to NARIs, which pass it on to potential users, is evolving into a new system centered on the concept of an innovation system. The CG system actors and its stakeholders are actively debating the role of the Centers in research and development. Innovation systems thinking helps clarify and define roles for CIP and our stakeholders.

Box

Invention to innovation

CGIAR research institutes are in the business of invention, the creation of new knowledge, processes and products. Innovation is the implementation of a creative idea in a new context with a range of partners and its conversion into a product, service or technology through the interactions of technology users and research and development organizations. Innovations are best encouraged by opening ideas to as many actors as possible so they can pick out and improve the worthwhile ones. Innovation can be enhanced by creating a favorable environment for this to occur, for example, by promoting access and capacity building and by bringing researchers and users together. Careful follow-up can track innovation as it occurs and facilitate the process.

Innovation systems thinking builds on previous work on farming systems and participatory research but widens the range of actors who are considered and pays close attention to the rules, norms and conventions that guide behavior, which shape technological innovation. The innovation systems approach emphasizes both the research that generates knowledge and the processes, mechanisms and organizations that will apply and re-use the stock of knowledge. It strengthens the mechanisms by which user needs are better articulated and understood by research organizations and builds trust to reduce transaction costs.

Potato and sweetpotato sectors in most of the countries where we work are characterized by their high levels of disorganization. They are dominated by small businesses, small holder farmers, informal markets, low levels of government regulatory presence and technical assistance. Low levels of trust and knowledge of the other actors are common. Processes of globalization have created opportunities for new and innovative value chains as millions of farm families shift from subsistence orientation to become emerging commercial operators in an informal sector to eventually becoming a participant in an organized agro-industrial system. These changes can have a profound impact on traditional gender roles and open the possibilities of radically re-defined roles in a modernizing context.

1.5.2 CIP context

Markets and agri-business development are part of innovation systems thinking and help identify the multiple constraints along a market chain that impede technological innovation and provide a framework for bringing actors together to address these multiple constraints. This requires a broad set of partnerships with a larger number of key actors and organizations, including the private sector, as shown in the following illustration.

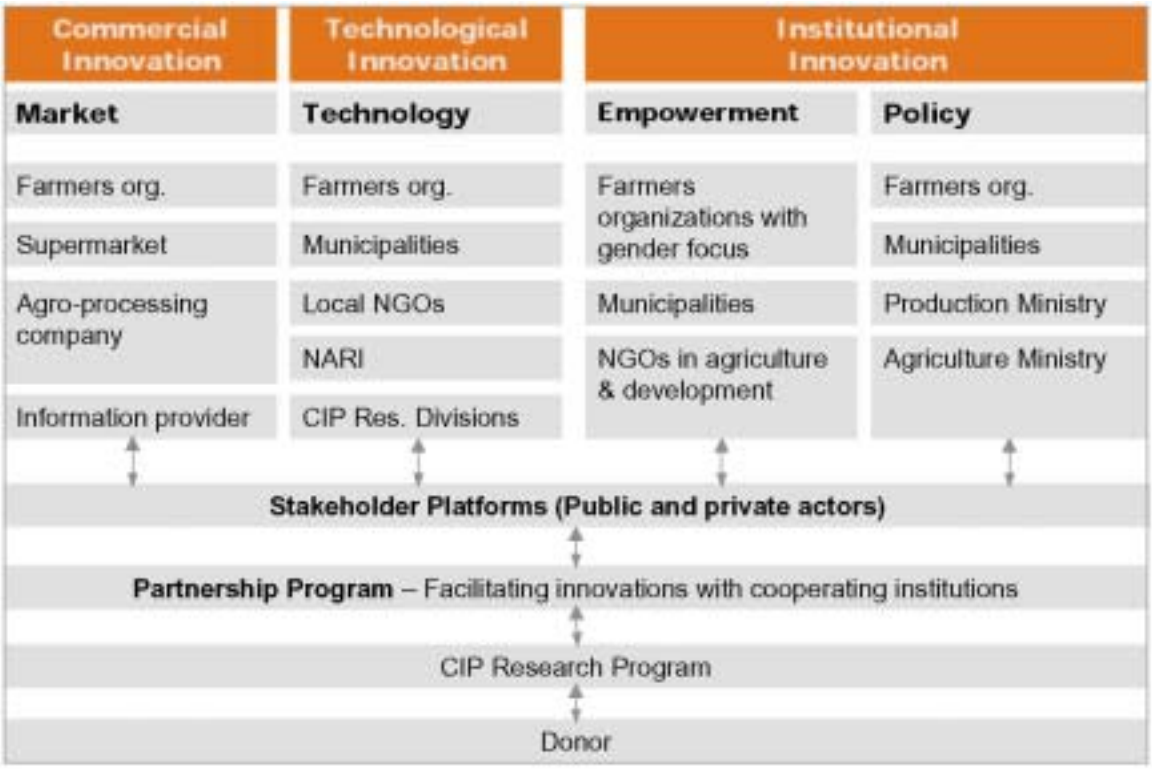


Figure1.1. The range of actors collaborating in a project to improve small farmers' income using the market chain approach

The figure illustrates multiple potential roles for CIP from providing technology solution to policy analysis that supports a positive regulatory or political environment. There will be a need for diagnostic mapping of innovations in priority regions, investigating the nature of innovations processes and how to create innovation system capacity. Action research to study the system will allow us to develop experimentally and learn from experiences. These lessons will be documented, conceptualized and become international public goods in their own right.

CIP will develop the innovation systems approach to understand and improve the articulation of research processes among CIP's Divisions, the way in which CIP works with its partners and the way in which outputs form part of particular interventions and can feed into particular outcomes and achieve impact with local partners. CIP will complement evaluation for accountability to make use of utilization-focused evaluation and program theory to help researchers learn and ensure that the R&D process fits coherently in the R&D cycle. Another aspect of embedding research organizations in a system of innovation is the need to develop relationships and networks that support a dialogue between researchers and stakeholders about challenges and opportunities and potential ways to address them.

The CIP Vision establishes our obligation to see our research imparting benefits to the poor and hungry. Networking and alliances will create more options to identify

key actors for diffusion and scaling up. Closer collaboration with development projects will also provide an opportunity for the uptake of CIP's outputs on a larger scale. CIP will use the innovation systems and market chain approaches to identify key actors to be involved in up-scaling and the key capacities that these actors will need. Based on this analysis, CIP will develop an innovation strategy for each of the geographical areas of integration that includes the relevant R&D themes described in Chapter 1. CIP will promote wider use of the innovation systems framework and other related approaches and methods. It will actively develop approaches for promoting south-south learning, such as horizontal evaluation.

Monitoring and impact assessment in the context of complex innovation systems implies developing methods for tracking innovations as they occur and identifying the bottlenecks that need to be overcome (institutional innovation) and the key capacities that are needed to facilitate innovation processes. It is important to understand the outcomes and impact pathways related to CIP's outputs within innovation systems for guiding the research on monitoring and evaluation of them. The following diagram illustrates the importance of distinguishing the performance indicators between outcomes and impact.

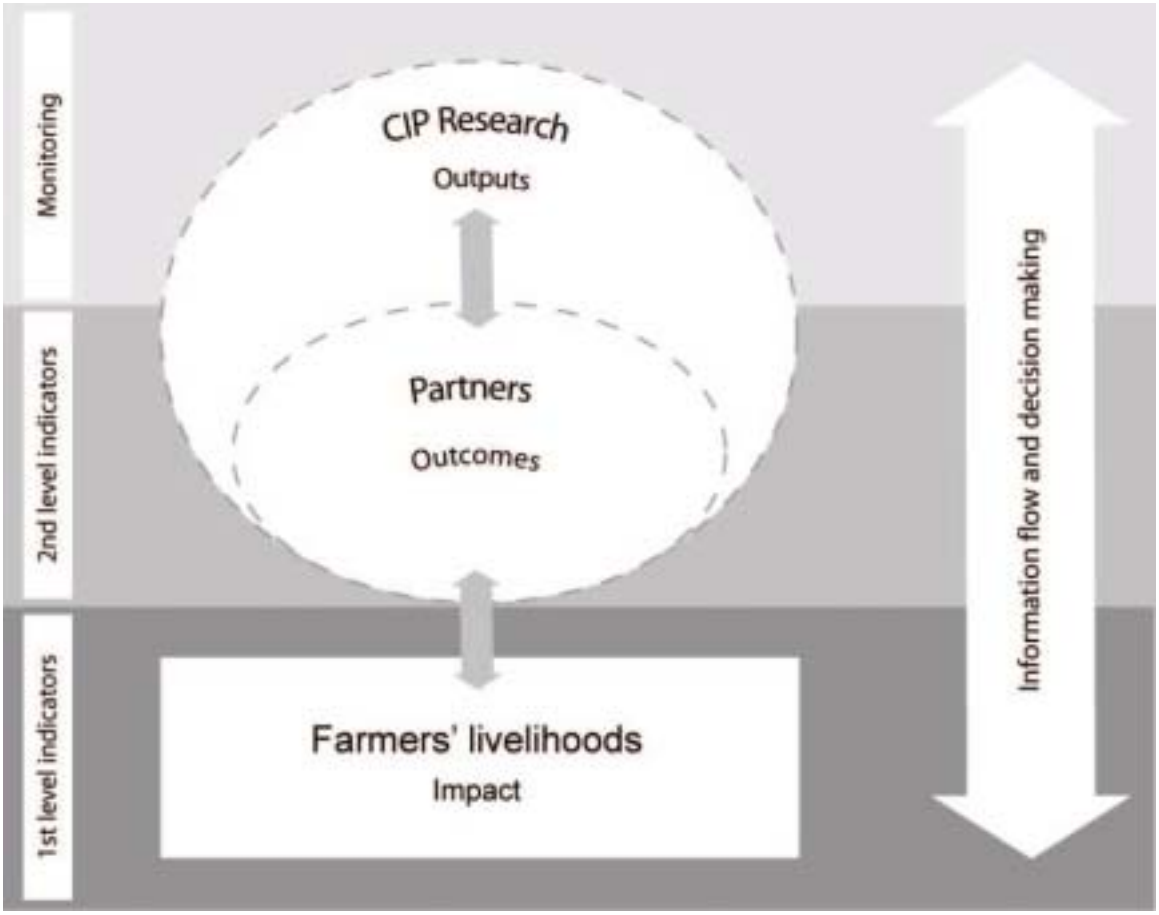


Figure 1.2. Monitoring and evaluation of outcomes and impact

1.5.3. Outlook

1.5.3.1 Strengthening systems capacities

We will emphasize capacity development to accompany the innovation systems approach to produce knowledge more efficiently and use it more effectively. This includes developing systems capacities to strengthen the process of producing knowledge, making it available and accessible, and applying it. CIP will identify and develop key capacities amongst R&D partners to make this possible.

The overall goal of capacity strengthening at CIP is to enhance the structure, organization, conduct and performance of knowledge-intensive institutions that are our partners or clients. We are thus engaged in a process of improving the capacity of actors in the innovation system and we will conduct research to understand the nature of the innovation processes and how to create capacity in innovation systems. CIP will focus on research areas that study constraints in moving to new agricultural paradigms, institutional organization and management as well as information sharing and knowledge management. We will provide and investigate capacity building in areas that are of direct importance our research program priorities including capacity strengthening in priority setting, impact assessment, research management and policy formation.

CIP will provide and investigate research-based approaches to demand-driven training, including learning best practice approaches from these experiences. CIP will focus on processes in adult learning, knowledge structures and competencies, instructional systems development, organization of learning within the organization and policies for regional cooperation and learning networks. CIP will enhance adult education with a learning content-management strategy to produce and share training and learning materials consisting of semantically enriched learning objects using the single-source publishing approach.

1.5.3.2 Policy

As a center with a global mandate CIP should provide policy advice to decision makers in a variety of areas where our global perspective provides us with unique insights. Combining policy analysis with an innovation systems perspective shows where the policy message should be delivered and hints on how to deliver it.

CIP will maintain a watching brief on important global and regional trends in potato and sweetpotato sectors. Our proposed work to improve the quality of root and tuber crop statistics is an example of policy relevant innovation.. We will provide information on the role of potato and sweetpotato in food and nutrition systems. We will monitor and describe major opportunities or threats to important national and international markets for food, feed and fuel. We will monitor the possible impact of climate change on important potato and sweetpotato production regions with a close look at food security and disaster recovery.

1.5.3.3 From international public goods to improvements in the livelihoods of the poor

CIP is faced with the challenge to turn international public goods into improvements in the livelihoods of the poor. As a research partner for development CIP needs to engage in coalitions with multiple partners, including intermediate organizations that are closer to the beneficiaries, such as NGOs, entrepreneurs and national research organizations. CIP will take advantage of its partnership programs to improve the articulation of the research processes with the development needs and to understand better the ways to work with new partners.

Research on pro-poor agriculture innovation systems in priority regions and countries will require the diagnostic mapping of various innovation systems as well as an investigation of the nature of the innovation processes. In order to develop novel approaches for the development of national innovation systems, CIP will create innovative instruments for interaction and intervention in the systems through action research, as well as document successful cases and lessons learnt in support of the innovation systems approach. CIP will continue research about participatory methodologies as a vehicle to:

- Identify multiple constraints along the market chain that impede technological innovation,
- Build farmers' capacity in managing cropping systems and linking them with markets,
- Find ways to add value to CIP's commodities through understanding ways of linking small-holders to markets, and
- Study institutional factors and develop approaches for the creation of coalition and stakeholder platforms.

Finally, CIP will continue to engage in research to understand impact pathways related to CIP's outputs within the innovation systems framework and will develop and adapt methods to measure their contribution to achieving the MDGs, including the issue of attribution.

1.6 Conclusion

In this chapter we described our traditional core business of germplasm conservation and genetic improvement. We compliment that core business with our fundamental investigation in crop protection and natural resources management research. We focus on our role in innovation systems to show how a global center can strategically reach into the realm of local impact and development to draw lessons with global implications. In the following chapters we further develop these concepts and finally anchor them in regional strategies. The regional strategies anchor the global work with real people in real places. The regional strategies fundamentally inform our global work.

Chapter 2: Pathways to Impact

2.1 Reduce temporal and chronic hunger in vulnerable communities 3
2.2 Link farmers to markets..... 4
2.3 Improve access to safe and nutritious food 4
2.4 Sustainable use of biodiversity..... 4
2.5 Sustainable intensification of potato- and sweetpotato-based farming systems 4
2.6 Sustainable and healthy horticulture in and around cities 5
2.7 Institutional learning for pro-poor change 5

During the preparation of the CIP Vision we linked the MDGs to fundamental development problems and identified pathways by which CIP's research can contribute to achieving the Goals. This is always a useful exercise but is particularly important for CIP. CIP is a member of the CGIAR and as such is responsive to a particularly large and diverse group of stakeholders. These stakeholders represent broadly divergent views on the role of the international centers in the global agriculture innovation system and as the first decade of the century unfolds in simplifying terms these have coalesced into two basic views of the centers. The first of these view the centers as providers of basic research that is a global public good. The second sees the centers as partners in research for development that accompany stakeholders to see that research outputs become outcomes and in some cases through to impact.

This strategic plan shows how we can comfortably retain relevance for both views without diluting the effort for either. This chapter illustrates the linkages between those views and shows the relevance of each for the other. CIP has expertise to reach both with a program that informs and strengthens the products of efforts in each direction.

In many of our priority countries potato and sweetpotato production and marketing are the domain of women in the farming families. Thus CIP has long been aware of the importance of gender in development. Gender considerations can affect the allocation, targeting and control of resources in households and communities. It is well known that gender roles can be affected differently by agriculture technologies or policies. We are aware that many of our partners have difficulty recognizing the importance of gender and in converting research findings into development approaches. Each of the themes below will systematically account for the implications of gender in our research and promote and facilitate the utilization of findings in our partnership activities.

During the preparation of the CIP Vision we systematically reviewed and considered various global trends that are relevant to the achievement of the MDGs our agenda. Since then several additional trends have assumed greater importance and received increasing attention. One trend is climate change and its impacts on biodiversity, vulnerability of production systems and impacts on health and nutrition. Another is the effects of pandemics; the effects of HIV/AIDS are shifting

from a phase of infection growth to a more painful phase of growth of death rates. Avian flu is another example of potentially disruptive pandemics for which the CG system can prepare. The market opening, communication and information trends of globalization continue and through the conclusion of international trade agreements are accelerating and their impacts being more broadly felt in our target countries. Urbanization, considered in our vision analysis several years ago, continues and is accelerating, coupled with this is the rapid growth in the global horticulture sector. Different ways of looking at our world have also grown in importance. One is the wider utilization of the integrative concepts of complex systems theory to address the multi-dimensional aspects of sustainable development. Another is the continuing evolution of the organization of international agricultural innovation systems. This strategic plan addresses both of these conceptual shifts.

In preparing this plan we identified key themes which create a logical connection between our research program and our contribution to the MDGs. These themes represent impact pathways that can result from use and adoption of our global research outputs. The table below summarizes the connection the themes provide between the needs of the poor and the millennium development targets. This summarization is illustrative as many research products can contribute to several MDGs at the same time.

Needs of Poor	**R&D Themes**	**Millennium Development Targets**
Access to stable and profitable markets	Link resource-poor farmers to markets	Halve number of people suffering from extreme poverty
Sufficient food all year	Reduce temporal and chronic hunger in vulnerable communities	Halve number of people suffering from hunger
Healthy diet for the family	Improve access to safe and nutritious food	Reduce under five mortality rate Reduce maternal mortality rate
Profitable and healthy farming	Sustainable intensification of potato and sweetpotato based farming systems	Reverse the loss of environmental resources
Diverse crops for multiple uses	Sustainable use of biodiversity	Reverse the loss of environmental resources
Enhanced capacity for innovation	Institutional learning for pro-poor change	Integrate principles of sustainable development into country policies
Secure and safe crop production	Sustainable and healthy horticulture in and around cities	Improved lives of slum dwellers

2.1 Sustainable use of biodiversity

This theme embraces the core reason for the existence of CIP, namely to protect, enhance and make available the rich biodiversity of potato, sweetpotato and little-used Andean root and tuber crops. In this increasingly networked world we must continue to strive to make diverse crops available for multiple uses. This diversification of our diets and uses of agricultural crops helps sustain this important natural resource. This theme captures the range of actions needed to protect, conserve, enhance and utilize the valuable diversity CIP holds in its genebanks.

2.2 Reduce temporal and chronic hunger in vulnerable communities

The unfortunate reality of the world is that despite the great increase in global food production, many individuals and communities do not have physical or financial access to food year round. Vulnerability can be created by many factors, such as remoteness, poverty, marginal ecosystems, pest and disease outbreaks, political instability, climate variability, pandemics and urbanization. Within communities and families, gender is unfortunately a common explanation for hunger. We can focus our own and partners' expertise to reach the vulnerable with solutions that can reduce constraints, create opportunities, improve productivity and reduce risks in the farming systems where the vulnerable live.

2.3 Improve access to safe and nutritious food

Malnourishment puts a vulnerable individual on a downward spiral of bad health that frequently kills. By disrupting access to traditional sources of nutrition, HIV/AIDS and social and political conflicts create large groups of at-risk individuals. The malnutrition "double burden" also involves unhealthy diets and lifestyles associated with urbanization and the large-scale consumption of modern processed foods. Solutions to malnutrition can be through supplementation, fortification and food-based approaches. With our partners we can promote food-based approaches as a viable component of nutrition strategies. Nutrient rich sweetpotato and potato cultivars can contribute to improved diets thus reducing mortality rates caused by malnutrition.

2.4 Link farmers to markets

Many farm families are in poverty traps where their livelihood options conspire to keep them poor. Once food security and health are secured, these families need new options to provide consistent income that enables the family to move out of and stay out of poverty. Local markets once safe from outside competition now face increased penetration from a wide range of suppliers due to globalization and urbanization. Learning to innovate, to collaborate, to engage with market actors and to become more competitive in regional and global markets are challenges for these families. Price and costs are important competition points when engaging in regional or global markets. Despite low production costs, low yields reverse that advantage and make many farmers high-cost suppliers. The desire to compete in markets creates a demand for yield-improving and input-saving technologies and crop varieties with quality and market traits to help close the persistent yield and cost gap. Linking farmers to markets is a theme where we can focus our expertise with partners to assist families leave poverty once and forever.

2.5 Sustainable intensification of potato- and sweetpotato-based farming systems

Most of the world's farms are less than 2 ha in size. In Sub-Saharan Africa and many parts of Asia, farms are still shrinking and may continue to do so for the next several generations. As the farm size shrinks many farm families switch from grains and legumes to root and tuber crops to meet subsistence and income goals. Farms with declining area are managed more and more intensively. The processes of intensification often mine resources, cause erosion or create ecological imbalances that result in pest and disease outbreaks. This theme will focus our attention on solutions for sustainable intensification of farming systems that will stop or reverse the loss of environmental resources.

2.6 Sustainable and healthy horticulture in and around cities

With the dramatic expansion of urban populations in the South and the increasing concentrations of poverty in and around cities, millions of urban households use urban and peri-urban spaces to raise animals and crops as part of their livelihoods. The chaotic character of city growth in our target countries often results in spatially marginalized agricultural production that is vulnerable to urban environmental and health hazards and unable to take advantage of the ecological benefits the city has to offer. Political marginalization deprives urban agriculture of legitimacy, integration in local marketing systems and urban development processes and the chance to contribute to sustainable, livable cities. Urban and peri-urban horticulture is a new theme in CIP's program, though building upon sweetpotato research has been conducted on urban systems in the past, through involvement in the Urban Harvest System-wide Program. Urban and peri-urban horticultural systems will bring CIP's focus on health and agriculture to issues of food safety, occupational safety and sustainable management of intensive systems.

2.7 Institutional learning for pro-poor change

Beyond the provision of particular technologies the poor need to have sustainable access to better technologies. They need to participate in innovation systems where their voices can be heard, they need access to prototype technology that broadly satisfies their many livelihood requirements and they need to be appropriately involved in learning about and testing this technology. CIP has a long history of developing participatory research and more recently has taken on discovery-based learning approaches such as farmer-field schools as a vehicle to build farmer capacity in managing cropping systems and linking with markets. CIP has also begun to acquire expertise in addressing the broader institutional factors that can inhibit innovation. CIP's role in this theme is to investigate how these methodologies, approaches and policy leveraging functions can be improved and what are the benefits that accrue to their use. This theme will directly complement and enhance CIP's other themes and enriches and strengthens its capacity to implement the Pro-poor R&D Cycle as a whole.

Chapter 3: The Pro-poor Research for Development Cycle

3.1 Enhancing impact 6
3.2 CIP's research and development process..... 6
3.3 Stages of the Pro-poor Research for Development Cycle 7
3.3.1 Targeting 7
3.3.2 Needs and opportunities assessment..... 8
3.3.3 Research for development 9
3.3.4 Linkages and partnerships for scaling up and out 10
3.3.5 Impact assessment 10

NB
Page numbers to be updated

3.1 Enhancing impact

CIP aims at enhancing the contribution of its research to the MDGs. This means research will be conducted in close interaction with development efforts, so that scientific progress can respond to development goals such as poverty and hunger reduction. However, development, as a final goal, is not the result of a single technical intervention or a single institution, but the combination of a complex set of institutional and organizational actors from both the public and private sector.

For this Strategy, CIP adopted a paradigm that integrates the concepts of innovation systems, agricultural knowledge systems, the social organization of innovation, and multiple sources of innovation. CIP will act as part of a complex group of organizations and individuals, engaged in different parts of the innovation system. Therefore, an important component of CIP's new research agenda will be to understand, and find ways to influence the innovation systems in priority regions and countries. We will do this mainly through our research outputs.

CIP has redefined its role as a ***research partner for development*** and will adopt new ways of defining research priorities and finding innovative ways for interaction and intervention in the systems. CIP will make its discoveries become innovations that contribute to the MDGs. For this purpose, research will be conducted to understand the impact pathways within the innovation systems. CIP will map the multiple directions and contributors to facilitate the use of its scientific discoveries such as technologies or methodologies to support decision-making to solve poverty-related problems.

3.2 CIP's research and development process

In the regions where CIP works, enhancing the income, health and sustainability of the poor will require us to carefully identify needs and opportunities at different scales, ranging from major international trends to the aggregated needs of individual households. Operating at scales ranging from macro to micro will help us target the geographical areas where we can work for greatest impact, use participatory techniques to match people's needs and opportunities, and identify and prioritize specific Research for Development interventions. These processes will be followed by linking with other partners to disseminate the knowledge gained, and an assessment of the impact of our work. We will need to strengthen

existing partnerships and build new ones, because many of the interventions envisaged require a broader set of skills and resources than those available at CIP.

We can make the greatest impact on poverty in geographical areas where poverty, hunger, child mortality, CIP's mandate crops and environmental vulnerability overlap. Using these factors as to allocate resources, highest priority will be given to areas where high concentration of households living in extreme poverty in vulnerable environments depend on potato, sweetpotato and Andean root and tuber crops for their livelihoods.

The Pro-poor Research for Development Cycle (to be updated with current version)

The Pro-poor Research for Development Cycle first introduced in the CIP Vision is a continuous iterative process. CIP's researchers will keep coming back to the different steps and refining them as new information becomes available. In addition, the cycle will be applied at different levels; global for strategic issues, regional to define regional priorities, and locally to document impact.

Iterations of the Pro-poor Research for Development Cycle will be tested in at least one area of integration per region. The size and location of these areas of research and development integration will be based on socioeconomic and environmental vulnerability studies and a thorough analysis of the opportunities present in the zone. Learning alliances or learning communities of practices will be used to extract lessons during the process and captured as outputs to be used in training events.

3.3 Stages of the Pro-poor R&D Cycle

3.3.1 Targeting

This is conceptualized as the initial stage of the cycle. However, because of the diversity of existing research activities at CIP, there may be interventions already in different stages, so in some cases some activities will have to be revisited to see whether they are in the right place, addressing the right need or opportunity, and particularly to learn from those advanced experiences.

The targeting conducted so far at CIP has given us the global picture based on the overlapping of different indicators such as poverty, hunger, mortality rates with the potato and sweetpotato maps. This initial stage has generated a list of regions and priority countries where CIP will focus its efforts in the future. Root and tuber crop production data are notoriously difficult to estimate and potato/sweetpotato production are expanding dramatically in Africa and Asia. As result, we will continue to refine our targeting at regional and country levels, based on improved area and production estimates, and higher resolution of the identification of needs and opportunities. An example of a specific output from the micro targeting will be the identification of areas of research and development integration per region where the pro-poor R&D cycle could be completed and lessons extracted.

BOX

CIP's priority target areas

(1) the Andes region of Latin America (Peru, Bolivia, Ecuador, and Colombia) and Haiti in the Carribean
(2) East and Southern Africa (the Lake Victoria region of Uganda, Kenya, Tanzania, Rwanda, Burundi, Ethiopia, Angola, Malawi, Mozambique and Madagascar);
(3) the Indo-Gangetic basin of South Asia (northern India, Bangladesh, Pakistan, and Nepal);
(4) North East Asia (North Korea and China, especially interior provinces of Sichuan, Guizhou, and Guangxi in the south, Hubei, Shaanxi, Henan, Anhui, Ningxia, Gangsu, Shangdong, Jiangsu, Qinghai, Hebei Shanxi, and Yunnan in central China; Hielongjiang, Jilin and Inner Mongolia in the north)
(5) most of Southeast Asia (Myanmar, Indonesia, Vietnam, the Philippines, Laos, and Papua New Guinea).
(6) Nigeria, Ghana, Cameroon and Chad in West Africa;
(7) the Caucasus region of Asia (Azerbaijan and Armenia);
(8) the Central Asian countries of Tajikistan, Kirghiz and Kazakhstan.

The regional strategic plans will include specific actions to refine targeting in the priority countries and establish priorities for intervention in agro-ecological and poverty-related aspects, which will be refined later with the identification of needs and opportunities.

3.3.2 Needs and opportunities assessment

Through regular assessments CIP will enhance the relevance of its research to the MDGs, improve the participation of stakeholders involved with a particular intervention on the research-delivery process, and increase the probability of technology and policy adoption. CIP will address the need to move the poor out of poverty, and the derived needs of users of technologies methodologies and approaches. Subsequently, CIP will mobilize its research to produce outputs that respond to these needs. CIP will identify the opportunities through a negotiation process with a wide range of potential partners for the interventions, taking into consideration the different domains in which partners intervene.

This Strategy will require greater involvement of CIP's regional staff, but also various regional stakeholders such as donors, agricultural research institutes, national agricultural research systems, non-governmental organizations, development projects, etc. The innovation system thinking has clear implications for this stage. The opinion of other components of the innovation system, particularly those with experience on development, will be taken into consideration.

The identification of needs and opportunities will have a holistic vision, meaning that it will not focus only on potato or sweetpotato constraints, but also take into consideration constraints related to farmer livelihood systems in relation to potato and sweetpotato innovation systems. This differentiation will facilitate conducting research-for-development interventions according to each region.

3.3.3 Research for development

Our research program is designed to recognize and respond to demands from our stakeholders, efficiently produce research outputs and facilitate their utilization by our users. We are highly decentralized with regional and country offices in Africa, Asia and Latin America that facilitate direct contact and feedback on our program.

As introduced in the Vision the research program includes two research divisions related to the conventional core business of the Center (genetic resources conservation and breeding), two integrative research divisions (integrated crop management and natural resources management), and two new research divisions, one of them oriented to enhance impact, and other oriented to assess the relationship between agriculture and human health. There are a number of Partnership Programs that contribute to the research outputs and also promote utilization of the outputs by our partners.

CIP brings to the research program its heritage of 35 years of experience and human and capital resources that together make us a unique partner in research for development (see box).

BOX

CIP's assets

CIP has assets and characteristics that singly and in combination make it unique. Recognizing these assets we seek to partner with others to deepen existing or engage with complementary assets that can help us address the research challenges identified in this Strategy. Our assets include:

- Germplasm collections of potato, sweetpotato and their relatives
- Breeding populations adapted to tropical and subtropical conditions
- Comparative knowledge of potato and sweetpotato farming and food systems
- Basic and applied knowledge on biophysical principles of the main potato and sweetpotato constraints.
- Working collections of important pathogens of potato and sweetpotato
- Biological, environmental and economic policy models and modeling experience
- Widespread and diverse local contacts
- Proven institutional innovation strategies
- Experience and knowledge of tropical mountain agro-ecosystems
- Experience in urban and peri-urban agriculture systems
- Experience in participatory research methods

3.3.4 Partnerships for Impact

Understanding potential or existing impact pathways related to CIP outputs will be part of its research agenda, which will include diagnosis studies and mapping the innovation systems in the areas of intervention and the design and assessment of inter-institutional projects oriented to identify the factors that make the pathway possible. This will include understanding platform formation and learning how to be part of them, how to create capacity building opportunities for CIP and its partners, how to be proactive in the platforms to respond to needs and opportunities with CIP products. The experience of the private sector will be useful for the purpose of research and development joint ventures.

CIP will access modern information technologies and use them for effective communication, dissemination of knowledge, and capacity building in potato and sweetpotato innovation systems. CIP will also identify, acquire and utilize valuable technologies in the private sector with 'freedom to operate for the poor'. Capacity building activities will be used to facilitate the access of less developed countries to information and technologies.

CIP will utilize the knowledge it is acquiring through its engagement in participatory research to create development platforms that will assemble all the various actors involved in R&D of the specific target areas. Building these platforms and facing the managerial challenges they pose, is and will continue to be actively researched at CIP, making it explicit in the regional strategic and operational plans.

3.3.5 Impact assessment

The definition of an impact pathway will start from the targeting stages and be refined along the different stages of the cycle; it will not be just the last stage when we pause to look at possible impact. This means a continuous involvement of CIP's Impact Enhancement Division in the different steps of the cycle. Conducting baseline studies with the participation of Research Divisions and Partnership Programs will be an essential component and included in the initial steps of the cycle, to be able to show changes in key indicators related to MDGs, focusing on number of people instead of only rates of return. This challenge will require the development or adaptation of methods to measure influence on MDGs, including the issue of attribution when interventions involve the participation of several partners. The strengthening of the in-house capacity of CIP and establishing links with external resource organizations with expertise in the area will be part of the strategy in the coming years. As a result, the strengthened impact enhancement team will provide essential feedback for the type of research the Center conducts in the future.

Chapter 4. The strategy for Latin America and the Caribbean

4.1 Context and trends 1
4.2 Targeting 3
4.3 Needs and opportunities 4
4.4 Research for development themes 6
4.4.1 Reducing temporal and chronic hunger among poor communities 6
4.4.2 Linking farmers to markets 7
4.4.3 Improving access to safe and nutritious food 7
4.4.4 Promoting sustainable use of biodiversity 7
4.4.5 Facilitating sustainable intensification of potato-based farming systems 8
4.4.6 Developing sustainable and healthy horticulture in and around cities . 8
4.4.7 Enhancing capacity for innovation 8
4.5 Partnerships for Impact 9
4.6 Impact Assessment 9

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This chapter introduces the CIP strategy for our priority countries in the Latin America and Caribbean region. The chapter structure reflects the topics introduced in chapters two and three. We show how we will address the pro-poor research for development cycle with a range of inter-related actions. Further we show how our research for development agenda is informed by the needs of the poor and contributes to the MDGs through the themes we defined earlier.

4.1 Context and trends

Founded in 1971 in Lima, CIP is appropriately located in the center of genetic diversity of potato and the pests and diseases that co-evolved with it. Adding sweetpotatoes and later other minor Andean roots and tubers to our mandate, we brought additional new world centers of genetic diversity. With our headquarters in Latin America and Caribbean (LAC) region, we have long-term strong linkages with partners and a dynamic research for development program. Nevertheless the adoption of the MDGs as our guiding principle will mean changes in the way we work. Successfully implementing the Pro-poor R&D Cycle will improve the livelihood of resource poor farmers in the region. CIP will focus its research for development program in LAC on potato-based systems in the tropical Andes of Bolivia, Peru, and Ecuador and Colombia. The Andean region has the poorest population in South America living in an area of extreme environmental fragility, and is the center of origin and primary center of conservation of potato biodiversity. Haiti, the poorest country in Latin America and an important sweetpotato producer is also a priority country identified during the initial targeting exercise.

Outside of the Andean region and Haiti CIP will work in particular poverty hotspots where there are strong and clear opportunities to contribute to MDGs with our mandate crops. These hot-spots will be included after a case by case needs and opportunity assessment. In the rest of LAC, CIP will continue playing a key role through the provision of germplasm, information and other research services to national programs on a cost recovery basis. It will consider engaging in

collaborative research with NARIs outside of the Andes where this can clearly be linked to meeting MDGs through the generation of global public goods. This could be through strategic partnering with strong research organizations to produce outputs useful in LAC or other regions of the world.

In the last decade, potato has maintained its importance as a strategic crop in the Andes. Potato continues to be the staple crop and principal economic activity of a majority of farmers in higher elevation cropping systems where there are few viable agricultural options. Potato is a key element in livelihood systems generating more value added and employment per hectare than any other Andean staple (see Table 4.1).

Table 4.1: Importance of potato in Bolivia, Ecuador, Peru and Colombia in 2004

Indicador	Bolivia	Ecuador	Peru	Colombia
Crop area (Ha)	129,500	50,000	260,000	161,860
Yield (Mt/Ha)	6.1	9.0	9.0	17.5
Production (Thousand Mt)	787	450	2,346	2,836
Production Growth (95-04) (%)	3.9	2.3	-2.3	0.1
Gross Product Value (Million USD)	148	120	347	528
Per capita consumption (Kg.)	57	31	69	45
Active potato farms (Thousands)	200	45	599	
Farm work days generated by sector (million)	15.5	9.0	29.2	24.3
Urban population (%)	64	63	73	73

Sources: FAOSTAT (http://apps.fao.org/faostat/collections), World Bank Development Indicators http://web.worldbank.org/wbsite/external/datastatistics

While total potato production in each country has been more or less constant, the composition of production is changing. The majority of Latin Americans live in urban areas and as urban populations increase, more production is being consigned to market. Urbanization has been associated with changing consumption patterns. While potato consumption has been more or less constant, the proportion of processed potatoes in different forms has dramatically increased and currently makes up at least 15-20 percent of total consumption. A mobile workforce and changing consumption preferences have led to very rapid growth of the fast food sector. At the top end of this market, fast food franchises import frozen French fries[2] but most restaurants depend upon local supply. Potato chip consumption has also increased enormously over the past decade, with both multi-national and small local companies in the market. Urbanization and globalization have also created niche markets for higher value potato products with a marked expansion of supermarkets over the past decade. These changes potentially offer new markets with higher and more stable prices. Larger companies in particular are switching from spot market purchases to longer term contracts with producers and guaranteed prices. But most of these markets are more demanding in quality, and

[2] Throughout the document we adopt North American usage for French fries and potato chips which correspond to the British usage of chips and crisps.

require constant supply. These changes could force smaller-scale farmers out of these new markets and leave them supplying the traditional fresh potato market, which is less demanding in quality requirements but with lower and more fluctuating prices.

Andean countries are negotiating free trade agreements with the United States. Although this might not pose a threat to farmers selling fresh potatoes, the reduction of import tariffs will potentially affect farmers producing potatoes for the rapidly expanding processing market.

Urbanization has also led to the emergence of areas with increased specialization for markets and high levels of chemical input use, often associated with very adverse health impacts. This trend can be expected to continue as new areas become drawn into the pesticide treadmill. Many farm owners in these areas of higher potential are not amongst the poorest, but the laborers applying pesticides often are.

Potato is relatively nutrient demanding compared to other crops which often follow it in the cropping system. But lacking incentives and technology for more sustainable approaches farmers are often forced into nutrient mining. Potato farming as currently practiced involves fine seed bed preparation which is extremely conducive to erosion. Declining nutrient availability and erosion have driven a downward spiral of declining yields and area growth of potato production, often at the expense of protected areas such as the high altitude *paramo* grasslands of the northern Andes or other non-suitable areas such as steep slopes.

More people live within the mountainous topography of the Andes than any mountain range in developing regions. The vertical relief inhibits the installation and maintenance of physical infrastructure and large numbers of rural peoples remain physically isolated. The poor rural populations are more vulnerable to influences such as climate change, because the probability of exposure to the stresses is greater and their resources are spent either purchasing or producing food. The Andean highlands are characterized by high climatic variability, decreased water availability, decreased nitrogen availability, and dramatic land use changes. These are all indicators of global environmental change that reduces the ability of the production systems to absorb shocks. Therefore, the rural poor in the Andes have limited availability and accessibility to food and thus are highly vulnerable to emerging environmental threats.

While urbanization has opened up new opportunities for farmers in some areas, it has also exacerbated inequalities. Some areas are trapped in low productivity agriculture which fails even to meet minimum nutrition requirements with aggregate calorific shortfalls and hidden hunger caused by micronutrient deficiencies of vitamin A, iron and zinc. Often these areas provide temporary labor to nearby cities or have originated more permanent longer distance labor migration. While these generate remissions, they have not contributed to longer term sustainable growth.

4.2 Targeting

Insert Map of LAC target countries

During CIP's visioning exercise, Colombia, Ecuador, Peru, Bolivia and Haiti were selected as priority targets on the basis of country level data. Even at the country level aggregation, differences are evident e.g. only Peru and Bolivia scored high in all the livelihood indicators used. This spatial variation is even higher at the sub-national level. Targeting at the sub-national level is needed to pick out the specific areas where poverty and our mandate crops coincide. CIP will refine its targeting in the Andes by selecting geographic areas of interest representing the dominant agroecologies. The indicators will include the concentration of poor people, potential for producing potato or other Andean root and tuber crops, environmental vulnerability and accessibility to markets. The dynamic of the livelihood indicators will also be included in the analysis.

4.3. Needs and opportunities

Andean farmers often complain about unprofitable markets, yet many market chain actors comment that they have difficulty in finding a sufficient supply of quality potatoes of appropriate varieties. CIP and its partners have a clear opportunity to respond to this emerging need. Part of the response can be in terms of technologies; both through the development of varieties that meet processor requirements better but also favor smaller capital-scarce farmers who cannot invest in chemical inputs. The technologies developed should consider the fact that with men and youth migrating to cities, woman and the elders play more important roles in farming in addition to other activities. The emigrants and their households like to continue consuming traditional foods thus increasing demands for the transformation of agricultural products. Adding value to potato and other Andean root and tubers requires CIP's involvement.

Farmers will also require a range of services to support market linkages. CIP has an opportunity to develop multi-stakeholder platforms that bring together actors to deliver these services. CIP can also contribute to seed systems development that will benefit from market pull as new market opportunities are opened up.

Potato yields in disadvantaged areas of the Andes, particularly in the Central and Southern Andes, are often less than 8 t/ha. There is a need to enhance the whole potato cropping system. Increasing crop yields in these areas should increase food availability (potato, barley and others cereals). This can be achieved through technological innovations such as fertilizer, soil management, integrated pest management, improved varieties and water management. The challenge is to obtain significant yield increases on a sustainable basis and build on the rich ecological and agrobiodiversity which makes Andean cropping systems resilient.

Malnutrition is a serious problem in much of the Andes. In some areas over 50 percent of children suffer chronic malnutrition and stunting is widespread. Food system interventions are needed to increase availability of energy, Fe, Zn, Ca and

provitamin A to vulnerable groups, especially mothers and children. There is a need to enhance dietary diversity to satisfy essential amino acids requirements.

A wide diversity of native Andean crops rich in protein, essential amino acids and minerals are available to be incorporated into the cropping systems, including maca, quinoa (*Chenopodium quinoa*) and tarwi. Maca, for example, has a particularly high content of calcium and iron and is a good source of energy and protein. Quinoa has high quality protein; it contains relatively more of the essential amino acids lysine, arginine, histidine and methionine and tarwi is an exceptional source of protein.

In areas with potentially higher productivity, specialization for market production has made possible and provided the cash needed for intensification through the purchase of chemical inputs. Most of these areas have higher rainfall and late blight is a particularly important problem. Very frequent spraying is needed to control blight in the susceptible varieties that are currently being grown. There is a major opportunity to find resistant potato varieties but farmers in high input areas will only grow these if they meet market requirements. Farmers also control insect pests, particularly weevils and tuber moths, using insecticides which are often highly toxic. This has led to very severe adverse health impacts and environmental damage. CIP has an opportunity to build on previous work on human health and environmental impacts of pesticide use and gather evidence about health impacts and the tradeoff with productivity to develop local coalitions of actors across a broad range of sectors to leverage policy change

Farmers in the Andes traditionally manage a highly diverse range of local crops in a Vavilov center of domestication. These meet a diverse range of needs in food systems but also have medicinal and other uses. Farmers eat a lot of potatoes and value the diversity that landraces provide. Some are adapted to particular uses, such as the preparation of traditional processed potato products like tunta. Modern varieties potentially can widen this diversity as they are often adapted to different agroecologies. But often farmers have "lost" local varieties or do not have access to good quality seed. CIP can help them to recover what they have lost and to find "new" old varieties that they like. These varieties could also be used in participatory plant breeding that maintain underlying genetic diversity while incorporating other characteristics that farmers are looking for.

4.4 Research for development themes

CIP will continue to carry out specific or component research with pests and diseases and bring these together as integrated crop management for potatoes and sweetpotatoes. However, these will be promoted as part of more integrative themes that will promote resource mobilization and motivate participation from a broader range of stakeholders and so enhance the quantity and quality of our impact.

4.4.1 Promoting sustainable use of biodiversity

The Andean region is a major center for crop domestication. Migration, production for market and climatic variability and change is putting at risk the use by farmers

of potato landraces and other crops indigenous to the Andes that form an integral part of potato cropping systems. CIP will develop and promote with partners strategies for maintaining and using potatoes and associated crops by farmers, through market linkages and other mechanisms.

4.4.2 Reducing temporal and chronic hunger among poor communities

Many households in the Andes suffer from temporal and chronic hunger. Andean potato weevils, potato tuber moth, nematodes and late blight lower yields across most of the region. In the southern, high risk Andes, drought and frost also affect yields, leading to almost total losses in some years. CIP will continue to work on insect management and will place particular emphasis on developing biological control methods that are accessible to low income farmers. CIP will also increase research to identify early maturing varieties that can escape drought and frost and varieties which have drought and frost tolerance. CIP will continue its strong program with late blight through resistance breeding and integrated management.

Global warming is likely to increase climatic variability and change conditions under which farming can be carried out in the Andes. Both have potentially adverse consequences for livelihoods of small farmers. CIP will build adaptive capacity to help farmers adapt to increasing climatic variability and change. CIP will use modeling approaches for ex-ante assessment of environmental and livelihood impacts of innovation. CIP will develop cropping and livestock based systems with greater resilience to climatic variability and change.

Poor farmers are generally forced to farm vulnerable areas; hillsides with low fertility and limited access to water. Under these conditions, productivity is highly variable and dependent upon rainfall and the management of the crop. CIP will breed for yield stability under the above-mentioned conditions. By cropping vulnerable areas, productivity decreases with time and poverty and malnutrition are exacerbated. Farmers are then trapped in a vicious poverty-environment cycle. CIP will develop technologies to break this vicious cycle through integrated approaches that include the management of the main natural assets: soil, water, and biodiversity. CIP will also focus on the improvement of the nutrition of the Andean inhabitants, optimizing the management of the production systems.

4.4.3 Improving access to safe and nutritious food

Many of the poor rural inhabitants of the Andes suffer from micronutrient deficiency. This contributes to maternal and infant mortality, stunting and damages intellectual development. CIP will contribute to developing more nutritious food systems for the poor including potatoes but also utilizing other Andean crops, vegetables, pulses, and livestock products.

4.4.4 Linking farmers to markets

Rapid urbanization, the growth of the market for processing and rapid expansion of supermarkets have opened up new market opportunities for potatoes and other crops that form part of potato cropping systems. Small farmers are typically poorly placed to make use of these opportunities, and are likely to be relegated to the least profitable and riskiest segments of the potato market. CIP will help farmers to develop appropriate technology, for example, through integrated crop

management to meet particular market criteria, product development and building strategic alliances with other partners to promote farmer organization, to capture economies of scale, and access to market intelligence to create symmetry in information availability. One of the assets that small farmers in the Andes possess is their rich agrobiodiversity in native potatoes and other crops and this research theme will build on this asset. In addition, CIP will carry out research to identify appropriate processing varieties for French fries and chips, with favorable agronomic characteristics for small farmers. While CIP will continue to prioritize potatoes it will also develop and promote the use of methodologies for linking farmers with markets with other crops and products that form part of their livelihood systems. This will increase the scope and probability of getting impacts and open up more possibilities for coordinating with a broad range of stakeholders.

4.4.5 Sustainable intensification of potato-based farming systems

Extractive farming systems have led to declining nutrient availability. Potatoes are a particularly erosive crop because of the fine seed bed preparation that is usually practiced. Intensification of potato cropping linked to more production for market has led to increased application of toxic pesticides, which is damaging farmers' health and the environment. CIP will work on healthier and more sustainable cropping systems to promote a "greener Andes". This will involve bringing together improved nutrient management, conservation tillage and integrated pest and disease management.

4.4.6 Sustainable and healthy horticulture in and around cities

Cities in the Andes are growing rapidly. In many cases horticulture is being practiced by poor producers around these cities. Sustainable and healthy horticulture can contribute to enhancing their livelihoods and improving the quality of life in urban environments in Bolivia, Peru, Ecuador and Colombia. CIP will deploy genetic enhancement assets, especially where potato or sweetpotato are present in these systems, to identify traits of particular use to urban producers. Synergies will also be explored across other horticultural crops through strategic partnerships, for example in relation to common stresses such as bacterial wilt or white fly. Among cropping systems assets, integrated pest and disease management to reduce or eliminate pesticide use will be prioritized, though conservation agriculture capacity will also be utilized for soil nutrient enhancement through use of urban organic wastes. This theme will make extensive use of NRM assets, in particular remote sensing and GIS tools to map land use dynamics. The need for policy analysis and for dialogue, policy development and multi-agency partnerships in urban environments will be supported through the impact enhancement and institutional learning assets available in CIP.

4.4.7 Institutional learning for pro-poor change

CIP will continue to develop and promote with partners participatory methodologies and approaches for which it has achieved renown in the Andes. This includes Farmer Field Schools, participatory technology development, the Participatory Market Chain Approach and mechanisms for articulating the supply and demand for technology by small farmers. CIP will continue to develop novel approaches for supporting the development of national innovation systems and linkages with policy that favors the poor in agricultural research and development.

CIP will support capacity building within the innovation systems framework by strengthening innovation capacities and systems' capacity building. The development of participatory methodologies and approaches to innovation will create a more favorable environment for technological innovation and the implementation of the rest of CIP's program. In addition, participatory methodologies and innovation approaches constitute global public goods in their own right. CIP will promote south-south learning with other regions to capture the spillover of these global public goods.

4.5 Partnerships for Impact

CIP has good working relationships and strong linkages with NARIs, NGOs and private sector partners in the Andean zone. This network of partners will facilitate scaling up its technologies. We will seek opportunities to concentrate a wide set of research activities and link them with partners that focus on diffusion. One such area in the Andean region will be around Lake Titicaca on the Peru-Bolivia border, one of the poorest spots in a poor region. Within each integration area CIP will build a strong multi-disciplinary team with the capability to engage stakeholders. Nevertheless, where good possibilities for impact exist outside of the priority integration areas CIP will also seek strategic partners that can provide linkages to uptake.

CIP's research divisions will work closely with its partnership programs, other CGIAR centers, and other partners to achieve scaling up. CIP will look vigorously for funding opportunities to sustain scaling up in the Andes and achieve wider impacts. It is particularly important for CIP to enhance its credibility as a center based in the Andes, through a strong presence making significant contributions to the MDGs.

4.6 Impact Assessment

CIP will create a capability for impact assessment and the use of innovation systems approaches in each of the geographical integration areas.

Chapter 5. The strategy for Sub-Saharan Africa

5.1 Context and trends 10
5.2 Targeting 12
5.3 Needs and opportunities 13
5.4 Research for development themes 18
5.4.2 Linking farmers to markets 18
5.4.3 Improving access to safe and nutritious food 19
5.4.4 Promoting sustainable use of biodiversity 19
5.4.5 Facilitating sustainable intensification of potato and sweetpotato-based farming systems 20
5.4.6 Developing sustainable and healthy horticulture in and around cities 20
5.4.7 Enhancing capacity for innovation 21
5.5 Scaling up 21
5.6 Impact assessment 23

NB
Page numbers to be updated

This chapter introduces the CIP strategy for our priority countries in the Sub-Saharan Africa region. The chapter structure reflects the topics introduced in chapters two and three. We show how we will address the pro-poor research for development cycle with a range of inter-related actions. Further we show how our research for development agenda is informed by the needs of the poor and contributes to the MDGs through the themes we defined earlier.

5.1. Context and trends

Food security in Sub-Saharan Africa (SSA) has worsened considerably since 1970, with the number of malnourished people estimated to have increased from around 88 million in 1970 to over 200 million in 1999-2001. The root causes underlying the problem are well-known: poor political and economic governance in many countries, conflicts within and between nations, inadequate investment in the agriculture sector and rural infrastructure, declining rates of investment in agricultural research, and poor management of water and land resources—all exacerbated by the AIDS epidemic, inadequate investment in health and education, high rates of urbanization and declining terms of trade for many primary exports. Moreover, experts in climate change have singled out SSA as the region most negatively affected by global warming, with the increasing frequency of droughts and floods evident in eastern and southern SSA. In this context, roots and tubers have emerged as playing a critical role in whatever food security does exist in many environments, and particularly in "hot-spots" of high poverty and malnutrition. Area under potato and sweetpotato has more than doubled in SSA in the decade from 1994 through 2003 (Figure 5.1).

By 2005, an estimated 1 million hectares were under potato and 2.5 million under sweetpotato in SSA. This rapid growth has presented CIP with opportunities to reach more and more individuals that are poor, underemployed, food insecure or malnourished. In the coming decade, CIP-led research for development can

directly contribute to improving the lives of millions of poor African families through:

(i) improving productivity and stability across seasons to reduce production risk;
(ii) improving incomes while minimizing natural resource degradation;
(iii) building market food chains to reduce market and price risk;
(iv) creating awareness of the health benefits of more nutritious varieties and diet diversification;
(v) developing and documenting effective innovation systems for scaling-out and scaling-up new technologies.

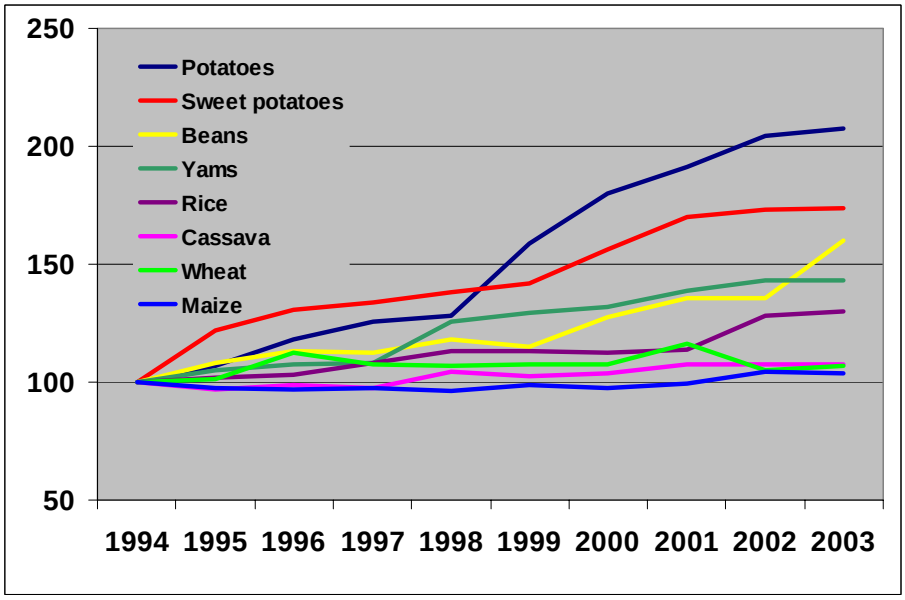

Figure 5.1. Trends in Area of Major Food Crops Cultivated in Sub-Saharan Africa from 1994 to 2003
Source: Own calculations from www.faostat.org and other sources

Two major factors have driven the growth in potato area in Sub-Saharan Africa during the last decade: declining food security in rural areas and increased demand from urban areas. Both trends favor potentially high value crops like potatoes. In tropical SSA, potatoes are concentrated in highland areas where cooler growing conditions favor tuber formation and reduce pest and disease pressure. These areas are known for their high population densities and small farm sizes. In such land-constrained highland systems, potatoes are capable of producing more energy and more nutrition per unit area per unit time than grains and hence, increasingly replace grains in highland farming systems.

Perhaps the more important factor explaining the growth in potato area is the growth in demand for potato from urban consumers for both fresh and processed potatoes, particularly French fries and potato chips. With 34 percent of its population in urban areas, SSA is the least urbanized region of the world. However, the rate of urbanization is the highest in the world. Western and central Africa, southern Africa and eastern Africa are projected to sustain rates of 3 percent, 3.5 percent and 4 percent growth through to 2015.

Sweetpotato is a short-to-medium maturity rustic crop that provides reliable yields under a variety of adverse conditions and is known as the classic food security crop of the poor in SSA. The rapid growth of sweetpotato area is broad-based occurring in at least 20 SSA countries due to a multitude of factors. First, sweetpotato has been used extensively to help displaced populations re-settle in post-conflict situations and these efforts have often provided farmers with clean planting material of improved sweetpotato varieties. Second, sweetpotato is not as susceptible to severe pest problems as cassava and banana. In vast areas of eastern, central, and southern Africa where cassava production has failed or been drastically reduced due to epidemics of mosaic or brown streak virus, many farmers have switched to sweetpotato as a substitute. They may well switch back as resistant cassava varieties become available but for the period covered in this plan, we do not expect that to happen. Third, sweetpotato is more resistant to drought than crops such as maize. In many parts of eastern and southern Africa, governments are advocating increased cassava and sweetpotato use in response to recurrent drought. These warmer, marginal areas are more prone to the vagaries of the climate which favors the use of short-duration crops. With increasing population pressure, farmers are also being forced onto more marginal land and to which the sweetpotato is better adapted than the grain crops. Fourth, two consequences of the devastating socio-economic impact of the HIV/AIDS epidemic on farm households are the loss of adult labor and farming skills. This may be encouraging a significant shift to lower labor, lower cost, and lower risk crops like sweetpotato and cassava. Fifth, in urban areas of many countries with worsening economic situations due to poor governance, households are substituting sweetpotato as their principal breakfast food as purchasing bread is no longer within reach.

Production of both potato and sweetpotato has grown mostly in response to increased area. This leads to the obvious query, why have average yields not improved and what can be done to improve productivity? Yield statistics for both crops have been influenced by the expansion of cultivation into more marginal lands as population pressure increases and lack of access to sufficient quantities of clean planting material of improved varieties. Particularly in the tropical highlands, lands are fragile; soil fertility is declining, and pest and disease incidence on potato increasing due to a lack of rotation, inability to fallow, movement away from intercropping, and breakdown of resistance in aging cultivars. It is essential to improve productivity or households will meet their basic food needs by expanding their plots into protected forest areas and/or even more fragile or marginal environments.

Given the opportunity, will producers seek to improve productivity? The increasing demand for both potato and sweetpotato offers an opportunity to tap naturally occurring incentives to improve productivity. Supply chain organization centered on serving specific niches in domestic markets (including planting materials) can be the node around which selected producing sectors seek to improve the quality of the harvested crop and lower costs by improving yields. This can result in improving incomes for producing families, increasing access to nutritious foods for both rural and urban consumers and thus reducing poverty and malnutrition.

The Forum for Agricultural Research (FARA), its sub-regional members (ASARECA[3] for Eastern and Central Africa), SADC for Southern Africa, and CORAF for West and Central Africa) are designated to coordinate agricultural research, technology dissemination and adoption. In May 2001, FARA, its sub-regional members and the CGIAR Centers issued the *Durban Statement* which called on the "international research system, including the CGIAR Centers and advanced research institutions, to forge more effective and efficient partnerships with African NARS and achieve greater programmatic integration." CIP has pioneered research conducted through partnerships in SSA, and welcomes this challenge and will actively participate within this mandate.

In response to increasing poverty and declining food security in SSA, there has been an increasing awareness of the critical need to improve agricultural productivity among Africa's leaders and the international community. The New Partnership for Africa's Development (NEPAD), established in 2001 by Africa's leaders, emphasized agricultural growth as the engine for pro-poor economic growth. Most of Africa's leaders agreed to NEPAD's call for doubling the amount spent on agricultural research of the next decade and striving to achieve at least 6 percent annual growth in agricultural production by the year 2020. This stimulated the development of several initiatives for accelerating African agricultural development and strengthening support for the sub-regional organizations and networks for agricultural research. Foremost among these initiatives is NEPAD's Comprehensive Africa Agricultural Development Programme (CAADP). CAADP calls for focusing agricultural investments on three mutually reinforcing pillars: (1) extending the area under sustainable land management and reliable water control systems, (2) improving rural infrastructure and trade-related capacities for improved market access, and (3) increasing food supply and reducing hunger.

5.2 Targeting

INSERT MAP OF SSA TARGET COUNTRIES

CIP's initial impact targeting exercise layered livelihood indicators over areas with high potential for potato or sweetpotato production in SSA. This process identified two broad regional groups for concentrating its efforts, in eastern and southern Africa and four countries in West Africa.

During the next decade, CIP intends to have staff based in most of the targeted countries. However, poor data quality coming from national level aggregate data used for targeting can obscure or miss regional importance of the crop, pockets of poverty or areas of high return to research investments. For example, more

[3] ASARECA stands for the Association for Strengthening Agricultural Research in Eastern and Southern Africa; CORAF for the Conseil Ouest e Centre Africain pour la Recherche et le Developpement Agricole; SADC for the Southern African Development Community. Note that in Southern Africa, an association specifically focused on agricultural research does not exist. Hence, within SADC, agricultural research priority setting is frequently delegated to FANR, the Food, Agriculture and Natural Resources sub-organization.

refined targeting will identify eastern DR Congo as a priority area due to the importance of the crop and the poor levels of most MDG indicators. Hence, targeting will be refined to select geographical areas of intervention that are agro-ecologically defined zones where strong needs align with: 1) good opportunities for impact with mandate crops, 2) potential for conducting quality research with national program partners and other CGIAR sister centers and 3) the existence of strong development partners to assure significant impact on livelihoods.

Conceptually, sweetpotato cropping systems are divided between areas where it serves as a primary food staple with at least 90 kg per capita produced annually (Rwanda, Burundi, Uganda, Malawi) and the rest of SSA, where it is a secondary food staple. Potato production is concentrated in the tropical highlands and some mid-altitude zones found in pockets throughout the continent. The central tropical highland areas of Rwanda, Burundi, Uganda, and DR Congo are major producing areas for potato, which is the fast expanding cash crop in those areas in addition to being a key food security crop alongside sweetpotato. Drawing on its experience in assisting Uganda to re-build its potato and sweetpotato research and seed programs in the late 1980's and 1990s, CIP intends to prioritize its capacity strengthening efforts to serve programs and populations recovering from conflict in Rwanda, Burundi, DR Congo, Mozambique, and Angola. Orange-fleshed sweetpotatoes have the potential to significantly contribute to reducing vitamin A deficiency in all targeted countries, with significant programs for research and dissemination already established in Uganda and Mozambique. Prioritization of remaining initiatives will be based on stakeholder demand, the availability of locally adapted varieties, and funding opportunities. In West Africa, large-scale impact through collaboration with relatively strong national root and tuber programs in Nigeria and Cameroon can be expected.

Efforts will be made to coordinate with other SSA initiatives that encourage multi-disciplinary, collaborative, inter-institutional research to address major poverty and malnutrition "hot-spots" or demonstrate the potential to raise rural communities out of poverty through provision of adequate financial resources and appropriate technologies.

The high urbanization rates in SSA have also resulted in increasing levels of poverty, morbidity and mortality because of the inability of industry, commerce or service sectors to satisfy the demand for urban jobs. This has resulted in the increasing importance for urban household food security of horticultural and livestock production in and around the urban centers. CIP will target these urban horticultural systems and will use data on levels of poverty, malnutrition and child and maternal morbidity and mortality to select the urban and peri-urban areas.

5.3 Needs and opportunities

The NEPAD-CAADP plan highlights selected fast track initiatives. The Pan-African Nutrition Initiative under pillar 3 is one of these and specially mentions the potential role of orange-fleshed sweetpotato in combating micronutrient deficiencies in SSA.

To reach the MDG target of cutting the proportion of people suffering from hunger by 2015 in SSA, root and tuber yield growth rates will need to increase to 2.7 percent per annum from current levels of 1.7 percent. Yield enhancement of both potato and sweetpotato is most quickly obtained through the use of disease-free planting material and the introduction of locally adapted, disease-resistant improved varieties. To sustain those increases, however, a more integrated approach must be taken to assure retention or enhancement of soil fertility and adequate water management. CIP recognizes opportunities to collaborate more closely with CGIAR centers and NARIs engaged in soil fertility and water management research in addition to partnering with sister crop institutions and partnership programs such as the African Highlands Initiative to engage in integrated crop management research focused on improving not only soil fertility and sustainable production levels but diet quality.

In addition to the tremendous need to improve the quantity and stability of energy supply in the SSA diet, there is an equally urgent need to address so-called *Hidden Hunger*, significant micronutrient deficiencies which have negative functional consequences but are not "felt" by deficient populations as inadequate caloric intake is. Large-scale deficiencies of many key micronutrients is the norm in the diets of most poor SSA children under five years of age, women of reproductive age, and vulnerable groups such as HIV/AIDS afflicted households and conflict and post-conflict victims. The prevalence of vitamin A deficiency (VAD) is dangerously high among children under 6 years of age in SSA, with estimates ranging from 26 percent to 70 percent in targeted countries (Table 5.1). Prevalence estimates of iron deficiency anemia (IDA) are also high among children under five and women of reproductive age (Table 5.1). VAD and IDA deficiencies contribute to increased mortality and morbidity rates among young children and women of reproductive age in SSA with serious consequences for human capital formation and labor productivity. In addition, zinc deficiency is increasing recognized as a likely public health problem.

Efficacy studies have already shown that beta-carotene-rich sweetpotato, whose concentration is reflected in the intensity of the orange flesh, can significantly improve vitamin A status in children. About a half teacup-sized portion (125 g) of medium intensity orange-fleshed sweetpotato (OFSP) can meet the daily recommended intakes of children under 8 years of age. Adaptive testing of OFSP began in East Africa in the mid-1990s. Successful pilot initiatives led CIP to launch The Vitamin A Partnership for Africa (VITAA) in May 2001 to promote the increased production and use of orange flesh sweetpotato to combat Vitamin A deficiency in SSA. The VITAA partnership includes more than 70 organizations from the health, nutrition, education and agriculture sectors, NGOs, community-based organizations (CBOs), root crops sub-regional networks (PRAPACE and SARRNET[4]) and private business sectors. It is an excellent platform for expanding the impact

[4] PRAPACE stands for Programme Régionale d'Amélioration de la Pomme de Terre en Afrique Centrale et de l'Est (Regional Program for the Improvement of Potato in Central and East Africa) and SARRNET is the Southern Africa Roots and Tubers Research Network.

of OFSP in the existing nine partner countries (Table 5.1) and organizing OFSP initiatives in other SSA countries where significant sweetpotato production exists. Moreover, CIP and East and Southern African breeders are now selecting for more drought and virus resistant OFSP varieties that also have significantly improved iron and zinc contents. Within the decade, biofortified potato is also within reach through conventional breeding and biotechnology.

Table 5.1.

Vitamin and Mineral Deficiencies: National Damage Assessments in Target Countries

	VITAMIN A DEFICIENCY		IRON DEFICIENCY ANEMIA (IDA)		
Country	Est. Prevalence of children under 6 yrs with sub-clinical deficiency (%)	Est. annual no. of child deaths precipitated	Est. Prevalence in Children under 5 yrs (%)	Est. Prevalence in woman age 15-49 (%)	Est. annual no. of maternal deaths from severe anemia
Angola	55	34,000	72	59	N/A
Burundi	44	8,500	82	60	N/A
Cameroon	36	10,500	58	32	360
Chad	45	12,500	76	56	550
Ethiopia#	30	51,000	85	58	4,390
Ghana#	60	12,000	64	40	230
Kenya#	70	23,500	60	43	930
Madagascar	42	13,000	73	42	520
Malawi	59	17,500	80	27	380
Mozambique#	26	14,000	80	54	1,470
Nigeria*	25	82,000	69	47	11,000
Rwanda*	39	9,500	69	43	690
Tanzania#	37	N/A	65	45	N/A
Uganda#	66	29,000	64	30	890

Source: UNICEF and the Micronutrient Initiative: Vitamin A & Mineral Deficiency: A Global Progress Report, 2004.

Member of VITAA Partnership since 2001. * Joined VITAA in 2005.

Note: South Africa is also a member of the VITAA partnership.

Recent stakeholder consultations conducted by CIP identified five major areas of need concerning potato research:

(1) control of late blight fungal disease (through varietal resistance and crop management);
(2) improved genetic material for high and stable yield potential and with preferred market characteristics;
(3) improved supply of quality potato seed
(4) control of viruses and their vectors (through varietal resistance and crop management) and

(5) control of bacterial wilt (through varietal resistance and crop management).

There is a tremendous need to build research capacity to work on all of these issues in many of our target countries as national research programs rebuild after years of conflict or under funding and seek to replace staff lost to HIV/AIDS or other institutions. Opportunities for working on key constraints to potato production, storage and marketing are increasing as potato is recognized as a profitable commercial crop with potential for value addition through processing for urban markets and with demand often exceeding supply in big urban centers. For example, Kenya has re-classified potato as its second highest priority crop for research investment, whereas previously it ranked 17th, receiving inadequate attention and funding.

Stakeholder consultations also revealed seven additional needs in addition to producing beta-carotene rich cultivars to combat vitamin A deficiency:

(1) improved control of the sweetpotato weevil;
(2) improvements to sweetpotato seed systems and seed storage methods,
(3) cultivars tolerant to drought, viruses, and marginal soil conditions;
(4) cultivars providing high yield as animal fodder as well as food;
(5) improved management of soil fertility and cropping systems;
(6) improved harvesting methods for sweetpotato, and
(7) better evidence on the economic rate of return to sweetpotato research and development.

As countries continue to emerge from conflict, disease epidemics continue to spread, and disaster response and mitigation efforts continue to respond to man-made and climate change induced crises, the need and opportunities for improving sweetpotato seed systems and varietal testing will continue to grow.

Excellent opportunities for conducting relevant and quality potato and sweetpotato research in East and Central Africa are due to the existence of the PRAPACE network, CIP's most productive partnership program ever. PRAPACE is well connected to a broad array of sub-regional, national and local research organizations, NGOs, CBOs, and increasing to private industry.

To compete in a commercial setting, smallholder potato and sweetpotato farmers will have to improve yields and quality. The demand for improved productivity, however, will depend on organizing value chains to include ever larger numbers of small holders. For potato, this is probably the single most strategic investment for CIP in the medium term. Opportunities to form effective partnerships for value chain enhancement are increasing as SSA policy makers increasingly recognize the essential role that markets play in poverty reduction. This investment helps generate that ever elusive demand for technologies among farmers.

Research and development stakeholders concerned with African development have successfully raised the concern about the potential for Africa to be left behind in having access to and being able to exploit biotechnology—often denoted as the "gene gap" in Africa. The response among donor stakeholders has been the funding of projects, programs and networks throughout the continent to redress

this gap. There are many constraints including the lack of skilled scientists and laboratories, lack of policies for intellectual property rights and biosafety, lack of public awareness, lack of access to up-to-date knowledge and other topics. To address these constraints, there are programs for public awareness, scientist training, laboratory construction and equipment purchase, collaborative research with advanced research institutes, policy development, risk assessment, university networking, information dissemination, public-private sector linkages and marketing. By understanding this dense network of overlapping efforts, CIP can concentrate on its areas of comparative advantage and leverage significant supplementary funds or in-kind collaboration.

Finally, the pilot initiatives by the partnership program Urban Harvest to work on urban agricultural issues in two major East African cities, Kampala and Nairobi, have shown that it is possible to convert national and municipal governments from denial and obstruction of agricultural activities to recognizing and supporting urban agriculture as a source of food security and income generation.

Opportunities exist for CIP to positively affect the lives of slum dwellers by investing more significantly in research concerning urban horticulture and value-added processing. This would initially prioritize areas where sweetpotato or potato are or could become a profitable part of peri-urban and/or urban production systems, but will gradually address horticultural systems with other related species, which may be susceptible to synergistic research in genetic enhancement, ICM and NRM.

5.4 Research for development themes

5.4.1 Promoting sustainable use of biodiversity

CIP will collect and characterize local landraces of orange-fleshed and drought tolerant sweetpotato varieties, and identify potentially useful parents for additional breeding efforts.

5.4.2 Reducing temporal and chronic hunger among poor communities

Improved productivity of potato and sweetpotato by addressing the major constraints limiting yields, improving storage methods through cost-effective technologies and training, and raising incomes through improved market access, can contribute substantially to reducing either temporal or chronic hunger. For sweetpotato, CIP will emphasize conventional breeding for drought and virus resistance and improving productivity through integrated pest management reducing losses due to sweetpotato weevil and white-flies. Reliance will be placed on biotechnology to generate genetically modified sweetpotato weevil resistant varieties as decades of conventional breeding have failed to provide this trait. Exploratory breeding work will be done to select for non-sweet sweetpotato that is acceptable to consumers in areas of SSA where sweetpotato is currently a secondary staple but ex-ante analysis indicates would be consumed more frequently if the taste was less sweet and more like cassava.

For potato, CIP prioritizes the adaptive testing and dissemination of horizontally resistant late blight potato varieties acceptable to consumers as a key medium-

term strategy for addressing the hunger problem in areas where high per capita production of potato occurs. Virus, drought and bacterial wilt resistance traits can also enhance overall productivity and will be bred into improved potato materials.

5.4.3 Improving access to safe and nutritious food

CIP will prioritize the breeding and adaptive testing of drought and virus resistant orange-fleshed sweetpotato given the tremendous need to combat vitamin A deficiency and improve diet quality in SSA. While orange-fleshed sweetpotato roots are excellent sources of energy, vitamins A and several B vitamins, they lack significant amounts of protein and extract nutrients from the soil. Hence, research will also focus on the agro-ecologically specific sweetpotato-legume combinations to achieve the dual goals of improving nutrient diversity and density per unit of land and increasing productivity. Once biofortified potatoes are developed, CIP will adaptively test them in countries where ex-ante analysis demonstrates high levels of micro-nutrition malnutrition overlapping with areas where systems exist to multiply and distribute clean potato seed. CIP will develop and test integrated models to actually achieve the behavioral change among users of biofortified crops needed to reduce micronutrient malnutrition in young children and improve household diet quality.

5.4.4 Linking farmers to markets

Sweetpotato is grown in SSA across a broad array of agro-ecologies. Markets for sweetpotato are often thin or non-existent in areas with significant numbers of poor households, and thus, CIP will emphasize engaging in effective partnerships to improve livelihoods through diversified utilization, improved storage techniques, and increased commercialization of sweetpotato roots and vines and economically viable sweetpotato-based processed products. Particular attention will be given to understanding cost-effective strategies for scaling-out orange-fleshed sweetpotato dissemination, adoption and commercialization based on a pilot models emphasizing the synergies to be gained from developing markets and creating demand for nutritious foods simultaneously. In contrast to Asia, the use of sweetpotato as an animal feed in SSA is minimal and value-added research will be done to explore the potential for its use by the pig and poultry feed industry and to expand the use of vines for animal feed, either in fresh form or as silage. An adequate supply of planting material (vines) at planting time is fundamental to creating sustainable production through consumption chains for sweetpotato. Building on the myriad of traditional practices for vine retention, CIP will determine the most appropriate water and fertility management strategies to maximize and assure sustainability of sweetpotato vine multiplication systems in distinct agro-ecological and market settings.

Effectively understanding how to link smallholder potato farmers to markets is key to improving incomes of the rural poor. Unlike sweetpotato, demand is already high in many SSA urban centers for processed potato products, and hence it is not a CIP priority to undertake potato utilization research. It is critical however, to have a deeper understanding of the rural-urban linkages underlying potato trading systems and to develop innovation systems for commercial clean potato seed production and retention that explore greater involvement of the private sector in in-vitro plantlet production and farmer seed associations. For example, low cost

medium term ware potato storage may empower farmers to stabilize farm gate prices.

5.4.5 Sustainable intensification of potato and sweetpotato-based farming systems

CIP research will focus its research on sustainable intensification on the fragile tropical highlands where both potato and sweetpotato, along with beans, are significant parts of the cropping system and declining soil fertility and increasing disease incidence are major problems. One of the key biotic constraints in this system that threatens sustained potato production is bacterial wilt. CIP will expand its integrated disease management approach to combat bacterial wilt to include greater emphasis on bio-control, concurrent soil fertility improvement, and breeding for bacterial wilt resistance. CIP will also seek to understand why and how farmers decide to adopt integrated crop management practices, and develop and test diverse methods of communication with the perspective of reaching massive numbers of farmers, especially those not normally reached through traditional extension approaches. Research on integrated control of potato late blight has a high priority as it continues to afflict the highest economic damage of all potato diseases. The goal is to design management systems that effectively combine partial host resistance with environmentally benign and economic fungicide use.

CIP will develop and test decision-making support tools and methods that integrate biophysical and socio-economic information for alleviating poverty and making cropping systems more productive in diverse agro-ecological settings. CIP will expand the use of satellite imagery to assess area under production of potato and sweetpotato with the aim of improving the statistical base of these under-reported crops in their key agro-ecologies thus enabling planners, policy makers and donors to better prioritize the use of their scarce resources. Exploratory research will assess whether advanced remote sensing equipment can be used to track the adoption of specific sweetpotato varieties. Exploratory research will also be initiated to improve integration of livestock into root and tuber based cropping systems to increase soil fertility, diet quality, and disposable income.

Participatory research can be part of the activities, but behavioral change at the level of farmers, research and development practitioners should also be part of this type of effort, and also looking at how the innovation system evolves (i.e. through better communication mechanisms) as a whole in line with the contexts in SSA.

5.4.6 Sustainable and healthy horticulture in and around cities

CIP will conduct research with relevant partners to develop improved horticulture systems in or around African cities. Though research will target enhanced productivity and reduced health risks of the system rather than focusing on individual commodities, initially this work will prioritize systems in which sweetpotato and/or potato play a significant role and will draw on science assets in genetic enhancement, ICM and IPM. Particular attention will also be given to establishing realistic food safety and environmental standards through working with local leaders to design policies which recognize the needs and rights of both

poor urban producers and consumers. In this work, it will draw on research assets related to institutional learning and innovation. Researchers will also develop and test the effectiveness of marketing campaigns focused on nutritional qualities of crops.

5.4.7 Enhancing capacity for innovation

CIP has invested in SSA in developing participatory breeding and other methodologies such as farmer-field schools as approaches for empowering both farmers and researchers to better address constraints encountered in potato and sweetpotato cropping systems. Participatory research will be undertaken to better understand how well these approaches have worked as means of empowering clients to achieve their objectives. Research will seek to determine the best approaches for establishing sustainable seed multiplication and dissemination systems under different political-economic settings, drawing on both the positive and negative experiences past and present and local knowledge. Emphasis will be placed on understanding the underlying processes through which technology diffusers and technology users interact and what stimulates behavioral change at the level of farmers and research and development practitioners.

Because few researchers are dedicated solely to sweetpotato within NARS, CIP will continue to work closely with graduate students in African universities to conduct much needed research in areas such as integrated crop management and sweetpotato utilization as an animal feed and continue to backstop effective research networks.

5.5 Partnerships for Impact

NEPAD has acknowledged that sustainable development will not be attained without effective and efficient research and development institutions. It is committed to strengthening existing institutions, establishing new centers of excellence in Africa, and creating networks of centers of excellence through the internet, cross-border staff exchange and training programs.

CIP will prioritize capacity strengthening of NARS partners within the NEPAD-CAADP framework, as the lack of critical mass in key areas of agricultural research is recognized as a major impediment to agricultural development in SSA. CIP will pioneer new capacity building methods ("researcher-field schools") in which researchers improve their skills through the execution of research activities with peer mentoring provided by CIP and other NARS scientists. CIP will continue to support networks in eastern and central Africa (PRAPACE) and in southern Africa (SARRNET) and in African universities to provide opportunities for established and young African scientists, particularly women, to conduct potato and sweetpotato research relevant to their countries. CIP will prioritize developing relevant training materials and courses in French and Portuguese as these countries lack comparative advantage in competing for English-based research grants and regional training programs. Moreover, CIP will seek to collaborate directly with the Bioscience Facility for Eastern and Southern Africa (BECA) in training young scientists in genetic transformation.

CAADP has also called for the development of fast-track initiatives to get agricultural growth moving and reduce hunger. CIP, through the VITAA platform, will seek to accelerate the selection and dissemination of locally adapted orange-fleshed sweetpotato varieties throughout Southern Africa, the region most afflicted by poor rates of agricultural growth and recurrent drought, through this mechanism in collaboration with strong development partners in the agriculture, nutrition, and communication fields. The VITAA platform will also establish strategic alliances with other institutions specialized in vegetable and fruit production and lead an integrated food-based approach to resolve vitamin A deficiency with orange-fleshed sweetpotato serving as the key entry point building on VITAA partner's prior experience in demand creation and marketing. CIP will lead the agronomic component of research initiatives to test innovative food-based approaches for addressing the nutritional needs of communities severely afflicted by HIV/AIDS in areas where sweetpotato is an important part of the cropping system.

An estimated 45 percent of CGIAR center resources are currently allocated to SSA. To better address food insecurity through seeking long-term solutions to hunger and micro-nutrient malnutrition, the CGIAR centers based in SSA are engaged in the joint development of medium term plans so as to identify potential synergies from greater collaboration between centers, avoid overburdening NARS, and hence, to increase the impact of their work. CIP will continue to actively participate in this and other integrative efforts, continue to reduce administrative costs through joint sharing of facilities with other CGIAR centers and establish collaborative research initiatives with CGIAR centers interested in integrated crop management research in the context of improved natural resource management, improved nutritional quality of the diet, and urban agriculture.

To accelerate the participatory development and adoption of its new technologies on a broader scale, CIP will develop strategic partnerships with larger, better-funded non-governmental organizations and private sector organizations to address the entire production to consumption chain for its mandate crops. Research for development proposals will be jointly designed to enhance feedback mechanisms from product end-users and the incorporation of research findings into development activities. Demand creation components will become an integral part of market development initiatives designed to enhance access to markets and new technologies by the rural and urban poor.

5.6 Impact assessment

CIP will increase number and quality of impact assessments of its research for development activities through hiring specialized staff in this area and through partnerships. Priority will be given to understanding the most cost-efficient pathways for disseminating new technologies and assessing uptake by and impact on the most vulnerable households in the community. Given the dominant role of women in the agricultural system and their vital contribution to household food security in SSA, particular attention will be paid to understanding how women are benefiting from new technologies, and mitigating any gender inequities that may arise from use of new technologies or the increasing commercialization of either crop.

The contribution of roots and tubers to African agriculture, especially sweetpotato, is probably underestimated due to the emphasis given to cereals in data collection initiatives and the difficulty in assessing the output of piecemeal harvested crops. Given the dearth of quality agricultural statistics for potato and sweetpotato for most SSA countries, CIP will seek to influence the design of national agricultural surveys and advocate greater use of satellite imagery to assess cultivated area in key potato and sweetpotato producing countries to ensure that higher quality data are collected and published.

Chapter 6. The strategy for South, West and Central Asia

6.1 Context and trends....25
6.2 Targeting 25
6.3. Needs and opportunities 27
6.4 Research for development themes 28
6.4.1 Reducing temporal and chronic hunger among poor communities 28
6.4.2 Linking farmers to markets 29
6.4.3 Improving the access to safe and nutritious food 29
6.4.4 Facilitating sustainable intensification of potato and sweetpotato-based farming systems 29
6.4.5 Developing sustainable and healthy horticulture in and around cities30
6.4.6 Enhancing capacity for innovation....30
6.5 Scaling up....31
6.7 Impact assessment 32

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Page numbers to be updated

This chapter introduces the CIP strategy for our priority countries in the South, West and Central Asia region. The chapter structure reflects the topics introduced in chapters two and three. We show how we will address the pro-poor research for development cycle with a range of inter-related actions. Further we show how our research for development agenda is informed by the needs of the poor and contributes to the MDGs through the themes we defined earlier.

6.1 Context and trends

Agricultural productivity is diverse in CIP's South, West and Central Asia (SWCA) region where crops are produced under different agro-ecologies and require different production practices and sequences. Most agricultural lands are in the plains but there are significant areas situated in the mid-hills and mountain regions. In the Caucasus, agriculture is practiced under different agro-ecological and climatic conditions, which vary from alpine into subtropical reaching even near-tropical conditions such as some lowland areas of Georgia. In Central Asia, Afghanistan and in Southwest Asia, agriculture depends on water for irrigation where most agricultural lands are in the plains, mid-hills, mountains and some desert areas and coastal regions. Climatic conditions vary and influence the production of agricultural crops, where in instances, severe droughts and climatic variability with heat and cold waves affect the incidence of pest and disease pressure.

Poverty in SWCA is high; of the 1.1 billion people in the world living on less than a dollar a day, South Asia accounts for 430 million. Recent estimates show that about 20-30 percent of the population in Central Asia and Caucasus live on less than $1/day. Contrary to common perception, undernutrition rates in the heavily populated South Asian countries like India, Bangladesh, Afghanistan and Pakistan are much higher (ranging from 38 to 51 percent) than those in other regions. It is in this region of the world that gender differences are most on display, from disparity in access to food in deficit households, to educational opportunities and connection to markets.

Many countries of the region are mountainous, with communities living below the poverty line, such as those in the foothills and mountains of the Himalaya chain, in India, Bhutan and Nepal. A similar situation is present in the mountains of Central Asia, especially among the rural communities of Tajikistan and Kyrgyzstan characterized by deprived livelihoods. Certain areas such as the north eastern states and the states of Orissa, Eastern Uttar Pradesh and Bihar in eastern India are targeted as areas with poverty, hunger and malnutrition as well. Like countries in SSA, political instability has affected some regions. Afghanistan has suffered instability for nearly 30 years.

With their high populations, widespread poverty and hunger and the importance of potato and sweetpotato, the countries of SWCA are a priority for CIP's work to contribute to the MDGs. The region is also the unfortunate host to several international and domestic conflicts that affect the achievement of the MDGs. Potato is a market oriented crop and could contribute to increased income in the poor farming areas and sweetpotato has a comparative advantage in marginal environments and could be a highly nutritious food or an animal feed crop.

In SWCA, several broad trends guide the targeting of CIP's activities. In order of their importance and potential, first is the very size and growth of potato production in India and the related growth of its neighbors. This is followed by the continued adjustments to post-independence for potato in CAC and finally the role of sweetpotato for addressing undernutrition and malnutrition in India and Bangladesh. India dominates the region in potato and sweetpotato production. Indian potato production has rapidly increased in the last decade, responding to greater popularity as a vegetable in urban diets and greater space in cropping systems. Potato consumption has increased over a broad front as it has become a more frequently served vegetable in traditional cuisine and has enjoyed growth in the western-oriented food industry serving the fast food market and tourist sectors.

Area growth has come from increasing incorporation of potato in the rice and wheat cropping systems of the Gangetic plains. Local and multinational snack and fast food industries are developing rapidly in the SWA sub-region, with India having a leading role as potato supplier to the domestic processing industry. Agro-industrial development is taking place rapidly in India with some activity in the other SWA countries. The increasing importance of multinational and domestic food processors will enhance the demand for superior quality potatoes. Trade within the region in seed and ware potato is expected to increase in the near future with new trade agreements established between countries especially in South Asia. Demand for selected high yielding seed varieties for ware and processing is therefore steadily increasing.

Countries in the CAC are in a period of transition from the times of the ex-Soviet union and are independent but require, however, major technical support to handle agricultural problems related to the MDGs. The CAC countries produce about 7 million tons of potatoes on about 505,000 hectares. The largest potato producer in CAC is Kazakhstan with 165,000 ha cultivated (2005) and a production of 2.1 million tons. During the pre-independence era, potato production in the CAC

region had been centrally planned and organized. Independence disrupted the sector and area and productivity fell as it shifted to small farmer hillside cultivation. For the first time since their independence, the total cultivated area in the countries of CAC region has passed 500,000 hectares and compared to 1996, has increased by 36 percent.

In SWCA, sweetpotato production is important only in India, Bangladesh and Sri Lanka. Sweetpotato production in South Asia is about 1.5 million tons on 0.2 million ha. India accounts for 68 percent of the total production, followed by 27 percent in Bangladesh and about 5 percent in Sri Lanka. Sweetpotato production in India and Bangladesh has grown slightly during the last decade thanks to growth in yields. Production is widespread but most zones are concentrated in the poorest states in eastern India and southern Bangladesh. Sweetpotato is emerging as an important crop in certain areas, mainly due to the high yielding varieties with high beta-carotene and high dry matter that are used for food and as animal feed. Utilization of sweetpotato is limited to consumption as a vegetable in the SWCA region. There is a very small quantity processed as a snack food in India and Bangladesh. Industrial use is non-existent but has potential. Using orange-fleshed sweetpotato (OFSP) as a food product with high beta-carotene to help reduce malnutrition accompanying vitamin A deficiency has been widely recognized by both government and non-governmental actors seeking to reduce hunger and malnutrition in vulnerable communities. Sweetpotato which is rich in carotene content is being used in tribal regions of the poverty stricken states of India in order to meet nutrition demand; especially in vitamin A. Pork is consumed in parts of the northeast of India and the potential to use sweetpotato as an animal feed exists.

6.2 Targeting

Insert map of SWCA target countries

Poverty and hunger is identified as a major problem in the SWCA region especially in South Asia. Due to the large population under the poverty line in the region and the constantly changing external environments, continuous refining of targeting will be done to capture areas where MDG target populations are concentrated. Targeting will be linked to the emerging needs and opportunities related to CIP's mandate crops. The progress on targeting and continuous monitoring will be necessary to capture the populations that are under the purview of the MDGS. With the important trends, CIP will target areas with high prevalence of hunger and malnutrition where potato and sweetpotato could have a significant contribution. Targeting will include poor urban and peri-urban populations involved in horticultural production of potatoes, sweetpotatoes and other crops. The urbanization rate for CIP's South and West Asian target countries is almost 4 percent, contributing to the corresponding growth in urban poverty and proliferation of urban slums and shantytowns.

Further targeting will be done through vulnerability analysis to take into account the constantly changing scenarios in the region. For this, factors such as prevalence of droughts and floods, marginal lands, land fragmentation, tenure,

management of natural resources and soil degradation both in mountains and on irrigated lands affecting sustainability on crop production will be analyzed. Communities living under extreme poverty and highly vulnerable conditions will be identified. Natural resources management is and will be an important issue. CIP will address NRM issues in targeted regions to elevate marginal and poor farming communities to a higher income status.

6.3. Needs and opportunities

Access to stable and profitable markets can lead to profitability in farming through producing diverse crops for multiple uses. Potato is and will continue in the foreseeable future to evolve as a commercial crop in all SWCA countries both for fresh consumption and for processing. Better varieties with integrated crop management practices will increase yield and provide higher productivity for the farmers. To be competitive enough, the production needs of farmers have to be addressed with little or no obstacles. The availability and marketing of healthy potato seed, processing varieties, ware potato for fresh consumption, and potato products are important for farmers in all potato producing countries in the region.

Sweetpotato is also profitable in the marginal areas where it is utilized as a nutritious food crop in nutrient-deficient areas in selected SWCA countries such as India, Bangladesh and Nepal. Sweetpotato has potential to be utilized in the animal feed industry in northeast India similar to its feed use in China and Vietnam.

Food production will be the most important activity in the food deficit and areas of hunger and poverty in the region. The harsh conditions in the mountain areas, the recurring drought and floods in the plains of some SWCA countries, the fragmentation of land, irregular land tenure and improper crop management practices are root causes of land pressure. As a result, there exists improper management of natural resources, both in the mountainous areas as well as in irrigated lands, which affects sustainability in crop production. Over-exploitation of natural resources can increase disease pressure and reduces reserves of underground water. Natural resources management is, therefore, an important issue that needs to be addressed if marginal and poor farming communities are to move out of poverty.

In poverty pockets in the region farmers recurrent drought frequently causes food shortages. Stable crops such as sweetpotato could be grown under adverse conditions. These communities can get better access to nutritional food through improved assess to healthy planting material availability through seed systems and also by improving the existing beta-carotene rich sweetpotato or potato varieties by bio-fortification.

Low-income households living in and around many of the cities in the region practice horticulture as part of their livelihoods strategies. CIP will seek to understand better their needs and to identify opportunities to enhance the contribution of potato, sweetpotato and other crops growing in these systems to livelihoods and mitigate risks to human and environmental health.

6.4 Research for development themes

6.4.1 Reducing temporal and chronic hunger among poor communities

Many farm families and communities in the SWCA region live in precarious conditions where food availability is often limited both absolutely and in temporal terms. For both potato and sweetpotato we will seek solutions that expand the availability of food through yield increasing and yield variability reducing solutions. We will also seek solutions to expand the time food is available through innovations in cropping systems and the provision of timely high quality seed. We will also design and facilitate the implementation of vulnerability forecasting, particularly for insects and diseases, to support decision-making by stakeholders.

6.4.2 Improving the access to safe and nutritious food

Nutritional food availability for the farming community at low cost and is important in many nutrient deficiency regions. In some areas, despite availability of sufficient calories, the diet remains poor from a nutritional standpoint. Building on our experience in Sub-Saharan Africa, we will introduce and promote the consumption of orange flesh sweetpotato as a food based approach to the reducing vitamin A deficiency.

An expected outcome will be the improvement of nutrition amongst the poor and reduction in night blindness prevalent in states of Eastern India and in Northern Bangladesh, amongst the under five population in these poverty and hunger pockets and countries.

6.4.3 Linking farmers to markets

As in other regions, the potato and sweetpotato sectors in the SWCA region are mostly characterized by their high level of disorganization. CIP in SWCA will build on our experience in LAC and SSA to introduce concepts of equitable value chain formation, stabilization and growth. With partners, CIP will provide solutions to help potato and sweetpotato farmers of SWCA identify and connect with markets and other actors in the value chain. They will also receive support through relevant partners to enhance their participation in current market chains to take advantage of the opportunity to participate in the market chain as an avenue to sell their fresh or processed produce.

6.4.4 Sustainable intensification of potato and sweetpotato-based farming systems

The SWCA region is home to a significant portion of the words irrigated farmlands. These lands are managed extremely intensively. We will investigate improved management of natural resources for irrigation, drought resistance and salinity. We will bring our experience from smallholder farms in the Andes to assist in reaching solutions to sustainable production in the small hillside farms in SWAC. We will also conduct research in vulnerable areas to help farmers innovate with their cropping cycles to provide greater resilience while reducing stresses on natural resources.

Production will be increased by using multiple cropping as currently practiced in the region with rice- and maize-based cropping systems. Potato and sweetpotato

are crops that will fit into such systems with innovative technology and thereby provide the added security of having diverse crops in the system for multiple uses. The expected outcome will be to satisfy the MDG of reversing the loss of environmental resources.

6.4.5 Sustainable and healthy horticulture in and around cities

Urban agriculture is already important in many of the fast-growing cities in SWCA and we expect this trend to grow in importance during the next ten years. CIP will bring its experience in urban agriculture in other countries to support improved safety and productivity of urban horticulture systems in SWCA cities. In particular we will focus on vegetables in the Solanaceae family and on safe food production and reducing risks to producers.

6.4.6 Enhancing capacity for innovation

The strength of agriculture innovation systems is highly variable in the region. This is particularly true for potato and sweetpotato research where there are few dedicated research professionals specialized on the crops. Developing capacity will be achieved through participatory research methods, including the use of Farmer Field School methods and participatory plant breeding. It will also involve institutional learning approaches for policy innovation.

The implementation of the Pro-poor R&D Cycle in SWCA will involve the participation of a wide range of stakeholders. CIP in SWCA will conduct research to improve the contribution of relevant stakeholders in the innovation systems, starting with promoting participatory research to enhance farmer contributions to technological innovation, but also working through mechanisms to promote inter-institutional learning to identify the most suitable scaling-up and out pathways of relevant technologies and methodologies. This will be particularly relevant for enhancing and facilitating the evolution of innovation system of the CAC countries, which used to be under a highly centralized technological regime during pre-independence times.

6.5 Partnerships for Impact

Of the priority countries in the south and west Asia subregion, the strengths of NARS are variable. India has the strongest government programs for both potato and sweetpotato. The crop-specific research institutions in India have a greater potential impact on partnership activities since financial and highly trained human resources are dedicated to both crops. The smaller governmental research and development programs in potato and sweetpotato in other countries of the region are either constrained with lack of funds or a lack in capability to retain trained personnel or both. Impact is therefore limited under these circumstances and CIP will define strategies to support these weaker programs.

The south and west Asian countries have NGOs and private sector organizations that play an important role in agricultural production and more broadly in development. These organizations are an important linkage mechanism among researchers, agriculture workers and the farming communities. CIP will seek to partner with these agencies to assure uptake of key technologies or practices by

beneficiaries in the respective countries and communities. CIP has experience working with international, national and local NGOs for this purpose.

In the CAC sub region, the Ministries of Agriculture host potato research programs in all eight countries. No specific institutes are dedicated to potato alone. Instead research on potato typically is mandated to horticultural institutes. CIP is and will continue to be a member of the Collaborative Research Program for the Sustainable Agricultural Development of Central Asia and the Caucasus established in Tashkent in 1998. The IARC Centers contributed to the creation of the "Central Asia and the Caucasus Association of Agricultural Research Institutions" (CACAARI), the overall objective of which is to foster the development of agricultural research in the CAC Region.

The domestic NGO presence in the CAC countries is weak and limited to a few countries. However, large international NGOs involved in community development and livelihood enhancement are slowly establishing a broader presence especially in farmer training. CIP SWCA will also make an effort to document the lessons learnt by the inter-institutional platforms, particularly to identify factors that limit or facilitate scaling up of technologies and methodologies.

CIP has a definite advantage in promoting capacity building among NARS and other components of the innovation system. Human resource development is important for all aspects of livelihood enhancement. CIP in SWCA and partner institutions in the region will play a major role in capacity building and human resource development in all aspects related to potato and sweetpotato research around the themes described before. CIP will collaborate with other sources especially those in countries with strong NARS for potato and sweetpotato research, to help in capacity building of weaker NARS and other stakeholders. CIP will also explore avenues to bring private sector experiences for capacity building.

A major portion of the farming work in the region is done by women. CIP in SWCA will include gender issues in capacity-building activities. For this CIP will enhance interactions and partnership with numerous agencies dedicated to enhance and encompass gender activities and training opportunities for capacity building in SWCA.

6.7 Impact assessment

CIP will study the impact pathways leading to achieving the MDGs and will transform lessons into methodologies (international public goods) which could guide interventions in SWCA and other regions of the world.

CIP will strengthen capacities in SWCA in impact assessment looking at contributions to the millennium development goals through research for development interventions.

CIP will conduct impact assessment for specific cases using the learning sites with the participation of stake holders and identify contributions and attributions to impact and effects of changes in the total innovation system.

Chapter 7. The strategy for East, Southeast Asia and the Pacific

NB
Page numbers to be updated

7.1 Context and trends....33
7.2 Targeting....34
7.3 Needs and opportunities....35
7.4 Research for development themes....38
7.4.1 Reducing temporal and chronic hunger among poor communities....38
7.4.2 Linking farmers to markets....39
7.4.3 Facilitating sustainable intensification of potato and sweetpotato-based farming systems....39
7.4.4 Improving access to safe and nutritious food....39
7.4.5 Promoting sustainable use of biodiversity....40
7.4.6 Developing sustainable and healthy horticulture in and around cities40
7.5 Scaling up....40
7.6 Impact assessment....41

This chapter introduces the CIP strategy for our priority countries in the East, Southeast Asia and the Pacific region. The chapter structure reflects the topics introduced in chapters two and three. We show how we will address the pro-poor research for development cycle with a range of inter-related actions. Further we show how our research for development agenda is informed by the needs of the poor and contributes to the MDGs through the themes we defined earlier.

7.1 Context and trends

CIP's East, Southeast Asia and the Pacific region (ESEAP) comprises a vast geographical area which holds one fourth of the world's population. For CIP and our priorities, the dominant factor in the region is the enormous presence of China and the importance of potatoes and sweetpotatoes there. Home to the rapidly growing economies known as the Asian Tigers, countries in ESEAP range from very wealthy to among the poorest in the world. The lifting of migration restrictions in several centrally planned countries in the region has resulted in an accelerated process of urbanization that has significantly changed the supply and demand relationship for food and other agricultural products. This process will most likely intensify in the coming years, creating new needs and opportunities for the agricultural sector in response to the demand for raw materials and food from an emerging industrial society. Migration of young people from rural areas to cities and demographic policies to reduce population growth is rapidly creating an aging rural population. An older population will influence trends on access to land and labor force as well as on technological development in coming years. In contrast, some countries are lagging in the transformation into market economies and remain mostly rural and very vulnerable to food shortage and possible famine. Some of the poorest countries in the ESEAP region are in Southeast Asia with very low average per capita income and negative development indicators. The islands of the Pacific, which have relatively small populations, are also among the most vulnerable countries in terms of food security due to limited opportunities for economic growth and fragile agro-ecosystems.

Most countries in ESEAP are densely populated and still growing. The pressure on land is among the highest in the world, where arable land availability is as low as 700 m² per capita. More than half of the population of ESEAP is heavily dependent on the agricultural sector. In Myanmar up to 70 percent of the population is involved in agriculture while in China more than 60 percent still lives in rural areas despite the accelerated urbanization of the last two decades.

Rice is the basic staple of the diet of most of the population of ESEAP; potatoes and sweetpotatoes appear in diets as vegetables. There are significant exceptions to this where potatoes are a dietary staple in the northern provinces of China, Mongolia and DPR Korea. In the subtropical mountains of Southeast Asia the potato is an important vegetable in diet diversification and an anchor in intensive cool-weather horticulture systems. Sweetpotato is a staple of most of the Pacific Islands and an important source of food and feed in several countries of ESEAP.

Led by China, the ESEAP region produces about 50 percent of the potato and 90% of the sweetpotato grown in developing countries. Other less widely grown Andean-origin root crops, such as canna (*Canna edulis)* and yam bean (*Pachyrhizus spp.*), are also produced in the region. Potato production increased very rapidly in the 1990s, essentially doubling during the decade to reach nearly 70 million tons per year by the turn of the century. Sweetpotato production in the ESEAP region averaged 120 million tons per year during 2000-02, a 9 percent increase from a decade earlier. Most of the recent growth in potato and sweetpotato production in the ESEAP Region took place in China. Potato production expanded the fastest in DPR Korea where the government targeted potatoes as a linchpin in their food security strategy.

7.2 Targeting

INSERT MAP OF ESEAP TARGET COUNTRIES

Three broad trends in the ESEAP region will drive the targeting of CIP's research activities over the coming period. First is the phenomenon of China, especially the size of its population and territory and the numbers currently living in poverty, but also the fact that China is experiencing very high economic growth and is implementing policies aimed at ensuring redistribution of wealth towards the poorer, north, west and south-western regions. China is also hugely important for CIP's mandate crops, accounting in 2005 for 88 percent of the total area of sweetpotato in ESEAP and 91 percent of the potato. Second, there exist a number of smaller countries in the region, such as Vietnam, Indonesia and Philippines, with significant economic growth, high rates of urbanization and market penetration, where processes of agro-industrialization are giving both potato and sweetpotato an important and potentially growing role in the economy. Even in these rapidly growing economies there are many communities that are mired in poverty and suffer malnutrition and high rates of maternal and child mortality. A third trend concerns the small, economically and politically stagnant countries such as Laos, Cambodia, Myanmar, DPR Korea, East Timor and islands of the Pacific, which have some of the highest rates of poverty, malnutrition and child

and maternal mortality, where potato and sweetpotato have often low levels of distribution at present (potato in DPR North Korea is an exception), but where these crops could make bigger contributions to both food and nutrition security and enhanced income generation.

The macro targeting during the visioning process included the area planted with mandate crops and the level of severity of a number of "impact filters" such as poverty, malnutrition and mortality rates. For China the results identified Sichuan, Yunnan and Chongging provinces in south-west China where large areas of both potato and sweetpotato combine with persistent poverty. In addition, central-eastern China is targeted because of the importance of sweetpotato and north and northeastern China for potato. Because of the very dynamic economy and agriculture sector policy changes, targeting of provinces in China will be regularly reviewed in relation to overall economic growth of the country and the implementation of Chinese government poverty eradication policies. The review process also considers the strong potential of both Chinese federal organizations and provincial agencies to increasingly function as research and development partners in the potato and sweetpotato program in the region.

INSERT CHINA PROVINCAL TARGET MAP

In relation to the second major trend, CIP will continue to prioritize countries such as Vietnam, Indonesia and Philippines, where the crops have the potential to become integrated with expanding rural-urban marketing linkages both within countries and as part of regional markets. A recent USDA assessment of Asian-Pacific food systems highlighted urbanization as a key driver of change. The horticultural systems around cities in the region have become key factors to the response the massive increase in urban food demand. The growth of urban markets will also increasingly involve transformation of the fresh product, with value being added along the rural-urban product chain and opportunities for poverty alleviation. Poverty and child and maternal health and mortality indicators for megacities will contribute also to the targeting process. Environmental vulnerability is an additional impact factor that needs to be applied to potato in these tropical and sub-tropical countries where the crop is grown with high inputs on sloping land in mid-altitude locations.

The third targeting scenario will seek to expand the role of both crops in the poverty hotspot countries for food and nutrition security and for added income.

7.3 Needs and opportunities

There are significant opportunities for improved production and utilization technologies of CIP commodities in this part of the world to address poverty, food security, and environmental degradation. There are about 100 million households in ESEAP that grow either potato or sweetpotato, each producing on average about 2 tons of these commodities on 0.1-0.2 hectares of planted area per year. Demand for potatoes is increasing rapidly, and a large share of production is marketed as a vegetable cash crop, with a small but increasing share going for processing. Potato also tends to be an input-intensive crop often grown in fragile mountain environments. Sweetpotato has a longer history in ESEAP and was until recently

primarily a food security crop. Per capita consumption of fresh sweetpotato is highest among low income, rural households and tends to decline as income rises. Unique among CIP regions, an increasing (and now majority) share of sweetpotato is being used for animal feed and processing. However, its continued role as a food security crop for low income families should not be overlooked. For the lesser utilized Andean-origin root crops crops, canna is principally used for its starch to make noodles, while yam bean is consumed as a fresh vegetable. Thus, improved potato, sweetpotato and Andean root crop productivity is likely to have favorable impacts on the incomes of poor farming families. A share of these benefits will likely be passed on to consumers through the price-lowering effects of increased production. Increases in total production in sweetpotato will result in larger market price declines than for similar increases in potato. Lower sweetpotato prices will favor poor households and also increase the crop's competitiveness as a source of animal feed and starch and flour in agro-industries. Improved potato production practices that reduce pesticide requirements and soil erosion are likely to have positive health and environmental impacts.

7.3.1 Potato

In the principal potato-growing zones of ESEAP, the principal technical constraints limiting productivity differ widely. Latitude provides a good demarcation for these environments, from the long-day, dry flatlands in northern China to the short-day, humid mountain environments in southeast Asia. Potato production in China can be broadly grouped into four principal systems according to latitude, each with a distinct set of needs and opportunities. The single cropping system characteristic of the northern latitudes; the double cropping system prevalent in the central part of China where two crops are accommodated in one season; the mixed cropping commonly found in the southwest where combinations of latitude and altitude favor multiple cropping patterns and where planting and harvests extends from spring to fall, and the winter crop of the most southern extreme of China where potatoes are planted in between two crops of rice in the winter.

In the single cropping area of the north, seasonal aphid pressure is high and potato viruses (PLRV and PVY), drought, and sometimes devastating late blight (*Phytophtora infestans*) epidemics from July to September are the major factors limiting yield. The double cropping system is characterized by a very short potato growing season where potato is first cultivated as a monocrop and then as an intercrop with maize. Viruses and bacterial wilt (*Ralstonia solanacearum*) are the main diseases. Late blight is important if potatoes are grown in the fall. The mixed cropping system is found in hilly and mountain areas in the southwest of China where late blight, bacterial wilt and wart are the main diseases. This system also extends into northern Myanmar.

The winter crop (November-February) is found in China, the Red River Delta in northern Vietnam, parts of Myanmar and northern Thailand, and the northern tip of Luzon in the Philippines. Potato is grown in rotation with rice or other cereal grains usually under irrigated conditions. The growing season is short, demanding early varieties with good storage ability if farmers save and use their own seed. Bacterial wilt, late blight and viruses are common diseases and potato tuber moth can be a limiting factor in storage, as seed has to be kept for long periods under

warm temperature. Expanding the potato area of winter crops in China and Indochina is an opportunity to increase food supply and improve nutrition of large populations in East and Southeast Asia.

In Southeast Asia the predominant potato production environment is in the high elevation, humid mountain areas. These areas are often under continuous year-round cultivation, with one or two crops of potato grown annually in rotation with cabbages or other vegetables. Late blight, bacterial wilt, viruses and various insect pests such as leaf miner fly (*Liriomyza huidobrensis)* and potato tuber moth (*Phthorimaea operculella* Zeller) all pose significant constraints to productivity in this system. Recently, the potato cyst nematode (*Globodera rostochiensis*) has emerged as another important pest in parts of Indonesia. Chemical input use is high, cultivated fields may be steeply sloped, and natural resource degradation is a major concern. This system is characteristic of potato production found in Indonesia, northern Thailand, southern Vietnam (Dalat highlands), and the Cordillera mountain area of Luzon, Philippines.

In all of the systems described above, potato is primarily cultivated on small farms. In China and Vietnam, past land reforms created an egalitarian farm structure in which individual farm families were issued long-term leases to small plots of land. With an exception for the flat lands of northern China, production is very labor intensive. About 22 percent of the total output is processed, most of it as gross starch at household level to make noodles. Only about 5 percent is transformed into fine starch, chips, frozen fries, mashed or dehydrated.

In northern Vietnam about a third of the potato crop is sold, a third fed to livestock, and a third kept for home consumption and seed. In Indonesia, Philippines and Thailand, farm structure is less equally distributed but small farms still predominate. Production is very labor intensive, and even small farms may make extensive use of hired labor in potato cultivation, employing landless laborers. Potato production in these countries is commercially oriented with more than 80 percent of the harvested crop being sold.

The lack of a reliable and affordable source of good quality seed is a major problem in all of the potato production environments found in the ESEAP region. Since several of the most significant potato diseases are seed borne, this becomes a double constraint to poor farmers. Though high prices keep it out of reach of poor farmers, Thailand, Indonesia and Vietnam import certified seed. China and the Philippines severely restrict the importation of potato tubers due to phytosanitary concerns. Each country of the region with significant potato production has invested in formal seed systems in which disease-free seed is produced and certified locally. These formal seed systems are often established with significant external financial and technical support and their record of sustainability after the termination of the support projects is poor.

Modern potato varieties have been widely adopted in Southeast Asia and are now beginning to make significant inroads into China, although the rate of variety turnover is generally slow. The lack of good seed systems constrains farmers' choices regarding variety adoption. Not only do inadequate seed systems limit

availability of seed of improved varieties, but the high expense of seed renewal leads farmers to adopt varieties that do not degenerate quickly. This usually implies varieties that possess some resistance to viruses and that have sufficient dormancy so seed can be stored under ambient conditions until the next planting period. This helps explain the long-standing popularity of certain varieties.

7.3.2 Sweetpotato

Sweetpotato has been an important food security crop in ESEAP since its introduction from the Americas in the 16th Century. With rising incomes, per capita consumption of sweetpotato has declined, and finding new profitable uses for sweetpotato is a major concern throughout the region.

The geographic distribution of sweetpotato in ESEAP extends from the south Pacific to northern China, and it covers altitudes ranging from sea level to more than 2000 masl. The Yangtze River Basin in Sichuan province is the most important sweetpotato-growing area in the world, accounting for about one-half of global production. Sichuan is also one of the poorer provinces in China. Sweetpotato is primarily planted in hilly areas and combined with unfavorable climatic conditions, productivity is low. Most sweetpotato produced in this zone is utilized on the farm where it is grown for animal feed. Both foliage and roots are fed extensively to pigs. In years of high production sweetpotato prices may be so low that some of the crop is left unharvested. Starch extraction to meet the rapidly rising demands of the food industry has become the second important use of sweetpotato in this zone.

Southeast Asia has a diversity of sweetpotato production systems. In Vietnam sweetpotato is used primarily for animal feed. In some areas of Vietnam sweetpotato is grown as a forage crop in which only the protein-rich foliage is harvested for feed. In Indonesia, sweetpotato is both a commercial and home garden subsistence crop. Various districts of Java and Sumatra have emerged as centers of commercial sweetpotato production. Here, sweetpotato is grown primarily in paddy fields in the dry season following the rice harvest. In tropical lowlands, the sweetpotato weevil (*Cylas* spp*)* is a major insect pest especially under dry conditions. In eastern Indonesia and Papua New Guinea, sweetpotato is an important food and feed crop. In the highlands of New Guinea sweetpotato is the main source food and per capita consumption is probably the highest in the world.

Modern varieties of sweetpotato have been widely adopted in China but have yet to make significant inroads into Southeast Asia. Although sweetpotato planting material is relatively easy to produce, most countries in ESEAP lack formal mechanisms for multiplying and disseminating planting material of new varieties (China is an important exception). Evidence from national programs shows that the genetic resources used to breed the new varieties released over the past 20 years have come from a relatively narrow base. Increasing the genetic diversity used to develop new hybrid crosses is one way CIP will help to boost the productivity of sweetpotato breeding programs in ESEAP.

A growing set of needs in the region relate to those households seeking secure and safe livelihoods through horticultural production in urban and peri-urban areas. Opportunities exist to mitigate negative health effects from pesticide use through ICM interventions as well as to apply remote sensing techniques to understand and manage the rapid change and instability which can affect horticultural systems. The importance of policy and institutional issues to the functioning of these systems can be addressed through the application of innovation systems and institutional learning approaches.

7.4 Research for development themes

7.4.1 Promoting sustainable use of biodiversity

The island countries of Southeast Asia are a secondary center of biodiversity for sweetpotato. The region is a valuable resource for genetic enhancement because of the large range of agro-ecologies in which sweetpotato is grown. CIP will continue to collect, characterize and utilize these resources to the benefit of the low-input farming systems of ESEAP.

7.4.2 Reducing temporal and chronic hunger among poor communities

Concentrations of most marginalized peoples in Southeast Asia are found in highland areas where potatoes and sweetpotatoes appear in cropping systems. The highland systems where these poor communities live are physically isolated by poor infrastructure and vulnerable to climate shocks and pest and disease outbreaks. For these communities providing yield stability is a higher priority than absolute productivity increases. We will seek to achieve stability by introducing varieties resistant to major pests and diseases and environmental stresses such as drought or heat. Potato is a well studied crop but sweetpotato was neglected by research and developments initiatives in most of the developing world. We will also seek to improve seed quality. Virus research, vectors and physiological aspects of potato and sweetpotato seed quality will be main elements of yield stability research.

7.4.3 Improving access to safe and nutritious food

Most ESEAP countries have made great strides in making adequate nutritious food available to their populations. Exceptions are the poorer countries of Southeast Asia. Potato and sweetpotato are eaten as vegetables in these countries and fill a role in diet diversification and improved nutrition. The value of the potato as a nutritious food is well recognized in those countries with potato production tradition and could be a vehicle for addressing specific cases of malnutrition in selected areas where potato consumption is meaningful such as in DPR Korea.

High beta-carotene OFSP with high dry matter and well adapted to the agro-ecologies in the region has been on the research agenda for many years and will remain so in the future in order to expand its nutritional benefits to a larger sector of the population. The Pacific islands and the poorest countries of Southeast Asia are the most likely areas of impact of improved nutritional quality. Sweetpotato is widely utilized in animal nutrition all over ESEAP. Research will refine our knowledge on efficient utilization of roots and vines in swine and bovine nutrition.

7.4.4 Linking farmers to markets

Processes of agro-industrialization are well established in China and many Southeast Asian countries. Linking poor farming families and communities to these markets is a solution to poverty. Enabling reliable participation and equitable treatment in these market chains are important objectives. Making technology work for the poor will require marketing studies, access to services and improving the capacity of farmers to become more competitive either individually or collectively. The involvement of all members of the value chain of the potato industry is required to share the benefits of technological development.

With agro-industrialization potato processing quality has become an important factor. Good frying quality for French fries and snack foods is rewarded by higher prices from processing companies. China has made significant investments into starch production in large processing plants in the north but coarse starch is also a popular way of processing potatoes among poor farmers. CIP will generate technology to facilitate competitive participation of poor farmers in the emerging processing market.

The perishability of the root and tuber crops calls for alternatives to fresh consumption. Research will look at simple and affordable ways to extend the storage life of fresh roots or transform them into long-term storable forms. We need to know the market for sweetpotato as food, feed and industrial raw material involving the actors of the entire value chain. The value added to sweetpotatoes by using it in animal production and industry should enable the uptake and dissemination of technological innovation of the sweetpotato production systems in ESEAP.

7.4.5 Sustainable intensification of potato and sweetpotato-based farming systems

Potato production in Southeast Asia is often the economic anchor in intensive small farm high value horticulture systems. Potato production often consumes more fertilizer and pesticides than other crops in the system. The pesticide exposure affects the health of farmers and their families. Contamination of soil and water and chemical residues in the product are a constant threat to consumers. The intensive movement of soil to grow potatoes leads to soil erosion especially in the hillsides of Southeast Asia. CIP will seek to minimize the environmental damage of intensifying potato agriculture and reduce health hazards to farmers and consumers of potato products.

7.4.6. Sustainable and healthy horticulture in and around cities

Sweetpotato is often a popular urban garden crop in ESEAP and it will continue to be in the future, with the rapid rate of urbanization taking place in this part of the world. CIP will continue to conduct research on production and utilization of sweetpotatoes in urban horticultural systems as a source of nutritious food supplementing the rice-based diets of ESEAP countries. It will also contribute directly, especially via ICM and NRM interventions, to improvements in the management of other horticultural crops and to the mitigation of negative health effects related to the cultivation of sweetpotato and other crops.

7.5 Partnerships for Impact

CIP will work with and build on the long history of regional partnerships in agricultural research in the region. Partners such as the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), which are supported by organizations of regional governments, offer stable platforms and partnerships in capacity building. Thematically based or subject-specific partnerships have also proved to be resilient approaches, both in responding to demands and in tapping into regional and local innovation systems. CIP's UPWARD network (Users' Perspectives with Agricultural Research and Development) is an example of a thematic partnership built around the mainstreaming of participatory research approaches within public and non-governmental organizations. UPWARD builds participatory research capacity in root and tuber crop production and utilization networks in the region through formal and research-based learning and innovation. It also provides a regional platform for cooperation between Future Harvest Centers on participatory research and capacity building.

An example of a subject-matter network, the Asian Network for Sweetpotato Genetic Resources (ANSWER), was created through an alliance between CIP, IPGRI and national sweetpotato genebanks and breeding programs in the early 1990s to build collaborative efforts in sweetpotato genetic resource conservation and breeding. This network demonstrated the potential for building a regional innovation system through knowledge exchange among organizations with very different capacities and resources. In particular it is a model for tapping the enormous expertise and experience of China in the area of sweetpotato breeding.

CIP will seek partnerships with stable, government-sponsored regional partnerships, especially for improved capacity-building in ESEAP, and will also elaborate the model of thematic and subject-matter partnerships and platforms at region level to facilitate innovation and knowledge exchange throughout ESEAP. In particular, it will help build partnerships which benefit from the growing role of China as an advanced research partner and capacity builder in the region.

Strategic partnerships between CIP and other CGIAR Centers have already been established in the area of crop genetic resources, participatory research and crop-livestock systems. CIP will continue to seek ways to gain synergy working with other Alliance Centers either in bilateral arrangements or through System-wide Programs.

A major characteristic of countries of the region is the dynamic and creative character of local innovation systems, especially in the development of new uses for fresh products and in the techniques for transforming them. Individual households in China and more recently small and medium-sized private enterprises have been major engines of growth. The successful mechanization of extruded sweetpotato based noodles in Sichuan resulted from the rapid take up and adaptation of extrusion machines developed by an engineer at the local agricultural research academy. CIP's experience with building alliances and platforms will be applied to supporting these local innovation system alliances, especially linkages along value chains and between the value chain and public

sector research development organizations. For example, provincial-level agricultural departments have a strong capability to support seed multiplication and distribution systems, which can be key components of local potato or sweetpotato innovations, such as in chip or starch processing. CIP will support a shift from supply-driven public sector interventions, towards a public system as a demand-orientated partner in public-private innovation.

A major strategy for scaling up innovations in intermediate countries is through strengthening local agricultural knowledge sharing and learning alliances. In countries such as Indonesia, Vietnam and the Philippines, agricultural knowledge and information systems are relatively weak and fragmented, particularly between civil society, the private sector and government organizations. CIP will function in a dual role in these countries. We will be a participant in local innovation systems, through providing research and development organizations access to new technologies and methods, be they germplasm, IPM strategies or socio-economic techniques. We will also be a facilitator of dialogue and partnership among organizations.

7.6 Impact assessment

CIP will develop regional capacity to foster impact assessment and impact enhancement activities in ESEAP. CIP will continue to backstop capacity development for participatory research and development within Divisions, Partnerships and Special Country Projects throughout the region but will strengthen capacity in market development, policy analysis, institutional strengthening, competitive production and provision of services enabling technology to serve the poor and increasing market penetration. All this will be done in close collaboration with partners from the national and international community with congruent mandates and synergic capacities and a common vision of improving livelihoods of the rural poor. CIP will tap into regional capacity developed in the past with the auspices of UPWARD that will provide leadership after redefining its functions, expanding its mandate and recomposing its cadre of professional expertise.

Chapter 8. Positioning for growth and impact

8.1 Preserving the core and responding to challenges 43
8.2 Research excellence 43
8.3 Enabling and empowering 44
8.4 Comparative advantages in research 45
8.5 Key features of CIP's operations 45
8.5.1 Organizational structure 45
8.5.2 Staff diversity 45
8.5.3 Partnerships 45
8.5.4 Impact assessment 46
8.5.5 Knowledge management 46
8.5.6 Decentralization 46
8.6 Acquiring resources 47

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Page numbers to be updated

8.1 Preserving the core and responding to challenges

Over its 35 years CIP has remained clearly focused on its founding paradigm: food for the poor by protecting biodiversity, productivity-enhancing research and capacity building on its mandate crops. We refer to this as our core. It is where most of our institutional assets and skills are concentrated.

Even while CIP has preserved its core, it welcomed the efficiencies of new research paradigms and has become a pioneer in several of them. We embraced the enhanced perspectives, the broader applicability and refined prioritization of the research agenda that these paradigms offered through the addition of new skills, approaches and methods.

This Strategy is a both a re-affirmation and a fundamental departure from our core. It is a re-affirmation because to carry forward our MDG-driven research agenda we will strengthen our expertise with and capacity of our core to contribute. It is a departure because we put our central organizational focus on specific themes in the Pro-poor R&D Cycle that we believe will be most effective for carrying forward that agenda.

The chapters above introduced our intentions of where we will work and what we will do. In this chapter we discuss how we will do it. To do it, CIP will need to grow. We will deepen the expertise in our long held core and we will broaden expertise to be able to confront the new challenges. We will grow geographically. For example, Sub-Saharan Africa is an ecologically diverse region where we have identified 17 priority countries and the majority of our NARS counterparts are weak. Interacting with and serving this large region will mean establishing a physical presence in more locations and making a serious commitment to enhancing our capacity strengthening efforts to create a critical mass of qualified young scientists. In south and east Asia, India and China are served by strong agricultural research systems. Our growth there will be fundamentally different and will be anchored in a philosophy of strategic alliance.

8.2 Research excellence

CIP is a center of excellence in research in potato and sweetpotato science. Our excellence rests fundamentally in the quality of our researchers and the outputs they produce. With the adoption of the Pro-poor R&D Cycle as an organizing paradigm we are investing in our core and additional initiatives that will strengthen our ability to more accurately target and effectively deliver research outputs in a timely and efficient manner. Perhaps one of the main benefits of this approach will be the constant pressure to know, evaluate and re-evaluate our priorities. Being truly demand driven assures that what we produce has an improved chance of being adopted. Our investment in new areas will be tailored to attract and retain the highest caliber researchers possible so as to acquire excellence in these new fields as well. Greater investment in key core research activities clearly linked into a demand-driven, development oriented paradigm will accelerate the development of technologies that farmers want to adopt and consumers will buy.

CIP has mechanisms in place to ensure the quality of its research inputs and outputs. We monitor and evaluate quality and performance before, during and after the completion of research. We have installed individual and collective planning and evaluation mechanisms to constantly stimulate the highest quality standards for our work and will increasingly involve our stakeholders in the evaluation process. We will continue to refine and improve these research quality management mechanisms to assure quality and timely delivery of outputs.

CIP researchers will continue to produce a wide array of information outputs that report our work. We will seek the highest content quality for each class of output. We expect CIP researchers to publish findings in external peer-reviewed journals. As a center with researchers from many fields, external publication is an invaluable device to keep up with the mainstream academic quality checks in the various disciplines. CIP researchers will also be expected to have the communication skills to effectively translate their findings to the general public as well as scientific audiences.

8.3 Enabling and empowering

Knowledge generation is only one of the roles that CIP fills in the global agriculture research for development innovation system. Our location and contacts in developing countries means we can also facilitate research by others, catalyze change and integrate and disseminate knowledge, materials and practices. We seek to assure that our outputs are used by all possible interested stakeholders. Especially for our research collaborators in developing countries this can mean investing in capacity strengthening.

8.3.1 Capacity strengthening

Making sure that national programs and others have the skills and institutions in place to effectively contribute to the Pro-poor R&D Cycle is and will continue to be an important task. We will not engage in routine professional training but we will provide specialized training to assure especially that our intermediate research outputs such as models, research tools and methods are taken up by their

intended users. We will propose, support and host research for postgraduate training.

We recognize that traditional capacity-building methods and practices often do not reach a critical number of trainees to justify the investment. We will implement a research program to convert our catalogue of training materials into formats that can be utilized with modern ICT and accessed either remotely for interactive self-directed study or by training professionals that can quickly assemble material specifically tailored for varied interests and levels of education. Our knowledge of the learning processes of adults has also advanced. We will test and apply new techniques for adult education for a range of collaborators from professional researchers to less trained development specialists to farmers. We will design, plan and engage in capacity strengthening in each of our projects.

8.3.2 Communication and public awareness

We recognize that we need to get the word out, not only about CIP and what we do but about the importance of the problems we work on and the possible solutions to them. We intend to use a variety of mechanisms to reach the general public, key decision makers, stakeholders and collaborators, including traditional and modern ICT. We want to spread the word that there are solutions to these serious problems and advances are being made. We will engage with a variety of communication outlets to reach this objective. We will seek to attract additional interest in the agenda that we have committed to.

8.4 Comparative advantages in research

The previous chapters identified where CIP will work and what it will do. That exercise reflects where we believe we can be a leading player in our research but also where we need to partner. Our Pro-poor R&D Cycle is a comprehensive framework for generating a focused research agenda, producing outputs, shepherding outcomes and following through to impact. Even with a strategy for growth, it is impractical and unrealistic to expect that CIP can achieve leading excellence in all fields. As described above, we will look to other organizations for leadership in on-the-ground delivery.

8.5 Key features of CIP's operations

8.5.1 Organizational structure

In the CIP Vision, we presented an organizational alignment of our research program through creating subject-based divisions that provided an institutional locus for the concentration of skills to confront problems across a broad front. These divisions interact with a second set of structures that provide a linkage to partners, our Partnership Programs. CIP is a pioneer in the CGIAR in the development and utilization of research networks. We continue to refine this approach to partnering as an efficient method for organizing joint efforts with a regional or global focus when numerous research partners exist. The divisions and Partnership Programs together provide focused expertise in each of the steps of the Pro-poor R&D Cycle

8.5.2 Staff diversity

CIP will continue to recruit highly qualified scientists. We will also seek to increase the number of researchers who are women and from developing countries and will target our job searches to reach a broader pool of applicants who are women and from developing countries.

Recognizing the widely shared difficulties of similar institutes to attract such candidates we will also implement a program to mentor and train young candidates. We will seek opportunities to incorporate such individuals through junior professional officer or post-doctoral programs.

8.5.3 Partnerships

As in the past, our proposed research agenda will be carried out with partners. We currently engage many different types of partners from public and private ARIs, universities, NARIs through to NGOs, CBOs and farmer-based organizations. We will continue to refine our partnering strategy. India and China, two of our priority countries, have large and experienced research institutes with which we can partner for work not only there but also for their neighbors. We will also partner for knowledge dissemination and follow through to impact with public and private partners.

8.5.4 Impact assessment

Impact assessment is an integral part of the Pro-poor R&D Cycle to inform and feed back information for improved iterations of the cycle. It is also a function that is increasingly demanded by our partners in the innovation systems where we participate. We expect and welcome accountability and evaluation of the effectiveness of investments with us. As we continually integrate with changing innovation systems, and fill different roles in them, we must seek new methods for accounting for this role and its impact. We will continue to conduct and publish high quality studies of our work, making them available to our stakeholders, clients and investors. Modern methods for impact assessment have evolved from economic accounting, we will need and use various disciplines in our impact assessment team to assess the broader nature of the outcomes and impacts we expect to achieve.

8.5.5 Knowledge management

A modern, decentralized research institution is in the business of generating and sharing knowledge internally and externally. CIP is investing in modern management information systems that will support physically, financially and programmatically decentralized operations. We recognize that we generate new information in many different forms and that information is converted into knowledge in many different ways. We must keep ourselves informed what others are doing and what we are doing. We must keep a record of what we have done. CIP will utilize modern ICT to generate, store and diffuse this knowledge.

8.5.6 Decentralization

From its founding CIP has been a highly decentralized center. With our global orientation we have kept our headquarters small and our regional offices scattered in locations around the world where they are most needed. With rare exceptions,

our regional offices have never had CIP-owned facilities but rather have been hosted by fellow CG centers or on the campuses of national agricultural research institutes. CIP believes this approach to staff deployment enhances the links to partner organizations and is an important component of capacity building. CIP will continue with this decentralized model of operations.

We will use advances in information and communications technology to enhance the functioning of the 'virtual' teams that we will assemble. We will constantly review and update policy and procedure to empower our staff deployed around the world to make informed decisions independent of central control. Decentralized operation means that more scientists are also administrators. We will strive to provide management tools that keep administration burdens to a minimum and science time at a maximum. We will hire talented scientists and trust them to implement policy intelligently and responsibly.

Respecting our priorities, we will increase our physical presence in the Sub-Saharan Africa and the South, West and Central Asia regions. This will mean offices in new countries and increased numbers of researchers.

Utilizing advances in ICT and modern managerial practices we will seek to devolve more discretionary decision making to the appropriate level of staff, creating more agile and flexible regionally based teams.

BOX

Institutional values

CIP encourages the development of new skills and competencies among staff at all levels and will actively encourage women and developing country citizens to improve their skills

CIP is and will remain honest and transparent in what we say and do. We accept responsibility for our individual and collective actions

CIP will create a working environment free of prejudice and is supportive of individual creativity and initiative

CIP will seek to devolve responsibility and decision making to appropriate levels for efficient and effective decision making

8.6 Acquiring resources

We believe that to make a meaningful contribution to the MDGs by the end of the planning period we must grow quickly. Our small headquarters and leased field offices makes CIP a low fixed-cost center among its peers. However, to implement the proposed strategy we will need to plan for growth of physical infrastructure, modern research equipment and high quality support services. All these decisions will flow from our programmatic priorities.

Thus we will embark on a vigorous plan to increase our operational and capital funding. We anticipate that official development assistance will remain our primary source of funds but we will increase our efforts to diversify these funding sources. We will seek to open new funding sources from among traditional CGIAR

donors and from non-traditional donors. While we will continue to respond to research calls, we recognize that this model of fundraising places strains on the individual scientist and on the administrative structures to prepare, submit, receive, monitor and report. Based on the priorities identified in this document, we will implement targeted campaign style efforts to streamline resource mobilization for large programmatic areas of our program.

CIP is and will remain a research institution. However, in this plan and with our operations paradigm we commit to following more of our outputs further down impact pathways. To do this without violating the expectations of our donor-investors we must strategically interact with our development partners.

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