Resilient Farming Systems in Times of Uncertainty

Biocultural Innovations in the Potato Park, Peru

Asociación ANDES

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Asociacion ANDES

About the author

The Association for Nature and Sustainable Development (ANDES by its Spanish acronym), is an international NGO based in Cusco, Peru. ANDES is a non-profit association involved in poverty alleviation, biodiversity management, and strengthening traditional resource rights. It has supported establishment of the Potato Park and its many innovations since 1998.

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The aim of the Natural Resources Group is to build partnerships, capacity and wise decision-making for fair and sustainable use of natural resources. Our priority in pursuing this purpose is on local control and management of natural resources and other ecosystems.

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Smallholder farmers living in harsh environments have developed strategies and technologies for resilience and adaptation to climatic changes that have enabled survival over millennia. These provide important resources for innovation in response to today's climatic challenges. This report explores such 'biocultural innovations', developed by the Potato Park – a community-managed landscape in Peru's high Andes. It also explores recent trends in climate, livelihoods, food security, crop diversity and social capital. Despite significant climatic challenges, the Potato Park has succeeded in increasing crop yields, doubling incomes and crop diversity and strengthening social capital since 2003.

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Acronyms

BCH	Biocultural heritage
BCHI	Biocultural heritage innovation
BCHT	Biocultural Heritage Territory
CIP	International Potato Centre
IIED	International Institute for Environment and Development
FAO	Food and Agriculture Organization
FG	Focus group
FGD	Focus group discussion
GMO	Genetically modified organism
GOREC	Regional Government of Cusco
HH	Households
PAR	Participatory action research
PACC	Climate Change Adaptation Program
PP	Potato Park
SENAMHI	Peruvian National Service for Meteorology and Hydrology
SIFOR	Smallholder Innovation for Resilience
TK	Traditional knowledge
WIPO	World Intellectual Property Organization

Executive summary

Smallholder farmers living in harsh environments have developed strategies and technologies for resilience and adaptation that have allowed them to survive for millennia. These traditional knowledge-based strategies have important yet largely untapped potential for developing innovations for adaptation to today's climatic challenges. This report explores such 'biocultural innovations', developed by the Potato Park – a community-managed landscape in Peru's high Andes dedicated to in-situ conservation of potato diversity and other Andean species; promotion of food security, food sovereignty and sustainable livelihoods; and conservation of indigenous peoples' biocultural heritage. Biocultural innovations arise from the interaction among the components of biocultural heritage (traditional knowledge, biodiversity, landscapes, cultural and spiritual values and customary laws), or the interaction between traditional knowledge and science. This report also explores recent trends in livelihoods, migration, food security, agricultural systems, crop diversity, seed systems, social capital and climate, in the Potato Park.

The report presents the results of a comprehensive baseline study conducted as part of the SIFOR project (Smallholder Innovation for Resilience: Strengthening Innovation Systems for Food Security in the Face of Climate Change), a five-year research project involving partners from China, India, Kenya and Peru. The main objectives were to provide baseline data for evaluating the impacts of the SIFOR project; to identify biocultural innovations that enhance food security for wider dissemination among Potato Park communities; and to identify those factors or conditions that support biocultural innovation. The data on trends provides an understanding of the context for innovation, and evidence of the impacts that the Potato Park's innovations have had on income, food security, crop diversity and social capital, and hence on resilience to climate change.

Conceptual framework

The conceptual framework was inspired by the Andean worldview and its system of organisation, the ayllu, which consists of three 'communities' or realms: the domesticated and human; the wild and semi-domesticated; and the sacred and the ancestors. When the three communities or ayllus are in balance, sumaq kausay or harmonious living is achieved. ANDES' technical team worked with members of the Potato Park to design a participatory, indigenous and decolonising methodology, enabling indigenous communities to create their own research approach based on their worldview, conceptual frameworks, culture and way of life. The methodology involved complementary qualitative and quantitative studies, including community and household surveys in four Potato Park communities – Amaru, Chawaytire, Pampallaqta and Paru Paru – covering 61 households. The Potato Park community technicians were actively involved throughout the process, which helped to strengthen their research capacity in facilitating research processes and quantitative data collection.

Key trends

Livelihoods and migration: Because of increasing male out-migration for work, only women were working in agriculture in 10% of households in 2012, increasing their workload. Women are in charge of selection and management of the harvested products, including differentiation of products for household consumption, sale or barter, and selection and storage of seeds for the next season. Average household income almost doubled between 2003 and 2012, and income exceeded expenditure for the first time in 2012.

Food security and agricultural systems: Despite significant climatic challenges affecting potato production, the share of households that are self-sufficient in basic foods (especially potatoes) is high and has remained stable, and potato yields have increased slightly since 2003.

Agrobiodiversity and seed systems: Potato diversity has almost doubled since 2003, reaching 1,345 different types of native potato (about 650 different varieties) in 2012. This high diversity is the result of a key Potato Park innovation: an agreement with the International Potato Centre (CIP) signed in 2004 which led to the repatriation of 410 native potato varieties. The great variety of potatoes provides resilience during extreme weather events, because there is a higher likelihood that at least some of the varieties grown will survive. Households maintain a diversity of varieties mainly for food security reasons. Seed security is a key concern of Potato Park farmers, who only use native seed, largely accessed through seed saving, exchange with other farmers or barter (ie. non-market sources).

Social capital: Traditional culture has strengthened since 2003, as indicated by the resurgence of traditional festivals. This, along with strengthened collective institutions, is due to the Potato Park's economic and institutional innovations, and to the highly participatory, indigenous-led research methodology used by ANDES. The return of native varieties from CIP also revived related traditional knowledge and practices.

Climatic changes and adaptation: 92% of households reported reduced rainfall, and 50% or more reported increased wind strength, drought, flooding, sunshine strength, frost and pests/diseases since 2003. The onset of rains is now two months later than 30 years ago, which has shortened the growing season. Rising temperatures have intensified pests and diseases affecting potato yields. As a result, farmers have had to move potato cultivation up in altitude by 200 metres in the last 30 years, and some potato varieties have been lost. Households are also adapting by using higher-yielding native potato varieties, manure and organic fertiliser.

Biocultural innovations

The study recorded a total of 31 biocultural innovations. These include:

- 18 technological innovations (eg. shifting the range of potato cultivation, community seed bank, seed and knowledge exchange).
- 4 market innovations (eg. the development of Potato Park micro-enterprises for biocultural products and tourism).
- 9 institutional innovations (eg. the Potato Park Association for collective governance of the park, an inter-community benefit-sharing agreement and inter-community groups of potato experts and community researchers). The repatriation agreement with CIP has significantly increased the gene pool for climate adaptation.

The research explored the factors that support innovation, including individual factors such as elders, women, and the appointment of key individuals as members of the Potato Park's potato expert group and specialised groups for marketing innovative products; participation in learning networks linking communities, respectful collaboration with external innovators and scientists, and capacity building; institutional factors such as legal recognition of indigenous peoples' values, lands and customary seed systems; and community factors such as a community innovation fund.

Conclusions and lessons learned

The findings show that the Potato Park's biocultural innovations have been effective in strengthening resilience to climate change, by enhancing food security, incomes, biocultural heritage (including crop diversity) and community organisation/social capital. This is due to key innovations, such as the Potato Park Association established in 2000 and the 2004 CIP agreement, developed with support from ANDES, which have spurred a number of other innovations. This highlights the importance of such community managed landscapes – or 'Biocultural Heritage Territories' – for adaptation to climate change. The following key strategies can be proposed to strengthen biocultural innovations for food security in the face of climate change – in the Potato Park and more widely:

- diversify crop production and commercialise farmers' varieties and underutilised species; support seed production and distribution
- develop policies to support ex-situ and in-situ complementarity and smallholder innovation
- strengthen the factors which promote community innovation: access to resources, training, technical support, microenterprises, cooperation with research centres and universities, respect for elders and transmission of traditional knowledge
- stimulate a greater level of awareness and interest in biocultural innovations amongst community members in the Potato Park
- continue to strengthen collaborative relationships with CIP and to scale-up biocultural territories at international, national and local levels.

The study highlights the critical importance of traditional knowledge and respectful and empowering partnerships between traditional knowledge holders and external thinkers and scientists for developing effective responses for climate change adaptation.

Introduction

1

Smallholder farmers living in harsh environments, such as mountains, are amongst the most affected by climate change. At the same time, they have developed strategies and technologies for resilience and adaptation over centuries that have allowed them to survive in these difficult environments. These have important, yet largely untapped, potential for dealing with today's climatic challenges. This report presents the findings of a baseline study in the Potato Park, Peru (Box 1), conducted as part of the SIFOR project (Smallholder Innovation for Resilience: Strengthening Innovation Systems for Food Security in the Face of Climate Change). The study reviewed trends in livelihoods, crop diversity, social capital and climate, and explored traditional knowledge-based innovations developed in response to these challenges.

1.1 The SIFOR baseline study in the Potato Park

SIFOR is a five-year research project involving partners from China, India, Kenya and Peru, initiated by IIED in mid-2012 with funding from the European Union. The overall objective of the project is to improve food security and resilience by strengthening the innovations of small-scale farmers and traditional knowledge (TK) in developing countries. To achieve this, the specific objective is to improve understanding, practical approaches and national and international policies to better support innovation systems based on traditional knowledge. The project aims to identify TK-based innovations that enhance productivity and conditions that support innovation; develop tools to increase the resilience of innovation systems and rights security; strengthen the capacity of smallholders to sustain innovation systems and agrobiodiversity; and promote supportive policies and institutions.

In Peru, where the partners are the Association ANDES and the Potato Park, the baseline study identified emerging biocultural innovations derived from the traditional knowledge of indigenous farmers in the Potato Park (Box 2). Such innovations should serve to address climate change, and improve the food security and living conditions of rural men and women. The project focused on 'biocultural innovations' rather than TK-based innovations. This reflects the reality that innovations do not arise from traditional knowledge alone, but from interaction among the components of biocultural heritage, including TK, biodiversity, landscapes, cultural and spiritual values and customary laws (endogenous innovations), and between traditional knowledge and science (collaborative innovations).

BOX 1. THE POTATO PARK, CUSCO, PERU

The Potato Park was established in 2000 and is managed by five Quechua communities through a collective governance structure based on customary laws. Its main objectives are the in-situ conservation of potato diversity and other Andean species, including landraces and wild relatives; promoting food security, food sovereignty and sustainable livelihoods; and the conservation of indigenous peoples' biocultural heritage. The Potato Park seeks to contribute to the creation of a comprehensive food system that is more resilient, sustainable, socially fair and secure than conventional food and farming systems.

The park is located in the Sacred Valley of the Incas, at altitudes between 3,400 and 4,600 metres above sea level, and covers an area of about 9,000 hectares. It contains a great diversity of potato varieties, both wild and domesticated, and is considered to be a secondary centre of origin of the potato (CIP, 2006). According to communities' traditional knowledge-based classification, around 1,344 different varieties of potatoes are cultivated in the park.[1] According to western scientific classification, the Potato Park contains some 650 native potato varieties. The varieties come from a variety of sources, including the communities of the park, the International Potato Center (CIP), nearby communities and the University of Cusco.

In addition to potatoes, other native crops – such as olluco (Ullucus tuberosus), peas, corn, quinoa, tarwi (an Andean species of lupin) and oca (Oxalis tuberosa) – are grown in the Potato Park using traditional agroecological practices. Meat, wool, medicines and fuel are also produced. Complementary economic activities include handicrafts, ecotourism, gastronomy and the production of natural products based on the local biocultural heritage (ANDES, Potato Park, IIED, 2012). Other important functions of the local agrobiodiversity include the maintenance of ecosystem services, which provide critical inputs to local agriculture, such as soil fertility, controlling pests and diseases, water and pollination.

[1] Western classification of potatoes is largely static and descriptive. In contrast, the Quechua in the Peruvian Andes employ a classification system which is based on hundreds of years of intense management of the genetic resources of the potato. They classify local varieties of potatoes following sub-systems involving taxonomy, local descriptors, and nomenclature that even differs between communities within the park itself.

BOX 2. DEFINING BIOCULTURAL INNOVATIONS

The SIFOR Project partners collaborated to develop a common framework for biocultural innovations for the baseline study. The concept of 'biocultural heritage innovations' (referred to from now on as 'biocultural innovations') was defined at a SIFOR partners' workshop in Cusco, Peru, as follows:

"Biocultural Heritage Innovations (BCHIs) are new knowledge, resources, skills and practices, or new combinations of these, which serve to: (a) strengthen and sustain the agro-biodiversity, particularly local seed systems, livelihoods and material and spiritual well-being of communities; (b) adapt to and mitigate risks due to global impacts, especially those of climate change. They are practical, sustainable, and are locally and globally relevant."

Also, "BCHIs have their basis in a people or community's BCH but may incorporate external elements. They integrate daily practices with traditional knowledge, spiritual values and customary norms. As such, they are dynamic, continuous, open, adaptive, and gender sensitive, integrating the creativity of people and nature" (Swiderska, 2013)

This report presents the results of a qualitative and quantitative baseline study carried out in four communities in the Potato Park: Amaru, Chawaytire, Pampallaqta and Paru Paru, in Pisac District, Calca Province, Department of Cusco. The qualitative research was carried out between January and August of 2013, while the quantitative survey was conducted from February to May 2014 (see Section 2).

The qualitative study explored local perceptions of past and current weather conditions; and identified the biocultural innovations developed by farmers to respond to these challenges, as well as the factors that influence the development of local biocultural innovations. The quantitative study explored trends in socio-economic conditions, food security, crop diversity, seed systems, climate change and biocultural innovation. The aim was to understand the context in which innovation takes place and to provide a baseline for monitoring and evaluating the SIFOR action research activities. The study provides in-depth insight into the farming systems of the Potato Park, and an indication of the impacts that the Potato Park innovations have had since the park was established.

The report begins with the background and context, before presenting the survey methodology in Section 2. Sections 3–7 present the findings on trends in key indicators relating to livelihoods, migration, food security, agricultural systems, crop diversity, seed systems, social capital, biocultural heritage and climatic changes. Section 8 identifies the main biocultural innovations in the park and the factors influencing their emergence. The final section presents some conclusions and recommendations arising from the baseline study to support the development of strategies to cope with climate change, and improve food security and living conditions in indigenous and peasant communities.

1.2 Biocultural diversity and historical change in the Cusco region

The Southern Peruvian Andes is a centre of biocultural diversity, one of the cradles of agriculture, and a region that is highly sensitive to climatic variability (Chepstow-Lusty, 2011). Cusco's biocultural landscapes hold an immense wealth of indigenous knowledge and practices. These landscapes represent an innovative production system based on agricultural and ecosystem diversity that endures and continues to develop over time. These biocultural landscapes are the centre of much of the socio-economic and technological development that has been taking place in the Andes over the past thousand years. The first four centuries of the last millennium were characterised by a sustained period of higher-than-average temperatures, characterised in the northern hemisphere as the Medieval Warm Period, followed by an interval of lower-than-average temperatures (the Little Ice Age), lasting until the mid-to-late 1800s (Sterken et al., 2006).

Considered one of the most sophisticated indigenous civilisations in the Americas, the rise of the Incan Empire in Cusco owed its sustained period of societal development to an era of major environmental change on a global scale. The reasons behind the success and demise of the Inca civilisation are not

completely clear; however, it is widely accepted that a combination of socio-political and environmental factors ultimately played a major role in determining its failure. Colonisation is a well-known factor in the demise of the empire. The Andean environment is another key factor, since successful agricultural practices were highly susceptible to any decline in conditions (Sterken et al., 2006). Today, despite diminishing glaciers, the headwaters of the Amazon continue to flow from Cusco's sacred mountains down to tropical rainforests, passing through diverse flora and fauna and through villages with thousands of years of continuous human habitation and domestication.

1.3 Climatic trends in the Cusco region

Although Cusco is considered one of the most culturally rich and biologically diverse regions of Peru, it is also one of the most vulnerable to climate change (SENAMHI and PACC Peru, 2012a). Over the past 40 years, the Peruvian National Service for Meteorology and Hydrology (SENAMHI) has documented a trend of increasing temperatures and annual rainfall, including increases in rain during both the rainy and dry seasons, as well as later onset of rains during the growing season (SENAMHI and PACC, 2012a; IPCC, 2014). Within this same 40-year period, there has also been an increase in maximum and minimum temperatures, while the number of days with frost decreased by as much as 15 days per year. There have been many indications of more extreme droughts associated with El Niño conditions, and more moderate to extreme rainfall events in the last decade (SENAMHI and PACC Peru, 2012b; IPCC 2014). According to organisations like PACC Peru (Climate Change Adaptation Program) and the Regional Government of Cusco (GOREC), these changes have had significant impacts on food production and food security.

Research conducted by the UK-based Tyndall Centre for Climate Change Research also concludes that Peru is one of the most vulnerable countries in the world to climate change (Andersen et al., 2009). Future climate change in Peru is expected to cause a reduction in average life expectancy and incomes, and to increase poverty, particularly amongst Andean farming communities (Andersen et al., 2009). The landscapes and livelihoods of smallholder farmers in rural areas are already changing in the context of new rural conditions, with increased livelihood diversification and migration amidst growing climate variability, and the expansion of non- and off-farm livelihood activities (Anderson et al., 2009). Some of these activities include working in tourism as porters on the Inca Trail, construction, commerce in urban markets (selling food and handicrafts), transport (taxi services) and municipal government services (e.g. road maintenance). Climate change is predicted to have complex and locally specific impacts on small-scale farmers; with particularly negative consequences for crops (Bellon and van Etten, 2013. These include impacts on the potato and centres of potato diversity such as the Cusco area, which has one of the highest levels of potato diversity in the world (CIP, 2008).

Farmer in the Potato Park (Peru) © Asociación ANDES.

Methodology

2

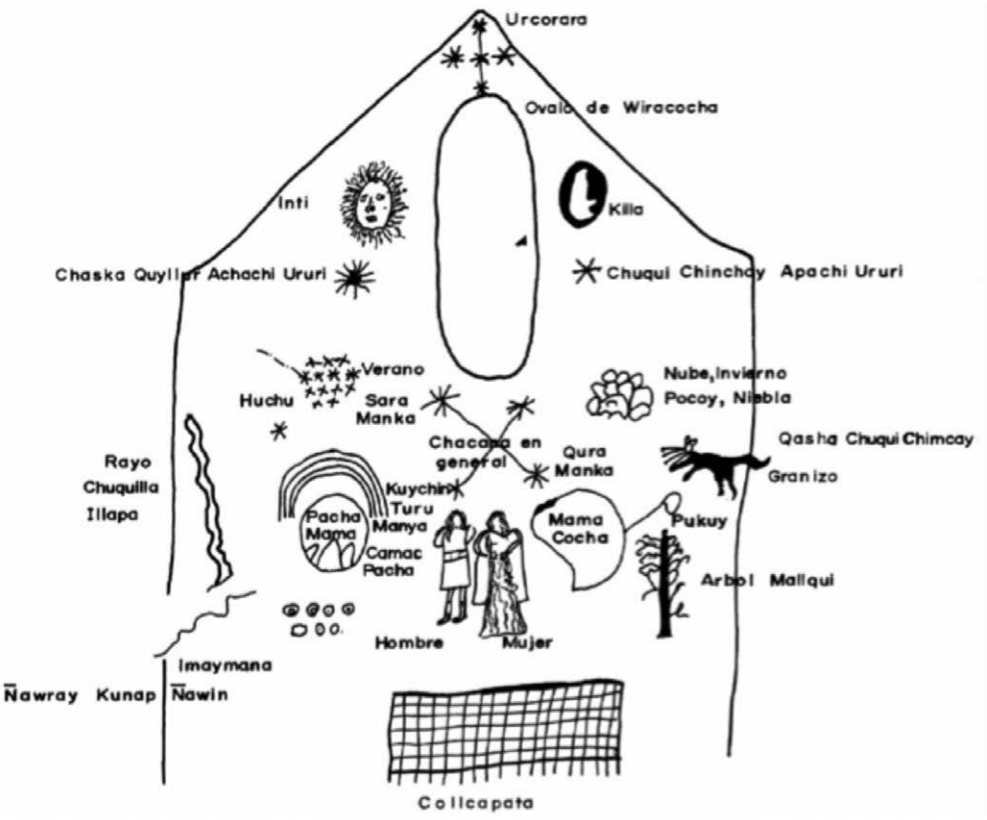
2.1 Approach

2.1.1 The *Ayllu* system as a conceptual framework

The conceptual framework for the research was inspired by a pre-Hispanic graphic representing the cosmology of the Incas, depicted in the Sun Temple in Cusco (Figure 1). The graphic, drawn by the native chronicler Juan de Santa Cruz Pachacuti Yamqui Salcamayhua in 1613, illustrates how the Incas ordered their environment spatially and socially. It pulls together and visually represents the holistic Andean worldview expressed in the *ayllu* system. The *ayllu* comprises three interconnected and interdependent communities: the *runa ayllu* (the community of humans and domesticated species), the *sallka ayllu* (the community of the 'wild' and semi-domesticated species), and the *auki ayllu* (the community of the sacred and the ancestors). The goal of the *ayllu* is to achieve *sumaq kausay,* ie. holistic living or 'wellbeing', which requires balance among these three *ayllus*. This graphic offers a unique depiction of native Quechua concepts about biocultural heritage, and was a useful conceptual framework for studying biocultural heritage-based innovations. This conceptual framework and the qualitative research methodology are described in more detail in the qualitative baseline study report (Asociación ANDES and the Potato Park, 2015).

The SIFOR project considers biocultural innovation as a novelty: new things are done, or old things are done in new ways, resulting in practices, products, markets, institutions and organisations which are improved and more efficient in their biocultural contexts than the former ones. A similar approach to innovation in agriculture has been practised in the Andes for millennia through the application of indigenous institutional and human resources to productive processes. As a result, communities have achieved new and better technologies, markets and institutions that have enhanced production and social organisation. The Andean *ayllu* system is one such biocultural innovation. To this day, in spite of the promotion of exclusively scientific methods in agricultural research and development in the region, the indigenous knowledge

Figure 1. Santa Cruz Pachakuti conceptual graphic representing the world as a complex system



Source: Lozada Pereira, 2006

and models of organisation embedded in the *ayllu* system continue to be a major source of new knowledge and practices for indigenous peoples.

2.1.2 Principles for the research design

The principles for developing the methodology were as follows:

1. It should be oriented to meet the needs of communities and contribute to their development through its design.
2. The local population should be researchers, acting as bridges between western and indigenous knowledge systems.
3. It should use flexible methods for collecting and validating scientific and traditional knowledge and for linking these two knowledge systems.

The methodology used by Association ANDES is based on an understanding that knowledge comes from multiple ways of knowing and that any single perspective or approach involves multiple limitations and biases. An important focus, therefore, is the creation of epistemological bridges between indigenous/traditional knowledge and knowledge managed by academic, scientific and other external agencies.

To achieve this, the research approach integrated different and complementary methodological approaches, including trans-disciplinarity;[2] participatory action research; emancipatory, decolonising[3] and indigenous methodologies; and quantitative household surveys. By questioning structures and power relations, the methodology seeks to place control of actions and decisions that affect the lives of indigenous peoples in their own hands. They are therefore involved in all aspects of the research – from conceptualisation of problems, actions, methods and techniques, to facilitation and data collection (Argumedo, 2012).

2.1.3 Combined qualitative and quantitative analysis

The baseline study mainly used a **mixed methods** approach, "a type of research in which the researcher mixes or combines techniques, methods, approaches, quantitative and qualitative concepts, and language in a single study" (Johnson and Onwuegbuzie, 2004). Qualitative and quantitative approaches are complementary, and each has its strengths and limitations (Barragan et al., 2003). Combining them provides a more complete understanding of reality. Some issues and correlations that can express causal links cannot be measured in quantitative terms without artificially forcing or simplifying results.

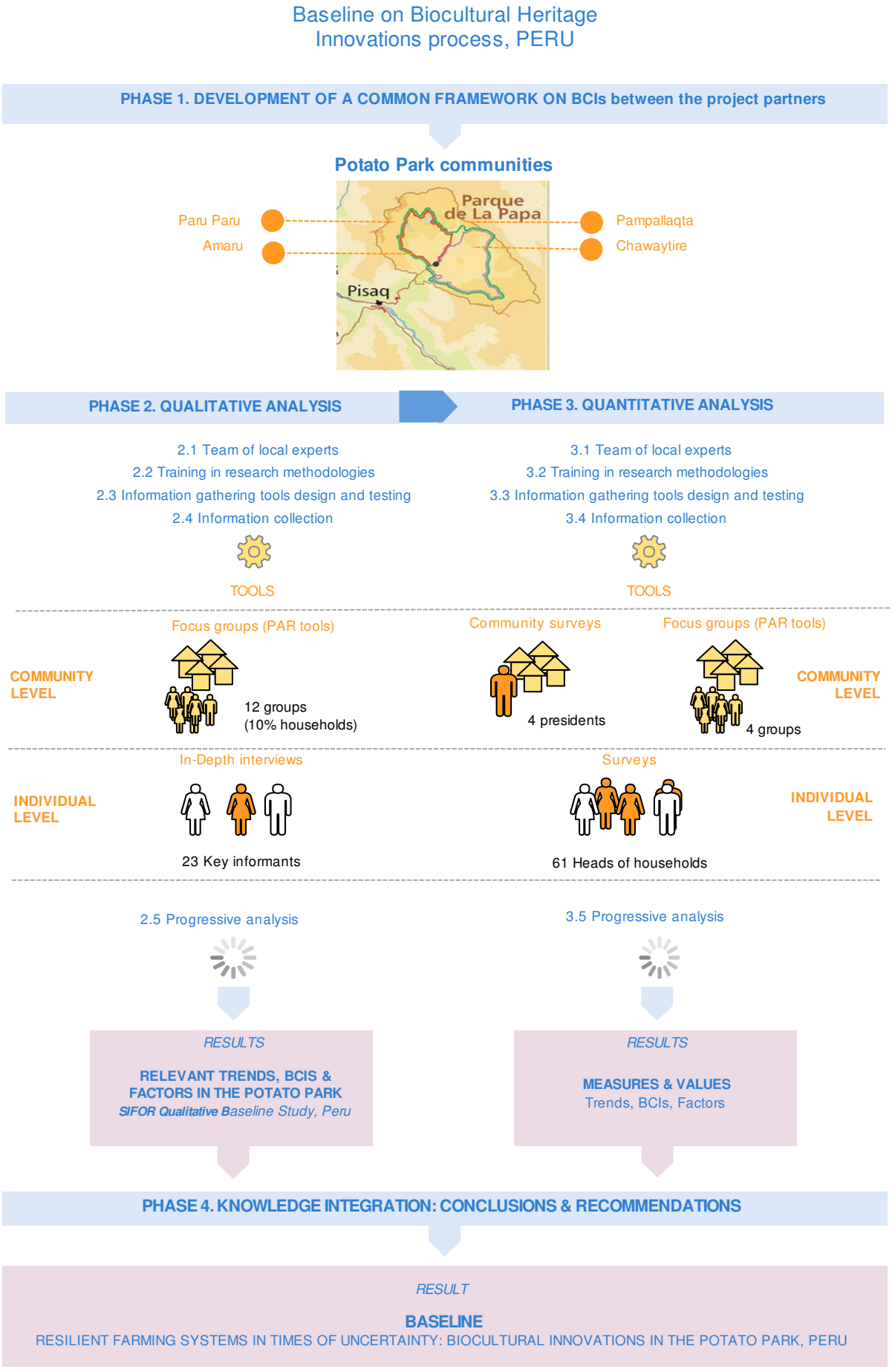
The research involved four main phases (Figure 2):

- **Phase 1.** Development of a common framework for biocultural heritage innovations among the project partners.
- **Phase 2.** Identification of relevant trends, BCIs and factors in the Potato Park (qualitative analysis)
- **Phase 3.** Local assessment of the relevant trends, BCIs and factors identified (quantitative analysis)
- **Phase 4.** Knowledge integration to identify conclusions and recommendations

This report integrates the results of the entire process. The quantitative survey findings on specific indicators are complemented by descriptive information on relevant trends, BCIs and innovation factors, drawn from the earlier report of the qualitative baseline study (Asociación ANDES and the Potato Park).

[2] Transdisciplinarity is a way of integrating different research methods, disciplines, epistemology and scientific knowledge relating to other ways of knowing the world, such as traditional knowledge.
[3] Decolonising approaches challenge the colonial power relations generated in research processes with indigenous peoples (Smith, 1999). They allow indigenous and rural communities to access the benefits of the research, and create their own research approach based on their worldview, conceptual frameworks, indigenous culture and ways of life (Argumedo, 2012).

Figure 2. Phases of the research process



2.2 Methods and tools

The quantitative baseline study was conducted using two complementary survey questionnaires developed by SIFOR partners: a household survey conducted from February to May 2014 and a community level survey conducted in January 2014.[4]

2.2.1 Sampling strategy and sample size

The unit of analysis was direct beneficiary households[5] of the Potato Park, i.e. in those communities growing a potato crop: Amaru, Chawaytire, Pampallaqta and Paru Paru. Researchers chose not to select a control community outside the Potato Park because the specific environmental conditions in each valley (geological, altitude, topographic, aspect, and others) would make results incomparable.

The key informants for the household survey were the heads of household.[6] The planned sampling approach was use of random selection to choose 10% of registered households in each community to participate in surveys and focus group workshops. However, random selection is quite complicated in the Andean context (see Section 2.3). Therefore, the Assembly of each community determined who would be involved having been previously informed about the purpose of the study. The Community Assemblies chose 61 households in the Potato Park communities (Table 1)

The community level surveys were conducted with the presidents of each community, using 2003 as the first reference year to explore trends. Except in two cases, these surveys were done in one visit. The only woman who participated in the community level survey was the President of Paru Paru.

2.2.2 Implementing the surveys

The household survey was conducted with the head or representative of selected households on previously established dates and times (between February and May 2014). The survey contained the following key indicators, each with sub-indicators[7]:

A. Respondent information

B. Household composition

C. Main livelihood activity and trends

D. Household characteristics

E. Agricultural production

F. Livestock production

G. Food security

H. Agrobiodiversity

I. Seed systems and seed security

J. Climate change and adaptation

K. Indigenous knowledge and social capital

L. Changes and innovation

Table 1. Sample size of the household survey

COMMUNITY	NUMBER OF HEADS OF HOUSEHOLDS REGISTERED	NUMBER OF SURVEYS	NUMBER OF SURVEYED WOMEN
Amaru	180	17	8
Chahuaytire	130	12	2
Pampallaqta	58	4	0
Paru Paru	120	11	3
Total	488	61	13

[4] For the community survey, see: http://pubs.iied.org/G04037; for the household survey, see: http://pubs.iied.org/G04038. The previous qualitative research and literature review allowed the common SIFOR survey to be translated (English-Spanish, Spanish-Quechua) and validated in the Andean context.
[5] A household is defined as the set of persons, whether related or not, who occupy, in whole or in part, a home, share meals together and serve other vital needs. Also, this group of people can include those considered by the head of family to be household members, for reasons of affection (godchildren, *compadres*, godfathers / godmothers, etc.). Rarely, one person can constitute a household (INEI, 2008).
[6] The head of household is the person recognised by the other household members as such and lives permanently in the house. If the head of household could not be identified, the main breadwinner of the household or the person responsible for the home was selected.
[7] See: http://pubs.iied.org/G04038

The survey was designed to describe the current situation, as well as trends mainly between 2003 and 2012, but going back 40 years when exploring climate changes. Gender considerations were integrated in a number of sub-indicators. Due to the length of the survey, it was decided to conduct it in three stages over several different days. This made it easier to adapt to the availability of respondents, as each part took 3–4 hours. It also avoided respondent fatigue, as well as interfering in their family agricultural work, and helped ensure accurate, relevant and measurable information.

The household surveys were implemented by community researchers using printed questionnaires and electronic equipment such as cameras, video cameras, GPS, recorders, and correspondence tables for measuring units.

The following guidelines and steps were ensured when gathering and analysing the information in the household surveys:

- **Approaching respondents.** The surveys were conducted in each community by local researchers from the Potato Park who understand local practices, values, cultural protocols and customary laws. They had been trained in the study's tools and objectives. Before the surveys began, a letter was sent to the community president to inform them and ask permission to carry out surveys and focus group workshops. The survey began with a community meeting in which local technicians respectfully followed the established procedures, performed the ritual exchange of coca leaves with the presidents of the communities and initiated conversations followed by an informal consultation with people in the community about their availability and agreement to provide the information required for the baseline study.
- **Neutrality.** The questionnaire was translated, adapted to the context and used carefully to avoid the possibility of suggesting answers to the respondent. Interviewers were trained to maintain a neutral stance regarding the content of the survey at all times, avoiding any facial expression or tone of voice that could indicate to respondents that they may have given an incorrect answer.
- **Control of survey.** Questions were asked exactly as they were printed in the adapted questionnaire, using the same language and the same order. Changing wording was avoided, mainly because it could have altered the nature of the question.
- **Consistency of analysis.** This was achieved by cleansing the data and eliminating omissions, invalid entries and inconsistent relations.
- **Synthesis, coding, and analysis of information.** Following the fieldwork and data cleansing, the data was compiled, analysed using descriptive statistics (eg. mean, maximum, minimum) and interpreted to establish the preliminary conclusions. Having information from the qualitative analysis on the social, political, cultural, and economic contexts in which the study was conducted allowed for a deeper analysis and interpretation of the quantitative data on the key indicators.

The overall trends in key quantitative indicators are found in Annex 2.

2.2.3 Focus groups

The more complicated questions or issues (climate change and agricultural biodiversity) were also tackled through focus groups in the four communities (May-July 2014). This technique is helpful for collecting and contrasting differing views on a topic. It can also allow for the presentation and discussion of environmental and historical data collected by the household surveys. The focus groups were composed so as to be representative of the population structure of the communities and included young people, elders, women, and men. The number of participants in each group was 10–12.

2.3 Limitations and challenges

The main methodological challenges for the baseline study, particularly for the quantitative household survey, were:

- Orientation to meet the needs of communities and contribute to community development.
- Use of flexible methods to collect and validate scientific information and traditional knowledge, and to link these two knowledge systems.
- Supporting the community representatives in their role as researchers and as bridges between different knowledge systems.

As noted above, although survey respondents should be selected randomly, this was quite complicated because of Andean customary laws in which the Community Assembly decides who should participate.

Also, it should be noted that the data entry was carried out by different people at different times. This was partly due to project staff turnover, which also delayed the quantitative survey data collection to 2014, and made the process of interpretation and analysis more complicated.

Livelihoods and migration

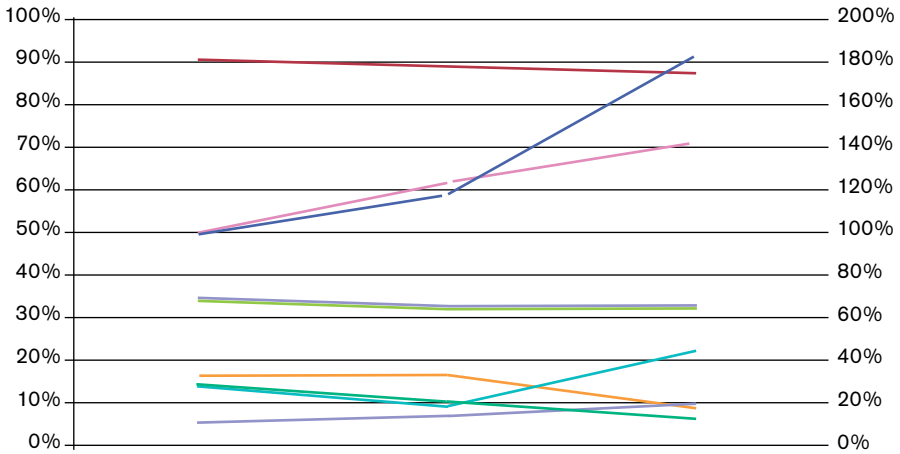
3

Average household income almost doubled between 2003 and 2012 (Table 2), reaching 765 soles per month. This notable rise in income is probably due in part to the Potato Park's income-generating activities, including the microenterprises established between 2002 and 2006 (see Section 8). However, income remained below the national poverty line of 284 soles per person, since there are five people per household on average in rural areas of Peru.[8] Furthermore, household expenditure also increased during this period (line LM7 in Figure 3). Women are the worst affected, as they remain in the communities while their husbands often migrate to Cusco and other nearby cities in search of temporary work (such as in tourism, taxi driving or construction work). The women are left with the agricultural work, household tasks and child and elderly care (Figure 3). Women play a critical role in the maintenance of crop genetic resources and the subsistence economy. Out-migration for work by men has increased over the analysed period; although the percentage of women migrants has decreased (lines LM4 and LM5 in Figure 3). The main reason for migration to urban centres is the lack of opportunities for income generation in the area. The most important income sources are agriculture and cattle raising. Income is mostly used to pay for food, education and clothing (LM8). We explore these general trends in more detail in the rest of this section, which is divided into livelihoods and migration.

3.1 Livelihoods

Average household incomes have increased significantly since 2003; in 2012, average monthly income was almost double the income in 2003 (Table 2).[9] Household expenditure has also been increasing over the years, most notably between 2008 and 2012, when it increased by 70%. In 2003 and 2008, expenditure exceeded income, but in 2012, income exceeded expenditure.

Figure 3. Summary of local trends in livelihoods and migration, 2003–2012



	2003	2008	2012
LM2. Husband and wife dedicated to agriculture	90.5%	88.9%	87.8%
LM3. Older people working in agriculture	14.5%	10.6%	6.6%
LM3. Women working in agriculture	34.7%	33.1%	33.3%
LM4. Migrants in the total labour force	14.0%	9.4%	22.3%
LM5. Women in the total number of migrants	16.7%	16.8%	9.2%
LM6. Households with only women working in agriculture	5.8%	7.3%	9.9%
LM8. Households expenditure on food	34.3%	32.4%	32.2%
LM1. Households income average*	100.0%	118.0%	183.4%
LM7. Total annual expenditure per household*	100.0%	12.6%	142.3%

(*) For these indicators, the 2003 result has been taken as 100. The values for 2008 and 2012 are the percentages of the results in these years in relation to the 2003 value. The other indicators have been estimated with primary data in absolute terms, each in their own units (see Annex 2). For normalisation purposes, they have been expressed in percentage terms.

[8] In 2012, the national poverty line was considered to be an available monthly income of 284 Soles per person: the cost of basic personal needs (INEI, 2013).
[9] This figure does not directly reflect inflation as HH income comes from a mix of mostly informal sources, and inflation does not have a direct impact on the informal economy of rural areas.

The most important income-generating activity identified by 70% of households surveyed, is paid agricultural work (Figure 4).

The most important activities for household food security are the production and sale of crops and livestock, identified by 53% of households (Figure 5). This confirms the importance of farming for the Potato Park communities.

The three most important items of household expenditure stayed the same between 2003 and 2012: food, education and clothing (Figure 6). While spending on food remains highest, its share has decreased slightly while the others have increased. It is also important to note that expenditure on agricultural inputs decreased from 3.6% to less than 2% in 2012. This could be an impact of the Potato Park activities to enhance seed security and traditional organic agriculture, reducing dependence on purchased inputs.

Table 2. Household monthly average income and expenditure, 2003–2012

YEAR	INCOME PER HOUSEHOLD PER MONTH (SOLES)	EXPENDITURE PER HOUSEHOLD PER MONTH (SOLES)	EXPENDITURE FOR ALL SURVEYED HOUSEHOLDS PER MONTH (SOLES)
2003	353.33	382.37	18,353.57
2008	416.96	472.49	24,569.64
2012	764.8	672.34	34,961.43

Figure 4. Most important income-generating activities (percentage of households surveyed)

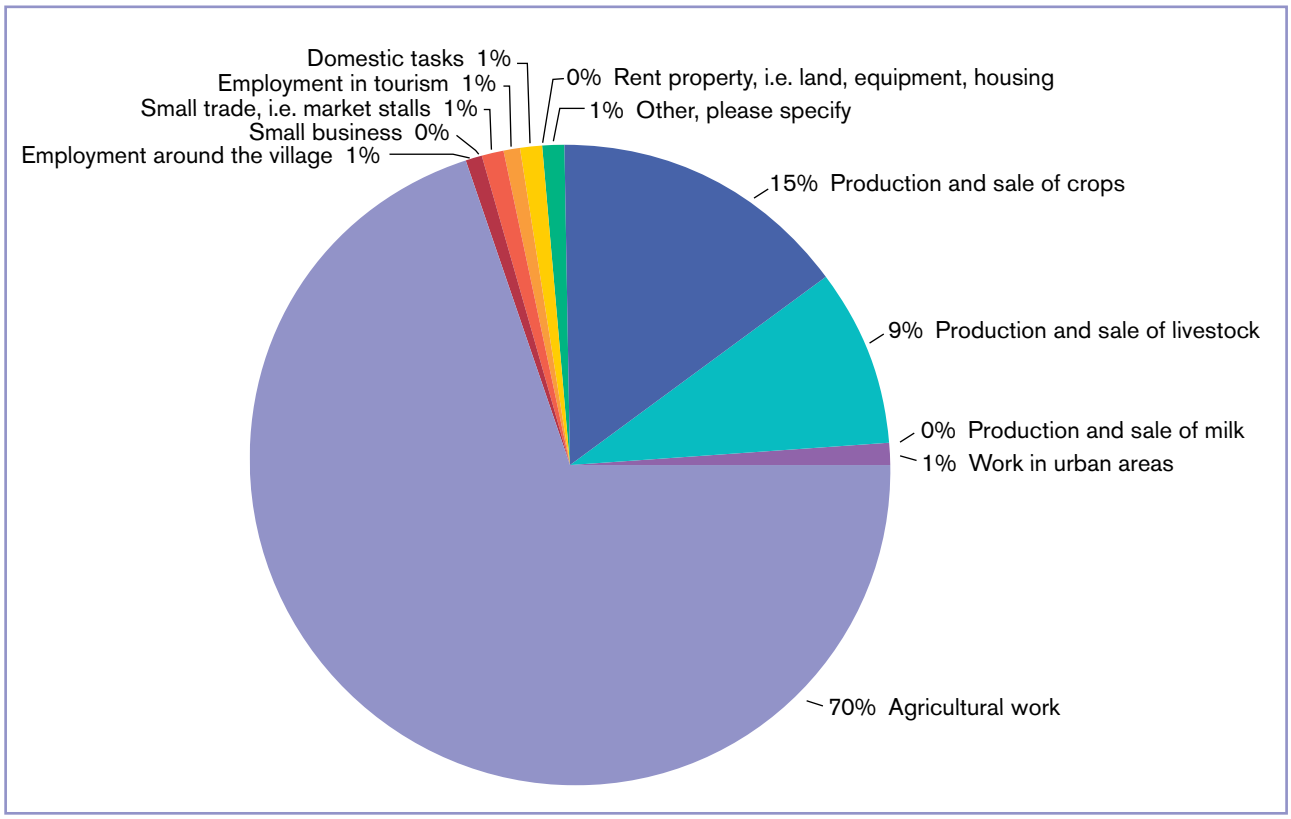


Figure 5. Most important household food security activities (percentage of households surveyed)

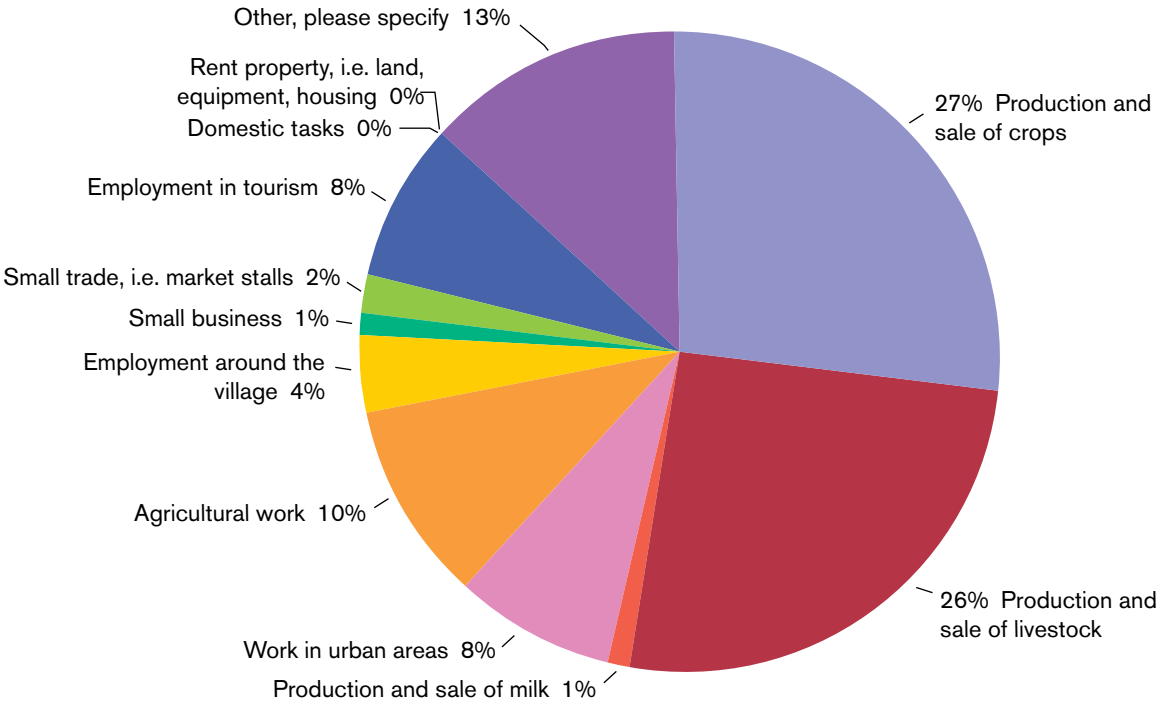
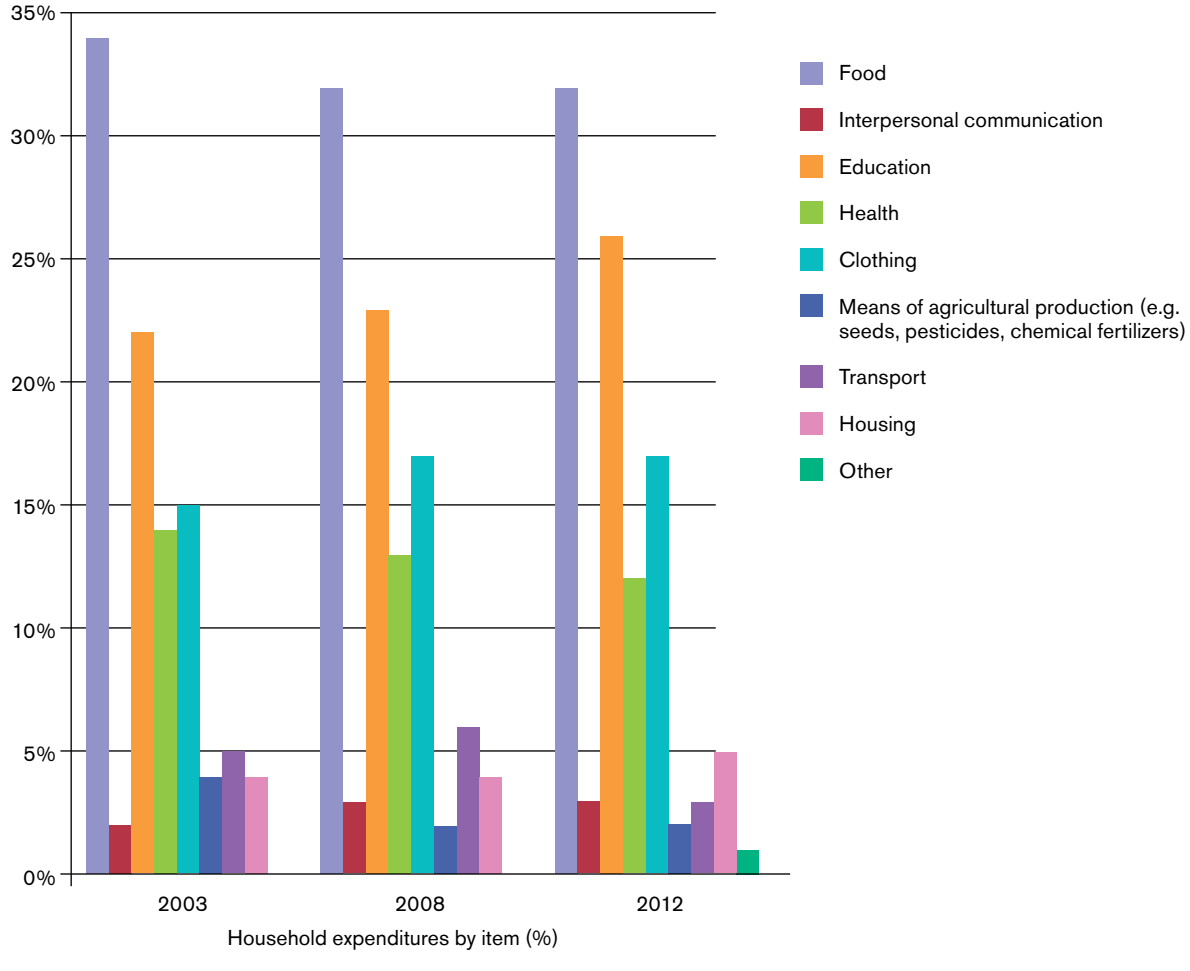


Figure 6. Share of household expenditure by item, 2003–2012



3.2 Migration

The number of migrants leaving the communities to seek temporary work increased overall between 2003 and 2012 to reach 22% (Table 3). This is due to the growth in other job opportunities outside the agricultural sector, such as taxi driving (in the case of men), as well as the increase in state social support programmes in the region and district municipalities that offer work opportunities outside the communities.

Table 3. Percentage of migrants in the total labour force, 2003–2008

YEAR	MIGRANTS (% OF TOTAL LABOUR FORCE)
2003	14%
2008	9%
2012	22%

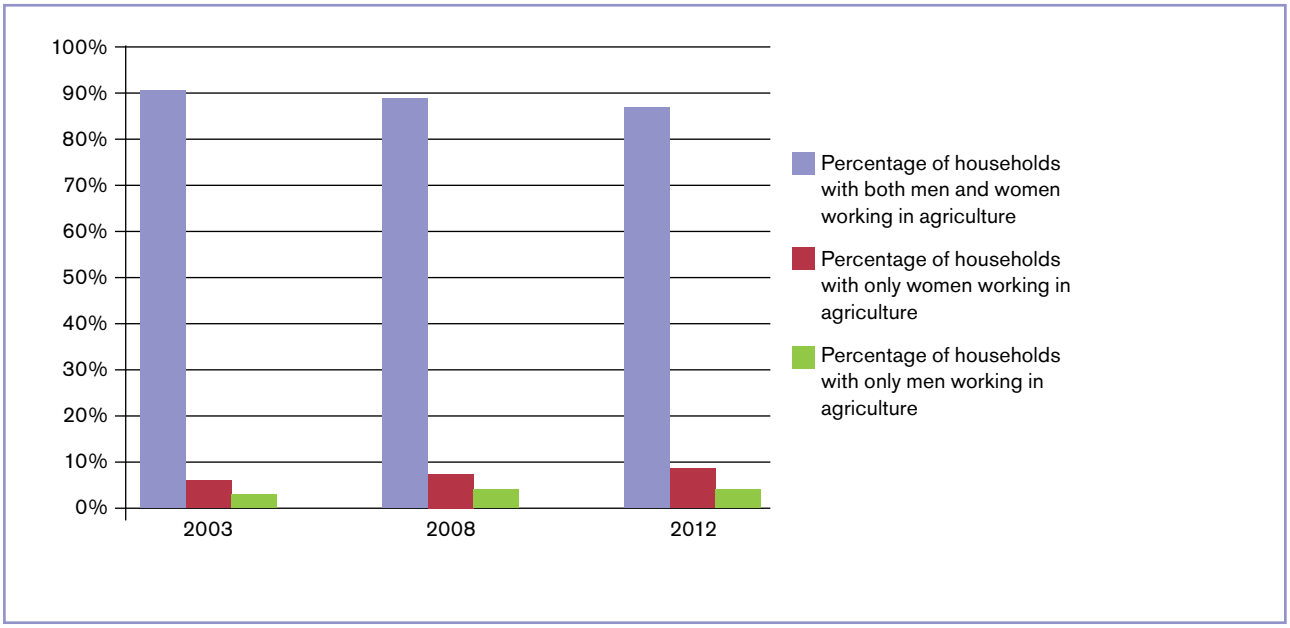
The majority of migrants are men. The percentage of female migrants declined by almost 7% between 2008 and 2012 (Table 4). According to a male farmer in Paru Paru, this is because "women, in general, remain to take care of their homes and children when men migrate". It may also be because of the Potato Park's economic activities providing more income opportunities for women.

Table 4. Share of women in the total number of migrants, 2003–2012

YEAR	FEMALE MIGRANTS (% OF MIGRANTS)
2003	16.69%
2008	16.76%
2012	9.15%

In 2012, nearly 10% of households had only women involved in farming, compared to about 6% in 2003. All households in the studied communities have at least one person involved in agriculture (Figure 7).

Figure 7. Percentage of households with men and women working in agriculture, 2003–2012



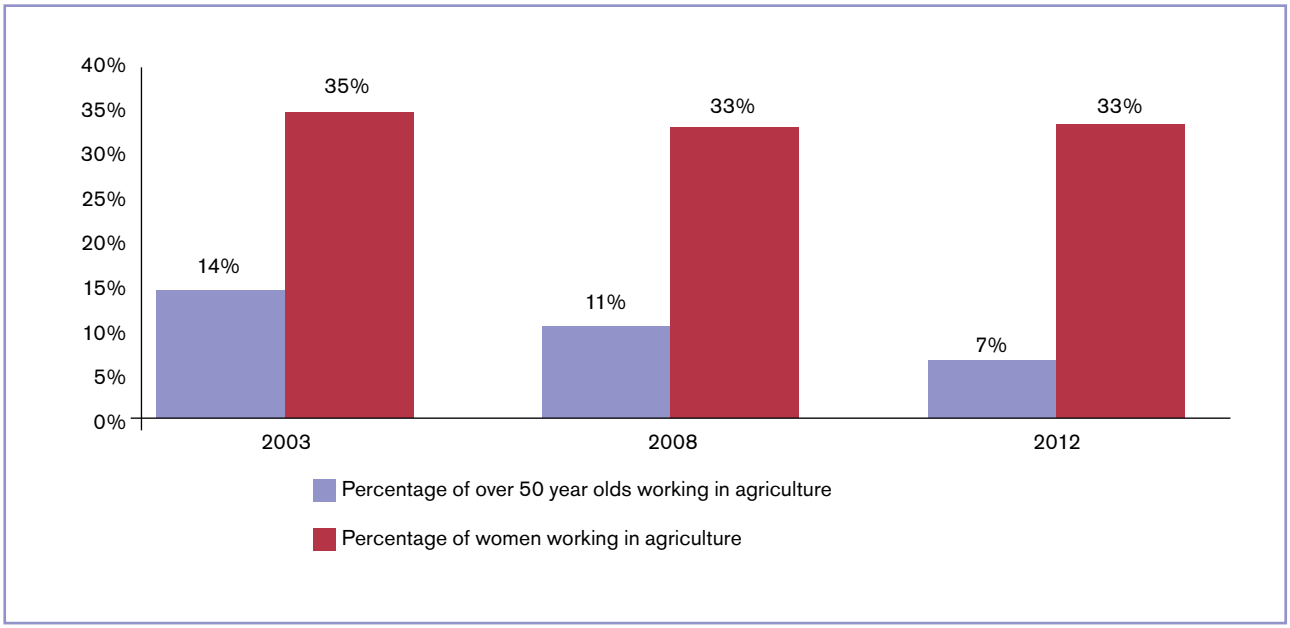
The percentage of households with both husband and wife working in agriculture has decreased slightly over the ten-year period, but remains high, at around 88% (Table 5). This slight decrease is due to the pursuit of economic activities other than agriculture by men.

Table 5. Households with both husband and wife involved in agriculture, 2003–2012

YEAR	% OF HOUSEHOLDS
2003	91%
2008	89%
2012	88%

Despite out-migration, the percentage of people older than 60 years working as farmers has been declining since 2003. This can be explained by various factors, including a reduction in time spent working by elders. The percentage of women working in farming has largely stayed constant, at around 33%, although it has fallen slightly since 2003 (Figure 8).

Figure 8. Women and the elderly working in agriculture, 2003–2012



Food security and agricultural systems

4

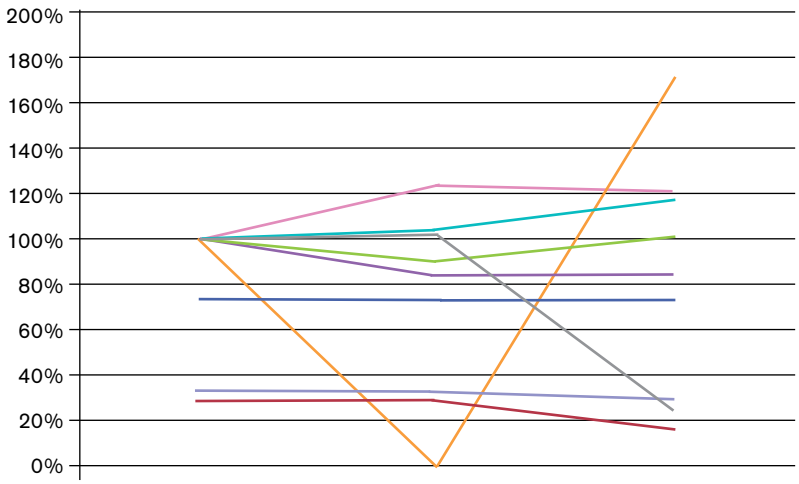
The main crops grown by surveyed households are potatoes and vegetables (Figures 9 and 10). Legumes are the main crops sold, while potato is sold least and fetches the lowest price. Barley is mainly used for livestock feed (Table 6). Food self-sufficiency is considered a very important strategy to deal with risk and uncertainty. The share of households self-sufficient in basic foods (especially potatoes) has remained stable over the past ten years (74% of households on average), while the percentage of households self-sufficient in vegetables and herbs (eg. parsley) is lower and has decreased (from 30% to 17.5% in 2012). The highest-altitude communities are the least self-sufficient in fresh vegetables because of the adverse climate. Potato yields increased slightly between 2003 and 2012. Productivity decreased in 2008 due to varietal diversification following the repatriation of 410 native varieties from CIP, but farmers' management and selection practices and collaborative research with CIP have allowed the successful adaptation of many of these varieties, allowing productivity to recover in 2012.

Private land ownership and private rentals have gone up continuously, while communal land ownership has gone down. This section explores these general trends in more detail.

The main crop in terms of area planted is the **potato;** the area under cultivation increased from 2003 to 2008. In recent years this area has remained stable at around 400 hectares in total (Figure 10). **Oats** were the second most important crop in terms of the area planted in 2003 and 2008 (between 150 and 200 ha); however, in 2012 no oats were planted. **Beans** are the third crop in terms of the area planted and this remains almost unchanged over time, at a total of 72 hectares.

The area cultivated with **lisa** (smooth potato) has fallen by 14 hectares to cover only 45 hectares in 2012. The area under **barley** declined considerably between 2008 and 2012, when only 10 ha were dedicated to this crop. **Oca** has continued to see the same area of cultivation over the years, around 21 hectares.

Figure 9. A summary of local trends in food security and agricultural systems, 2003–2012



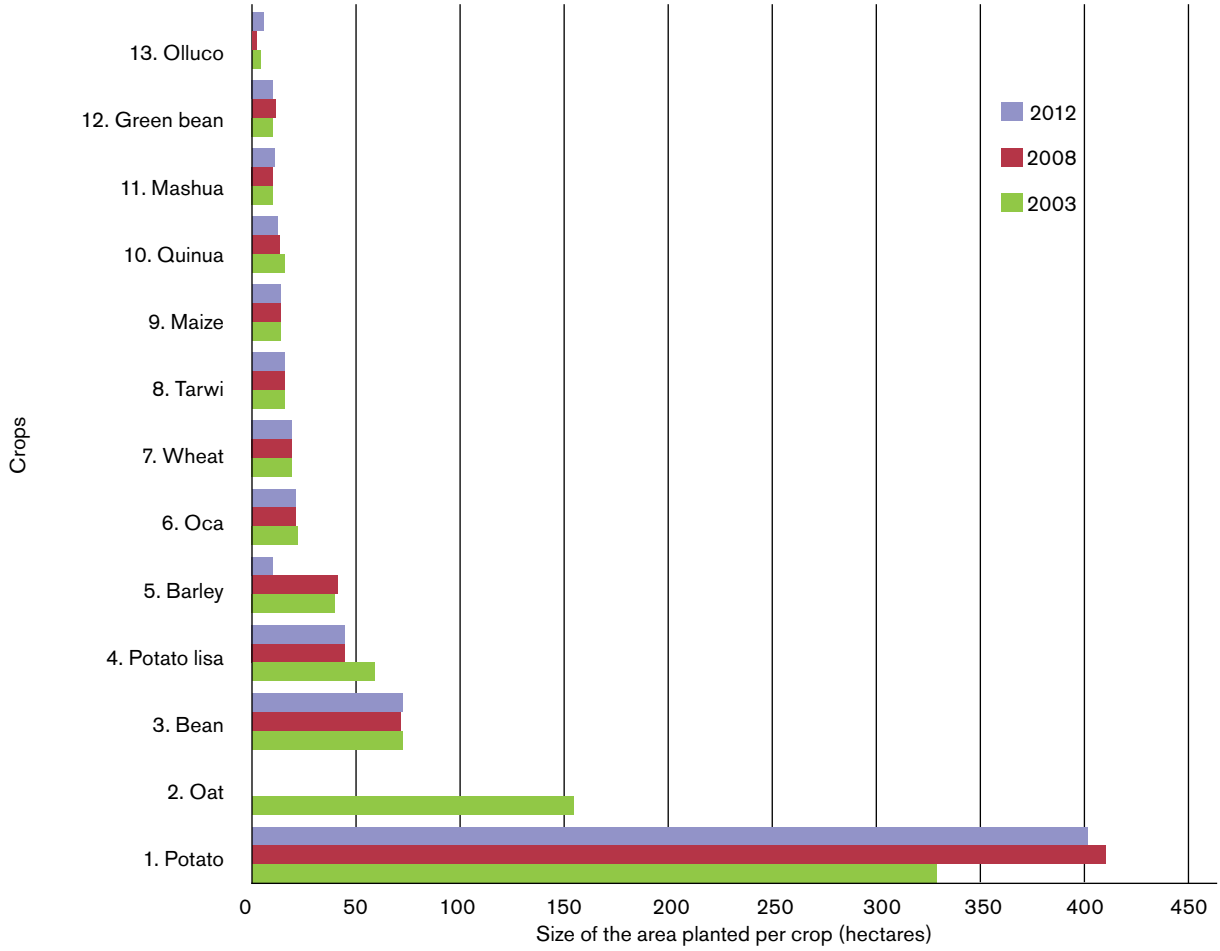
	2003	2008	2012
FSAS2. Potato productivity*	100%	91%	101%
FSAS3. Size of land owned by households (rainfed)*	100%	85%	85%
FSAS4. Total land owned*	100%	105%	118%
FSAS4. Land rented to third person*	100%	0%	172%
FSAS1. Autoproduction of basic foodstuffs (i.e. potato)	74%	74%	74%
FSAS1. Autoproduction of fresh vegetables	30%	30%	18%
FSAS1. Autoproduction of meat	34%	34%	30%
FSAS5. Average size of area planted: potato*	100%	125%	122%
FSAS5. Average size of area planted: barley*	100%	103%	25%

(*) For these indicators, the 2003 result has been taken as 100. The values for 2008 and 2012 are the percentages of the results in these years in relation to the 2003 value. The other indicators have been estimated with primary data in absolute terms, each in their own units (see Annex 2). For normalisation purposes, they have been expressed in percentage terms.

Table 6. Agricultural production in surveyed households

CROPS	AREA PER HOUSEHOLD (HA)	YIELD PER YEAR (AV KG/HA/ YEAR/ HH)	SELF-CONSUMPTION (% OF PRODUCTION)	LIVESTOCK FEED (% OF PRODUCTION)	% SOLD	SALE PRICE PER KILO (SOLES)
Maize	0.10	258.50	59.67	9.13	12	1.91
Potato	0.14	1,466.16	68.36	6.14	11.62	0.99
Legumes	0.06	344	66.16	7.75	26.50	1.35
Olluco	0.08	938.67	81	7	15	1.75
Barley	0.03	216.34	61.70	13.86	23.93	1.23
Mashua	0.02	292	67.56	13.80	21.20	1.12

Figure 10. Total area planted per crop, 2003–2012



Notes: *Mashua*, Tropaeolum tuberosum, grows in the Andes (Peru and Bolivia). Its tubers are cooked or roasted as vegetables. For the details of the other local crops, see Box 1.

Over 70% of all crops are used for subsistence and feeding livestock. Households are most self-sufficient in *Olluco*, a root vegetable of the *Basellaceae* family (Ullucus tuberosus), at 81% (Table 6). Barley is the most popular crop for feeding livestock. Legumes are the crops which are most sold at market (26.5%), while potato is sold least (11%) and fetches the lowest price.

The greatest food self-sufficiency in **basic foodstuffs** was found in the communities of Amaru and Pampallaqta (100% and 75%, respectively) (Figure 11). This has remained stable over the ten-year period studied. In Chawaytire, self-sufficiency in basic foodstuffs has grown to 50% while in Paru Paru it is 70% but has been declining over the period of study.

With regard to **self-sufficiency in vegetables**, the highest percentage corresponds to the community of Chawaytire, at 30%, although this has declined from 60% in 2003. This decline is echoed in the other communities. The lowest level of self-sufficiency is in Pampallaqta, at only 5%, a value that has been maintained throughout the study period. Generally, self-sufficiency in vegetables is declining as a result of climatic changes since, like other crops, vegetables are having to be grown at higher altitudes, as diseases and pests are also expanding their ranges to higher altitudes (due to increased temperatures).

Self-sufficiency in meat has not changed much. It has increased or been maintained over the 10 years of study, except in Amaru, where it has decreased from 50 to 25%, as for vegetables. The highest value corresponds to Chawaytire, at 50%.

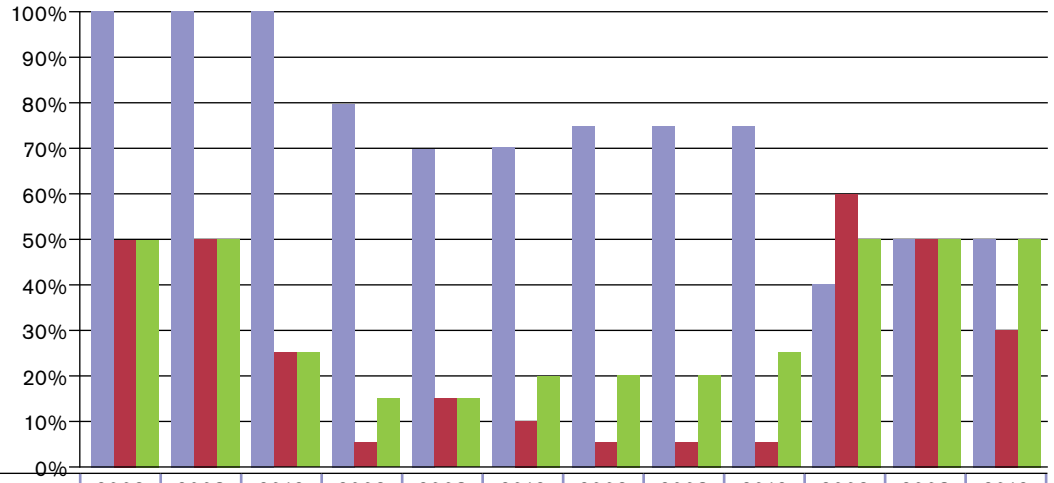
Food self-sufficiency is either very important or important to 96% of the households surveyed (Table 7).

Table 7. Perception of the importance of food self-sufficiency

1. Very important	87%
2. Important	9%
3. Little important	4%
4. Not at all important	0%

No defined strategies to cope with hunger periods were identified as there is regular food security. However, diets are poorly balanced as a result of shortages in sources of nutrition such as vegetables. In the past, barter markets ensured nutritionally balanced diets: women from communities in lower altitudes with warmer climates used to travel frequently to the Sacred Valley to exchange their fruits and vegetables for high-altitude tubers such as potatoes, *mashua* and *olluco*. These exchanges were especially important during the harvest season. These markets are disappearing, however, partly due to the integration of households into the regional monetary economy. There is a need to strengthen the functioning of barter markets and establish strategies for dietary diversification.

Figure 11. Trends in food self-sufficiency, community average, 2003–2012



	2003	2008	2012	2003	2008	2012	2003	2008	2012	2003	2008	2012
	Amaru			Paru Paru			Pampallaqta			Chawaytiri		
Basic foodstuff self-sufficiency	100%	100%	100%	80%	70%	70%	75%	75%	75%	40%	50%	50%
Vegetable self-sufficiency	50%	50%	25%	5%	15%	10%	5%	5%	5%	60%	50%	30%
Meat self-sufficiency	50%	50%	25%	15%	15%	20%	20%	20%	25%	50%	50%	50%

4.1 Productivity of the two main crops: potato and *tarwi*

The survey explored trends in productivity (kg per hectare) for different crop varieties (landrace, improved and hybrid), and for biomass for cattle feed. The main staple crop for all the communities is the potato, with the exception of Amaru where maize is prioritised. For potato, the trend has been to maintain the native varieties, for which the average yield increased slightly from 1,060 kg/ha in 2003 to 1,073 kg/ha in 2012, despite a slight decline in 2008 (to 996 kg/ha) (Table 8).

The second-most widely grown crop is a legume known as *tarwi* (an Andean species of lupin). Average productivity for *tarwi* has increased from 290 kg/ha in 2003 and 2008 to 458 kg/ha in 2012 – a yield increase of 36%.

4.2 Household land ownership

In the communities of the Potato Park there are two main types of land tenure/property:

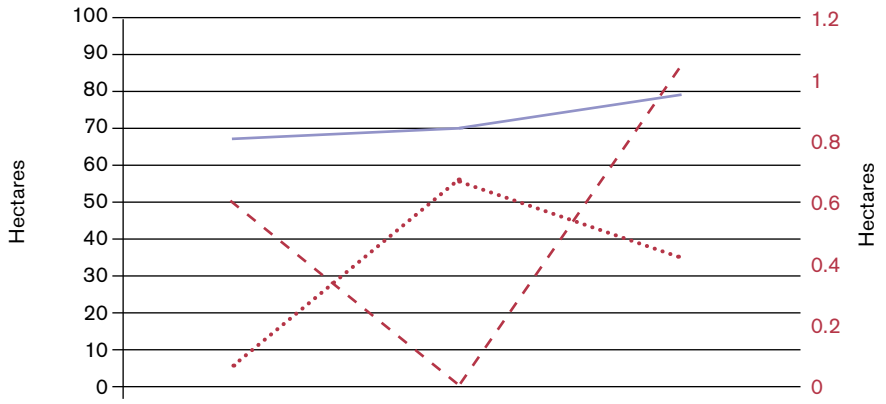
- private property
- communal land (not considered in the survey as this is specific to the Andes)

The total land owned by the surveyed households has increased steadily over the years by a total of 12 ha (Figure 12). Only a small area of land is rented out each year, reaching a little over 1 ha in 2012. The land leased by farmers is also very limited, indicating that rental is not a very common type of tenure.

Table 8. Potato and *tarwi*/bean productivity, 2012

		POTATO			TARWI		
		2003	2008	2012	2003	2008	2012
People who prioritise potato as their main crop		79%	89%	91%	64%	86%	74%
Share of local varieties in all varieties grown		100%	100%	100%	100%	86%	100%
Yield (kilos per hectare)	Average	1,060	966	1,073	293	294	458
	Maximum	3,700	3,500	3,000	720	1,200	3,000
	Minimum	97	90	50	24	24	48

Figure 12. Land ownership and rental, 2003–2012



	2003	2008	2012
Land owned	66.94	70.09	78.96
Land rented to third party	0.6	0	1.03
Land leased to third party	0.07	0.67	0.42

Note: The left axis is for land owned; and the right axis is for land rented and leased – a separate axis was included for this because the figures are much lower and would otherwise not appear on the graph.

Ownership of cultivated land in rainfed areas in the Potato Park has declined slightly over the years: from an average of 0.53 ha per household in 2003 to 0.45 ha in 2012 (Table 9). Ownership of irrigated land, by contrast, has remained stable at around 0.27 ha/household, despite a slight decline in 2008.

Forest and communal lands have been decreasing over the years for all communities. The community with most forest land and communal land is Chawatyre at 300 ha in 2012; those with the least are Amaru and Pampallaqta, with 6 and 8 ha respectively.

Table 9. Average area of land owned by households, 2003–2012

YEAR	MEDIAN RAINFED LAND (HECTARES)	MEDIAN IRRIGATED LAND (HECTARES)
2003	0.53	0.28
2008	0.45	0.23
2012	0.45	0.27

Adaptive management © Asociación ANDES.

Agrobiodiversity and seed systems

5

The diversity of potatoes reported is high (1,345 varieties). The diversity of staple food crop varieties and landraces has increased over the past ten years, while the diversity of cash crop varieties has not (Figure 13). Climatic changes have affected the number of varieties planted in several ways. Some varieties, which are only able to grow at lower altitudes, have disappeared completely due to the increase in temperature and pests. The great variety of potatoes means unexpected weather events such as frost are less detrimental because there is a higher likelihood that a variety will be more resistant. Households maintain a diversity of crop varieties for food security reasons.

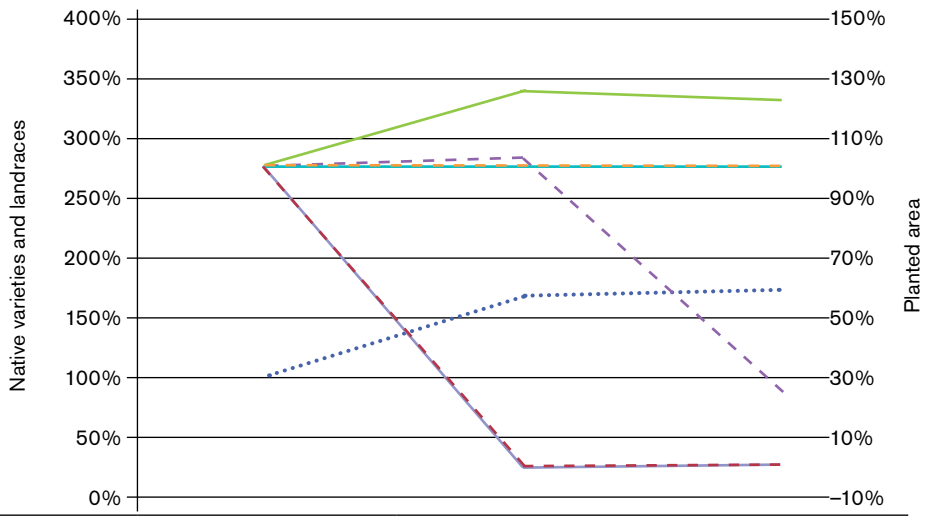
Farmers in the Potato Park only use native seeds (ie. landraces), which are mainly accessed through seed saving, exchange with other farmers or local barter markets. Seed security is a key concern of potato park households. Women play a central role in seed selection and conservation as they are responsible for deciding their use. The community is the main source of new seeds.

5.1 Agrobiodiversity

Since 2004, a total of approximately 1,345 different native potato varieties have been grown in the Potato Park (using the TK-based classification). Of these, 410 varieties have come from a repatriation agreement signed between the CIP and the Potato Park in 2004,[10] 778 are local cultivars which were already in the park, and 157 varieties have come from the local network (from neighbouring communities). Hence potato diversity has almost doubled in the Potato Park since 2004, from 778 to 1,345. The diversity of other crops has also increased significantly since 2003, including mashua, oca and olluco, partly due to a transfer from CIP.

There are five native maize varieties in Amaru, where maize is the main staple crop (due to its lower altitude). The number of native potato varieties varies between 370 in Amaru (including repatriated and local varieties), 988 in Chawatyre and 1,180 in Pampallaqta and Paru Paru (Tables 10–13).

Figure 13. Summary of trends in crop diversity and seed systems, 2003–2012



	2003	2008	2012
ABSS2. Number of staple food crops, varieties and landraces: Potato	100%	165%	173%
ABSS5. Average area planted with potato	100%	125%	122%
ABSS5. Average area planted with barley	100%	103%	25%
ABSS5. Average area planted with tarwi	100%	100%	100%
ABSS5. Average area planted with corn	100%	100%	100%
ABSS3. Number of cash crops, varieties and landraces: Barley	100%	0%	0%
ABSS3. Number of cash crops, varieties and landraces: Oat	100%	0%	0%

For these indicators, the 2003 result has been taken as 100. The values for 2008 and 2012 are the percentages of the results in these years in relation to the 2003 value.

[10] In order to boost in-situ conservation and livelihoods, CIP returned native potato varieties which had been collected from the Potato Park communities in the 1960s but that had since been lost due to genetic erosion. For more see Section 8.

Table 10. Native varieties (landraces): number and area cultivated, Amaru community 2012

MAIZE		POTATO		
Number of native varieties	% of crop area planted with native varieties	Repatriated versus local material (number)		% of crop area planted with native varieties
5	100	Repatriated material	Local material	
		338	32	100

Table 11. Native varieties (landraces): number and area cultivated, Paru Paru community 2012

POTATO			BEAN	
Number of native varieties		% of crop area planted with native varieties	Number of native varieties	% of crop area planted with native varieties
Repatriated material	Local material	100	2	100
402	778			

Table 12. Native varieties (landraces): number and area cultivated, Pampallaqta community 2012

POTATO			OLLUCO	
Number of native varieties		% of crop area planted with native varieties	Number of native varieties	% of crop area planted with native varieties
Repatriated material	Local material	100	3	11.76
402	778			

Table 13. Native varieties (landraces): number and area cultivated, Chawaytire community 2012

POTATO			LISA (SMOOTH POTATO)	
Number of native varieties		% of crop area planted with native varieties	Number of native varieties	% of crop area planted with native varieties
Repatriated material	Local material	100	2	100
210	778			

With regard to the share of area planted with native varieties in the total area cultivated, the data indicate that all the varieties planted by households in the park are native, with the exception of *olluco* in Pampallaqta, where the percentage of native varieties has been decreasing over time, reaching 11.7% in 2012.

In the case of commercial crops (barley and oats), the number of local varieties in all the communities studied remains low (not more than one or two) – much lower than for staple food crops.

The survey identified seven traditional varieties of potato that have become extinct over the last 30 years as a result of climatic changes, notably rising temperature which correlates with more frequent pests and diseases. The community of Pampallaqta has lost the greatest number of varieties and was one of the earliest to lose a variety (Table 14).

Virtually all crops that the families of the Potato Park have planted are preserved through saved seed. Households mix varieties of the same species in the same field. On average, the number of varieties per crop grown by families in 2012 were 7 for potato, 3 for maize and bean, and 2 for quinoa and *oca* (Table 15).

The main reason households gave for retaining and using different varieties was food security (86% of households), followed by barter and sale in the market (though only 5% of households) (Figure 14).

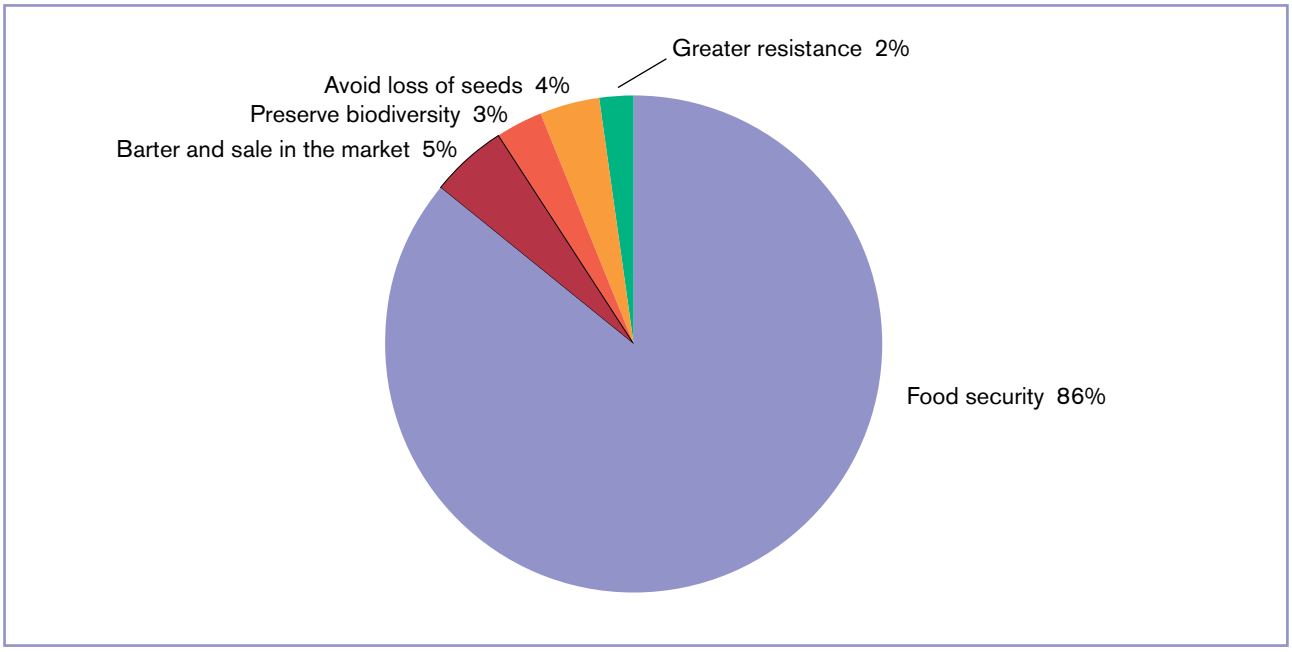
Table 14. Number of potato varieties lost in the past 30 years and reasons for loss

COMMUNITY	POTATO VARIETY	LAST YEAR HARVESTED	TRADITIONAL / INTRODUCED	REASONS FOR THE LOSS
Paru Paru	Quillo waqbto	1983	Traditional	Climatic change
Pampallaqta	Ruqui	1998	Traditional	Climatic change
	Chapina		Traditional	Climatic change
	Loves Ccaya			
	Suna Manchachi	1982	Traditional	Climatic change
Chawatyre	Machu Ruki	1997	Traditional	Climatic change
	Socotoro	1994	Traditional	Climatic change

Table 15. Number of varieties per crop, 2012

CROP	VARIETY (AVERAGE PER HH)
Potato	7
Maize	3
Bean	3
Barley	1
Quinoa	2
Oca	2
Smooth potato	1
Oats	1
Olluco	1

Figure 14. Reasons households store and plant different varieties (% households)



The main crop varieties re-introduced in the last 30 years in the communities of the Potato Park have been native potatoes. The main reasons given for their re-introduction were to cope with climatic changes, followed by food security and pest resistance.

The community of **Chawatyre** historically had the most crops (in 1975 and 1980) and has introduced the most crops due to climatic change: *tarwi*, barley, quinoa, bean and potato (4 varieties) (Table 16).

In **Paru Paru**, there were several introductions of varieties at different times between 1985 and 2000. In the latter year, the introduction was a consequence of climatic changes. The crops introduced were potato (4 varieties) and oats.

In **Pampallaqta**, the only crop introduced was a bean crop in 1986 for food security reasons.

5.2 Seed systems

There are no hybrid seeds in the Potato Park, only native or improved/introduced varieties. For the native seeds, the main source is self-saved or stored seed (approximately 69%) and the Potato Park community seed plots, which produce seeds for distribution to community members. The main sources of improved/introduced seeds are through exchange with other farmers in the same community and at barter markets (in both cases, 39%) and to a lesser extent, the community seed plots (Table 17).

In general, the main sources of seeds are self-saving and storage by farmers (34%); exchange with other farmers of the same community (around 22%) and barter markets (approx. 21%). It is not common to purchase seed.

The whole family is involved in agricultural activities, but women are directly responsible for the selection of seeds and decisions on use of the variety, taking into account the food needs of the family and the surplus for sale or barter, and for managing the seed for the next stage of planting. Women farmers use techniques of seed selection and conservation learned from their mothers/parents in a natural and direct way.

Rural women are the ones that take care of storing native seeds; they use the communal seed bank when a particular genetic resource has been lost for various reasons. The elderly are responsible for disseminating botanical seed, as a means of increasing potato diversity and for selecting new varieties.

Table 16. Number of crop species and varieties introduced in the past 30 years and reasons for their introduction

COMMUNITY	YEAR	VARIETIES AND CROPS	REASONS FOR THE INTRODUCTION
Chawatyre	1975	Grillon (barley)	Climatic change
		Puka Quinoa (quinoa)	
		Yanasenca (tarwi)	
	1980	Bean	Climatic change
		Dry (potato)	
		Canchis (potato)	To improve yield
		Revolucion (potato)	
		Puka huallaco (bean)	Climate change
Paru Paru	1985	Andina (potato)	Food security: to increase yields and diversification
Pampallacta	1986	Puka huallaco (bean)	
Paru Paru	1997	Revolucion (potato)	
Paru Paru	1998	Yungay (potato)	Greater resistance to pests and diseases, especially rancha (potato late blight)
Paru Paru	1999	Chaska (potato)	Food security
	2000	Mantaro (oats)	Climatic change

Table 17. Seed sources

SEED SOURCES	PROPORTION OF ALL VARIETIES OF SEED SOURCES	HYBRID SEEDS	SEEDS OF INTRODUCED IMPROVED VARIETIES	SEEDS OF NATIVE VARIETIES
1. Self-saved	34%	0	0	69%
2. Community seed plots	14%	0	13%	15%
3. Purchase	0	0	0	0
4. Exchanges within the same community	22%	0	39%	4%
5. Exchanges with other communities	1%	0	0	2%
6. Obtained from relatives	2%	0	4%	0
7. Gifts and remittances	4%	0	4%	4%
8. Local market	1%	0	0	2%
9. Local extension station	0	0	0	0
10. Barter markets	21%	0	39%	2%
11. NGO assistance	0	0	0	0
12. Grain food aid	0	0	0	0
13. Government programme	0	0	0	0
14.Private companies (contract)	0	0	0	0
15. Public research institution, i.e, university research organisations	0	0	0	0
16. Other	0	0	0	0

In addition, the participation of women in local seed fairs is invaluable for the conservation of the biodiversity of the Andean potato. Various studies show that women who attend the fairs can recognise up to 56 different varieties (Tapia and de la Torre, 1993). However, women's work overload is putting this role in danger, especially in the context of out-migration by men. This highlights the need for a more equitable distribution of work in order to ensure the conservation of agrobiodiversity.

In the Potato Park and other traditional peasant communities when the harvest is carried out on communal land, an event called *layme* (Quechua), all members of the family participate in the harvest, but the selection and management of the harvested products is done by women. This includes dividing the harvest into the food needs of the family, surpluses for sale or barter, and especially the selection of seeds for the next season. This last process also includes the dissemination of native varieties, including new ones that will be introduced to the farm.

Men participate in the classification of seeds of tubers; they show a greater interest than women in the introduction of new varieties. This distribution of tasks is very linked to both traditional and socio-economic factors (Tapia and de la Torre, 1993). Rea (1988) recognised however that when potato varieties were inventoried in the Altiplano, women had more knowledge than men.

The survey also explored how households access new and improved varieties of seed and assessed the ease/difficulty of each mode of access. The analysis was carried out for potato seed, and shows that the easiest mode of accessing improved seeds is **through the community** (Table 18). Self-improvement (i.e. selective breeding) is described as difficult or very difficult by those who practise it.

Households were asked about the strengths and weaknesses of varieties selected from previous harvests. This question was explored for the native potato varieties as they are the main crop and no hybrids are grown (Table 19).

Table 18. Household views on methods for obtaining new and improved potato seed (% of responses)

SEED SOURCE	ACCESSIBILITY		
	EASY, QUICK AND AT A LOW COST	DIFFICULT, REQUIRES A LONG TIME AND A COST	VERY DIFFICULT, REQUIRING LUCK OR LARGE EXPENSE
1. Self-improvement	0	6.3%	8.3%
2. Community	37.5%	22.9%	14.6%
3. Purchase	2.1%	0	0
4. Exchanges with farmers of the same community	2.1%	4.2%	0
5. Exchanges with farmers of other communities	0	2.1%	0

Table 19. Strengths and weaknesses of varieties selected from previous harvests (% of responses)

STRENGTHS		WEAKNESSES	
Good production	41%	Low resistance to pests (rancha)	37%
Increased productivity	46%	Low resistance to frost	55%
Good texture	13%	Low resistance to rain	8%

The main strength of the native varieties of potato selected from previous harvests is their increased productivity (46% of answers) followed closely by good production, while the main weakness identified is susceptibility to frost.

Seed security is a key concern of potato park farmers: 98% of respondents indicated that they consider seed security to be very important as a way of avoiding buying unreliable seed (Table 20).

Table 20. Level of concern with seed security

1. Very concerned (= very important)	98%
2. Concerned (= Important)	0
3. Little worried (= a little important)	2%
4. No worries (= is not important)	0

Social capital and traditional practices

6

Household participation in communal activities and networking with other communities are ways to reinforce collaborative processes of work and knowledge exchange. The high involvement of family members in community events has been maintained over the past 20 years, except in Amaru where it has decreased to 50% (Figure 15). Only men participate in these activities. The majority of traditional practices and technologies are still in use, as agricultural extension programmes are very poor and animal and plant public health services non-existent.

Traditional crops are still being consumed, although new crops have been added. In the last 20 years, there has been a resurgence of indigenous festivals and rituals linked to potato conservation and production. This is likely to be the result of support from ANDES to revitalise traditional knowledge and practices since it began working in the Potato Park in 1998. These rituals mainly involve men.

Despite high illiteracy rates, particularly among women, the entire population still speaks the native language. The wearing of traditional dress shows clear inter-generation changes. There are now few families in which all members wear traditional dress (14%), and it is used mostly in traditional festivals. Transport infrastructure and marketing systems are poor and there is a lack of well-defined territorial organisation and planning.

All the households surveyed in the four Potato Park communities speak the native language (Quechua). This has remained unchanged for the past 30 years. In all the communities some traditional-style houses remain. These involve earth-based materials and construction techniques such as compressed blocks (adobe), wood and other traditional materials. The local traditional architecture allows a low thermal conductivity and a high heat-storage capacity. The highest percentage of such houses is in the community of Amaru (Table 21).

It is usually the head of household and the father who are involved in traditional indigenous rituals (such as the tradition of offering gifts to the spirit of the potato, celebrating the summer solstice, etc.; Table 22).

Such participation has been maintained over the past 20 years, except in Amaru (Table 23). Pampallaqta and Chawatyre are the communities where the greatest percentage of households participate in traditional festivals and rituals. These communities celebrate the most important festival in the Potato Park: the *Linderaje* festival. *Linderaje*, which is celebrated close to the mountain peaks, ratifies communal boundaries, fortifying the commitment of communities to unity. The location of Amaru in the lower part of the Potato Park (closest to the town of Pisaq) may explain its lesser participation in this festival. The results show that there has been a resurgence of indigenous festivals (i.e, *Linderaje, Ccacha Raymi, Tinaky*) in the last 20 years

Figure 15. A summary of local trends in social capital and traditional practices, 2003–2012

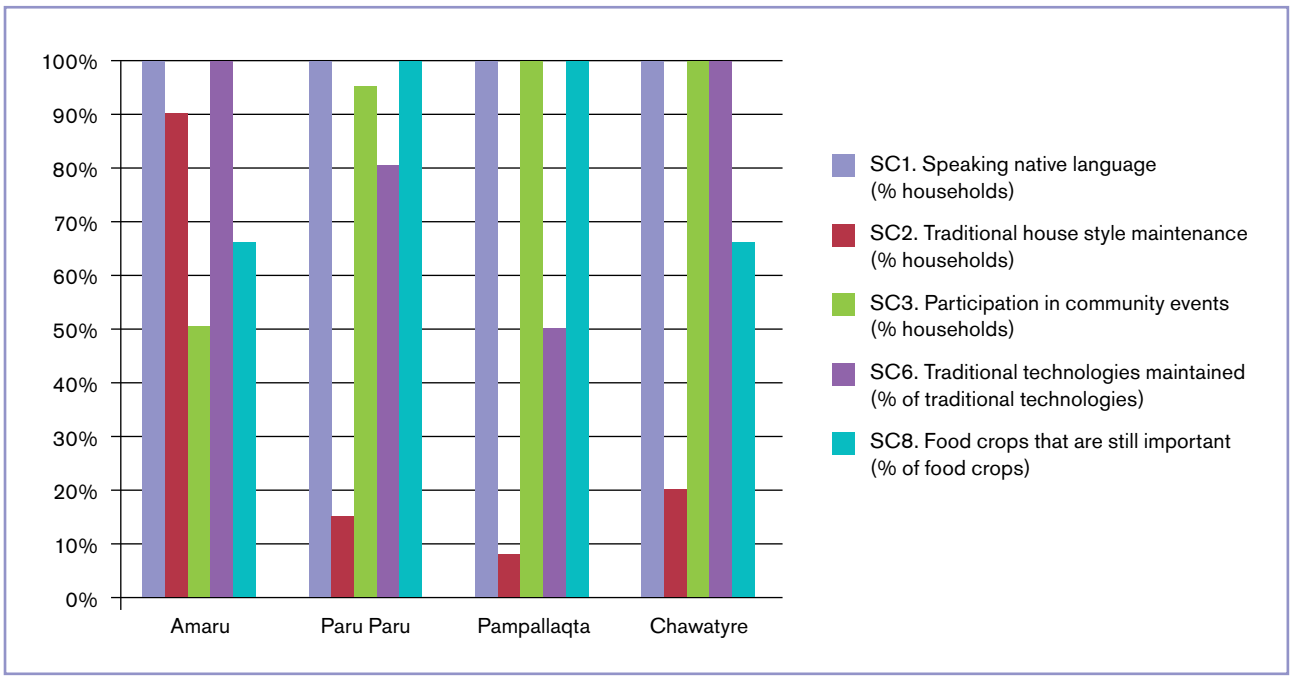


Table 21. Households with traditional houses

COMMUNITIES	MAINTAIN TRADITIONAL STYLE OF THE HOUSES (MOSTLY)	PERCENTAGE HOUSEHOLDS MAINTAINING TRADITIONAL HOUSE STYLE
Amaru	Yes	90%
Paru Paru	Yes	15%
Pampallaqta	Yes	8%
Chawatyre	Yes	20%

Table 22. Households that participate in traditional rituals

WHO IN THE HOUSEHOLD IS INVOLVED IN TRADITIONAL RITUALS	PERCENTAGE (%)
1. Head of family	33
2. Father head of family	23
3. Children	13
4. Second son	2
5. Third son	4
6. Eldest daughter	2
7. Third daughter	4
8. All members of the family	8

and a decline in Christian (Catholic) festivals. Both men and women are active participants in these collective festivals (Table 23).

The survey results indicate that traditional dress is most often worn by women (in 33% of households), followed by the head of the family and then the eldest son. Younger people are less likely to wear traditional dress, although in 14% of households all family members still wear traditional dress (Table 24).

Only men participate in communal activities such as collective work, communal assemblies and specific committees.

In terms of farming, the findings show that the majority of traditional practices and technologies are still in use, such as land fallowing, *tarpuy* (planting), mounding soil around the base of plants, *mullu* (system of land rotation), *lampeo* (hilling) and seed selection. A few are now used less or have evolved into better practices; for example, in Pampallaqta the foot plough used to require three people – adaptations mean it can now be done by only one or two people (see Section 8.1).

The people most often contacted in other communities are relatives, followed by friends, and the main reason for contacting them is to exchange labour and maintain solidarity relations (Table 25).

The survey findings show that the communities continue to consume traditional food crops, but that the number of different crops consumed has increased in the last 30 years (Table 26). The most significant change is the neglect of quinoa in Amaru, which seems to have been replaced with *tarwi*. In the other communities, the number of different crops consumed has either stayed the same or increased.

Table 23. Participation in main traditional festivals

COMMUNITY	MAIN TRADITIONAL FESTIVALS AND RITUALS	TRADITIONAL FESTIVALS AND RITUALS THAT ARE NOT IMPORTANT TODAY	MEMBERS OF THE COMMUNITY PARTICIPATING IN COMMUNITY EVENTS TODAY	FAMILY MEMBERS INVOLVED IN COMMUNITY EVENTS 20 YEARS AGO %	PARTICIPATION OF MEN AND WOMEN IN TRADITIONAL CELEBRATIONS, AND RITUALS
Amaru	1. Lord of Exaltation 2. Community Anniversary 3. Carnival	Carnival	50%	100%	Both are actively involved
Paru Paru	1. Community Anniversary 2. Linderaje 3. Ccacha Raymi	1. Carnival, 2. Male Tusay Christmas, 3. Day of the Virgin Magdalena	95%	97%	Both are actively involved
Pampallaqta	1. Linderaje, 2. Community Anniversary, 3. Farming Festival	1. San Juan Festival, 2. Carnival, 3. Santa Cruz	100%	100%	Both are actively involved
Chawatyre	1. Virgin Asunta 2. Carnival 3. Community Anniversary 4. Tinaky	1. Comadres 2. Mayor Pusay 3. Rahuay	100%	100%	Both are actively involved

Table 24. Members of the household who wear traditional clothing

PEOPLE WHO STILL USE TRADITIONAL CLOTHING	PERCENTAGE %
1. Head of family	19%
2. Wife of the head of household	33%
3. Mother of head of the family	5%
4. Son	12%
5. Second son	3.5%
6. Third Son	2%
7. Eldest daughter	5%
8. Second daughter	5%
9. All members of the family	14%

Table 25. People contacted in other communities

PEOPLE CONTACTED IN OTHER COMMUNITIES	PERCENTAGE %
Relatives	51%
Friends	45%
Other people	3%
REASON FOR CONTACTING MEMBERS OF ANOTHER COMMUNITY	**PERCENTAGE %**
Work	67%
Celebrations	13%
Ayni (reciprocal exchange)	8%

Table 26. Staple food/key food crops consumed today and 30 years ago

COMMUNITIES	MOST IMPORTANT FOOD CROPS TODAY (IN ORDER OF IMPORTANCE)	MOST IMPORTANT FOOD CROPS 30 YEARS AGO
Amaru	Maize, potato, tarwi	Maize, potato, quinoa
Paru Paru	Potato, fava beans	Potato, fava beans
Pampallacta	Potato, oca, oats	Only native potatoes
Chawatyre	Potato, lisa, quinoa, tarwi, mashua	Potato, oca, mashua

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Climatic changes and Adaptation

7

7.1 Climatic changes and impacts on cropping system

This section presents the qualitative baseline survey findings on climatic changes in the Potato Park. The changes identified largely reflect those for the Cusco region as a whole (Section 1.3) and can be summarised as: 1) erratic weather and temperature changes that are altering the growing season; 2) changes in potato yields and varieties; and 3) pests and diseases that are intensifying with rising temperatures (ANDES and the Potato Park, 2015). These effects are altering indigenous agricultural practices and cropping systems, not only in the communities of the Potato Park, but in the Cusco region as a whole.

The elders in the Potato Park have noted gradual warming conditions which have caused cultivated and wild species to migrate upwards where temperatures are cooler and soil pests fewer. Elders have also noted a decrease in the amount and number of days of snow cover on mountain peaks, an increase in extreme events such as heavy rains and drought, late onset of rains, as well as increased rainfall outside the rainy season. Small-scale indigenous farmers in the Potato Park face great climate change challenges, which pose an existential threat to community livelihoods, sustainable farming and to the future of Andean crop diversity and culture (ANDES, 2014).

Weather changes are resulting in a shorter potato-growing season. Forty years ago, in the mid-altitude zone, the rainy season was recorded as beginning in September or October; for the past few years, however, the rainy season has not started until November (PACC Peru, 2012). In the highland region, the first potato planting is determined by the onset of the rainy season; therefore, changes in the start of the rainy season mean changes in the growing calendar. Farmers in the Potato Park note that a generation earlier, when their parents were farming, they would plant potatoes in September, whereas now they plant them later, in October or November. Similarly, they used to harvest potatoes in June, but now the harvest happens earlier, in April or May, to avoid the frosts. These observations show a reduction at both ends of the growing calendar, resulting in a shorter season overall.

The increase in both mean temperature and erratic weather events has affected which varieties of native potatoes can be successfully planted, as well as the season's yield. Some potato varieties, which are only able to grow at lower altitudes, have disappeared completely, due to the increase in temperature and presence of pests. The communities are increasingly experiencing erratic weather events, such as hailstorms, and rains that come outside the typical season for such events. Together, these changes can be detrimental to the potato yield.

In the Potato Park, farmers are already seeing an increase in the occurrence of potato diseases, such as late blight, due to increasing temperatures. As potato late blight becomes more rampant, farmers are moving their fields higher up the mountain to find colder temperatures and areas free of such pests and diseases. Transects conducted in collaboration with CIP have shown that potato cultivation has risen by 200 metres in the last 30 years. Planting at higher altitudes requires farmers to climb higher, which means more time is required to tend their potato crops. Other potato pests, such as the potato tuber moth and the Andean potato weevil, have also increased. These findings are supported by the quantitative survey findings presented below.

7.2 Climatic changes identified through the quantitative survey

Households surveyed reported erratic weather patterns since 2003, notably reduced rainfall (92% of households), increased wind strength (65%) and stronger sunshine (50%) (Figure 16; Table 27). They have also noted an increase in extreme events in the last ten years: drought (56%), flooding (57%), frost, hail and snow in the rainy season; as well as environmental changes as a consequence of these climatic changes, including insects and pests (50%) and livestock diseases (87%). Weather changes are resulting in a shorter potato-growing season.

Figure 16. Summary of local trends in climate, 2003–2012

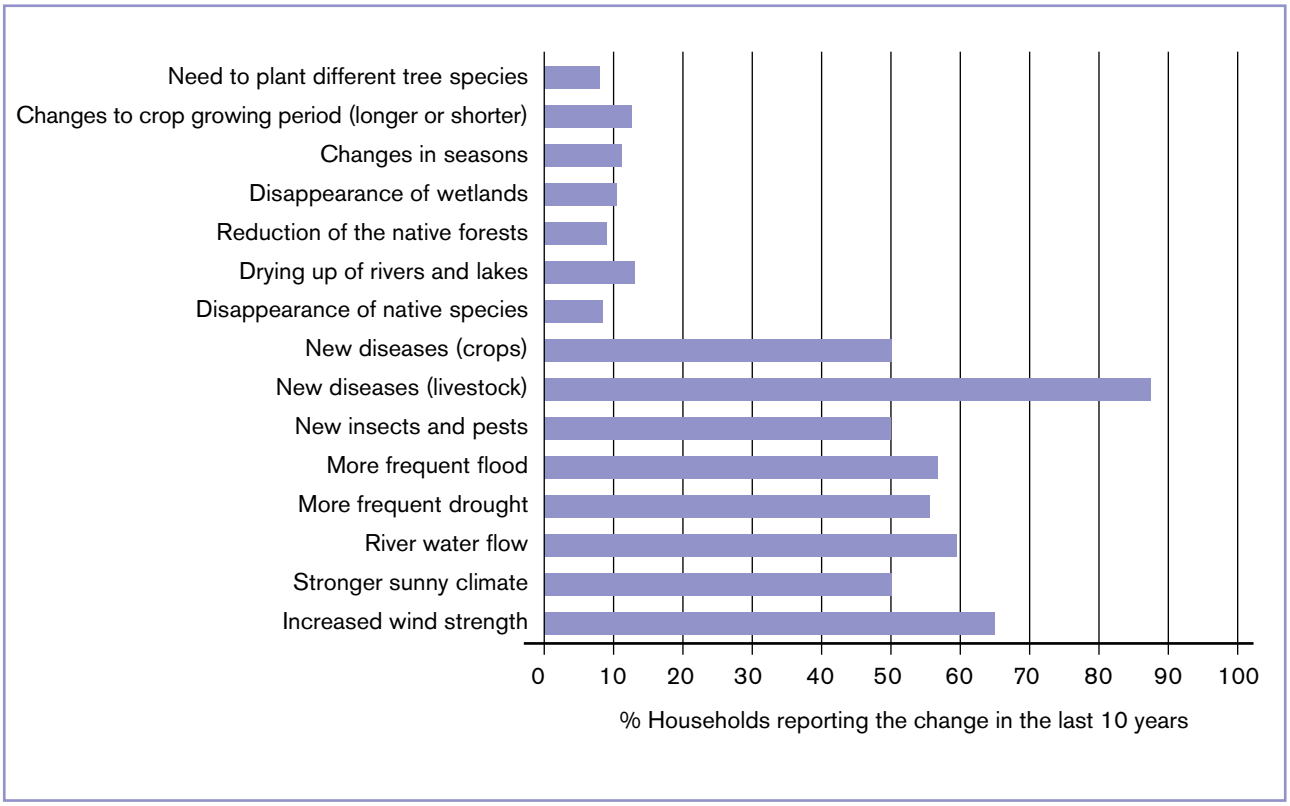

Table 27. Households reporting climatic changes since 2003

CLIMATE RELATED PHENOMENA	% HOUSEHOLDS REPORTING CHANGE
1. Decreased rainfall	92%
2. Temperature (summer/winter)	0%
3. Increased wind strength	65%
4. Stronger sunshine	50%
5. River water flow	60%
6. More frequent drought	56%
7. More frequent flood	57%
8. New insects/pests	50%
9. New diseases (livestock)	87%
10. New diseases (crops)	50%
11. Increased frost	62%
12. Increased hail	48%

All surveyed households reported having observed some kind of environmental change associated with these climate changes. More than 10% of those surveyed have observed the drying up of rivers and lakes; variation in crop growing periods; changes in the duration of the seasons and disappearance of wetlands (Table 28).

According to the data obtained from the surveys, the onset of the rainy season has been delayed by two months over the last 40 years. Thirty or forty years ago the rainy season started in September, 10–20 years ago it started in October, and now it starts in November. The end of the rainy season remains the month of April (Table 29).

The most commonly reported extreme events experienced by households in the last 10 years were hail during the rainy season (94%), drought (92%) and strong winds (89%) (Table 30). With regard to the frequency, in all cases these are phenomena that occur more than twice a year, and the average duration is: 1 hour for the hail in rainy season, 7 days for droughts and 30 minutes in the case of strong winds.

Table 28. Households reporting environmental changes associated with climatic change since 2003

ENVIRONMENTAL CHANGE ASSOCIATED WITH CC	% HOUSEHOLDS THAT OBSERVED THESE PHENOMENA
1. Disappearance of native species	9%
2. Drying up of rivers and lakes	13%
3. Reduction of the native forests	9%
4. Disappearance of wetlands	10%
5. Changes in the duration of the seasons	11%
6. Crop growth period longer or shorter	13%
7. Changes in the model of tree planting	8%
8. Other	0%

Table 29. Changes in the rainy season and its duration observed by households in the past 40 years

REFERENCE PERIOD	MONTH OF START OF THE RAINY SEASON	END OF THE RAINY SEASON
Now	November	April
Ten years ago	October	April
Twenty years ago	October	April
Thirty years ago	September	April
Forty years ago	September	April

Table 30. Extreme events observed in the last 10 years (since 2003)

EXTREME EVENT	% HOUSEHOLDS THAT HAVE OBSERVED THESE PHENOMENA SINCE 2003
Drought	92%
Floods	69%
Downpour	78%
Frost in rainy season	71%
Hail in the rainy season	94%
Snow in rainy season	86%
Strong wind	89%

Before 2003, there was more frost and drought than other extreme events, according to 63–65% of farmers surveyed. However, the findings suggest that drought and frost have increased since 2003 (Table 31).

7.3 Key changes in the main crops since 2003

The analysis was carried out for the cultivation of potato. The perception of the population is that the resistance of the potato crop to climatic phenomena has decreased a little, reflecting an increase in climatic challenges faced. Similarly, over 20% of households reported that quality and productivity have decreased significantly. Over 40% reported there have been no significant changes in susceptibility to pests and diseases in the last 10 years, while nearly 20% reported an increase and 38% a decrease (Table 32).

7.4 Adaptation strategies

Potato Park farmers are responding to these climatic challenges through diversification, as well as mobility (i.e. moving potato cultivation up in altitude), as evident from the qualitative survey. In the highlands, farming families generally plant around 100 varieties of potatoes. Lino Mamani Huarka, plants between 120 and 140 native potato varieties. Such a great variety of potatoes means that unexpected weather events, such as frost, are less detrimental because there is a higher likelihood that at least some varieties will be resistant to the conditions.

The survey asked households what they are doing to adapt to the main changes affecting potato cultivation: ie. reduced productivity, quality and resistance to climatic challenges. The main strategy for increasing productivity and quality is the adoption of higher yielding native potato varieties (Table 33). In order to address reduced resistance to climate adversities, 50% of households reported the adoption of higher yielding varieties and 50% reported the use of manure and organic fertiliser. The next section explores key innovations for adaptation to climatic and livelihood challenges.

Table 31. Most common climatic phenomena before 2003 (% of households)

CLIMATE PHENOMENON	% OF HOUSEHOLDS THAT HAD OBSERVED PHENOMENA BEFORE 2003
Drought	63%
Frost	65%
Cloudy weather	73%

Table 32. Key changes in the main crops since 2003

	HOUSEHOLDS REPORTING CHANGE (%)			DEGREE – MAGNITUDE OF CHANGE (% HHS)			
	INCREASE	DECREASE	NO CHANGE	VERY LITTLE	LITTLE	NORMAL	MUCH
Productivity	19%	56%	25%	10%	17%	52%	21%
Quality	6%	56%	38%	7%	28%	41%	24%
Features	18%	33%	48%	17%	39%	17%	26%
Resistance to climatic events	0%	65%	35%	0%	54%	33%	12%
Plant height	0%	71%	29%	62%	19%	19%	0%
Location of planting	5%	59%	36%	80%	0%	13%	7%%
Uniformity of crops	6%	47%	47%	0%	48%	39%	13%
Sowing time	0%	0%	100%	30%	50%	10%	10%
Harvest time	0%	0%	100%	25%	37%	25%	12%
Susceptibility to pests and diseases	19%	38%	43%	9%	55%	18%	18%

Table 33. Climate adaptation strategies for potato

	PERCENTAGE HOUSEHOLDS REPORTING ADAPTATION STRATEGIES				
	ADOPTION OF HIGHER YIELDING VARIETIES	USE OF MANURE AND FERTILISER	USE OF HERBICIDES AND PESTICIDES	EARLY SOWING	HIGH ROTATION CROPS
Productivity	50%	33%	17%	0	0
Quality	60%	20%	0	0	20%
Resistance	50%	50%	0	0	0

Biocultural innovations

8

8.1 Exploring key biocultural innovations in the Potato Park

This section explores the main biocultural innovations (BCIs) identified through the qualitative baseline study (Asociación ANDES and the Potato Park, 2015). The BCIs that are being applied by the Potato Park communities include:

1) New technologies based on ancient agricultural technologies (technological innovations).
2) New products and services to cope with socio-economic disturbances (market innovations).
3) New institutions and policies based on rules, norms and protocols associated with customary laws (institutional innovations).

These innovations contribute to agricultural productivity as well as livelihood resilience in the face of climate change. A total of 31 biocultural innovations were recorded in the Potato Park, including 18 technological innovations, 4 market innovations, and 9 institutional and policy innovations. These were either developed by the communities alone (endogenous), or jointly by the communities and external partners, notably the NGO ANDES and CIP scientists.

8.1.1 Technological innovations

Technological innovations are considered the practical use of new knowledge derived from the interaction of the components of biocultural heritage, or the interaction between traditional knowledge and science (or external knowledge), in accordance with the *Ayllu* system. They are classified into four sub-categories reflecting their role in reducing risk:

A. Technologies that spread risk across space:

- **Shifting the range of potato cultivation**: For the past 25 years farmers in the park have expanded the range of established potatoes varieties to higher elevations (see previous section). Because of the increase in pest and diseases, as well as changes in rainfall and temperature, potato yields in the area have been decreasing. Shifting potato fields to higher elevations has been shown to reduce such problems.
- **Expanding the cultivation of new crops into higher areas**: New crops and cropping systems for market production (eg. vegetables and pulses) and livestock fodder have been added to the traditional agricultural production in the park. These practices are combined with the use of traditional terraces for soil conservation and pond construction for water reserves.
- **Experimenting with local cultivars in different areas to adapt to changing conditions**: Each potato cultivar does not need to be resistant to all climate effects; rather, the farmers use a selection of varieties that include resistance to different effects to increase the chance of survival overall.
- **Changing the time and the location for *chuño* production**: The production of this freeze-dried potato for food storage has been moved to higher and colder areas and times where the climate allows the freeze-drying method used by local farmers. In the last few years, *chuño* has been produced at about 4,000 metres above sea level, mostly during the months of June and July.

B. Technologies that spread risks across time:

- **Establishing a community seed bank:** The Potato Park's seed bank serves as a back-up for local seed self-sufficiency by providing farmers with access to a wide diversity of native potato seeds and thus a reliable source of planting material year round. It also plays a key role in enabling communities to improve their income and serves as a repository of local potato diversity, including climate-related desirable characteristics adapted to local conditions. The Seed Bank stores seeds in a building and thus represents an ex-situ conservation and management strategy.
- **Reducing the traditional potato fallow period:** The traditional fallow period has been reduced from seven years to four years without losing its benefits. The new four-year rotation system combines traditional elements with new tools and agrocecological practices for the management of fertility, humidity, and soil erosion.
- **Using net houses (tents) for clean potato seed production throughout the year:** This technique prevents infection by viruses, bacteria, fungi and other pests and enhances physiological characteristics such as turgidity and firmness. The technique was introduced by CIP and adapted by local farmers. Net house facilities were built by Quechua farmers in collaboration with CIP and ANDES.
- **Improving water capture through the construction of family and community micro-reservoirs:** These reservoirs combine the traditional water harvesting technology (*aruna*) and the use of modern materials and techniques to ensure water availability for irrigation and consumption.

C. Technologies that spread risks across asset classes:

- **Reintroduction of potato diversity into farmers' fields:** From the large Potato Park gene pool, farmers select for varieties that are more resistant to higher temperatures, pests and unexpected frosts.
- **Community genetic reserve:** Model based on the biocultural landscape of *ayllu* with a focus on conservation that blends indigenous and scientific knowledge to evolve and conserve the diversification of species. The community genetic reserve is maintained in locations designated for active, long-term, in-situ conservation and management of landraces and wild relatives of a wide range of crops, to ensure the adaptability of agricultural production systems.
- **Improving organic farming techniques:** Through training courses provided by ANDES and other partners such as CIP, universities, and government institutions, there has been a diversification of farming inputs such as the development and production of locally made natural fertilisers and pesticides, which support improved pest control, soil and water management.

D. Technologies that spread risks across households or communities:

- **Development of *wiri*, a new ploughing technique for potato cultivation: a m**odified traditional Andean foot plough (*chaquitaccla*), which helps reduce the amount of labourers required and encourages the participation and involvement of women.
- **Exchanges of climate-resilient varieties and associated knowledge and practices among farming communities:** This approach draws from indigenous farmers' traditional practices of saving and sharing seeds; such practices are embedded in traditional network structures that connect farmers and landraces within and across environments and are being revived and strengthened.
- **Revival of the tradition of offering gifts to the spirit of the potato:** This practice intertwines elements that are ecological, biological and social, as well as empirical and spiritual, allowing the sharing of knowledge about the environment and culture of the potato amongst participants. The observance of this ritual practice has enhanced potato diversity while also introducing mechanisms for coping with environmental problems.
- **Biocultural descriptors for local potato varieties with culinary virtues:** This TK-based potato classification tool is based on the exchange of knowledge among women from the park about the uses, shapes, sizes, colours and phenological characteristics of the hundreds of potato cultivars they use for cooking.
- **The "Khipu" Biocultural Heritage Register:** This database register includes traditional knowledge on how to use resources such as potatoes and other native crop varieties, medicinal plants, and other communal resources deemed relevant by the communities of the park. It uses the *khipu*, an Andean record-keeping system that uses knots tied on strings, to organise the information and describe key features.
- **Dynamic conservation:** The development of complementary in-situ and ex-situ conservation strategies for repatriated potatoes in collaboration with CIP under the *ayni* concept (reciprocal exchange). An integrated approach blends traditional and scientific knowledge.

8.1.2 Market innovations

Market innovations include innovative farm and non-farm based and biocultural heritage-derived livelihood options, and business opportunities for products and services that support socio-economically viable and climate-resilient livelihoods. These include market linkages, use of collective trademarks, microenterprises and value-chain development. These innovations engage multiple stakeholders, such as the private sector, universities, research institutes, government, and community organisations. Market innovations identified include:

A. Development of collective microenterprises for producing and marketing biocultural products

- Creams, ointments, tinctures, and teas for maintaining health and treating conditions such as digestive problems, skin conditions, *soroche* (altitude sickness), and joint pain.
- Personal care products such as shampoos and soaps based on wild and cultivated plants.
- New potato-based dishes served in a traditional restaurant or "culinary sanctuary".
- New food products such as *Chocopapa* (potato chocolate), made from a combination of dark potatoes and chocolate.

- Innovations in traditional textile designs and styles (including weavings with potato-themed designs, use local iconography, and new styles of bags, belts, scarves, and hats).
- Tourism programmes that increase biological and cultural diversity by adding value to the biocultural heritage of the park.

B. Informal collective trademark

The Potato Park communities have developed a collectively owned Potato Park trademark, linked to the park as a conservation area, to authenticate and promote the park's diverse biocultural products and services. Use of the trademark is guided by rules in line with the customary laws that promote indigenous product development and innovation.

C. Development of the potato culinary heritage

The establishment of a culinary sanctuary (restaurant) offers schools and visitors educational courses and "walking workshops" on potato biocultural systems, the politics of food and potato culinary art. It gives women a central role in showcasing their talents.

D. Marketing strategies that link monetary markets and barter techniques based on reciprocity

Potato Park goods or services are exchanged via the revival of barter techniques for services such as training and other health, education, or economic development support.

8.1.3 Institutional innovations

Institutional innovations were defined as new institutions and policies that promote the use of indigenous knowledge and effective functioning of local institutions to reduce vulnerability to climate change.

A. Community governance of biocultural heritage

- **The Potato Park Biocultural Heritage Territory Model:** The Potato Park is an innovation in itself, as it brings together five previously separate communities to lead a collective process of endogenous development and conservation.
- **The Association of Communities of the Potato Park:** The association has emerged as a community-owned model for the governance of biocultural heritage. It is a unified collective decision-making body for the five communities, with shared values, goals, structures and arrangements.
- **Biocultural protocol: The Potato Park Inter-community Agreement for Benefit Sharing:** Developed jointly by the Potato Park communities and ANDES, the agreement has the format of a biocultural community protocol using customary laws to ensure equitable benefit sharing amongst the five communities that make up the park, based on a local perspective of equity. It guides the distribution of repatriated seeds and 10% of the profits from Potato Park micro-enterprises using the collective trademark.
- **Network of community-based researchers:** A network of community-based researchers has been drawn from the Potato Park communities. They advance endogenous capacity development and indigenous leadership in participatory research, and the management of the Potato Park and its large native potato collection.
- **Horizontal partnerships with scientists:** Well-established and exemplary collaborative partnerships between indigenous farmers and research centres, including CIP and national and international universities. The objectives are research oriented, aimed at contributing to the sustainable management of biodiversity and landscapes.
- **New biocultural festivals based on local traditions – *Qachun Huaccachi* Festival:** *Qachun Huaccachi* is a native potato cultivar considered a symbol of love amongst the park communities. The festival highlights the biocultural significance of *Qachun Huaccachi* and native potatoes for culture, society and global food security.

B. Influencing policy change from the bottom up

- **Repatriation agreement between the Potato Park and the International Potato Center:** The agreement, first signed in 2004, has returned 410 native potato varieties from CIP to the communities for food security and in-situ conservation. They had been collected from the area but had since been lost. This strategy aims to avoid the threat of intellectual property rights being obtained by others over traditional knowledge or potato varieties, while increasing the level of biodiversity within the park and addressing a history of wrongful appropriation of indigenous resources (ANDES, Potato Park Communities and IIED, 2012).
- **Membership of the multilateral system of the FAO's Treaty on Plant Genetic Resources for Food and Agriculture:** The Potato Park is the first community-managed gene bank which has gained membership of the FAO's ITPGRFA, which facilitates access to genetic resources through a material transfer agreement. The membership will give the park influence within the system and provide formal recognition of the park's potato resources and rights at the international level.

- **Transferring the Potato Park's potato collection to the Svalbard International Seed Vault:** The transfer, conducted in October 2015, serves to strengthen the park's membership of the FAO Treaty multilateral system, raise international awareness of the growing concerns of Peru's potato farmers and promote a balanced relationship between in-situ and ex-situ conservation strategies.
- **Declaring a National Day of the Potato:** With strong lobbying by the park's leaders, the Peruvian Government passed a law which declared May 30 as the National Day of the Potato, emphasising the potato's leading role as a source of nutrition, and its links to the culture and cuisine of Peru, especially for Andean peoples.

8.2 Biocultural innovations identified in the household survey

This section presents the innovations identified in the quantitative household survey. It includes the main innovation types, level of adoption and impact of the innovations.

8.2.1 Major innovations in the past 30 years

The two most commonly reported innovations developed by surveyed households in the past 30 years are institutional innovations. They are the establishment of a local group of crop experts and the repatriation of traditional crops. The third innovation in order of importance falls under the category of technological innovations and consists of the introduction of new/modified tools for farming (Table 34).

Table 34. Types of innovation developed/adopted by households (not only BCI) over last 30 years

TYPE OF INNOVATION		RESPONSES (%)
Market innovations: livelihood, food security	Micro-finance or banking service	6%
	Distribution/sale of crops/products at national level	5%
	Distribution/sale at the international level	6%
	Marketing strategies to sell products	6%
	Financial accounting principles	6%
Technological innovations: crops, biodiversity, agricultural practices	Free exchanges of seeds	5%
	Drip irrigation of crops	5%
	Protection of crops in seed banks or preservation areas	5%
	Crop practices	3%
	Identification of resistant cultivars	3%
	New/modified tools	8%
Institutional innovations: social capital, institutional, networks and organisation	Repatriation of traditional crops	8%
	Local group of crop experts	9%
	Improvement of crops in the community	6%
	Communal production of seeds	6%
	Organisation in the community to assist with crop/harvest	6%

8.2.2 Adoption of innovations

The level of adoption of different types of innovations related to climate change adaptation and resilience is shown Table 35. The most commonly adopted innovations in the four communities are those categorised as social or institutional capital: the repatriation of traditional crops, the groups of local technicians, communal organisation to help with the harvest, the communal production of seeds, and crop enhancement.

In Amaru 100% of surveyed households have adopted the five innovation types in this group; while in Paru Paru, 75% of households have been involved in community organisation to help with the harvest. In Pampallaqta and Chawatyre, the population predominantly participates in the repatriation of crops, the local crop expert group for Participatory Plant Breeding and harvest organisation. In Pampallaqta, the most widespread innovation is the communal production of seeds.

Table 35. Percentage adoption by households in each community

TYPE OF INNOVATION		SHARE OF HHS REPORTING ADOPTION			
		AMARU	PARU PARU	PAMPALLAQTA	CHAWAYTIRE
Livelihood, food security	Micro-finance or banking service	0%	0	3%	0%
	Distribution/sale of crops/ products at national level	35%	50%	29%	50%
	Distribution/sale at the international level	3%	33%	51%	80%
	Use marketing strategies to sell products	40%	42%	10%	80%
	Use of financial accounting principles	50%	17%	1%	0%
Crops, biodiversity, agricultural practices	Free exchanges of seeds	1%	13%	66%	0%
	Drip irrigation of crops	0%	8%	66%	0%
	Growth of transgenic crops	3%	8%	0%	0%
	Protection of crops in seed banks or preservation areas	1%	58%	44%	0%
	Crop practices	1%	0%	21%	0%
	Identification of resistant cultivars		0%	66%	51%
	New tools/modified		75%	66%	100%
Social capital, institutional, networks and organisation	Repatriation of traditional crops	100%	17%	66%	100%
	Local group of crop experts	100%	17%	66%	88%
	Improvement of crops in the community	100%	8%	59%	51%
	Communal production of seeds	100%	8%	66%	41%
	Organisation in the community to help the crop/harvest	100%	75%	66%	88%

8.2.3 Impact of the innovations

The survey explored the impact of the innovations on biocultural systems, food security, ways of life and social inclusion. The main impacts reported relate to improved food security and nutrition (Table 36). Reference was also made to impacts on culture, biocultural heritage and community organisation.

Table 36. Impact of innovations on biocultural system, food security, ways of life and social inclusion

TYPE OF INNOVATION		IMPACT
Livelihood, food security	Micro-finance or banking service	Food security increase
	Distribution/sale of crops/products at national level	Food security increase
	Distribution/sale at the international level	Power Culture Best sales/revenues
	Use marketing strategies to sell products	Food income
	Use of financial accounting principles	Food
Crops, biodiversity, agricultural practices	Free exchanges of seeds	Food security increase
	Drip irrigation of crops	Food security increase
	Growth of transgenic crops	Food security decrease
	Protection of crops in seed banks or preservation areas	Food security increase
	Crop practices	Food security increase
	Identification of resistant cultivars	Culture Food security increase
	New/modified tools	Food security increase
Social capital, institutional, networks and organisation	Repatriation of traditional crops	Order of the community Food security increase
	Local group of crop experts	Better relations between the communities Food security increase
	Improvement of crops in the community	Food security increase Rejection of GMO in the communities (environmental protection)
	Communal production of seeds	Food security increase Protection of biocultural heritage
	Organisation in the community to assist with crops/harvest	To revalue the National Day of the Potato Food security increase Recognition of biocultural heritage

Most of the innovations have been created collaboratively between local stakeholders (the community, local experts and the Potato Park) and other stakeholders that have been supporting them, such as the NGO ANDES, the Pisaq Council, or the Peruvian government. Table 37 indicates which stakeholder(s) provided the idea for different innovations

Table 37. Origin of the innovation

TYPE OF INNOVATION		WHO PROVIDED THE IDEA?			
		AMARU	PARU PARU	PAMPALLAQTA	CHAWAYTIRE
Livelihood, food security	Micro-finance or banking service				
	Distribution/sale of crops/ products at national level	Community	Local		Community
	Distribution/sale at the international level	Community	NGOs		Municipality/ ANDES
	Use marketing strategies to sell products	Potato Park	ANDES		ANDES
	Use of financial accounting principles	Community	ANDES		
Crops, biodiversity, agricultural practices	Free exchanges of seeds	Community	Local		
	Drip irrigation of crops				
	Growth of transgenic crops		Local		
	Protection of crops in seed banks or preservation areas		Local		
	Crop practices				
	Identification of resistant cultivars	Traditional knowledge	Local	Traditional knowledge	Traditional knowledge
	New tools/modified	ANDES	ANDES	ANDES, PP	ANDES
Social capital, institutional, networks and organisation	Repatriation of traditional crops	Political initiative	NGOs		Government
	Local technical group of crops	ANDES/PP	Community		ANDES/PP
	Improvement of crops in the community	ANDES/PP	PP		ANDES/PP
	Communal production of seeds	ANDES/PP	PP		ANDES/PP
	Organisation in the community to tend the crops	ANDES/PP	PP		ANDES/PP

Regarding agricultural innovations, traditional knowledge has been the main source for some of them, such as free exchange of seeds or the identification of resistant cultivars. For innovations such as the protection of crops in seed banks or preservation areas, it has been necessary to combine traditional and scientific knowledge (Table 38).

8.2.4 Importance of innovations

The majority (98%) of the surveyed households identified innovations, in general terms, as very important or important for the well-being of their families and communities (Table 39).

Innovations are considered especially necessary for household welfare in the following areas: economic growth, increased agricultural production and addressing climate change (Table 40).

Table 38. Contribution of traditional and external knowledge

TYPE OF INNOVATION		CONTRIBUTION OF TRADITIONAL AND EXTERNAL KNOWLEDGE
Crops, biodiversity, agricultural practices	Free exchange of seeds	Traditional knowledge
	Drip irrigation of crops	Traditional knowledge
	Growth of transgenic crops	Mainly science
	Protection of crops in seed banks or preservation areas	Both types of knowledge
	Crop practices	Traditional knowledge
	Identification of resistant cultivars	Traditional knowledge
	New/ modified tools	Mainly external knowledge

Table 39. Importance of innovations for household welfare

IMPORTANCE	%
Very important	74
Important	24
Somewhat important	2
No importance	0

Table 40. Areas where innovations are needed most

AREAS WHERE INNOVATIONS ARE NECESSARY	PERCENTAGE (%)
1. Maximising agricultural production	20
2. Economic growth	22
3. Climate change	20
4. Marketing of products	16
5. Models of community participation	16
6. Integration with national and international economies	3
7. Reduction in the cost of living	2
8. Health	0

8.3 Factors influencing biocultural innovations

Factors or conditions that influence (i.e support or constrain) the development and spread of biocultural innovations were explored through the qualitative baseline study. Regarding ***social factors***, the survey explored individual, networking, institutional and community level factors. Innovations are thought to depend on the presence of elders (**individuals**) who are recognised and respected in their communities, and who develop and share innovations. The firmly held beliefs and practices related to customary laws and institutions seem to support the development of biocultural innovations and their diffusion within and across generations, as they promote knowledge sharing; most agricultural knowledge, including innovative practices, is transmitted orally from farmer to farmer.

Other factors that influence innovations are access to technical support and resources for supporting innovative ideas; the appointment of key individuals as special focal points on innovation within each community (e.g. members of the potato guardians local expert group); and co-ordination meetings and participation in community decisions affecting their production systems, including the management of the Potato Park. Other individual factors identified include the existence of women with capacity to act as entrepreneurs, and the existence of specialised groups for marketing and selling newly developed products (eg. micro-enterprises).

Community Assemblies continue to be important sites for sharing knowledge, group decision making and problem solving. The presence of creative and innovative external organisations and connections between these organisations and community leaders/innovators were also identified as important. Participation in learning networks, including inter-community groups, supported innovation by bringing together like-minded individuals and groups to solve problems. Participation in networks and events for sharing and learning can also support the wider dissemination of innovations to farmers, policy makers, scientists and academics.

Policies and legal instruments were identified as **institutional** factors that present opportunities to promote innovation (see Box 3 and the policy matrix in Annex 1). In order for indigenous communities to establish, sustain or enhance biocultural innovation systems, policies are needed which recognise and protect their biocultural heritage, including indigenous peoples' cultural and spiritual values, traditional knowledge and crops, and resource management practices with a view to promoting endogenous development. The protection of indigenous lands and biocultural resources from activities that are environmentally unsound, or that the indigenous people concerned consider to be socially and culturally inappropriate, was also identified as an important institutional factor for supporting biocultural innovations.

Other key institutional factors identified are as follows:

- The protection of customary seed systems and environmentally sound means of food production to ensure a range of choices and innovations.
- Training to build innovation capacity.
- The establishment of microenterprises that are oriented towards the application of traditional knowledge.
- The integration of local norms, rules and protocols for managing innovations.

Among critical **networking** factors, the research identified the existence of capacity-building programmes for indigenous communities, based on the adaptation and exchange of traditional experience, knowledge and resource-management practices to ensure their endogenous development. The participation of indigenous peoples and their communities in the national formulation of policies, laws and programmes relating to conservation, climate change, resource management and other development processes was another factor identified as important. Another key factor is the involvement of indigenous people and their communities at the national and local levels in innovation, resource management and conservation strategies, as well as climate change adaptation and other relevant programmes to support sustainable development.

The **community** factors supporting BCI include defining the legal status of the Potato Park, establishing a trust fund for supporting biocultural innovations, establishing a long-term vision for the Potato Park, electing local authorities supportive of innovation, and the transmission of traditional knowledge and practices to younger generations. Another key factor is the involvement of the community in planning at different levels on resource management and conservation strategies.

BOX 3. POLICIES OF RELEVANCE TO BIOCULTURAL HERITAGE AND INNOVATION

Although Peru does not have a policy and regulatory framework specifically intended to promote or protect biocultural heritage, which is a relatively new concept, some relevant policy initiatives have been identified. Challenges and gaps in policies relevant to the implementation of innovations based on indigenous knowledge, with emphasis on climate change adaptation and food security, have also been identified.

The key policy frameworks at the international level include: the Convention on Biological Diversity (1992); the UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage (2003); the UN Declaration on the Rights of Indigenous Peoples (2007); the proposal for the protection of traditional cultural expressions of the World Intellectual Property Organisation (WIPO); and the Nagoya Protocol on Access to Genetic Resources (2010), among others.

National policies that can support innovation processes in the Potato Park and are significant in the context of the SIFOR project include (see Annex 1):

- the Agenda for Environmental Research (2013–2021): this may allow the integration and strengthening of TK and innovations in the Potato Park for territorial management; adaptation to climate change; management and improvement of agrobiodiversity; management of water resources, etc.
- the National Strategy on Food Security and Nutrition (2013–2021): this contributes to the specific recognition of local practices and innovations aimed at conserving agrobiodiversity and generating local innovations that support improved productivity and agricultural sustainability
- the National Program on Biotechnology (2013–2016) which opens the possibility of collaborative projects between the Potato Park and research institutions
- the Regulations of the General Seed Law DS 006-2012-AG (2012) that offers the possibility of producing native seeds and commercialising them (in a non-certified way).[11]

In the Cusco region a series of relevant ordinances have been implemented, including those related to the prohibition of GMO cultivation in Cusco (2007) and on access to biodiversity and protection of traditional knowledge (2008).

Reviewing the policy and legal framework enabled an understanding of how the different dimensions of biocultural innovations in the Potato Park can be directly or indirectly supported by external rules, policies and/or programmes. In addition, it allows the identification of the types of support (financial, technical, commercial, legal, etc.) that can be accessed by the communities for the protection of their biocultural heritage and related innovations. The Policy Matrix in Annex 1 lists relevant policies and their potential impacts on the Potato Park and the SIFOR objectives.

[11] In general, informal seed systems continue to operate – now they can operate in a more 'legitimate' way if the Potato Park wants to become a producer of native seeds.

Conclusions and recommendations

9

The combined qualitative and quantitative baseline study provides a useful overview of biocultural innovations developed by the Potato Park communities, which reflects the understanding of the communities. It provides a comprehensive data set for Monitoring and Evaluation of the SIFOR project, and for tracking how widely the innovations are adopted within and beyond the park. It provides insights into the Potato Park's farming systems, key trends that provide the context for innovation, and evidence of the impacts of its innovations.

Climatic changes have brought significant challenges for potato cultivation which have been detrimental to potato yields, including shortening the growing season and reducing the land available for cultivation (due to rising temperatures and pests). Yet, potato yields have increased slightly since 2003, yields of tarwi (a legume, the second staple crop) have increased significantly (by 36%) and average income has almost doubled. This suggests that the Potato Park's TK-based or 'biocultural' innovations developed since 2000 with support of ANDES, and its use of native varieties and agroecological practices, have been effective in enhancing food security in the face of climate change.

At the same time, the diversity of varieties of the main staple crop (potato) has more than doubled since 2003, boosting resilience and options for adaptation, today and in the future. Resilience has also been strengthened through enhanced social capital (eg. traditional practices and community institutions). These impacts are also evident from other studies assessing key innovations, such as the CIP agreement (Stenner et al., 2016), and the Potato Park's collective trademark (Argumedo, 2013). This highlights the critical importance of traditional knowledge and respectful and empowering partnerships between TK holders and external thinkers and scientists for developing effective responses to climate change.

The study shows that it is possible to conduct a quantitative household survey in a participatory way, by building the capacity of community researchers to conduct the survey and participate in research design and analysis. A decolonizing methodology, as the philosophy of the research, served to implement a multiple evidence-based approach in which epistemological bridges are created between indigenous knowledge and western science. This generated a more complete understanding, and enhanced community research capacity and ownership through the process. It required some flexibility, e.g. allowing community authorities to select households rather than using random sampling.

The main climatic changes observed since 2003 by over 50% of households include reduced rainfall (92% of households), increased livestock and crop disease, frost and wind strength, and an increase in extreme events such as flooding and drought. Although no households identified increased temperatures, 50% identified increased sunshine strength, which is an indicator of increased day time temperature. Research conducted with CIP shows that the lower planting line for potatoes has risen by 200 metres in the last 30 years due to increased pests and disease, which correlates with a rise in temperature. The land area for potato farming has shrunk as the mountain top has been reached, and farmers have to walk longer distances to reach their fields. There has also been a delay in the onset of rains (by 2 months) in the last 40 years. These climatic changes mirror those documented by scientists for the Cusco region, with the exception of rainfall which has increased in the region as a whole. This could be due to the particular micro-climate of the Potato Park which differs from Cusco city.

Although the number of households with both men and women in farming is still high, the percentage of households with only women working has increased to 10% in 2012, due to men migrating for work outside the park. This is making the lives of women harder as they are left with agricultural work, as well as household tasks and looking after children and elders. In 2012, income was higher than spending for the first time (in the 10 year period); this is likely to be due to the diversification of income sources including productive and tourism activities related to the Potato Park. Other studies have shown that the Potato Park's economic activities – particularly tourism – are an important and growing source of revenue (ANDES, the Potato Park and IIED, 2012; Argumedo 2013). There has been a slight decrease in spending on agricultural inputs, reaching a very low level in 2012, which is probably due to the strengthening of traditional organic farming systems since the Potato Park was established. There are no strategies for hunger periods as there is regular food security, however, nutrition is declining with the disappearance of barter markets.

The results show that the park communities have effectively conserved the increased potato diversity since 410 native varieties were repatriated from CIP, whereas, before the park was established, potato diversity was declining, a general trend which continues outside the park. However, seven potato varieties have been lost in the last 30 years due to rising temperatures and pests, causing the loss varieties that only grow at lower altitudes. Food security is the main reason for planting different varieties, since it ensures that some varieties will survive extreme events; and this also ensures continued crop evolution for adaptation in future.

Biocultural heritage is very much intact in the Potato Park, in fact the results show a strengthening of traditional festivals since 2003 (and a decline in Christian festivals). This is most likely due to the work of

the Potato Park and ANDES to revitalise cultural values and practices, and repatriate native potato diversity which has brought back associated TK and cultural practices (Stenner et al., 2016).

The findings show that traditional knowledge plays a critical role in the development of effective innovations to cope with climatic and livelihood challenges. Out of the 31 biocultural innovations identified, 18 are technological innovations based on traditional farming technologies and practices. These focus on reducing/spreading risk through mobility (eg. across altitudes), storage, diversification and sharing (eg. of seeds), rather than focusing on maximising yields through simplification and privatisation as characterised by conventional strategies for food security and 'climate-smart' agriculture. This shows that production systems in risk prone environments have evolved a very different logic, to that of intensive/modern agricultural systems designed for ideal conditions. Maximising resilience in risk prone environments may require responses which build on this logic, and use science to support it, rather than the other way round.

The 4 market biocultural innovations (eg. collective micro-enterprises), provide important examples of market-based approaches which are designed by indigenous people and serve to strengthen both cultural and economic incentives for conservation– unlike conventional market mechanisms which can undermine cultural values. Some key institutional innovations in the park have provided the framework for many other innovations. The establishment of the Potato Park Association strengthened links between the six communities for knowledge sharing and joint innovation, and provided the basis for establishing a collectively managed 'Biocultural Heritage Territory'. It enabled the communities to develop a repatriation agreement with CIP, test the repatriated potatoes in different parts of the landscape for adaptation, and strengthen their collective identity and market 'brand' (through an informal Potato Park trademark). The repatriation agreement led to further market innovations (eg. new potato based products), and institutional innovations, such as the potato expert/guardian's group and the inter-community agreement for equitable benefit-sharing, further strengthening community cohesion. It has also led to technological innovations, such as the community seed bank, re-introduction of potato diversity in farmers' fields and the community genetic reserve for crop evolution.

Food security is the main impact of these innovations according to the community responses; however, it is clear that they have also had significant impacts on incomes, crop diversity, biocultural heritage, community organization and climate resilience and adaptation. Almost all the households considered innovations as important or very important, particularly for economic growth, increased production and confronting climate change.

In terms of the factors or conditions that support biocultural innovation, the study suggests that traditional knowledge and networking amongst communities are key, as well as networking with external actors (eg. scientists). Enabling policies that support biocultural heritage and related rights and innovation systems are also needed, including policies for agriculture, agricultural research and development and science and technology. ANDES has played a key role in creating enabling conditions not only by supporting key innovations, but also through its highly participatory decolonising research approach which has built research capacity, strengthened traditional knowledge and culture, empowered farmers and strengthened social cohesion.

Looking Ahead

There is a need to further develop innovations for Biocultural Heritage Territories in the Potato Park, and to scale up these innovations more widely. Further exploration of key factors that support biocultural innovation is also needed to identify priority actions to strengthen innovation systems, with a gendered approach. The following key strategies can be proposed to strengthen biocultural innovations for food security in the face of climate change in the Potato Park and more widely:

- For diversification of crop production: Repatriation of crops from CIP and INIA (the National Institute for Agricultural Innovation), enhance in-situ and ex-situ complementarities, farmer experimentation with commercial varieties and new crop species, promotion of underutilised Andean crop species, and community-to-community seed exchanges.
- For genetic enhancement: strengthen the *Ayllu* system as a biocultural territory model with a focus on providing a biocultural environment for in-situ conservation and crop co-evolution; participatory varietal selection (potato), participatory plant breeding

(maize and other crops) and seed exchanges with other communities in the Andean region.

- To enhance seed production and distribution: establish Community Seed Banks, Hydroponic/ Sandponic Seed Multiplication Units, Community Seed Enterprises and seed sharing as per the Open Source Seed Initiative (OSSI).
- Commercialisation of farmers' varieties and underutilised species: develop potato-based natural products, culinary sanctuaries and indigenous gastronomy, short and long value chains and gender-focused innovations.
- For enhancing ex-situ and in-situ complementarity: develop Biocultural Community Protocols to guide exchange of seeds, in line with the FAO Multi-Lateral System; repatriation of plant genetic resources for food and agriculture from other gene banks and the Svalbard Seed Vault where the Potato Park has sent its community seed bank; create an Information System for Traditional Knowledge and Farmer Climate Schools.
- Training courses on biocultural heritage territories (integrated landscape management) for researchers, farmers and students; exchange visits with other communities, workshops and a training programmes for policy makers; create a Community Extension Network and training of local communities and fostering collaborative research with national and international universities and research centres.
- Support scaling up of the Potato Park innovations in the Cusco region, such as Lares Barter Market Park and Vilcanota Spiritual Park, working towards a Food Sovereignty Corridor in the Andes; and scaling up the Potato Park in other regions of Peru through regional governments, to establish a national Network of Agrobiodiversity Protected Landscapes; and globally, through the International Network of Biocultural Heritage Territories for In-situ conservation Sites and the International Federation of Community Seed Banks for seed exchange (which were recently established by International Network of Mountain Indigenous Peoples, INMIP).

ANDES will continue to engage in joint reflection of climate change and food security challenges with the Potato Park communities, to stimulate discussion on biocultural innovations, their origins, and potential application as solutions to local and global problems. ANDES will continue to share these biocultural innovations locally and globally, and learn from the experiences of others, through the International Network of Indigenous Mountain Peoples; and participate in movements that promote community rights to biocultural heritage and social and environmental justice.

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Annexes

Annex 1. The Policy Matrix

The policy and normative frameworks identified in this matrix are not specifically intended to promote or protect biocultural innovations (a relatively new concept in the literature and discourse), nor do they explicitly exclude future research and exploration of the frameworks in relation to different types of biocultural innovations other than those promoted in the Potato Park.

The matrix developed identifies the policies, norms, strategies, plans, etc., which, either directly or indirectly, relate positively to the innovation process in the Potato Park, and which are also relevant in the context of the SIFOR project and its results, as they are implemented in the Park. For more information about SIFOR's expected results/outcomes, see: http://pubs.iied.org/G03557.html

Law/Policy	Summary**	Theme	(Potential) impacts of drivers of change in the Potato Park	State of implementation (national/regional)	Relation to the SIFOR project's Expected Results
Convention on Biological Diversity (1992)	Promotion of the protection and dissemination of indigenous knowledge, innovations and practices (with FPIC of participating communities)	Protection of TK (including knowledge, innovations, practices of indigenous peoples)	Political/legal foundation for much of the work in the Park related to TK, genetic resources, repatriation and other activities related to conservation and sustainable use of the biocultural heritage of the Potato Park	Advances in the application of the law on the protection of TK, mainly through registers (public confidential)	Result 1: recognition and revaluing local innovations and TK which contribute to sustainable use of agrobiodiversity Result 2: tools to promote local innovation and its diffusion Result 3: knowledge, capacity and strengthening of local agrobiodiversity.
UN Declaration on the Rights of Indigenous Peoples (2007)	Recognition and protection of cultural heritage (TK and innovations) for indigenous peoples	Cultural heritage and TK	Political/legal foundation for much of the work in the Park related to biocultural heritage and recognition of rights	Creation of a Ministry of Culture and Vice-Ministry of Inter-culturality (2010); process of incorporating TK in the internal ministerial agenda	Result 1: recognition and revaluing local innovations and TK which contribute to sustainable use of agrobiodiversity
UNESCO convention for the safeguarding of the Intangible cultural heritage (2003)	Intangible cultural heritage	Cultural heritage	There is a possibility of identifying elements of biocultural heritage to be registered before INC	The Direction of the Registry of Cultural Heritage of the National Institute of Culture is in the process of identifying/registerign samples of national cultural heritage	Result 1: recognition and revaluing local innovations and TK which contribute to sustainable use of agrobiodiversity
Proposal to WIPO to protect traditional cultural expressions (2009-2010)	Protection of cultural expressions	Biocultural heritage	Process underway; not linked, but with possible inspirational elements for inclusion in the regional and national processes.	Relatively active participation of the Ministry of External Affairs in international spaces	Result 1: recognition and revaluing local innovations and TK which contribute to sustainable use of agrobiodiversity
Nagoya Protocol on Access to Genetic Resources (2010)	Protection of TK	TK and biocultural protocols	Express mention of protection of TK and biocultural protocols as a tool to provide protection of collective biocultural heritage; possible legal foundation for biocultural protocols	Recently ratified; normative review process, especially in relation to access and benefit sharing (ABS)	Result 1: recognition and revaluing local innovations and TK which contribute to sustainable use of agrobiodiversity Result 2: tools to promote local innovation and dissemination Result 3: knowledge, capacity and strengthening of local agrobiodiversity

Law/Policy	Summary**	Theme	(Potential) impacts of drivers of change in the Potato Park	State of implementation (national/regional)	Relation to the SIFOR project's Expected Results
Andean Decision 523 which establishes a Regional Strategy for Biodiversity (CAN, 2001)	Strategies and recognised lines of action related to agrobiodiversity, TK, ABS, and others	Biodiversity and TK	Foundation for national and regional plans and strategies for agrobiodiversity, climate change and TK	MINAM (Ministry of Environment) has advanced the implementation of specific plans derived from Decision 523 on agrobiodiversity, TK and ABS	Result 1: recognition and revaluing local innovations and TK which contribute to improvements in the sustainable use of agrobiodiversity
National Law on the Protection of Collective Knowlege of Indigenous Peoples (Law 27811) (2001)	Procedures for protection of TK associated to biodiveristy	Legal protection for TK	Creation of a local registry on TK in the Potato Park; possibility of using this registry in a defensive way (linking to the National Commission of Biopiracy) or as a way of forming a source of data and information for research activities	Public confidential registers have been implemented in charge of INDECOPI (Peru's national authority for intellectual property); training for dissemination and application of the law have been carried out (especially among indigenous groups in Amazonia); law revision underway	Result 1: recognition and revaluing local innovations and TK which contribute to sustainable use of agrobiodiversity Result 2: tools to promote local innovation and dissemination
National Registry of Native Potatoes (Resolución Ministerial 0533-2008-AG)	Register (not constituting rights) and recognition of native potato cultivation	Native crops and seeds	Possibility of registering the Potato Park's varieties through INIA – the National Institute for Agricultural Innovation	Descriptors have been developed and some native varieties from different parts of the country have been registered	Result 1: recognition and revaluing local innovations and TK which contribute to sustainable use of agrobiodiversity
National Environmental Research Agenda (2013-2021)	Prioritisation of strategy lines and actions for environmental research Also, supports research from the point of view institutional and public policy	Recognition of TK and its contribution to research	Integration and strengthening TK and innovations in the Potato Park for territorial management; adaptation to climate change; management and improvement of agrobiodiversity; management of water resources etc.	Recently adopted; co-ordinated by MINAM	Result 1: recognition and revaluing local innovations and TK which contribute to sustainable use of agrobiodiversity Result 4: awareness raising among interest groups (scientists, politicians, etc.) of the role of institutional and policy frameworks in incentives for local innovation to improve local living conditions
National program on Biotechnology (2013-2016)	Promotion of biotechnology in themes of health, agriculture, industry, others	Promotion of biotechnology and recognition of biodiversity	Possibility of executing collaborative projects between the Potato Park and research institutions	Coordinated by CONCYTEC – executed with funds from FINCYT	Result 3: knowledge, capacity, preparation and strengthening of local agrobiodiversity
National Strategy for Development of Science, Technology and innovation (2014)	Recognition of potential of TK; territorial focus (regional) del SINACYT; creation of a national program on biotechnology	Promotion of innovation at all levels	Possibility of alliances between the Potato Park and research institutions to strengthen local innovation (in a participatory way)	Strategy in process of public consultation; led by CONCYTEC	Result 4: awareness raising among politicians, academics and opinion shapers
Prohibition of cultivation of GMOs in Cusco (Ordenanza Regional 010-2007-GRC)	Declares a moratorium on the entry and cultivation of genetically modified organisms (GMOs) in the Cusco Region The conservation of native crops is promoted as an alternative	Biosafety, agrobiodiversity and native crops	Legal foundation for the Potato Park continuing its organic production and local sustainable technology development activities; possibility to influence policy related to biosafety and GMOs	A moratorium was implemented and an informal monitoring system from civil society has been established; a technical group on Agrobiodiversity, Biotechnology and TK in Cusco has been established (with participation of ANDES)	Result 1: recognition and revaluing local innovations and TK which contribute to sustainable use of agrobiodiversity and native crops Result 4: awareness raising among interest groups (scientists, politicians, etc) on the role of institutional and policy frameworks in incentives for local innovation, especially native crops

Law/Policy	Summary**	Theme	(Potential) impacts of drivers of change in the Potato Park	State of implementation (national/regional)	Relation to the SIFOR project's Expected Results
Andean Decision 391, Common Regime for Access to Genetic Resources (CAN) (1996)	Procedures for access to genetic resources (including native seeds and crops) Recognition of the value of TK associated with genetic resources and the need to share benefits	Access and protection of genetic resources and TK	Possibility of regulating forms of access to biocultural heritage (in the field of seeds and native genetic diversity) and associated TK for fair and equitable distribution of benefits from research and development activities	Competent authorities recognised in regulations (INIA, Dirección General Forestal y de Fauna Silvestre and Vice-Ministry of Fishing)	Result 1: recognition and revaluing local innovations and TK which contribute to improvements in the sustainable use of agrobiodiversity
Andean Decision 524 which establishes the Consultative Group on Indigenous Issues (CAN) (2001)	Spaces for discussion of indigenous regional agendas and themes	Protection of TK and territories	Spaces to develop proposals for regional policies on biodiversity and possibility of influencing policy	At this moment, it is deactivated during a reorganising process at CAN	Result 1: recognition and revaluing local innovations and TK which contribute to sustainable use of agrobiodiversity
National Law that creates the Comission against Biopiracy (Law 28216, 2004)	Institutional spaces to deal with cases of biopiracy or appropriation of biological resources and TK	Protection of TK, native crops and genetic resources	Possibility for the Potato Park to denounce cases of biopiracy related to genetic resources or TK before the Commission	Active and regular work since 2004; 13 cases heard in the international arena related to resources of Peruvian origin (maca, yacón, muña, sacha inchi, others)	Result 4: awareness raising among interest groups (scientists, politicians, etc) on the role of institutional and policy frameworks in incentives for local innovation to improve local living conditions
National Law and regulations on Prior Consultation (Ley 29785 and DS **001-2012-MC)**	Procedures for prior consultation for investment and productive activities in community lands	Prior Informed Consent; preservation of biocultural heritage (at the level of territories and landscapes)	It is not clear (it has not been defined by the Ministry of Culture) if the arena for consultation extends beyond Andean indigenous communities	The is still no implementation of the law due to the absence of specific regulations	Result 4: awareness raising among interest groups (scientists, politicians, etc) on the role of institutional and policy frameworks in incentives for local innovation to improve local living conditions
Creation of National round table against poverty (DS 001-2012-PROMUDEH)	Promotion of measures to support local development, social inclusion	Poverty alleviation	Possibility of benefits for the Potato Park with programmes and opportunities to access poverty alleviation mechanisms (social programmes, etc.) but especially taking advantage of the local management of the Potato Park to show successful improvement to living conditions for local communities	Orientation of the round table through policies and supervision of the poverty alleviation programmes	Result 4: awareness raising among interest groups (scientists, politicians, etc) on the role of institutional and policy frameworks in relation to incentives for local innovation – as a means to improve local living conditions.
Draft National Bill on Support for Development of Peasant Cooperatives (2013)	Promotion of networks at the community level	Agricultural production, especially crops	Possible associative form for the Potato Park to register production of native seeds and their local, regional and national commercialisation	Still at the level of draft bill	Result 1: recognition and revaluing local innovations and TK which contribute to improvements in the sustainable use of agrobiodiversity (especially native seeds)
National Strategy on food and nutrition security (2013-2021)	Policy framework for national and regional food security (Specific Objectives 1.2 – revalues ancestral technologies and agricultural practices, transfer of technologies)	Food Security	Specific recognition of local practices and innovations aimed at conserving agrobiodiversity and generating local innovations that support improved productivity and agricultural sustainability	Recently adopted strategy; led by the Multisectoral Commission of Food Security (MINAGRI)	Result 1: recognition and revaluing local innovations and TK which contribute to improvements in the sustainable use of agrobiodiversity

Law/Policy	Summary**	Theme	(Potential) impacts of drivers of change in the Potato Park	State of implementation (national/regional)	Relation to the SIFOR project's Expected Results
Creation of the Regional Council on Food Security (Resolución Ejecutiva Regional 1087-2008-GR/ CUSCO/PR)	Aims to contribute to food security and reduce vulnerability and destruction	Food security	Possibility of influencing policy with a specific proposal from the Potato Park (and ANDES) related to Food Security	Initial work agenda established	Result 4: awareness raising among politicians, academics and opinion shapers
ABS and TK protection are regulated in Cusco (Ordenanza Regional 048-2008-CR/GRC)	A Regional commission for the Protection of TK, Biodiversity, and Living culgture of communities, regulating bioprospecting, PIC for activiteis related to genetic resources and TK; protection of TK	Protection of cultural and biological heritage of Cusco and its communities	Participation of the Potato Park (through ANDES) in the Commission; possibility for direct influence in special themes of interest for biocultural innovation: research, bioprospecting, access to TK, etc.	The Regional Administration on Natural Resources is the competent body to implement the Ordinance; the commission from Ordinances 048-2008 and 010-2007 were merged.	Result 1: recognition and revaluing local innovations and TK which contribute to sustainable use of agrobiodiversity and native crops Result 3: knowledge, capacity and strengthening of local agrobiodiversity Result 4: awareness raising among interest groups (scientists, politicians, etc) on the role of local markets in providing incentives to local agrobiodiversity
National Law for the promotion of organic production, (Law 29196, 2008)	Promotion of organic production orgánica	Native and organic seeds and crops	Recognition of the SGP asa mechanism for certifying native locally produced seeds from the Potato Park; possibility of implementing participatory guarantee systems (local seed certification)	The criteria have not yet been determined (by INIA) for the production of non-certified seeds in the case of native potatoes and other Andean crops	Result 2: Tools to promote local innovation and dissemination
Draft National Bill for the promotion of peasant markets (2009)	Promotion and support to different forms and levels of peasant markets	Promotion and revaluing local products	Innovations in the Potato Park at the level of seeds/native crops could be commercialised and disseminated through peasant markets	Recently at the draft bill stage	Result 3: knowledge, capacity and strengthening of local agrobiodiversity Result 4: awareness raising among interest groups (scientists, politicians, etc) on the role of local markets as incentive to agrobiodiversity conservation
National Regulations for General Seed Law (DS 006-2012-AG)	Promotion of seed production Production of seeds, including production of non-certified seeds of native crops	Native crops and seeds	Possibility of producing native seeds and commercialising them (in a non-certified way); in general, the informal exchange and commercialisation seed system continues to operate – now it can operate in a more 'legitimate' way from a formal point of view (in case the Potato Park wants to become a producer of native seeds	The criteria have not yet been determined (by INIA) for the production of non-certified seeds for native potatoes and other Andean crops	Result 2: tools to promote local innovation and dissemination
National Regulations for the Law for the promotion of organic production (DS 010-2012-AG)	Promotion of organic production (at the regional level on the part of Regional Gov); certification through participatory guarantee systems; creation of Regional Councils for Organic Production	Organic crops and seeds	Possibility of implementing participatory guarantee systems (local seed certification)	Regional Councils for Organic Products (or Consejos Regionales de Productos Organicos – COREPO) are being established (in Cusco it already exists); it has participatory guarantee systems in various provinces of Cusco	Result 2: tools to promote local innovation and dissemination

** Types of innovation

Technological

Institutional

Market

Annex 2. Overall trends in key indicators

Trends

Code 1	Code 2	Indicator	Unit	1984	2003	2008	2012	2014	Trend
LM1	1	Households income average per month	Soles	–	353,3	417,0	764,8	–	116%
LM2	1	Households with husband and wife dedicated to the agriculture activity	%	–	90.5%	88.9%	87.8%	–	-3%
LM3	1	Older people (over 60 years) working in agriculture	%	–	14.5%	10.6%	6.6%	–	-54%
LM3	2	Women working in agriculture	%	–	34.7%	33.1%	33.3%	–	-4%
LM4	1	Migrants in the total labor force	%	–	14.0%	9.4%	22.3%	–	60%
LM5	2	Women in the total number of migrants	%	–	16.7%	16.8%	9.2%	–	-45%
LM5	3	Households with men and women working in agriculture	%	–	90.5%	88.9%	87.8%	–	-3%
LM5	4	Households with only women working in agriculture	%	–	5.8%	7.3%	9.9%	–	73%
LM5	5	Households with only men working in agriculture	%	–	3.5%	3.7%	4.3%	–	22%
LM7	1	Total annual expenditures of households	Soles	–	18353,57	24569,64	34961,43	–	90%
LM7	2	Total annual expenditures of households per month	Soles	–	382,37	472,49	672,34	–	76%
LM8	1	Percentage of household expenditure by item. Food	%	–	34.3%	32.4%	32.2%	–	-6%
LM8	2	Percentage of household expenditure by item. Interpersonal Communication	%	–	2.2%	2.8%	2.6%	–	20%
LM8	3	Percentage of household expenditure by item. Education	%	–	21.9%	22.5%	26.3%	–	20%
LM8	4	Percentage of household expenditure by item. Health	%	–	13.9%	13.4%	11.8%	–	-15%
LM8	5	Percentage of household expenditure by item. Clothing	%	–	15.3%	16.90%	17.1%	–	12%
LM8	6	Percentage of household expenditure by item. Means of agricultural production (e.g. seeds, pesticides, chemical fertilizers)	%	–	3.7%	2.1%	2.0%	–	-46%
LM8	7	Percentage of household expenditure by item. Transport	%	–	5.1%	6.3%	2.6%	–	-49%
LM8	8	Percentage of household expenditure by item. Housing	%	–	3.7%	3.5%	4.6%	–	26%
FSAS1	1	Self-sufficiency/autoproduction of basic foodstuffs	%	–	74%	74%	74%	–	0%
FSAS1	2	Self-sufficiency of plants/vegetables	%	–	30%	30%	18%	–	-42%
FSAS1	3	Self-sufficiency of meat	%	–	34%	34%	30%	–	-11%
FSAS2	1	Productivity of potato	Kg/ha	–	1060,5	966,00	1073,0	–	1%
FSAS2	2	Productivity of tarwi	Kg/ha	–	293,7	294,3	458,4	–	56%
FSAS3	1	Size of land owned by households. Median rainfed lands	Hectares	–	0.53	0.45	0.45	–	-15%
FSAS3	2	Size of land owned by households. Median irrigated lands	Hectares	–	0.28	0.23	0.27	–	-4%
FSAS4	1	Total land owned	Hectares	–	66.94	70.09	78.96	–	18%
FSAS4	2	Total land rented to third persons	Hectares	–	0.6	0.0	1.03	–	72%
FSAS4	3	Total land leased third persons	Hectares	–	0.07	0.67	0.42	–	500%
ABSS2	1	Staple food crops varieties and landraces: Potato	Number	–	778	–	1345	–	73%
ABSS3	1	Cash food crops, varieties and landraces: Barley	Number	–	1	1	1	–	0%
ABSS3	2	Cash food crops, varieties and landraces: Oat	Number	–	1	–	1	–	0%
ABSS5	1	Average area planted with potato	Hectares	–	329	410	400	–	22%
ABSS5	2	Average area planted with barley	Hectares	–	40	41	10	–	-75%
ABSS5	3	Averagearea planted with tarwi	Hectares	–	16	16	16	–	0%
ABSS5	4	Average area planted with corn	Hectares	–	14	14	14	–	0%
SC1	1	Population speaking native language	%	100.0%	–	–	–	100.0%	0%
SC3	1	Members of the community participating in community events	%	99.3%	–	–	–	86.3%	-15%

Biocultural Heritage Innovations

Code 1	Code 2	Indicator	Unit	2014	2015	2016	2017	2018	Trend
BCI1	1	Market Innovation. Micro-finance or banking service	% households	6.09%	–	–	–	–	–
BCI1	2	Market Innovation. Distribution/sale of crops/products at national level	% households	5.22%	–	–	–	–	–
BCI1	3	Market Innovation. Distribution/sale at the international level	% households	6.09%	–	–	–	–	–
BCI1	4	Market Innovation. Use marketing strategies to sell products	% households	6.09%	–	–	–	–	–
BCI1	5	Market Innovation. Use of financial accounting principles	% households	6.09%	–	–	–	–	–
BCI1	6	Technological innovation. Free Exchanges of seeds	% households	5.22%	–	–	–	–	–
BCI1	7	Technological innovation. Drip irrigation of crops	% households	5.22%	–	–	–	–	–
BCI1	8	Technological innovation. Protection of crops in seed banks or preservation areas	% households	5.22%	–	–	–	–	–
BCI1	9	Technological innovation. Crop Practices	% households	2.61%	–	–	–	–	–
BCI1	10	Technological innovation. Identification of resistant cultivars	% households	3.48%	–	–	–	–	–
BCI1	11	Technological innovation. New tools/modified	% households	7.83%	–	–	–	–	–
BCI1	12	Institutional Innovation. Repatriation of traditional crops	% households	7.83%	–	–	–	–	–
BCI1	13	Institutional Innovation. Local group of crop experts	% households	9.57%	–	–	–	–	–
BCI1	14	Institutional Innovation. Improvement of crops in the community	% households	6.09%	–	–	–	–	–
BCI1	15	Institutional Innovation. Communal production of seeds	% households	6.09%	–	–	–	–	–
BCI1	16	Institutional Innovation. Organization in the community to assist with crop/harvest	% households	6.09%	–	–	–	–	–
BCI4	1	Importance of the new innovations in the welfare of the household: very important	% households	74.51	–	–	–	–	–
BCI4	2	Importance of the new innovations in the welfare of the household: important	% households	23,53	–	–	–	–	–
BCI4	3	Importance of the new innovations in the welfare of the household: somewhat important	% households	1.96	–	–	–	–	–
BCI4	4	Importance of the new innovations in the welfare of the household: no importance	% households	0,00	–	–	–	–	–
BCI4	5	Areas where innovations are necessary: Maximizing agricultural production	% households	20.28	–	–	–	–	–
BCI4	6	Areas where innovations are necessary: Economic Growth	% households	22.58	–	–	–	–	–
BCI4	7	Areas where innovations are necessary: Climate Changes	% households	19.82	–	–	–	–	–
BCI4	8	Areas where innovations are necessary: Marketing of products	% households	16.13	–	–	–	–	–
BCI4	9	Areas where innovations are necessary: Models of participation of the community	% households	16.13	–	–	–	–	–
BCI4	10	Areas where innovations are necessary: Integration with national and international economies	% households	2.76	–	–	–	–	–
BCI4	11	Areas where innovations are necessary: Reduction in the cost of living	% households	2.30	–	–	–	–	–
BCI4	12	Areas where innovations are necessary: Health	% households	0,0	–	–	–	–	–

Smallholder farmers living in harsh environments have developed strategies and technologies for resilience and adaptation to climatic changes that have enabled survival over millennia. These provide important resources for innovation in response to today's climatic challenges. This report explores such 'biocultural innovations', developed by the Potato Park – a community-managed landscape in Peru's high Andes. It also explores recent trends in climate, livelihoods, food security, crop diversity and social capital. Despite significant climatic challenges, the Potato Park has succeeded in increasing crop yields, doubling incomes and crop diversity and strengthening social capital since 2003.

IIED is a policy and action research organisation. We promote sustainable development to improve livelihoods and protect the environments on which these livelihoods are built. We specialise in linking local priorities to global challenges. IIED is based in London and works in Africa, Asia, Latin America, the Middle East and the Pacific, with some of the world's most vulnerable people. We work with them to strengthen their voice in the decision-making arenas that affect them — from village councils to international conventions.

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