

# **Biodiversity of andean grains: Balancing market potential and sustainable livelihoods**

**Edited by Alessandra Giuliani, Felix Hintermann, Wilfredo Rojas and Stefano Padulosi**



**Bern University  
of Applied  
Sciences**





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Stefano Padulosi**

**Bioversity International  
and the  
Bern University of Applied Sciences, School of Agricultural,  
Forest and Food Sciences (HAFL)**

*December 2012*

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Bioversity International is part of the Consultative Group on International Agricultural Research, which works to reduce hunger, poverty and environmental degradation in developing countries by generating and sharing relevant agricultural knowledge, technologies and policies. This research, focused on development, is conducted by a Consortium of 15 CGIAR centres working with hundreds of partners worldwide and supported by a multi-donor Fund.

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### **Citation**

Giuliani, A., F. Hintermann, W. Rojas and S. Padulosi, editors. 2012. Biodiversity of Andean grains: balancing market potential and sustainable livelihoods. Bioversity International, Rome, Italy

### **Cover**

Top photo: Women farmer from the Andean region (S. Padulosi/Bioversity);  
bottom photo: A quinoa field in Bolivia (S. Padulosi/Bioversity).

ISBN 978-92-9043-932-5

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## Foreword

Growing up in Lima, Peru in the sixties, I was occasionally offered quinoa for lunch, the small translucent grains as a creamy porridge with bits of farmer's cheese, or in soup. This was by no means common among households I knew, but my mother was a finicky and enlightened cook who believed in tasty and nutritious eating, particularly for children, always thought to be on the brink of malnourishment. She herself was not familiar with the grain but read about its nutritional virtues through the press. This was a time when quinoa was being rediscovered by nutritionists, who extolled its high protein content, said to be comparable only to meat!

A lot has changed since then. Today, quinoa is a favourite grain with foodies and health-conscious consumers in developed countries. The recent market success of the grain has also resulted in wholesale abandonment of traditional farming practices, more in keeping with fragile lands, with the consequence that the long-term sustainability of these productive systems is being compromised by short-term gains. This is a menace to the livelihoods of the quinoa farmers themselves. The situation is particularly serious in the southern Altiplano of Bolivia, the most important area for the production of quinoa for the international market. This market seems to prefer the larger quinoa grains found in only 5 of the 40 Quinoa Real types produced in this area, which thus remain underutilized and in danger of disappearing.

The present volume addresses Andean grains and in particular quinoa, looking at their current use from several angles and highlighting the trade-offs involved in changing from traditional to commercial agricultural systems. The book offers many helpful suggestions for policy-makers, including recommendations for investments in sustainable production technologies and use of incentives for the use and maintenance of these very nutritious and resilient crops.

Finally, this publication could not have come at a more convenient time as we celebrate the 2013 International Year of Quinoa. We sincerely hope it will contribute to raise awareness over needs, challenges and opportunities regarding the sustainable promotion of quinoa as well as other Andean grains and minor crops that albeit lesser known than major staples, may hold the future of the food and nutrition security of Humankind.

*Marleni Ramirez*  
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## Acknowledgements

We would like to thank Bioersivity International and the Bern University of Applied Sciences, School of Agricultural, Forest and Food Sciences (HAFL), who provided the resources for developing this publication. The editorial effort to put this work together is a joint endeavour of the two institutions.

We are very grateful to the International Fund for Agricultural Development (IFAD) who has generously supported the IFAD NUS Project in its two phases (2001-2005 and 2007-2010) and thereby enabled the successful implementation of several of the investigations reported in this document. A third phase geared more towards on farm conservation is also currently being supported by IFAD, the CGIAR Research Programme on Climate Change, Agriculture and Food Security (CCAFS). Similarly we would like to acknowledge the contribution of the Congressional Hunger Center for sponsoring the research carried out in Uyuni, Bolivia, under the framework of their Mickey Leland International Hunger Fellows Program.

We would also like to acknowledge the support of the CGIAR Research Programme on Policies, Institutions and Markets.

Our appreciation also goes to the Bolivian System of Agricultural Technology (SIBTA) who contributed with various research works through the project SINARGEAA – Andean Grains and to the project ‘Sustainable production of quinoa a neglected crop of the Andes’ supported by McNight Foundation.

We would like to thank all the authors who have contributed to this publication for their effort in putting together this work, highlighting the relevance of Andean grains and quinoa in particular to the livelihoods of millions of people living in the Andean region. A special recognition is made of Fundación Promoción e Investigación de Productos Andinos –PROINPA in Bolivia, for their invaluable contribution in support of the promotion of indigenous crops and in particular Andean grains, work that they pursue with a unique commitment and a much respected participatory approach.

We are grateful to Karen Amaya for helping with the translation of Spanish texts into English. Our thanks go to Thor Lawrence for final language editing and preparation of the report for publication with the overall assistance of Nadia Bergamini, and to Patrizia Tazza for graphic design and layout.

## About this publication

In the last decade, more attention has been given to the cultivation and commercialization of underutilized species, and numerous—but scattered—programmes, projects and research in many countries have shed light on these species and their potential. Nevertheless, there are still major gaps in our knowledge about underutilized species and their ecology. Large-scale evidence in the nutrition and health spheres, such as nutritional data and impact on malnutrition and health, is still needed. The capacity to conserve these species and improve their yield and quality is limited. Little has been done to identify the most effective means of commercialization or the best marketing and policy frameworks to enable the promotion of their use and maximize their economic value. Until now, the market potential of underutilized species has seldom been converted into broader approaches to value-chain development, addressing both biodiversity conservation and pro-poor growth. This is mainly due to a lack of knowledge of the potential uses, and hence value, of these plants for all the market chain actors, not only as food and feed, but also for other uses, including processed products and the utilization of by-products. Although it is common understanding that underutilized species could contribute to pro-poor growth, it will be a major challenge to build the structures and develop the capacities necessary to enable resource-poor farmers to better integrate into value chains. In general, the constraints and potential solutions are known, but a widely agreed strategy for achieving sustainable links between small-scale farmers and high-value agricultural product markets remains elusive.

This publication aims at shedding light on the use, nutritional properties, market potential and contribution to local livelihoods of Andean grains (quinoa, cañahua and amaranth). It addresses some of the research gaps regarding knowledge of the use, as well as the market and non-market values of quinoa, cañahua and amaranth, and the associated traditional knowledge, taking into account local livelihood assets of people living in a difficult environment. It also investigates what effects the change from subsistence to market production has on the farming community and their environment. This publication looks in particular at quinoa in Southern Bolivia, where this indigenous crop has great potential to contribute to local livelihoods.

Chapter 1 is an introduction by Alessandra Giuliani to examine definitions and characteristics of the so-called ‘underutilized plant species’, as part of a broader view of biodiversity, and their contribution to improving livelihoods in the context of the current challenges, including food security and nutrition, climate change and income generation opportunities in an increasingly globalized world. An overview is presented of the state of the art for projects and studies on Andean grains worldwide.

Chapter 2 focuses on a study on the real value and potential of biodiversity of the Andean grains (quinoa, cañahua and amaranth) in Bolivia, carried out, through a consultancy work, by José Luis Soto Mendizábal and Enrique Carrasco Gutiérrez. The study was conducted as part of the ‘Strengthening of income opportunities and nutritional security of the rural poor through the use and marketing of crops

that are underused or in oblivion' project implemented by Bioversity International and PROINPA as main partner in Bolivia, with funding from the International Fund for Agricultural Development (IFAD), herewith referred to as the IFAD NUS Project, in addition to other projects executed by PROINPA, including 'SINARGEAA - Andean Grains' funded by the Bolivian System of Agricultural Technology (SIBTA) and 'Sustainable production of quinoa, a neglected crop of the Andes' supported by the McKnight Foundation. The purpose of the study reported here is the illustration through reliable technical, social and economic data of the great importance of the Andean grains, in particular in Bolivia, as a means to improve both income and welfare of native farming communities, together with other individuals involved in the commercial chain of production, mainly transformation and consumption.

Chapter 3 reports the outcome of a study carried out by Damiana Astudillo while she was a research fellow of the Mickey Leland International Hunger Fellows Program. The study focused on quinoa in the Salinas and Colcha K Municipalities of southern Bolivia. Rather than focusing on the economic potential of crops, it analyzes the effects that the transition from subsistence farming to cash cropping has on the livelihoods of the farmers. The work focuses on a livelihood approach, and is based on a comprehensive household survey that provided detailed information on knowledge and use of quinoa diversity in southern Bolivia. The research points out that promotion of markets alone does not substantially improve the situation of poor farmers unless there are accompanying measures to expand markets,

Chapter 4 is a report prepared by Genaro Aroni, Milton Pinto and Wilfredo Rojas for the PROINPA Foundation (Promotion and Research of Andean Products) which provides an example of small-scale processing technology for quinoa, with a big potential to facilitate saponin removal and thereby to eliminate an important constraint to use of quinoa for home consumption. Traditionally, this process is done manually, with a laborious and time-consuming process. This example describes the introduction of quinoa micro-processing units to increase consumption in five communities of the Bolivia Southern Altiplano, as one activity in the frame of the IFAD-NUS Project. A survey to determine the usefulness of the quinoa micro-processing unit was carried out with families from three communities. The results are quite encouraging and it is expected that there are other sources of funding that could provide quinoa micro-processing units in other communities in the Southern Altiplano.

Chapter 5 is an overview given by Matthias Jaeger of the difficulties faced by the small-scale farmers and poor actors in the market chain in the Andes in identifying market opportunities for new products derived from Andean grains. Growing, harvesting, processing and marketing these products requires good management skills and co-ordination to sell products to markets, access processing facilities and obtain good quality labour inputs. Small-scale farmers have limited access to capital, education, market information and marketing institutions, and are at a relative disadvantage compared with large-scale commercial farmers. Many constraints hamper the ability of small-scale farmers to participate in high-value markets, an opportunity that now arises for Andean

Grain products. These barriers are being addressed by value-chain-oriented research, looking at the importance of re-governing markets to improve efficiency and small-scale farmer accessibility. The chapter here looks in particular at the establishment of collaborative, multi-disciplinary platforms with stakeholders involved in the value chain, and the benefits for the small-scale farmers. Examples of recently implemented platforms in the Andes are reported.

In Chapter 6, the editors highlight the most important conclusions and recommendations from the two studies. Quinoa, cañahua, and amaranth are traditional Andean crops of high nutritional value and suitable for many dietary and medical uses. In view of the growing demand in Europe and North America for organic, healthy and traditional products, these Andean crops have a large market potential that can contribute to the livelihoods of the small-scale farmers in the Andes. However, production increase, particularly in the Southern Altiplano of Bolivia, is often made without crop rotation, following very unsustainable production systems. The impact of these practices on the fragile soils of the Andean region needs to be assessed and more sustainable practices should be implemented to avoid negative repercussions both now and in the future on the local agro-ecosystems. More sustainable cultivation practices are hence needed. Moreover, in the poor areas of the Andean Region, the case study in southern Bolivia shows that the mere increase of production of quinoa for the market (market expansion) might not necessarily improve the livelihoods of the farmers if not coupled with activities for developing partnerships, focusing on nutrition and basic services for isolated communities. However, there is still very limited knowledge about the agro-ecological and social basis of quinoa sustainability in the southern altiplano of Bolivia, where recently, national and international research programmes have begun to investigate the complex issues of agricultural sustainability in this region.

We sincerely hope that this publication will provide some food for thoughts at the occasion of the UN 2013 International Year of Quinoa declared by the UN General Assembly (<http://aiq2013.org/en/>), and serve as guidance for the future promotion of other crops-currently underutilized-, in ways that they will be maintained through a sustainable production and use for the benefit of current and future generations.

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# 1. Biodiversity and underutilized species in the context of global challenges

*Alessandra Giuliani*

*Photograph courtesy of S. Padulosi*



## **Underutilized plant species as part of a large biodiversity portfolio**

### **The significance of agrobiodiversity**

The Convention on Biological Diversity (CBD) defines biological diversity—biodiversity in short—as the diversity of life in all its forms, including the diversity within species, among species and of ecosystems (CBD 2000). A vital subset of biodiversity is represented by agricultural biodiversity, also known as agrobiodiversity, or the genetic resources for food and agriculture. Agrobiodiversity is the result of the interaction between the environment, genetic resources and management systems, and practices used by culturally diverse peoples, with land and water resources therefore used for production in different ways. Thus, agrobiodiversity encompasses the diversity of animals, plants and micro-organisms that are necessary for sustaining key functions of the agro-ecosystem (FAO 1999a) and survive according to local management and environmental conditions (Vandermeer and Perfecto 1995). Local knowledge and culture can therefore be considered as integral parts of agrobiodiversity, because it is human activity that shapes and conserves this biodiversity. Hence, conservation of agrobiodiversity in production systems is linked to its sustainable use (FAO 2005). While agriculture is based on the domestication and use of crop and livestock species, the continuum between (wild) biodiversity and agrobiodiversity has been recognized for many decades both in research on plant genetic resources and in conservation efforts, starting with the hypothesis of “centres of diversity” of crop species proposed by Vavilov in the 1920s. Crop diversity within species is as important as diversity between species.

Agrobiodiversity is considered to contribute substantially to poverty reduction through the provision of food security, health improvement, income generation and vulnerability reduction (Koziell and McNeill 2003; Roe and Elliot, 2004; FAO 2005). According to Smale and Bellon (1999), the value of genetic diversity reflects on the overall country welfare rather than on specific individuals. This represents a public value for future generations in case of potential disasters and unforeseen events. For many poor people, crop diversity is a necessity for survival rather than a choice, particularly in times of climate change and food crisis. In addition, together with the food insecurity dimension, nutrition issues, such as hidden hunger derived from micronutrient deficiencies, and diseases of ‘affluence’ (obesity, cardiovascular and degenerative diseases), represent an enormous challenge for the future. Attempts to reverse this trend have resulted in re-iterated calls for food-based approaches. The deployment of agrobiodiversity is an approach that entails a greater use of local biodiversity to ensure dietary diversity and good nutrition (Frison et al. 2006). Good nutrition, as a major component of health, has much to contribute to poverty reduction and improved livelihoods (WHO 1999; McIntyre et al. 2009).

Since the beginning of the last century, some 75% of plant genetic diversity has been abandoned as farmers worldwide have left their countless local varieties and landraces for genetically uniform, high-yielding varieties. Today,

only three crops—rice, maize and wheat—contribute nearly 60% of calories obtained by humans from plants (FAO 1999b). There are various causes for this decline: (1) rapid expansion of industrial and Green Revolution agriculture; (2) food system and marketing globalization; and (3) augmented demand on limited production resources leading to degradation of natural resources (FAO 1996, 2005; MEA 2005; McIntyre et al. 2009). Through these processes, the new varieties introduced have enhanced agricultural productivity, at the expense of the maintenance of traditional species. In response, genebanks and seed banks (*ex situ* conservation) have been created to conserve plant diversity for future crop development, and to conserve crop diversity that otherwise might have disappeared from agricultural systems (McIntyre et al. 2009). In recent years, conservation policies have shifted to a more holistic approach to agrobiodiversity use, management and conservation, including both *ex situ* and conservation of crops and seeds on-farm or in the community (*in situ*). Future global food security is tightly linked to improved productivity and suitable management and use of crop plant agrobiodiversity (Lenné and Wood 2011).

### **Underutilized plant species**

While modern crop production primarily involves only hundreds of the many thousands of food plants known globally (Prescott-Allen and Prescott-Allen 1990), ethno-botanic surveys indicate that thousands of underutilized species are still collected or cultivated. These ‘non-commodity’ crops are part of a whole biodiversity portfolio. They were once more popular, and today are neglected by user groups, for a variety of agronomic, genetic, economic, social and cultural factors (Padulosi 1999; Padulosi et al. 2002). Agrobiodiversity is closely linked to cultural diversity. Farmers and communities may prefer particular species or varieties for use in religious events, in socially-defined roles, or for particular health properties (Frison et al. 2006). In particular, underutilized species hold a vast heritage of indigenous knowledge associated with their management and use (Eyzaguirre et al. 1999), while scientific knowledge is emerging, but limited. Traditional knowledge covers various aspects from cultivation and collection practices, plant properties (in particular for functional plants), post-harvest and processing, their multiple uses, and cooking recipes. The role of gender is also of great importance in managing and conserving agrobiodiversity, in particular of underutilized species. Women are often concerned with how multiple plant use can add to household income, (Eyzaguirre 2006). They manage home gardens, often used as a refuge for underutilized plant species (Eyzaguirre and Linares 2004). Women also make extensive use of wild patches and marginal areas within farm communities, where they harvest wild plants to use as medicine, condiment and nutritional food (Howard 2003).

Jaenicke and Hoeschle-Zeledon (2006) indicate that it is difficult to define the term ‘underutilized plant species’. Terms such as ‘underutilized’, ‘neglected’, ‘orphan’, ‘minor’, ‘promising’, ‘niche’ and ‘traditional’ are often used interchangeably to characterize the range of those plant species with under-exploited potential for contributing to food security, health (nutritional or medicinal), income generation and environmental services. Padulosi et al. (2008) define the underutilized species

as mainly local and traditional crops (with their ecotypes and landraces), or wild species whose distribution, biology, cultivation and uses are poorly documented. The underutilized species are plants that are not widespread mainstream crops, but which have at least significant local importance (Crops for the Future 2008). The range of these species is wide, including plants that provide edible fruits, grains, leaves, nuts, oils, roots and tubers, fibres, medicines, spices, stimulants and other products. Though they may be highly nutritious, or have medicinal properties, they are ignored by researchers, extension services, farmers, policy- and decision-makers, donors, technology providers and consumers.

Multiple-use also characterizes these species, as well as the use of various parts of the plant. For example, the Gruni tribe in Ghana use the baobab (*Adansonia digitata*) leaves as vegetables make a pulp from dried fruit to mix into other food, and pound the seeds for porridge (Jaenicke et al. 2009). From an economic point of view, a workable definition of underutilized species has been developed as species characterized by the fact that they are locally abundant, but globally rare, and that their current use is limited to their economic potential (Gruère et al. 2009). According to Rojas et al. (2009) 'the best way of sharing the common understanding of what underutilized plant species are is to indicate those traits that make these species distinct from other crops'. Table 1.1 lists some of the common characteristics of these species.

**Table 1.1.** Common features of the underutilized plant species

- 
- represented by wild species, ecotypes and landraces
  - highly adapted to agro-ecological niches and marginal areas
  - collected from the wild or produced in traditional production systems with little or no external inputs
  - characterized by fragile or non-existent seed supply systems
  - cultivated and utilized drawing on traditional knowledge (TK)
  - strongly linked to the cultural heritage of their places of origin
  - important in local consumption and production systems
  - poor value addition and marketing
  - ignored by policy-makers and excluded from R&D agendas
  - very weakly represented in *ex situ* gene banks
- 

Source: Adapted from Padulosi, Hoeschle-Zeledon and Bordon, 2008, and Jaenicke and Hoeschle-Zeledon, 2006

Increased public awareness about underutilized species was prompted by the Convention on Biological Diversity (1992) and the Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture (FAO 1996). The Consultative Group on International Agricultural Research (CGIAR) has also expanded its research agenda to include underutilized

species (CGIAR 2004). Bioversity International (former the International Plant Genetic Resources Institute, IPGRI), the world's largest international organization dedicated to the use and conservation of agricultural biodiversity to improve the lives of people, has developed a conceptual framework for the promotion of the so called 'neglected and underutilized species – NUS' by building on the results of more than ten years of work carried out around the world on these species (IPGRI 2002). As a result, a number of projects, national and international level collaborations and focused conferences to support NUS have been launched, contributing to highlight and lobby for needed consideration of these minor crops (Rojas et al. 2009). The Global Facilitation Unit for Underutilized Crops (GFU), now part of Crops for the Future ([www.cropsforthefuture.org](http://www.cropsforthefuture.org)), an international organization dedicated to neglected and underutilized crops, launched in November 2008, has a database with the distribution and use of nearly 400 plant species (currently at [www.underutilized-species.org](http://www.underutilized-species.org), but due to move to the Crops for the Future Web site).

### **The role of underutilized species in the context of global challenges**

Recent studies have revealed the importance of underutilized species in the livelihoods of the poor (Naylor et al. 2004). Underutilized species play a significant role in food security systems; plants that grow in infertile or eroded soils—as well as livestock that eat degraded vegetation—are often crucial to household nutritional strategies. These species usually require reduced inputs and are resistant to disease, while also providing nutritional diversity. This is especially important in regions where increasing dependency on purchased cereal staples such as maize can lead to vitamin-deficiency diseases (Blench 1997). Lack of economic alternatives for poor populations, increased human pressure on natural resources, and climate change, also provide motivation for a stronger role for marginally-used species in improving rural livelihoods and reducing environmental degradation (Hughes 2009).

### **Food insecurity and malnutrition**

Underutilized species represent an enormous wealth of agrobiodiversity and have great potential for contributing to improved food security and nutrition, and for combating the 'hidden hunger' caused by micronutrient (and mineral) deficiencies. Indigenous/traditional species and varieties offer nutritional advantages (Johns and Eyzaguirre 2007). This is relevant particularly for those areas where people are marginalized by poor access to natural and financial resources. Some species are gathered as a source of food or cash, especially during "lean" periods in the agricultural cycle. Others supply diversity, essential nutrients, vitamins or minerals in diets that would otherwise consist primarily of carbohydrates (Johns 2004; Johns and Sthapit 2004). To cite some examples, palm fruits from Brazil are rich in beta-carotene. The bitter gourd and fenugreek grown in India contain compounds that can improve the body's ability to respond to insulin. Research in Africa has shown that minor crops often play a major role in household nutrition, including cereal grain crops such as fonio (*Digitaria exilis*), pulses, and oils seeds such as



bambara groundnut (*Vigna subterranean*) (Heller et al. 1997), leafy vegetables (Chweya and Eyzaguirre 1999) and other plants containing carotenoids such as lycopene and lutein are also well recognized and tropical fruits, such as African plums (*Dacryodes edulis*), or the dika or bush mango (*Irvingia gabonensis*) (Johns 2007). There are numerous edible roots and tubers in the tropical humid forests and woodlands. Forest yams, for example, are consumed in Africa, Australia and Asia (Vinceti et al. 2008.). Studies reported in Schippers and Budd (1997) indicated, for example, that in south-west Cameroon, indigenous potherbs constitute up to 50% of a household's vegetable intake. Some underutilized species provide an essential nutritional safety net, particularly during periods of food crop failure and times of unrest.

At the same time, loss of native plant species is having negative consequences for the whole of society, both directly, as lost opportunities in use of local resources, or indirectly, by narrowing down the natural and cultural heritage. For example, in Ethiopia, neglect of local knowledge is believed to be one of the less visible root causes of food insecurity, exacerbated by drought and abnormal floods in the country, where high quality food plant species are underutilized and mismanaged (Woube 2009). In many countries, socioeconomic changes and migration, accompanied by an increasing erosion of traditional knowledge, may result in a decrease in the demand for diversity of native plant species (Bellon 2004) and their derived products.

### **Marginal areas and climate change stresses**

Minor crops are strongly associated with marginal environments, where 'difficult' areas characterized by extreme heat, poor soils, unreliable rainfall, hilly topography, degraded vegetation and access problems make the large-scale production of world crops and livestock uneconomic (Blench 1997). Most of these minor species are still selected, adapted and multiplied by farmers in marginal environments (Horna et al. 2007). A high proportion of the poor in developing countries live in such marginal areas, and underutilized species are often the only ones capable of coping with these conditions. Hence, the underutilized species have the potential to contribute not merely to agricultural biodiversity, but most importantly also to the livelihood of the poor. Underutilized species are often used as a risk buffer in the face of climate challenges. Examples include:

- In the flood-affected regions in Bangladesh, Haq and Nawaz (2009) report that floating gardens are created to grow a mix of traditional saline-tolerant vegetables: bitter melon, red amaranth and kohlrabi. These gardens are an important source of food during floods.
- Minor millets have a wide genetic adaptation and are able to grow in diverse soils, in marginal arid and mountainous lands where major cereals have poor success. The 2009 study of Padulosi et al. shows the potential of minor millets in India to grow with low inputs while resisting severe edapho-climatic stresses, thus being the best candidates to replace crops like wheat and rice in areas where these may gradually become less competitive due to climate change.
- Vakeesan et al. (2008) state that saline lands in Sri Lanka are brought back into production using green manure obtained from underutilized species grown *in*

*situ* (such as sunn hemp and green gram).

- In northern Ghana, from January to June, when the availability of staple crops is limited due to floods and droughts, the local communities fight hunger, based around the baobab tree (*Adansonia digitata*) (Jaenicke and Pasiecznik 2009).

### **Household income instability and vulnerability in developing countries**

In spite of their being labelled as ‘foods of last resort’, underutilized food crops are now receiving wider attention from researchers, farmers and consumers in developing countries, for both their nutritional and market values. Underutilized species can also help poor farmers spread risk and diversify their output when faced with fluctuations in major cash crops (Blench 1997).

Pilot studies carried out on underutilized species in Syria (Giuliani 2007) illustrate that the annual household income share generated by activities related to some underutilized species adaptable to semi-arid environment varies between 10 and 23%: an important contribution to the livelihoods of the rural communities engaged in these activities. The marketing development of African garden eggs demonstrated a way to increase social welfare by generating income for the local producers and chain actors in Ghana, and by promoting the sustained use and conservation of agricultural biodiversity (Horna et al. 2007).

The karaya tree (*Sterculia urens*) is found in tropical dry deciduous forests in India. It needs very little water, and will grow on the poorest of stony soils. The karaya tree yields a valuable gum, and tapping these trees is a major livelihood activity for tribal communities in central India. A project was started in 2008 to try to ensure the sustainability of production (Gandhe and Dolke 2009).

However, in many cases, the potential value of underutilized species for the livelihoods of farming communities remains underexploited. This also contributes to a loss of species diversity, with consequent erosion, and thus restricting options that might benefit future generations in the locations and urban consumers elsewhere, who would be willing to pay for these products.

### **Market access and market globalization**

Changes in the global agricultural economy are providing farmers with new challenges and opportunities. Due to increased purchasing power, the demand for higher value and processed food products, as opposed to commodities, has grown worldwide (Gehlhar and Regmi 2005). Despite growing market opportunities, there is a danger that small-scale farmers, in particular the poorest, will be left out, even though they possess competitive advantages over larger producers, for example in accessing family labour and intensive local knowledge (Poulton et al. 2005).

The markets for underutilized varieties and species are gaining policy attention as a potential source of livelihood, and a means to conserve biodiversity. Nevertheless, the growing debate on enhancing farmer access to markets tends to neglect underutilized plant products. Given the private and public value that underutilized plant species have, market access for the products derived from these species provides an opportunity both to reduce poverty and to contribute

to *in situ* conservation. However, it is important to keep in mind that in addition to multiple market imperfections and the challenges of entering existing domestic and international markets, there are often no opportunities for producers to market their particular products. In the case of underutilized species, this is due to the lack of demand for the specific products derived from these species (Markelova et al. 2009).

Underutilized species have untapped market potential for several reasons. In terms of market access, unlike commodities and high value products, producers of underutilized products and those engaged in value-adding activities, such as processors, often face significant transaction costs<sup>1</sup>. They face additional challenges in the form of poorly-defined markets and weak demand precisely because their products are less well known (Hellin and Hignman 2009). Some species, such as perishable minor fresh fruits and vegetables, require careful storage and handling and rapid transport to markets, or some level of primary processing close to the collection area, otherwise they cannot be sold on the market (Giuliani 2007). Many underutilized products are also often produced in small volumes and are dispersed over wide areas, making it difficult to meet buyer requirements for quality, quantity and consistency of production. Local processing may contribute positively to market access. This is particularly the case in remote markets and for underutilized species. Local processing provides diverse employment opportunities and creates additional income for local people. It can encourage local development for small local enterprises offering employment and training (Reiner 2009). For example, studies in Peru have demonstrated that product development and diversification played a key role in the expansion of maca (*Lepidium meyenii*), and that maca production has triggered the development of a number of small-scale businesses related to its processing and commercialization (Hermann and Bernet 2009).

A number of case studies show the advantages of collective action<sup>2</sup> for small-scale farmer marketing of staples, but in particular for high-value and underutilized crops (Markelova et al. 2009). Indeed, accessing markets with specialised products, such as those derived from local underutilized species, often demands new skills for farmers and outside agents in order to develop the market for their products. This is the reason why producers of underutilized species face particularly high transaction costs in terms of market access (Markelova et al. 2009). Examples, such as the one of market development for minor millets in the Kolli Hills of Tamil Nadu, show that collective action initiatives play an essential role in market development for underutilized crops (Gruère et al. 2009; Padulosi et al. 2009). Collective action, leading to a reduction in transaction costs, may be the most effective way of making 'conservation and commercialization' work.

Indeed, to reach wider markets, small-scale farmers need to aggregate their produce and make it more attractive, changing the image of these products that

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1. Transaction costs arise as a result of the movement of goods through the value chain, classified into information, negotiation, and monitoring or enforcement costs. Sources: Hobbs, 1997; Pingali, Khwaja and Meijer, 2007).

2. Collective action is defined as the coordinated behaviour and set of voluntary actions undertaken by a group of individuals to achieve shared interests. Sources: Vermillion, 2001; Meinzen-Dick, Di Gregorio and McCarthy, 2004.

are too often considered the ‘food of the poor’. Public awareness campaigns, which underline the nutritional, taste and traditional values of products, can help change this poor image. To this end, some assistance is needed (Meinzen-Dick and Eyzaguirre 2009). To cite an example, in the Kolli Hills, India, the M.S. Swaminathan Research Foundation has supported local farmers to increase markets for minor millets (beside that of white rice) by developing new recipes and diversifying the products (Gruère et al. 2009). The Papa Andina programme (Devaux et al. 2006) has helped small-scale farmer farmers of native potatoes in the Andes to develop value-added products to be sold on the urban niche markets. The programme has promoted Andean products among urban consumers through packaging and advertising the diverse local potato varieties. These collective plans can even be translated into product norms, such as the application of origin-certifying labels, such as geographical indication and designation of origin, thus gaining legal recognition for the particular traits of local production (Meinzen-Dick and Eyzaguirre 2009) and strengthening relations between producers and consumers (Van de Kop et al. 2006).

## **Andean grains: state of the art**

The Andean region falls into three broad ecosystems: the ‘Green’ Andes stretching from northern Ecuador through Colombia and Venezuela; the ‘Yellow’ Andes of central Peru and eastern Bolivia; and the ‘high climatic risk’ Andes of southern Peru and the Bolivian Altiplano (highlands). Altitudes vary from sea level to over 4500 m and local peoples’ livelihoods, especially in the ‘high climatic risk’ Andes, are threatened by harmful abiotic adverse factors that affect crop production, such as drought, frost, soil salinity, hail, snow, wind, flooding and heat, all within a single growing season (Jacobsen et al. 2003; Hellin and Hignan 2005; Hariadi et al. 2011). Since Spanish Colonization, livelihood security in the highland areas has been further undermined by discrimination against the indigenous Aymara and Quechua communities (Hellin and Hignan 2005). Despite the poverty of the rural Andes, indigenous groups have survived for thousands of years. Much of indigenous people’s livelihood security has been based on the consumption of a range of tubers, principally potatoes, and a mix of different grains, including quinoa (Dandier and Sage 1985; NRC 1989). Farmers have adapted and selected different varieties of these crops in order to reduce their vulnerability to a range of environmental risks.

Andean grains are a typical example of underutilized plant species. The most common grains are: quinoa (*Chenopodium quinoa*), cañahua or kañiwa (*Chenopodium pallidicaule*), amaranth (*Amaranthus caudatus*) and lupin [*tarwi*] (*Lupinus mutabilis*). These are strategic crops for the livelihood of millions of people in the Andes (NRC 1989; Holle 1991; Jacobsen et al. 2003; Jacobsen 2011). Their valuable nutritional content, their adaptability to harsh environments, their diversity of uses, and the food culture and traditions associated with these grains, are at the basis of their extensive use in the Andes over centuries (Jaeger et al. 2009). Nevertheless, the role of these species as a staple food has dramatically decreased since the 1970s, and by the early 1980s grains like quinoa were in danger of disappearing. For example, in the 1960s, quinoa and another

indigenous crop, cañahua, were both among Peru's ten most important crops, but by 1996 quinoa had dropped to thirtieth place (Tripp 1982). This decline has its roots reaching back to the Spanish conquest in the sixteenth century; traditional crops such as quinoa were deliberately repressed and replaced with European species such as wheat, barley and broad beans (NRC 1989), a culinary colonialism that continues to a large extent today. The relegation of native foods to 'food of the poor' was indicative of a more profound discrimination against the indigenous population, a discrimination that continued after independence and remains widespread today. As populations of the Andean countries become increasingly urbanized, the urban poor have tended to move away from consuming quinoa, and instead purchase products that are easier to prepare and are of a more consistent quality, though less nutritious, such as pasta and rice. The preference for pasta and other wheat products has extended to rural areas. One of the incentives is that these products are cheaper than domestically produced quinoa. Traditional crops such as quinoa are unable to compete against subsidized foods. For instance, at 1999 prices, a Bolivian farmer who sold 1 kg of unprocessed quinoa could buy about 1.8 kg of pasta ready to cook (Hellin and Higman 2005). Moreover, lack of improved varieties, lack of enhanced cultivation practices, drudgery in processing and value addition, disorganized or non-existent market chains all helped this process (Querol 1988; Tapia 1992).

The reduced use of Andean grains has been accompanied by the loss of their genetic diversity, with important, albeit less obvious, repercussions for the livelihoods of Andean communities. The sustainability and resilience of local agricultural systems declined, opportunities for improving food and nutrition security were missed, and local cultural traditions disappeared: a combination that reduced self esteem and cultural identity of the people (Bressani 1993; Kraljevic 2006). The case of Andean grains is representative of the limits of the Green Revolution approach, which concentrated its efforts on global commodity crops, missing out hundreds of other valuable species of regional or local importance and of great value to people's livelihoods (Padulosi et al. 2008).

However, in the recent years, quinoa and other Andean grains have attracted renewed interest thanks to their high nutritional value. In particular, quinoa has recently been used as a novel functional food because of all its properties (Abugoch 2009). Andean grains, in particular quinoa, have been recognized as a complete food as it has higher protein content and a better balanced protein composition than cereals (Lambert and Yarwood 1992; Galwey 2003). They have remarkable nutritional properties, not only from their protein content but also from their excellent amino acid balance. They are an important source of minerals and vitamins, particularly for high iron content (Repo-Carrasco et al. 2001). On the basis of their nutritional values, amaranth and quinoa have been used as important ingredients, primarily in bread, pasta and baby's food (Yawadio Nsimba et al. 2008). Quinoa contains various bitter-tasting saponins that represent an important antinutritional factor (Kuljanabagavad and Wink 2009). Triterpene saponins have been found in all parts of the quinoa plant, including leaves, flowers, fruits, seeds and seed coats (Cuadrado et al. 1995; Kuljanabagavad et al. 2008; Mastebroek et al. 2000; Mizui et al. 1988, 1990). It requires aqueous

extraction prior to consumption (Ma et al. 1989). Saponin is a quinoa sub-product of recent interest for the production of detergents.

Andean grains tolerate drought, frost and salinity, and have the ability to grow on marginal soils (Bhargava et al. 2006). There is great genetic diversity in quinoa and the Andean crops, with differences in form, colour and size, as well as in quality and quantity of primary elements (starches, proteins, sugars, fatty acids, minerals, vitamins, glucosides) and secondary metabolites (saponins, alkaloids, tannins, oxalates, carotenes, anthocyanins, betalains) (Jacobsen et al. 2003). Hence, there are potential specific uses associated with different varieties. All the above results fostered an increased demand of Andean grains, in particular quinoa, for export to Europe, leading to booming cultivation, particularly in Bolivia and Peru. The increased production is not necessarily sustainable, as it too often ignores crop rotation, and the market opportunity does not necessarily improve the long-term livelihoods of the poor farmers.

According to Soto et al. (2006), the demand for quinoa in national, and particularly international, markets continues to increase. More than half of the Bolivian farmers consider quinoa a “good business” because good prices can be obtained on the market. More than 80% of the farmers regard quinoa as “important” in their family diet.

Today, quinoa cannot be called a truly underutilized crop in view of the export boom. It has to be considered anyway underutilized with regard to its overall genetic diversity because only few varieties (of the quinoa real type) are being widely commercialized for export, whereas hundreds of other less popular varieties, whose grain size or color do not meet the preferences of the market, are marginalized and abandoned by the farmers. This narrowing down of the portfolio of quinoa diversity makes production systems more vulnerable to biotic and abiotic stresses as well as reduces the nutritional opportunities linked to quinoa intraspecific diversity. Greater diversity of quinoa is also relevant to safeguard centuries-old food culture that celebrates quinoa through diverse dishes made with local varieties now under threat.

There are some evidence that the growing quinoa export market is causing threats to the traditional management of lands, in particular in the Bolivian Southern Altiplano, such as soil erosion, increased pest harms, diminishing use of animal manures, because of the intensive cultivation and increased mechanization. These threats are exacerbated by climate change with negative consequences on the indigenous communities in the highlands (Jacobsen 2011).

The current increasing production of quinoa in the Bolivian Southern Altiplano raises reasonable concerns about social and environmental sustainability issues in this area. However, there is still a limited knowledge about the agro-ecological and social basis of quinoa sustainability in this region, currently being addressed by recent research programmes that investigate on this complex issue. (Winkel 2008; Winkel et al. 2012).

### **Current and recent projects and efforts to re-value the Andean grains**

Several national and international projects and collaborative research frameworks have been developed to contribute to revitalizing these minor crops. One

important project aiming at demonstrating the value of underutilized species and the development of best practices for their increased use has been the IFAD NUS Project. The project was launched in 2001, funded by the International Fund for Agricultural Development (IFAD) and coordinated by Bioversity International, involving a pool of national research and development centres (Jaeger et al. 2009). The IFAD NUS Project framework was developed through a series of multi-stakeholder workshops held in 2000 in Bolivia, Peru, Ecuador, India, Nepal, Yemen and Egypt. The Project's first phase was concluded in 2005. Based on the outcome of an independent evaluation, a second 3-year phase was granted and successfully implemented from 2007 to 2010 (Padulosi 2007). The project results have proven that Andean grains can indeed provide lucrative income opportunities for the local populations. However, a more holistic and multi-disciplinary approach to develop their promotion is needed. More information about the IFAD NUS project is reported in Chapter 2. A third IFAD phase is also currently being implemented in Bolivia (Padulosi et al. 2012).

At the International Potato Center (CIP) in Peru, under the umbrella of the 'Quinoa Project', funded by the Danish International Development Assistance (Danida), a wide range of studies have been carried out aiming at developing new uses of quinoa and its products, and improving market development. The main goal of the project is the sustainable production of quinoa, to help overcome malnutrition and increase food security and farmer incomes. The principal beneficiaries of the work are the small-scale farmers in the Andes, small enterprises, and consumers. Through the Quinoa Project, improved seed and advice on best agronomic practices, development of new products from particular cultivars and offering new products with better quality and lower price were achieved. The Project has been very active, with positive results. The project has been built up and consolidated in only 3 years in collaboration with CIP, national research institutions in Peru, Bolivia and Ecuador, and collaborators from other countries. Collaboration with national research institutions has enhanced national research capacity, bringing further benefit in the long term (CIP, no date).

A new project on minor Andean crops with the name of ANDESCROP has been initiated in 2010 and will last until December 2013. The project is funded by Danida and it is being implemented in four communities of the Altiplano in Bolivia. The project is a jointly effort by the University of Copenhagen (Denmark), the Universidad Mayor de San Andrés of La Paz and PROINPA. Its objective is to improve food security in the Andean region by developing methods for sustainable use of Andean plant genetic resources, soil, water and biodiversity, and by linking small-scale producers to modern markets; as well as strengthening local research capacity and developing human resources for continued and innovative research and development in the Andean crops. The priorities species are Andean grains (quinoa, cañahua, tarwi) and tuber and roots (native potato, oca and ahípa). Among others, some first results were the selection of local varieties of these crops for (potential) future food production, which were presented in highland communities to promote their highly nutritional properties of the different varieties; informal seed systems have been studied; studies on soil erosion have



been initiated in the Southern Altiplano where quinoa production is threatened by an unsustainable, mechanized production.

A recent project (2009–2011) on Andean grains has been implemented by the Collaborative Crop Research Program (CCRP) and funded by the McKnight Foundation. The project looks at food security improvement for communities in the Cotopaxi, Chimborazo and Canar provinces of Ecuador through farming of quinoa, lupin and amaranth. This project is an extension of an earlier one on lupin and quinoa. That four-year project ran from 2005 to 2009 and aimed at increasing production and consumption of three Andean grains (quinoa, lupin and amaranth) in Ecuador. The previous phase, carried out by the National Program for Andean Legumes and Grains of the National Agricultural Research Institute (PRONALEGGA of INIAP), Ecuador Social Development Committee “Path to Progress” (CODESOCP), Ecuador, included a large nutrition component to study the effects of lupin promotion efforts.

Across the Andes, especially in Ecuador, the result of including processed and non-native staples like noodles and rice instead of highly nutritious local grains is both obesity and malnutrition. In its first phase, the project was able to increase consumption of lupin in a few communities through aggressive promotion through recipe exchanges, lupin festivals, information sessions, school feeding programmes and radio features. Furthermore, new varieties and production practices were tested, which led to significant yield increases and helped spread promising varieties and seed. Later, the project connected farmers with other actors along the supply chain in an effort to create more lucrative and equitable commercial relationships (McKnight Foundation, no date a).

A project on the sustainable production of quinoa (‘A neglected food crop in the Andean region’) carried out by the Promoción e Investigación de Productos Andinos (PROINPA), Bolivia, the Centro de Investigación de Recursos Naturales y Medio Ambiente (CIRNMA), Peru, and the Brigham Young University (BYU), USA, was initiated in 2001 and concluded in 2010 (in two Phases). The project aimed at holistically improving quinoa production, utilization and marketing in the Andean region. These objectives were pursued through: (1) conservation of quinoa genetic resources; (2) increasing the number and genetic diversity of new quinoa varieties through plant breeding; (3) rescuing and promoting traditional uses of quinoa; (4) diversifying food consumption; and (5) promoting food security and generating income through the marketing of quinoa products in domestic and international markets. The project has developed a long-term germplasm conservation programme, which includes systematic collection of landraces; documentation of farmers’ scientific knowledge and local know-how concerning their utilization and management; and characterization of the landraces’ morphological and agronomic characteristics. The project also involved participatory plant breeding with the aim of providing farmers with a genetically diverse array of quinoa varieties that incorporate desirable characteristics, including improved tolerance to biotic and abiotic stresses; enhanced nutritive value of the grain; and improved quality for food processing and marketing (McKnight Foundation, no date b). During the second phase the project focused more specifically on: (1) nutrition; (2) increased production and quality of quinoa; (3) genetic improvement; (4)



training of organized groups; (5) diversification of consumption of quinoa; (6) strengthening producer organizations; and (7) improved institutional capacities.

Increased quinoa production and consumption has also been encouraged by government-supported initiatives. Since 1994, the government of Peru has authorized the national food assistance programme Programa Nacional de Apoyo Alimentaria (PRONAA) to purchase certain agricultural products—including quinoa and other Andean grains—directly from farmers. Part of the extra incentive to cultivate quinoa has come due to its use in school and popular canteens. Between 1990 and 1995, the government programme on school breakfasts was based largely on imported wheat. Since 1997, more emphasis has been given to the use of quinoa and other native grains. The state has become one of the main buyers of native crops in Peru, leading to an increase in the area under cultivation. For example, in the 1980s, the area sown to quinoa annually was about 15 000 ha, which rose to approximately 30 000 ha around 2000 (Rivera 1999). The beneficial impact of governmental programmes like PRONAA has been recognized by other governments, development workers and some private companies in the Andean region: farmers benefit from a market for their produce and without having to compete with subsidized imports; and vulnerable groups, such as children and women, receive good quality, basic nutrition (Hellin and Higman 2005). A similar programme has followed in Ecuador. A project named El Proyecto Nacional de Quinoa en Ecuador (Equaquinoa), supported by the World Food Programme, along with a number of NGOs, CIP, other international and national research bodies and private companies, aimed at doubling the quinoa production area in Ecuador.

Many other projects addressing Andean grains worth mentioning are:

Management, Conservation and Sustainable Use of High Andean Grain Genetic Resources, under the SINARGEA. Funded by the Bolivian Agricultural Technology System (SIBTA). Period 2003-2009. Executed by PROINPA.

Participatory Development and validation of technological innovations to reduce the vulnerability of highland families whose livelihood is based on quinoa and potato crops. Funded by the McKnight Foundation. Period 2010-2014. Executed by PROINPA.

Quinoa Program. Funded by the Netherlands. Period 2008-13. Implemented by AUTAPO Foundation.

CIRAD's contribution to the final project report Equeco. Southern Altiplano Bolivia. Executed by the French.

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## 2. Market potential of Andean grains

*José Luis Soto and Enrique Carrasco*

*Photograph courtesy of M. Hermann*

Quinoa seeds genetic diversity from Bolivian germplasm



## Context of the study: the IFAD-NUS Project

The study reported here was carried out within the framework of the IFAD-NUS Project and of the SINARGEAA – Andean Grains project. As touched upon in Chapter 1, in 2001, Bioversity International started a programme called ‘Enhancing the contribution of neglected and underutilized species to food security and to incomes of the rural poor’, with funding from the International Fund for Agricultural Development (IFAD). The aim was to demonstrate the value of underutilized species and to develop best practices to increase their use. This has generally been known as the IFAD-NUS Project.

This project represents the first UN-supported global initiative to promote underutilized species. During the first phase (2001–2005), it contributed to raising the visibility of these species at both national and international levels, and it was the most comprehensive effort up to then to enhance their use. The project worked to improve the use of several species in different countries, including Andean grains in Bolivia, Ecuador and Peru; nutritious millets in India and Nepal; and medicinal and aromatic plants in Egypt and Yemen. This initiative comprised a wide range of activities, including assessment and maintenance of diversity, selection of better varieties, improvement of processing, value-addition, enhancement of supply chains, influencing policy-makers, and building public awareness (Padulosi 2007).

The executing institutions of the Project in the Andean zone were: in Bolivia, Fundación para la Promoción e Investigación de Productos Andinos – Fundación PROINPA; in Ecuador, Instituto Nacional de Investigaciones Agropecuarias – INIAP, and in Peru, Centro de Investigación de Recursos Naturales y Medio Ambiente – CIRNMA.

A follow-up project was implemented from 2007 to 2010 to ensure the realization of the full potential of underutilized species in improving income generation, increasing sustainable production and ensuring better nutrition among rural communities.

With regard to the Bolivian and Peruvian components of the project, 34 project sites of 20 to 120 families were involved in phase I and II. All in all, more than 1,170 families have been directly involved in the implementation of the project, a fact that helps underscore the truly bottom-up, community-based and participatory approach of this project. PROINPA (Fundación para la Promoción e Investigación de Productos Andinos) in Bolivia and CIRNMA (Centro de Investigación de Recursos Naturales y Medio Ambiente) in Peru are the two national agencies implementing the work in the countries, and coordinating activities undertaken jointly with a wide range of over twenty stakeholders from local NGOs and private enterprises, including food processing companies, universities, other research organizations and extension workers, tourism companies, local communities and laboratories.. The reach of the stakeholders covers expertise from grain production to ecotourism, nutritional analysis, conservation, marketing and food quality standard assurance (Padulosi 2007).

The purpose of the present study is to illustrate through reliable data (technical, social and economic variables of intra e interspecific diversity) the

great importance of the Andean grains not only as a means to improve income but also to enhance the welfare of native farming communities and any other individuals involved in the commercial chain of production, mainly transformation and consumption.

### **Main Andean crops**

All throughout the Andean countries, including Bolivia, farming has always been traditional in both rural as well as urban areas. Andean farming is not only economically important; the social, ecological, nutritional and functional (both real and potential) aspects are also of great relevance. The traditional Andean crops offer many advantages: they can be cooked or consumed in many different ways; they offer culinary diversity; great nutritional value due to high protein contents; and relatively low prices if compared with animal sources.

Another very important issue in their relevance is the great potential they have for domestic and foreign commercialization. Andean nationals living abroad miss their native products, such as grains, roots, tubers and fruits (“nostalgia produce”). At the same time, consumers in developed countries are increasingly searching for better, healthier and nutritional products, not to mention the cultural and historical values thereto related. Great export markets are open for these Andean products.

The diversity of traditional Andean crops is very big. The following list just mentions a few:

- Tubers, such as papalisa, ullucu or melloco (*Ullucus tuberosus*), oca (*Oxalis tuberosa*), mashua or isaño (*Tropaeolum tuberosum*) and potatoes (*Solanum tuberosum* ssp. *andigenum*).
- Tuber roots, such as racacha, arracacha or zanahoria blanca [white carrot or parsnip] (*Arracacia xanthorrhiza*), yacón, aricoma or jícama (*Smallanthus sonchifolius*), walusa (*Xanthosoma sagittifolium*), maca (*Lepidium meyenii*), mauka or chago (*Mirabilis expansa*) and sweet potato (*Ipomoea batatas*).
- Andean grains, such as quinoa (*Chenopodium quinoa*), cañahua or kañiwa (*Chenopodium pallidicaule*), amaranth (*Amaranthus caudatus*), tarwi, chocho or lupino (*Lupinus mutabilis*) and many others.
- Fruits, such as chirimoya (*Annona cherimola*), tree tomatoes or tamarillo (*Solanum betaceum*), uvilla (*Physalis peruviana*), babaco (*Carica pentagona*), naranjilla (*Solanum quitoense*), pitajaya (*Hylocereus* sp.) and blackberries (*Rubus glaucus*).

All this valuable diversity is in peril due to the loss of genetic resources and the associated knowledge. This loss is to be blamed on modern farming, and the national legislation and policies that usually encourage such farming, coupled with changing consumer patterns, climate change, national political conflicts, migration and so forth.

Andean crops are disappearing, although they could play an important role in dietary safety, nutrition and the economy of farmer families.

This study focuses on the potential of three Andean grains: cañahua, quinoa and amaranth.

## Importance of Andean Grains in local communities' Economy

Andean grains are linked to different markets, from the most common ones where farmers go to meet their self-consumption needs, to those where they take their products to generate income and cover major needs. Market demand for Andean grains is usually focused on few varieties, mostly the “commercial varieties”. All other varieties, called “traditional varieties” that is most of the diversity found, are usually not required by markets and have a very low price. Therefore, they are usually cultivated in small areas and they are generally used for self-consumption.

The native diversity of “traditional varieties” is of high importance for the small farmer, mainly because it is linked to the costumes, knowledge and traditions (festivities and rituals carried out by farmer communities), and is the intangible value of biodiversity that can be utilized for income generation and enhance farmer families' economy. The genetic diversity of Andean crops has a wide diversity of ways to process it, variability in forms, colours and sizes. Therefore, it is probable to find through agroindustrial research, adequate genotypes for a different transformation and utilization procedures, that as consequence will influence in a positive way the economy of small-scale farmers (Carrasco and Soto 2010).

## Characteristics of Andean grains

Andean grains as quinoa (*Chenopodium quinoa* Willd.), cañahua or cañihua (*Chenopodium pallidicaule* Aellen) and amaranth or kiwicha (*Amaranthus caudatus* L.) stand out due to their intrinsic characteristics. Among these we have:

- a) Genetic variability (precocity, plant and grain color, size of grain, resistance to adverse factors and yield);
- b) Adaptability to adverse conditions in the Andean region (Altiplano or high Andean plains, salt pans, valleys and sea level) where these become strategic crops as source of food products;
- c) Nutritional quality represented mainly by the presence of essential amino acids, both in quality as in quantity;
- d) Diversified uses in food preparations (traditional and new), in recipes to be used in traditional medicine, uses in festivities and rituals, agroindustrial uses (starch granule size, inverted sugar content, fused water percentage).

### Quinoa

Quinoa (*Chenopodium quinoa* Willd) is also known as *jupha*, *jiura*, *kiuna* or arroz del Peru, depending on the language (Aymara or Quechua) and the geographical location. In Bolivia, as well as in Peru, it is known as quinoa (Apaza and Delgado 2005; Tapia and Fries 2007; Soto 2010).

It is in the spinach family and is closely related to cañahua. The grains vary from 1.5 to 2.5 mm in diameter, and they are highly nutritious; like cañahua, quinoa is considered an Andean grain and not a pseudo-cereal.

Quinoa can be considered as an oligocentric species as it's center of origin



is of wide distribution and multiple diversification, being attributed to the banks of Lake Titicaca as the region of highest diversity and genetic variation (Mujica 1992).

Quinoa is cultivated from the southern part of Colombia (Pasto) to the north of Argentina (Jujuy and Salta) and Chile (Antofagasta and Concepcion), throughout the Andean region. There is quinoa ranging from the sea level, through the valley regions (2,000 to 2,800 masl) and up to high altitudes (2,800 to 4,000 masl). The higher cultivations are more common and the best known, since it is a plant that tolerates climate extremes (drought and frost), although it may be vulnerable to pests and diseases, and thus requires greater care than cañahua. Still, it is a security dietary crop with great marketing potential (Wahli 1990; Lescano 1994; Soto et al. 2004; Tapia and Fries 2007, Rojas, et al. 2010).

According to the agroecological conditions where they thrive and that generate diverse botanical, agronomic and adaptation characteristics, Lescano (1994) proposed that quinoa can be grouped in five large groups: a) interandean valleys; b) Altiplanos; c) Salt pans; d) Sea level; e) Yungas.

Quinoa in Bolivia has a wide geographical distribution, but currently it is mostly produced in three regions of the north, centre and south of the Bolivian Altiplano. These regions comprise the departments of La Paz (Omasuyos, Ingavi, Los Andes, and Manco Cápac provinces); Oruro (Sebastián Pagador, Eduardo Avaroa, and Ladislao Cabrera provinces) and Potosí (Antonio Quijarro, Nor lipez, Daniel Campos, and Enrique Valdivieso provinces). Quinoa cultivars can also be found in high valleys of the Chuquisaca, Tarija and Cochabamba departments, and the yungas region in the department of La Paz (Rojas 2002; Soto 2010).

### **Nutritional value and uses**

In nutritional terms, quinoa has an exceptionally good balance of proteins, fat, oils and starch. The protein content is high since the embryo forms the greater part of the seed. The average fat per grain is ca 16%, but may reach 23%, double the amount of any other cereal. Furthermore, the proteins in quinoa are very close to the minimum required standards set for human nutrition by FAO/WHO. The proteins contained in quinoa have a high content of the amino acids lysine, methionine and cysteine. Its seeds contain between 58% and 68% starch, and 5% sugars, and although the starch granules are quite small, they contain close to 20% amylose, and turn into gelatine between 55 and 65°C. The fat content is approximately 4% to 9%, half of which is linoleic acid, essential for human dietary intake. Quinoa also contains high levels of phosphorus and calcium. The nutrients concentrated in its leaves have low levels of the nitrate and oxalate considered prejudicial for nutrition, and thus they may be consumed when tender, before panicle formation (Wahli 1990; Lescano 1994; Repo-Carrasco 1998; Soto 2004; Apaza and Delgado 2005).

The nutritional value of quinoa varies considerably between varieties, and in some cases even within the same variety, basically as a result of the soil where they are grown and the fertilization regime. The highest values can be found on soils that are well fertilized with adequate nitrogen. However, inter-specific variations are mainly based on genetic factors, as indicated by the comparison of 20 accessions shown in Table 2.1

The foregoing Table 2.1 reflects the inter-specific variation that exists. One parameter that draws attention is the low protein content, which is less than 16%, but this is due to the samples that were analysed, as we can find variations with 20% or more protein. Table 2.2 shows the industrial qualities of these lines.

The content of invert sugar varies from 10% for QC1 up to 32% for QC18. The ideal percentage of invert sugar content is  $\geq 25\%$ . This indicates the quantity of sugar that prompts fermenting through unfolding or inversion; in other words it is the parameter determining the quality of the carbohydrates, as well as being an important value to classify quinoa as a dietary product suitable for diabetics.

**Table 2.1.** Variation in nutritional values of 20 different quinoa accessions from the Banco Nacional de Germoplasma de Granos Altoandinos (BNGA)

Line	Humidity %	Fat %	Protein %	Ash %	Fibre %	Carbohydrates %	Energy kcal/100 g
QC1	8.57	7.05	13.25	2.78	7.15	61.20	362.43
QC2	8.73	8.55	12.75	2.98	6.64	60.35	369.55
QC3	9.93	7.25	13.59	3.11	7.04	59.08	356.69
QC4	10.27	6.48	14.01	2.68	6.96	59.60	354.01
QC5	10.29	7.21	13.69	3.02	6.78	59.01	356.45
QC6	8.77	6.25	14.25	3.48	5.66	61.59	361.21
QC7	9.11	6.31	12.68	3.06	6.28	62.56	359.63
QC8	8.89	8.25	14.25	2.99	7.15	58.47	365.10
QC9	10.51	7.85	14.58	3.04	7.82	56.20	353.67
QC10	12.20	7.28	14.23	3.22	6.95	56.12	347.22
QC11	13.01	6.89	13.68	4.05	6.54	55.83	340.63
QC12	11.37	7.12	15.24	3.02	7.71	55.54	347.40
QC13	11.67	7.29	15.11	2.99	6.13	56.81	353.55
QC14	11.85	7.56	12.47	2.15	6.29	59.68	357.42
QC15	12.79	5.48	13.36	3.18	7.02	58.17	337.23
QC16	11.47	7.98	15.48	3.11	7.01	54.95	353.09
QC17	11.52	7.26	14.68	2.92	6.52	57.10	352.83
QC18	10.99	7.65	13.25	3.45	6.49	58.17	354.97
QC19	11.20	6.65	14.29	3.06	7.25	57.55	348.07
QC20	11.31	8.21	15.48	3.24	6.26	55.50	357.29
Range	8.57-13.01	5.48- 8.55	12.47- 15.48	2.15- 4.05	5.66-7.82	54.95-62.56	340.63- 369.55

Source: PROINPA Foundation, SINARGEAA Granos Andinos Annual Report 2006-2007

The foregoing Table 2.1 reflects the inter-specific variation that exists. One parameter that draws attention is the low protein content, which is less than 16%, but this is due to the samples that were analysed, as we can find variations with 20% or more protein. Table 2.2 shows the industrial qualities of these accessions.

The content of invert sugar varies from 10% for QC1 up to 32% for QC18. The ideal percentage of invert sugar content is  $\geq 25\%$ . This indicates the quantity of sugar that prompts fermenting through unfolding or inversion; in other words it is the parameter determining the quality of the carbohydrates, as well as being an important value to classify quinoa as a dietary product suitable for diabetics.

The variable "Percentage of fused water" has a range from 25% in line QC18 to 66% for QC17. This variable measures the capacity of the starch to absorb water, which is very important for pasta, bread and other baked goods. The ideal value for this parameter for industrial application is  $\geq 50\%$ , and five accessions meet this standard.

**Table 2.2.** Industrial quality parameters of 20 accessions of quinoa from BNGA

Line	% invert sugar	% of fused water	Starch granule size (mm)
QC1	10	32	3.5
QC2	18	55	4.0
QC3	21	45	2.5
QC4	15	29	5.5
QC5	13	35	2.5
QC6	21	65	3.5
QC7	16	46	10.0
QC8	14	35	12.0
QC9	18	28	2.5
QC10	15	34	5.5
QC11	25	39	3.5
QC12	19	65	4.0
QC13	17	26	5.5
QC14	24	39	3.5
QC15	19	45	12.0
QC16	15	48	15.0
QC17	13	66	3.5
QC18	32	25	8.5
QC19	22	36	6.5
QC20	16	55	12.0
Range	10-32	25-66	2.5-15.0

Source: PROINPA Foundation, SINARGEEA Granos Andinos Annual Report 2006-2007

The summary of the estimated statistical parameters for each nutritional value and agroindustrial characteristic of the quinoa germoplasm studied are shown in Table 2.3., and are expressed in dry basis (Rojas and Pinto 2006). It can be observed that the analysed quinoa accessions show a wide variability for most of the studied parameters, being an indicative of their genetic potential (Rojas et al. 2010a).

**Table 2.3.** Values of different nutritional and agroindustrial characteristics and simple statistics of 555 quinoa accessions

Component	Minimum	Maximum	Mean	Standard Deviation
Protein (%)	10.21	18.39	14.33	1.69
Fat (%)	2.05	10.88	6.46	1.05
Fibre (%)	3.46	9.68	7.01	1.19
Ash (%)	2.12	5.12	3.63	0.50
Carbohydrates (%)	52.31	72.98	58.96	3.40
Humidity (%)	4.91	15.3	9.91	1.78
Energy (Kcal/100g)	312.92	401.27	353.36	13.11
Starch granule ( $\mu$ )	1.00	28.00	4.47	3.25
Inverted sugar (%)	10	35	16.89	3.69
Fused water (%)	16	66	28.92	7.34

*Source: PROINPA Foundation, SINARGEAA Granos Andinos Annual Report 2006–2007. Sample analysis carried out by LAYSAA (Laboratorio de Análisis y Servicios de Asesoramiento en Alimentos), Cochabamba*

Table 2.3 shows that the accessions have a high variability for most of the studied characteristics, which is an indicative of the genetic potential of the quinoa germoplasm. The percentage of protein fluctuated from 10.21 to 18.39%, and these values have a wider range than the ones reported by Moron (1999) (11.6-14.96%). The quantity of protein is basic, but the interesting feature in quinoa is the presence of essential amino acids. The fat content ranged between 2.05 and 10.88%, value higher than 1.8- 9.3% reported by Moron (1999). They indicated that the fat content in quinoa has a high value due to the high percentage of non saturated fatty acids. These values are interesting when processing to obtain plant oil.

This table also shows important quantities of fiber ranging from 3.46 to 9.68%, and these are also values that are higher than the ones reported by Jacobsen and Sherwood (2002). Regarding ash, the quinoa accessions studied reported a variation of 2.12 to 5.12%. Likewise, the carbohydrate content of quinoa grains varied from 52.31 to 72.98% and energy ranged from 312.92 to 401.27 Kcal (Rojas et al. 2010).

The genetic variation of the starch granule size fluctuated between 1 and 28  $\mu$ , being able to focus this variable towards the agroindustry in order to elaborate different mixtures with cereals and legumes, and establish the functional character of quinoa. It is important that the starch granule is small to facilitate the texturizing process. When the starch granule is small it is easier to insufflate as the spaces inside the granule permits larger quantities of air to be introduced and to be exchanged, and a higher generation of air bubbles (Rojas et al. 2007).

The content of inverted sugar, that expresses the quantity of sugar that initiates fermentation by unfolding or inversion -and that is the parameter that establishes the quality of the carbohydrates-, varied from 10 to 35%. Moreover, it is an important parameter that permits the classification of quinoa as a food that is appropriate for diabetics. The optimum percentage of inverted sugar is  $\geq 25\%$ . The accessions of the collection that comply with this condition have the potential to be used in mixtures with flour for bread baking. The percentage of fused water shows a variation range from 16 to 66%. This variable measures the water absorption capacity of the starch in different transformation practices; the ideal value for this parameter for the baking industry is  $\geq 50\%$ .

### **Food uses**

Quinoa is an important source of nourishment, especially for the Andean inhabitants: This grain is used in human diets in diverse forms and manners. Key informants (in particular women interviewed during the present study reported the traditional use of quinoa in soups (porridge, *lawa* or *allphi*), in stews (cooked *phisara*, *pesq'e*), or the flour powder may be used to make bread, which is cooked by steaming (known as *K'ispiñas*, *muk'unas* and *phiri*). It is also used in lieu of wheat flour, making bread and pasta richer, and it serves for baking biscuits, cakes and pastries in general. It can be used to produce cold and hot beverages such as *chicha* or *Q'usa*, refreshments or *Ullphi*, juices and so forth. If mixed with maize, wheat, barley or potato, highly nourishing, tasty meals can result. Peru and Bolivia have begun a campaign to feed malnourished children with these products. The tender leaves of quinoa may be used in salads (*llipcha* or *ch'iwa*) as they are rich in vitamins and minerals, especially calcium, phosphorous and iron.

The consumption of these types of preparations varies according to the period of the year and the agricultural activities that are developed in communities. Frequently these are consumed for breakfast, lunch, dinner or between foods.

The plants are also used as forage for alpaca, llama, bovine cattle, sheep and Guinea pigs. The grains are excellent food for poultry and swine.

### **Medicinal uses**

The use of Andean grains in traditional medicine is known from ancient times. In high Andean and valley communities, Kallawayas healers that in Aymara means "carrier of medicinal herbs" use quinoa for multiple medicinal purposes, using the grains, the stems and the leaves for this. Preparation forms and ways of administration vary for internal to external uses (Pinto et al. 2010).

Quinoa is considered to have considerable medical properties, and was much used in the past for treatment of various illnesses and ailments. It is often used

for liver abscesses, hepatic infections, dental anaesthesia, angina, as an anti-inflammatory, for urinary tract problems, and to promote wound healing. The ground grains of black quinoa *ajaras* when mixed with other wild plants such as *thola* are used as dressings to heal broken bones (Rojas et al. 2004).

### By-products

The chaff after threshing, called *jipi*, is a light fine material comprising perianths and small leaf and stem fragments, and is used by farmers as supplement feed for sheep and cattle in times of feed shortage. The *broza* (scrub) is the stem, with a high lignin content, and usually used as fuel. The broken grains are usually used as direct feed for poultry.

Another by-product arousing industrial interest is saponin in the leftover quinoa grains, and which, due to its chemical qualities, can be used in the manufacture of liquid detergents, soaps, shampoos, toothpaste, stain removers, foam stabilizer for beverages, especially beer, and as an insecticide. Other applications include its use in the preparation of material for fire extinguishers; in the mining and hydrometallurgy industry for mineral floatation; and in photographic processing (Vilaseca et al. 2007).

### Cañahua

Cañahua (*Chenopodium pallidicaule* Aellen) is also known as cañihua, cañahua, kañawa, kañagua, kaniwa, quañiwa or qaniwa, depending on its geographical origin (Bolivia or Peru) and the language (Aymara or Quechua); it is commonly known as cañahua in Bolivia, and as cañihua in Peru (Mujica et al. 2002; Tapia and Fries 2007).

Cañahua is a plant that is part of the spinach family, and closely related to quinoa; it is a small, very nutritious grain. It is not a cereal because it does not belong to the gramineae family. Some have classified it as a pseudo-cereal, although the most accurate classification would be to label it as an Andean grain, alongside quinoa and amaranth.

It thrives on the Altiplano (the Altiplano of the Andes, 3,200 to 4,300 masl), mainly in Bolivia and Peru in the areas surrounding Lake Titicaca. Lescano (1994) argues that cañahua, has not had a wider diffusion outside the Bolivian (region north of Oruro and Cochabamba's mountain range) and Peruvian (regions of Ayaviri, Puno, Cuzco and Ayacucho) Altiplano borders. Rojas and Camargo (2004) mentioned that in Bolivia cañahua is cultivated in the provinces of Pacajes, Ingavi, Los Andes, Omasuyos, Camacho and Manco Kapac of La Paz departments, in the provinces of San Pedro Torora and Nor Carangas of Oruro department, and in the provinces of Independencia, Tapacari and Bolivar of the Cochabamba department. It is grown on marginal lands, reflecting its high tolerance to abiotic factors (droughts and frosts), as well as resistance to pests and diseases. Therefore this crop should be considered truly resilient crop, strategic for food security, since it grows where other equivalent species do not thrive.

### Nutritional value and uses

Cañahua has very high nutritional value because of its quality and balance

proteins, carbohydrates, vegetable and mineral oils (Table 2.4). The protein content is not only high, but it also has very good biological value as it is easily assimilated by the body, and with an optimal balance of the essential amino acids lysine and methionine (Repo-Carrasco 1998; Mujica et al. 2002; Soto 2004).

The nutritional content proteins, carbohydrates and other elements—in cañahua can vary considerably, reflecting edaphic qualities. The most important factor, however, is genetic variation, as presented in Table 2.4, where the 20 accessions show very different values despite their all being cultivated at the same site in the same year season (2006-2007).

Table 2.4 highlights the wide intra-specific variety, which can be exploited for different uses in agro-industrial products, for different markets and even for direct

**Table 2.4.** Variation in the nutritional value of 20 different accessions of cañahua from the Banco Nacional de Germoplasma de Granos Altoandinos (BNGA)

Line	Humidity %	Fat %	Protein %	Ash %	Fibre %	Carbohydrate %	Energy kcal/100 g
CC1	9.31	10.8	15.25	4.21	7.96	52.47	365.59
CC2	9.40	14.5	18.24	4.02	8.12	45.72	380.32
CC3	10.37	8.01	16.29	4.77	7.54	53.02	348.53
CC4	9.60	10.75	17.05	5.21	8.21	49.18	358.58
CC5	9.68	9.45	18.29	4.68	7.62	50.28	357.03
CC6	10.75	8.22	17.95	5.26	8.45	49.37	341.69
CC7	9.80	8.15	18.46	5.45	8.15	49.99	345.61
CC8	10.15	10.21	16.77	4.69	8.24	49.94	356.11
CC9	10.27	9.24	18.01	4.35	8.13	50.00	353.04
CC10	10.41	9.97	17.65	5.02	8.64	48.31	350.79
CC11	10.14	8.05	17.21	4.12	7.28	53.20	353.17
CC12	9.29	8.65	16.98	3.95	7.58	53.55	358.74
CC13	10.49	8.78	16.87	4.23	8.02	51.61	351.41
CC14	8.97	8.21	17.24	4.85	8.14	52.59	352.11
CC15	9.56	9.45	18.05	5.15	7.15	50.64	357.59
CC16	10.42	10.02	17.26	4.78	7.58	49.94	356.42
CC17	10.10	9.69	17.48	4.43	7.78	50.52	356.90
CC18	9.77	9.45	16.25	4.75	8.05	51.73	355.11
CC19	8.52	8.25	14.56	5.25	8.01	55.41	353.69
CC20	8.85	8.99	17.77	4.29	7.29	52.81	361.59
Range	8.52–10.75	8.01– 10.75	15.25– 18.46	3.95– 5.45	7.15– 8.64	45.72–55.41	341.69– 380.32

Source: PROINPA Foundation, SINARGEAA Granos Andinos Annual Report 2006-2007



consumption. This variability must be duly preserved for its potential for better and higher profits.

Table 2.4 shows that the protein content in the lines tested ranges from 15.25% to 18.46%, and the fat content from 8.01% to 10.75%, which are a result of the intra-specific variation as all external factors are similar.

Table 2.5 shows the industrial potential of the same 20 cañahua accessions, and the grain size variation from 5.5 to 25  $\mu\text{m}$ . From the data, line CC1 is the most promising one for the production of textured products and snacks (Rojas and Pinto, 2006), bearing in mind that the smallest grains are easiest to puff, since the space between granules allows greater quantities of air for the exchange and creation of air bubbles.

**Table 2.5. Industrial** potential of the 20 cañahua accessions, from the Banco Nacional de Germoplasma de Granos Altoandinos (BNGA)

Line	Invert sugar (%)	Fused water (%)	Starch granule size ( $\mu\text{m}$ )
CC1	18	12	5.5
CC2	33	10	6.5
CC3	19	21	15.5
CC4	16	25	10.0
CC5	21	18	9.5
CC6	19	19	7.5
CC7	33	24	21.0
CC8	23	17	18.0
CC9	17	25	17.0
CC10	18	22	18.0
CC11	21	23	16.5
CC12	23	32	22.0
CC13	18	29	15.0
CC14	14	17	25.0
CC15	19	25	18.0
CC16	15	33	22.0
CC17	25	21	6.5
CC18	30	25	7.5
CC19	22	27	9.0
CC20	26	18	15.0
Range	14–33	10–33	5.5–25.0

Source: PROINPA Foundation, SINARGEAA Granos Andinos Annual Report 2006-2007

The content of invert sugar varies from 14% for CC14 to 33% for CC7. This variable shows the quantity of sugar that prompts fermentation by unfolding,

or by inversion; in other words, it is a parameter to determine the quality of carbohydrates. The optimal percentage for inverted sugar is  $\geq 25\%$ . Five accessions of the cañahua germplasm tested meet this optimum, and thus are suitable for admixtures with different flours to bake bread.

The fused water ranges from 10% for CC2 to 33% for CC16. This variable measures the ability of the starch to absorb water, and is a very important parameter in suitability for bread and similar products. The ideal value for this parameter in industrial applications is  $\geq 50\%$ , but no accession tested reaches this value.

In Table 2.6., a summary of the estimated statistical parameters are shown for each nutritional and agroindustrial characteristic studied from the cañahua germplasm, and that are expressed in dry basis (Rojas and Pinto 2008). It can be observed that the cañahua accessions analysed also show a wide variability for the majority of the parameters studied, which is an indication of their genetic potential (Rojas et al. 2010).

**Table 2.6.** Values of nutritional and agroindustrial characteristics, and simple statistics from 90 cañahua accessions

Component	Minimum	Maximum	Mean	Standard Deviation
Protein (%)	12.76	19.00	16.12	1.55
Fat (%)	2.11	14.50	7.46	1.96
Fibre (%)	5.45	11.12	8.41	1.16
Ash (%)	3.12	5.77	4.29	0.58
Carbohydrates (%)	45.72	67.70	56.91	5.33
Humidity (%)	4.68	14.70	10.37	1.76
Energy (Kcal/100g)	324.54	396.42	358.92	20.52
Starch granule ( $\mu$ )	5.50	38.0	18.98	6.96
Inverted sugar (%)	5	35	15.33	7.55
Fused water (%)	9	39	20.18	6.21

Source: PROINPA Foundation, SINARGEAA Granos Andinos Annual Report 2006-2007. Sample analysis carried out by LAYSAA, Cochabamba

The quantity of protein is presented in Table 2.6 and shows a fluctuation of 12.76 to 19.00% (Rojas and Pinto 2006; 2008), and these values have a wider range than the ones reported by Mujica et al. (2002), that based on different research studies presented values ranging from 13.8 to 16.72%. The fat content fluctuated from 2.11 to 14.50%, and these results have also a wider range than the ones reported by Mujica et al. in 2002 (4.5 to 8.4%). The fiber content is higher in comparison to the one shown by wheat (3%).

The genetic variation of the starch granule size shows a wide fluctuation ranging from 12.76 to 19.00%. These values can guide the use of cañahua in the elaboration of texturized products, snacks and appetizers. Other variables as inverted sugar content and fused water also have a wide variation, and taking into account these values, the accessions that show an equal or higher percentage to the ones shown in Table 2.6., have the potential to be used in mixtures for bread baking.

### Food uses

Cañahua is excellent nourishment for children and in vegetarian diets, It is also a good dietary supplement for sportspeople since it has a higher volume of soluble fibre compared with quinoa and amaranth, and it is easier to digest. This grain is gluten-free and thus is suitable nourishment for people with coeliac disease, and it is also saponin free (unlike quinoa) (Carrasco et al. 2004).

Its use is varied; from popped grain and milled, also known as *ha'ku* (cañahua powder), whereby the grain when popped may be turned into a delicious powder to be taken with water or milk and sugar, used in soups and stews such as *kispiña* and pottages, or in breads and beverages.

The fresh leaves can be eaten as salads, with high protein and iron content. Iron assimilation may be facilitated by the vitamin C content.

### Medicinal uses

The toasted grain can be milled and used to control amoebae-related dysentery in children, and it is highly recommended for people with anaemia, particularly in pregnancy or when breast feeding, and in cases of physical and mental exhaustion, diabetes and high-altitude sickness. The powdered dry seeds dissolved in water and vinegar is considered an excellent cure for typhoid fever (Mujica et al. 2002; Rojas et al. 2004).

The ashes of the stems can be used as mosquito and spider repellent. These ashes (*llipta*) may be added to meals in order to avoid indigestion, and may also be used in lieu of lime when chewing coca leaves.

Altitude sickness or *sorojchi* is a temporary physical discomfort caused by lack of oxygen that occurs especially in high altitudes; in order to avoid this discomfort, farmers roast and mill wild cañahua grains with the leaves of another medicinal plant called *k'intu*, the mixture is boiled in water and it is then given to the affected person (Pinto et al. 2008). To cure dislocations or luxations cañahua grains are milled and mixed with other plants as altamisa, (*Ambrosia artemisiifolia*) chilla (*Austro eupatorium* spp.), *manq'a paqui* (*Salvia* spp.) and chickpea. This mixture is placed on the dislocated area as a cataplasm that absorbs and gives stability as cast. When a person feels weak due to physical and mental weariness, he/she is given cañahua as *pito*, a traditional preparation that has high nutritional value, and permits persons regain strength and muscle stability. Some families in rural areas collect wild cañahua plants that they boil in water and give this preparation to persons with stomach problems (Pinto et al. 2010).

### By-products

The chaff after threshing, locally termed *jipi*, comprises perianths and small stem fragments and is used as fodder for cattle and sheep. The *kiri* or *chillpi*—plant stems—is used as fodder for cattle and donkeys. The very small grains are used as feed for poultry.

### Amaranth

Amaranth (*Amaranthus caudatus* L.) has a Cosmopolitan distribution as it thrives in regions with very diverse climatic, soil and topographic conditions. Therefore, it can be found from sea level to high altitude regions (more than 3,000 masl). Lescano (1994) mentioned that the grain, together with other Andean grains that occur in high regions constitute a valuable contribution of pre-incaic and incaic crops to modern civilization, and is found from certain areas in Mexico to the north of Argentina.

Amaranth is a species belonging to the Amaranthaceae plant family, which is comprised mostly by weeds and found throughout the warm and sub-tropical regions. There is, however, some confusion as to its taxonomy. There are close to 60 *Amaranthus* species, many of which are grown as legumes, cereals or decorative plants.

Amaranth is highly resistant to cold and dry weather, and grows even in poor soil; it is nutritious, which makes it an ideal alternative crop in areas where it is hard to grow other crops. It is used in traditional recipes throughout Asia, the Americas and Africa (Kietz 1992; Garnica 2006; Tapia and Fries 2007).

Amaranth is known as *millmi*, *coimi*, *coymi* and *yuyo* in Bolivia, especially in the central part of the country, and as *coimi* in the south. In Peru it is known as *kiwicha*, *coyo*, *achis* and *achita*.

The geographic distribution of amaranth in Bolivia is not that wide compared to quinoa and cañahua. The main production areas are: interandean or mesothermal valleys (in Cochabamba in the provinces of Mizque, Punata, Arani, Capinota, and Esteban Arce; in Chuquisaca in the provinces of Yamparaez, Tomina, Sudañez and Padilla; in Tarija in the province of Cercado), and in the department of La Paz (Yungas) (Soto 2010; Rojas et al. 2010).

### Nutritional value and uses

The amaranth grain contains approximately 16% protein, which is more than cereals such as maize, rice or wheat (9.2, 8.4 and 11.5%, respectively). Nevertheless, its importance lies not in the quantity but the quality of the protein. The extraordinary nutritional, physical and chemical properties of the amaranth protein are well documented: it has high levels of lysine, and adequate quantities of tryptophan and sulphuric amino acids. In contrast, in the majority of cereals these are found at much lower levels, and the same for the sulphuric amino acids in legumes. It has high caloric value, carbohydrates, fibre and mineral salts. The small grains are also rich in lysine (16.5% of the protein amino acid content), an essential amino acid that is found in milk. The grain is comparable in its nourishing potential to milk; it is ideal for children, and in pregnancy or whilst breast feeding.

According to FAO and the World Health Organization (WHO), based on a protein “ideal value” of 100, amaranth scores 75, cow milk 72, soy 68, wheat 60 and maize 44. Its digestibility is 93%; if mixtures are made of amaranth and maize flour, the combination is particularly good, with an index of 100 as the result of the balancing of amino acids low in one, but high in the other. Moreover, the amaranth grain is gluten free, and thus ideal nourishment for people with coeliac disease.

**Table 2.7.** Content of fat, protein and starch, and starch granule size of 23 accessions in the amaranth collection from the Banco de Germoplasma de Pairumani

Line	Fat%	Protein%	Starch%*	Starch granule ( $\mu\text{m}$ )
39	6.76	15.21	40.11	5.2
36	6.50	14.18	42.35	6.3
37	5.51	15.11	n/d	10.3
69	4.55	16.38	n/d	11.2
98	8.10	16.15	37.12	5.0
28	6.76	18.27	39.13	6.2
2	7.10	15.15	n/d	7.8
26	12.80	14.18	32.45	4.6
25	7.26	14.89	44.12	6.6
24	5.76	16.21	n/d	11.8
74	8.50	17.13	31.23	6.3
85	7.26	10.22	44.25	9.6
75	5.76	15.18	n/d	10.5
10	8.50	18.21	n/d	7.2
82	6.26	14.23	n/d	3.8
104	9.76	17.13	n/d	8.5
9	7.26	16.29	n/d	8.3
38	8.51	14.23	n/d	7.5
49	7.18	11.28	n/d	8.5
21	7.36	15.32	n/d	8.9
19	8.02	17.71	n/d	7.7
6	8.76	16.16	35.56	6.1
3	6.29	13.28	40.67	5.5
Range	4.55–12.80	10.22–18.27	44.25–31.23	3.8–11.8

Notes: Only those varieties with starch granule diameters < 7.2  $\mu\text{m}$  have been taken into account. n/d = not determined.

Source: IPGRI-IFAD-PROINPA Annual Report 2003-2004

The main component of the amaranth seed is starch, at between 50 and 60% of its dry weight. The diameter of the starch granule is between 1 and 3 microns, whereas maize granules are ten times bigger, and those in potato may reach 100 times that. The small dimensions of the starch granules in amaranth facilitate its digestion, which proceeds at a rate 2.4 to 5 times faster than that of maize starch (Kietz 1992; Repo-Carrasco 1998; Soto 2004; Garnica 2006).

Amaranth leaves have high levels of calcium, iron, manganese, phosphorus and Vitamins A and C, making it an ideal complement to the grains. Leaves may be eaten when tender, but cooked in order to avoid anti-nutritional agents such as oxalates and nitrates. They are eaten as vegetables in some countries, replacing chard and spinach. The leaf protein has a high content of desirable amino acids, such as aspartic, glycine and lysine, as well as glutamate. Furthermore, the leaves may be used as fodder for cattle and other animals.

The nutritional value and industrial potential of amaranth varies according to the variety, as shown in Table 2.7, based on accessions from the Amaranth Nuclei Collection of the Germplasm Bank of Legumes and Cereals of the Pairumani Phyto-genetic Investigation Center (Cochabamba, Bolivia).

**Table 2.8.** Values of nutritional and agroindustrial characteristics, and simple statistics of 12 amaranth accessions

Component	Minimum	Maximum	Mean	Standard Deviation
Protein (%)	10.60	12.90	11.63	0.67
Fat (%)	6.45	8.60	7.01	0.64
Fibre (%)	2.41	5.56	3.31	0.90
Ash (%)	1.91	2.56	2.20	0.22
Carbohydrates (%)	64.40	69.60	67.30	1.43
Humidity (%)	10.70	12.80	11.88	0.72
Energy (Kcal/100g)	371	386	378.58	4.32
Calcium (mg/100g)	121	197	159.67	24.16
Iron (mg/100g)	3.90	5.40	4.73	0.47
Phosphorous (mg/100g)	321	481	380.33	49.45
Potassium (mg/100g)	323	474	378.75	44.81
Vitamin C (mg/100g)	0.75	2.63	1.26	0.78
Inverted sugar (%)	1.50	2.32	1.81	0.25

Source: PROINPA Foundation, SINARGEAA Granos Andinos Annual Report 2006-2007. Sample analysis carried out by Fundación Instituto de Tecnología de Alimentos – ITA, Sucre

In Table 2.8., a summary of the estimated statistical parameters for each nutritional and agroindustrial value in the amaranth germplasm studied is shown, and are expressed in dry basis (Aliaga and Serrano 2009). The quantity of protein fluctuated from 10.60 to 12.90% and these are values that are within the range reported by Rojas et al. in 2010 (10.60 to 12.90%).

The amaranth has good proteic efficiency comparable to casein found in milk and complements cereals that are poor in lysine. The proportion of essential amino acids in the amaranth grain protein is significantly better than other protein of plant origin. The energetic value varied from 371 to 386 Kcal/100g of eatable product, while the average content of minerals as calcium, potassium, phosphorous and iron was 159.67, 378.75, 380.33 and 4.73 mg/100g respectively (Table 2.8.) reported by Rojas et al. (2010).

### Food uses

The harvested and selected grains are mainly used to prepare flour that is a somewhat difficult process due to the grain's small size and its hard consistency for traditional milling (with a stone mill). Therefore, it is advisable to toast the grains previously in small quantities in a very hot clay pot where the grains pop when they are placed inside and these can then be grinded easily. The result is flour with nice smell and taste. Amaranth flour is widely used to prepare instant beverages, *chicha*, and bakery and confectionary products (Rocha 2003).

Amaranth is highly nutritious for all ages; it may be used as a flour to bake bread, cakes and biscuits if combined with wheat or triticale flour. The leaves of all the cultivated varieties may be used once cooked and drained, in salads, stews and so forth. Its nutritional quality and flavour is considered much better than spinach, chard, lettuce and other vegetables (Kietz 1992; Garnica 2006). The whole plant (not only leaves and stems) may be used as fodder for ruminants, with good results. Furthermore, the grain has been successfully used as fodder for swine and poultry. The dried foliage may be used as a natural colorant in manufacturing noodles, and also as fillings for pasta, tarts and other dishes (Garnica 2006).

### Medicinal use

Amaranth has been used since pre-Hispanic times for medical purposes, due to its medical properties confirmed through research in recent years. The leaves, for example, were used for infusions against diarrhoea. Due to its valuable nutritional properties, it is highly recommended to prevent or help in the treatment of conditions such as osteoporosis, diabetes mellitus, obesity, hypertension, constipation and diverticulosis, chronic kidney insufficiency, hepatic insufficiency and hepatic encephalopathy. It is an excellent dietary supplement for coeliac patients; it may also be used in diets to help patients with autism. It is recommended for those with mouth-related ailments, geriatric, malnourished and cancer patients, and as in hyper-energy and protein diets; it is considered a cholesterol reducer. It is also recommended for patients that require high caloric levels (Kietz 1992; Garnica 2006).



### **By-products**

Amaranth is a nutritional double-purpose plant, providing both vegetable and grain. The residue of the plant may be used to process into balanced feed for bovines, ovines, caprines and poultry.

### **New and innovative agroindustrial uses for Andean grains**

Andean grains can be combined and mixed with legumes as dry lima beans (*Phaseolus lunatus*), kidney beans (*Phaseolus vulgaris*) and tarwi (*Lupinus mutabilis*) to enhance the quality of the diet especially for children through the supply of school breakfast. However, the role of the agroindustry to add value to this species is only emerging. Still, currently various subproducts elaborated or semi-elaborated can be found in markets, although prices are generally higher so most of the population cannot afford them (Pinto et al. 2010). Among these we can find ready to consume products called *cereales* and that are usually consumed for breakfast. In local markets, *granolas* that contain cereals (wheat) and insufflated Andean grains (quinoa, cañahua, and amaranth) and that are mixed with dehydrated fruits and oleaginous species (peanuts, almonds and chopped nuts) can be found; these are very popular products among people of all ages. The agroindustry elaborated these mixtures of products to balance the nutrients depending on the nutritional pyramid. The disadvantage of these types of products is the non-enzymatic browning that occurs when toasting the grains.

Among other elaborated products are “flakes” that can be pre-cooked or raw, and can be used to elaborate preserves, hot breakfasts, juices and soups. There are also other processed products as extruded grains and reconstituted baby food (Pinto et al. 2010).

### **Comparing the three grains**

To obtain real and potential data on the chemical composition of Andean grains, various researchers and institution have carried out different types of sample analysis of grains and parts of the plants (stems and leaves) in order to show their nutritional benefits (Rojas et al. 2010). However, in most cases the data only shows average results not specifying the variety that was analysed or it is only stated that there is a wide variation due to individual characteristics of the genetic material found in the samples analysed in the laboratory.

Table 2.9 compares the nutritional values of amaranth, cañahua and quinoa with other cereals of mass consumption. It clearly shows the superior nutritional value of the Andean grains.

Observing the information presented in Table 2.9., the variation ranges for bromatological characteristics (physic-chemical analysis by edible portion) of different species are shown. The table shows that Andean grains (quinoa, cañahua and amaranth) show values that are comparatively superior to the ones found in cereals as maize, wheat and rice. On the other hand, Andean grains are mentioned as very nice in taste and possess a good source of minerals.

**Table 2.9. Nutritional** composition of the Andean grains (amaranth, cañahua and quinoa) vis-a-vis wheat, rice and maize (g/100 g)

Component	Quinoa	Cañahua	Amaranth	Wheat	Rice	Maize
Protein	12.6–18.4	11.6–19.5	10.2–18.3	8.6	6.6*	8.7*
Fat	4.2–8.7	1.7–8.9	4.5–12.8	1.5	0.4*	3.9*
Carbohydrate	54.3–73.0	53.4–72.7	66.5*	73.7	80.4*	75.7*
Fibre	3.5–8.0	4.1–18.5	6.6*	3.3	0.7*	2.4*
Ash	2.1–4.7	3.1–22.1	2.1*	1.7	0.8*	1.5*

Notes: \* = Values for maize taken from the Bolivian Table of Food Composition (INLASA, 2005). Analyses performed by LAYSAA Laboratories in Cochabamba and INLASA in La Paz, Bolivia.  
Source: Table adapted by J.L. Soto in 2010 from Canahua et al. 2003, and Foundation PROINPA Rubro Granos Andinos, 2006

In Table 2.10., values presented in various studies carried out by Instituto Nacional de Laboratorios de Salud (INLASA) are shown.

**Table 2.10.** Quantity of calcium, phosphorous and iron found in 100 grams of an edible portion of quinoa, cañahua and amaranth

Andean Grain	Calcium (mg)	Phosphorous (mg)	Iron(mg)
Quinoa*	113.3	250.6	5.0
Cañahua*	122.0	372.0	13.0
Amaranto*	249.3	459.0	6.6

\* Average of 4-6 varieties analysed by type of grain. Elaborated by J.L. Soto 2008  
SOURCE: Instituto Nacional de Laboratorios de Salud INLASA (2005), La Paz, Bolivia

The data presented in Table 2.10., shows that cañahua is especially rich in iron, while amaranth is rich in calcium and phosphorous. Repo-Carrasco (1998) stated that in general, most minerals (61%) are located in the aleurone layer of the grain.

Literature in human nutrition indicates that there are various essential amino acids that the human body cannot synthesize and that need to be ingested in mixed diets. Four of these are lysine, methionine, threonine and tryptophan. In Table 2.11., the values of these four essential amino acids can be compared between Andean grains, rice and wheat.

The values shown by Andean grains regarding the essential amino acids in the protein cover the recommended amino acid requirements for children in different ages, and even for adults (FAO/OMS/UNU 1985).

**Table 2.11.** Content of amino acids in various Andean grains, rice and wheat (g amino acid/16g of nitrogen)

Amino acids	Quinoa	Cañahua	Amaranth	Rice	Wheat
Lysine	5.6	5.3	6.0	3.2	2.8
Methionine	3.1	3.0	3.8	3.6	1.3
Threonine	3.4	3.3	3.3	3.2	2.9
Tryptophan	1.1	0.9	1.1	1.1	1.2

Source: Repo-Carrasco 1998

## Value chain of Andean grains

### Production

#### Cultivation and yield

The major quinoa-growing areas are found around Lake Titicaca on the Northern Altiplano of La Paz, the Central Plateau (La Paz and Oruro) and the salt plains area of the Coipasa and Uyuni salt flats (southern part, Oruro and Potosí), approximately 70,000 ha in total in 2012.

The production of cañahua is limited to a small area of the Andes, and has little importance outside Bolivia and Peru. These grains are cultivated mainly in the central Altiplano of La Paz (Omasuyos, Los Andes, Ingavi, Pacajes and Aroma Provinces), Oruro (Pantaleón Dalence, Cercado, Sabaya, Sajama, Atahuallpa, San Pedro de Totora, Nor Carangas and Tomas Barrón Provinces) and Cochabamba, mainly in the high valleys (Bolivar, Independencia, Arque, Tapacari and Ayopaya Provinces).

Amaranth is currently known as *millmi* throughout the central part of Bolivia, and as *coimi* in the south. It is cultivated on a small scale, with the main production areas found in Chuquisaca (Yamparaez, Tomina, Sudanéz, and Oropeza Provinces), Cochabamba (Mizque, Punata, Arani, Capinota, Campero, Estaban Arce and Quillacollo Provinces), Tarija (Cercado Province) and the La Paz Yungas region, as well as in some high Andean valleys (between 1,870 and 3,100 masl).

#### Quinoa

It has been estimated that there are ca. 70,000 farmers in the northern, central and southern Altiplano dedicated to cultivate quinoa and of these 15,000 are directly linked with external and internal commercialization. The rest of the producers belong to families that cultivate quinoa mostly for self-consumption and exchange with other families (Soraide 2008).

In Bolivia quinoa production is located mainly in the Altiplano region (north, center and south). According to Collao (2004), in the northern and centre Altiplano (2 800 to 4 100 masl), along the banks of the Titicaca lake area characterized

by rainfall fluctuating between 400-800 mm, quinoa varieties with medium sized grains have low levels of saponin. These are known as “sweet quinoa” and are mostly used for self-consumption and for internal markets.

In the southern Altiplano ecotypes of *Quinoa Real* or “Royal Quinoa” characterized by a much bigger grain (larger than 2.2 mm of diameter) with high levels of saponin are produced. Quinoa Real is found throughout the southern part of the country, particularly near the Coypasa and Uyuni salt flats, in the Oruro and Potosí Departments (Rojas et al. 2004). The extent of quinoa cultivation in 2001 was 33,928 ha throughout the Bolivian Altiplano, with a recorded production of 21,739 t, equivalent to an average yield of 641 kg/ha (SINSAAT 2003). The latest statistics show that for the 2012 period an area of 69,972 ha was sown with quinoa, with an annual production of 44,262 t and an average yield of 632 kg/ha (IBCE 2012).

Of the total volume produced in 2012, 59% was exported (26,252 t) generating 79.9 million US\$ revenue for the country (IBCE 2013).

**Table 2.12.** Production scope, yield and cultivated areas of quinoa in the Northern La Paz area for the base year 2001 compared with national production

Province	Area (ha)	Yield (kg/ha)	Production (t)
Camacho	1 474	600	885
Omasuyos	2 262	600	1 357
Manco Cápac	487	600	292
Los Andes	1 333	600	800
Ingavi	1 161	600	697
Subtotal	6 717		4 030
National total	36 100		22 904

*Source: Data collected by the demand assessment study of the production chain of quinoa in Bolivia (FDTA-Altiplano 2002)*

In this study we present data regarding quinoa production and cultivation in communities of the provinces of the department of La Paz, where many varieties can be found that are either underused or neglected. However, quinoa production in this region represents only 18% of the entire Bolivian production, and the IFAD-NUS Project was focusing in this area since it is the most affected by the loss of quinoa diversity.

Table 2.12 shows the data available from year 2001, where the Northern Altiplano produced ca 17.6% of the entire Bolivian production of quinoa. The area was 18.6% of total national cultivation (6,717 ha), with an average yield of 600 kg/ha, compared with overall national average yield of 625 kg/ha for the period.

**Table 2.13.** Presents information on the evolution of quinoa production in Bolivia during the period 2003-2008

<b>Agricultural campaign</b>	<b>Cultivated surface (hectares)</b>	<b>Average yield (kg/ha)</b>	<b>Production( tons)</b>
2003-2004	43,782	565	24,757
2004-2005	44,877	572	25,648
2005-2006	49,357	525	25,907
2006-2007	50,375	460	23,190
2007-2008	50,356	572	28,809
2008-2009	54,242	568	30,810

Source: INE-ENA-MDRyT 2008  
Elaborated by J.L. Soto 2008

According to official data of Instituto Nacional de Estadística (INE) and Ministerio Rural y Tierras (MDRyT) in recent years the cultivated surface has grown ca. 40%. Historical trends of production volumes are related to the cultivated surface, although there has been a decreasing tendency in yield by surface. In 2009 according to statistics of INE and MDRyT, the cultivated surface was 54,242 ha.

### Evolution of quinoa export in Bolivia

According to the data shown in Table 2.14., the development of quinoa export expressed in monetary value and volumes in metric tons from 2004 to 2009 show a significant increase, making Bolivia the first quinoa exporting country at the global level. The main companies that export Quinoa Real are: SINDAN, ANAPQUI, JACHA INTI, SAITE, IRUPANA, QUINUABOL, ANDEAN VALLEY, QUINUA FOODS, plus 12 other small-scale companies.

**Table 2.14.** Evolution of quinoa export in Bolivia

	<b>Year</b>					
	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>
Value in thousands of US\$	4,408	5,573	8,911	13,107	23,028	43,156
Volume in tons (t)	3,910	4,890	7,750	10,585	10,429	14,376
Average price US\$/t	1,127	1,140	1,150	1,238	2,208	3,002

Source: UIEPDS-MDRyT-INE 2009

### Internal market

It is estimated that within the national market 1,000 t of quinoa/year are being commercialized, and the average consumption per capita/year is 5.15 kg. (Table 2.15.). This is considered to be very low in relation to other substitute products such as rice and pasta (Soraide 2008).

**Table 2.15.** Consumption of quinoa per capita (kg/year/person) in main cities in Bolivia

City	Consumption	
	1993	2008
La Paz	4,423	4,448
El Alto	3,586	3,477
Santa Cruz	3,248	3,253
Cochabamba	9,605	5,782
Oruro	9,605	7,252
Potosí	4,873	2,362
Sucre	7,882	9,469
Promedio	6,933	5,149

Source: Soraide (2008) based in Alandia (1993); IICA/PNUD, FAUTAPO (2007), Study on the consumption in cities as Oruro and Potosí

### Cañahua

In Bolivia, the cañahua value chain has many limitations and difficulties, including the availability of consolidated statistics; the species does not even appear in INE's agricultural census. However, certain secondary information has been compiled and is presented in Table 2.16.

**Table 2.16.** Cañahua production, yield and surface cultivated in Bolivia

Agricultural campaign	Cultivated surface (hectares)	Average yield (kg/ha)	Production (t)
2001*	1,530	645	1,000
2002	SI	SI	SI
2003-2004**	932	666	620
2004-2005**	936	697	653
2005-2006	950	665	628
2006-2007	955	660	630
2007-2008	938	627	616

Elaborated by J. L. Soto, 2008 based in different authors: \* SINSAAT 2003; \*\* Ruud Picavet 2005; \*\*\* INE-ENA 2008; Ministerio de Desarrollo Rural y Tierras 2009

In Table 2.16. data reported by SINSAAT (2003) for cultivated cañahua in Bolivia are presented for the period 2001, showing that the cultivated surface with cañahua reached 1530 ha with a production of 1 000 t, and reaching an average yield of 645 kg/ha. Data of the period ranging from 2003 to 2008 can be observed, reaching an average cultivated surface of 695 ha, an average production of 630 t/year, and an average yield of 660 kg/ha. Comparing the periods analysed, the cultivation surface between 2001 and 2008 has been reduced in 55%, and the production has also been reduced in 62%, while the yield has been similar showing little variation from 600 to 650 kg/ha.

## Amaranth

**Table 2.17.** Estimated ranges of cultivated area and production of amaranth (minimum–maximum), and average yield in the main production areas in Bolivia, 2006–2007

Department	Area (ha)	Yield (kg/ha)	Production (t)
Chuquisaca	250–300	817 (18 qt)	204–245
La Paz (Yungas)	100–130	1180 (26 qt)	118–153
Cochabamba	70–90	635 (14 qt)	44–57
Tarija	60–80	726 (16 qt)	43–58
Total	480–600		409–483

*Notes: qt = quintal. Source: Data elaborated based on first-hand information from by key informants, surveys and estimates by JL Soto, 2007*

In Bolivia, amaranth is cultivated at small-scale, being an item that has not received much attention in production regarding its demand on international markets. However, no consolidated statistics on the cultivated surface, yield or production are available.

This study is based on first-hand information provided by key informants who are closely linked to the sector.

Based on the data in Table 2.17, it is estimated that the cultivated area of amaranth in the main production areas is 480 to 600 ha, producing 409–483 t for the 2006–2007 season. Yield is variable and directly related to production area. Yungas, in La Paz, is the highest yielding production area, with approximately 1,100 kg/ha, while yield in other areas does not reach a ton.

## Social, economic and labour issues

There are clear differences between the farming economies in the Andean region compared with other regions, such as the valleys. In the northern Altiplano, both quinoa and cañahua are mainly destined for home consumption, and only a small surplus production is commercialized (10 to 35 kg), although farmers thus make some profit and also cover the demand of internal markets. Small areas are cultivated, ranging from a few rows to a 100 m<sup>2</sup> plot. Usually these crops are



prioritized as third or fourth in importance, after potatoes, fodder and cattle. These crops are usually harvested by the family group and therefore the production system is basically traditional. Nevertheless, farmers from communities linked to the market for Andean grains (processing enterprises and traders) give priority to the cultivation of these crops. They even jeopardize their household food security by preferring to sell their produce (up to 95%) instead of using it for their families.

### Profit margins for producers

Profit margins for farmers that harvest Andean grains are in direct relation to the growing area and the production technology applied is illustrated in Table 2.18.

**Table 2.18.** Gross crop margins (Bolivianos – Bs) for Andean grains in 2007 (estimates)

Crop	Base yield (kg/ha)	Base price (Bs/kg)	Production value (Bs/ha)	Production costs (Bs/ha)	Gross margin (Bs/ha)
<b>Quinoa</b>					
Traditional production	340	2.6	884	600	284
Modern production	780	5.2	4,056	1,400	2,656
<b>Cañahua</b>					
Traditional production	350	3.9	1,365	550	815
Modern production	690	5.6	3,864	1,050	2,814
<b>Amaranth</b>					
Sucre	817	6.9	5,637	2,500	3,137
Yungas	1,360	9.2	12,512	6,000	6,512

*Notes: Exchange rate in September 2010: US\$ 1 = Bs 6.97. Source: J.L. Soto, 2007, based on data collected through surveys and key informants within the sector in December 2007*

As can be seen from Table 2.18, all gross margins are favourable to the producer. This means that producers make a profit from the cultivation of quinoa, cañahua and amaranth, which in some cases exceeds 20%. According to our analysis, this profit margin could be between 45 and 100%, in which case it could be a very favourable business for producers to invest in these crops. However, it is necessary to point out that the base prices were from enterprises that purchase Andean grains of high commercial value, and these prices were at a peak in 2007, having increased significantly from prior years.

However, if we take the base prices from local peasant fairs, where the crops are usually sold, as our reference benchmark, the gross profit margins will

undoubtedly be lower than those shown in the table, and in some cases even negative, as reported by several farmers.

### **Processing and marketing**

The small, yet growing, agribusiness of Andean grains in Bolivia takes generally the form of family enterprises, with limited infrastructure capacity to process or transform foodstuff. The most common activity is the transformation of grains into flour and flakes, broadening their uses, for example for popped products.

Nevertheless, a great number of products derived from quinoa, cañahua and amaranth grains can be found throughout the country, including biscuits, instant soups, *api* (hot drink) porridges, candies, marmalades, cheese snacks, snacks and even pasta (see Tables 2.19 and 2.20).

### **Processed products on local markets**

Andean grains can be combined with legumes as dry lima beans or tarwi to enhance the quality of the diet especially for children through breakfast. However, the involvement of the agroindustry is still incipient. Currently there are various elaborated and semi-elaborated subproducts that can be found, although their prices tend to be high and therefore most of the population is not able to purchase them (Rojas et al. 2010). In local markets and supermarkets various processed products based on Andean grains, as the ones mentioned below, can be found:

### **Quinoa**

#### **Washed quinoa (pearled quinoa)**

This term applies to selected quinoa grains that have been processed to be “saponin free or scarified”, whereby saponin (a bitter substance of the grain) is eliminated and the grain becomes suitable for human consumption. The washed quinoa grain, also known as pearled quinoa, can be used in the preparation of soup or meal, toasted, drinks and for other processed foodstuff.

#### **Quinoa flakes**

The washed quinoa grain is flattened by passing between steel rollers, resulting in flakes between 0.1 and 0.4 mm thick. The flakes can be used in soup, drinks, as a breakfast cereal (similar to rolled oats), in confectionary and other products.

#### **Quinoa flour**

The washed quinoa grains are crushed, ground and sifted, resulting in fine flour 0.3 to 0.8 mm particle size. A hammer and disc mill is used. The flour can be used for bread making in lieu of wheat flour at up to 20–30%. It is frequently used in confectionary items such as cakes (pastries), biscuits, porridge, pasta and noodles.

#### **Expanded quinoa or popped quinoa**

This product is normally referred to as expanded quinoa grains, produced from washed grains that undergo an expansion process. Expanded quinoa (insufflated) is processed through a combination of heat and pressure; an insufflating machine

also known as a popping machine, is needed. The resulting product must be consumed immediately, and may be covered with various coatings (vanilla-flavoured coating, chocolate, honey, etc.).

### **Cañahua**

#### **Washed grain**

The cañahua grains are selected and washed, and used as raw material for subsequent transformation to produce cañahua powder and raw flour, which is used for bread making.

#### **Cañahua powder**

Toasted cañahua flour can be mixed with water or milk for an instant beverage, or as a simple infusion. It is also used in the pastry industry. It has a pleasant taste and has been an important and essential part of the diet in the Andes since ancestral times. It has a high caloric content and easily assimilated iron and fibre.

#### **Raw cañahua flour**

Cañahua flour is the result of grinding washed grains, which are subject to crushing, grinding and sifting, resulting in flour of 0.3 to 0.8 mm particle size. This is a fairly new product for many consumers; however it is increasingly being used for pastry and bread.

### **Amaranth**

#### **Washed grain**

Selected and washed grains are used to produce stews, soups and other dishes, as well as beverages.

Amaranth grains are very small, between 1.0 and 1.5 mm in diameter, and their physical composition is very similar to that of the quinoa grain (without the bitter taste of quinoa).

#### **Flour**

Blended with other cereal flours, it is used to prepare dough for bread, pastries, cakes and related products, resulting in nourishing products with good flavour.

#### **Popped grain**

One of the most common uses is as cooked grains (toasted or popped), which can be consumed in lieu of bread.

### **Further-processed products in local markets**

Agribusiness in Bolivia has developed new products based on Andean grains, primarily quinoa, amaranth and cañahua. These involve the intermediate products mentioned above, as well as final products. They are being retailed in local markets, specialized venues and supermarkets. They are all different regarding their degree of development, but nevertheless demand has increased

substantially, and one can see an ever increasing presence of these products in more commercial venues. Some of the newly developed products are considered below.

#### **Noodles and pasta (quinoa)**

The use of quinoa flour for noodles and pasta is a highly promising alternative for the food industry. These are non-fermented products based on of non-fermented mixtures duly mixed and kneaded, mixed with wheat flour and clean water (Mújica et al. 2006).

#### **Muesli (quinoa, cañahua and amaranth)**

Muesli is a mixture of different cereals (usually wheat and oats), plus Andean grains (quinoa, cañahua and amaranth), with dried fruits (dates, raisins, etc.) and other ingredients (coconut, almonds, honey, etc.), clean water and vegetable oils. The usual raw material is oat flakes; nevertheless one may use wheat and Andean grains flakes as well. The name muesli (spelt müsli) is common in Europe (Repo-Carrasco 1998). Muesli is ready to eat (instant), usually mixed with milk or yogurt, mainly for breakfast.

Among the newly developed products are chocolate- or honey-covered energy bars, extruded cheese puff snacks, biscuits, and instant beverages such as quinuachoc and chocomill, that have a good market acceptance.

#### **Packing and marketing of transformed products**

Small- and medium-sized agribusinesses that process Andean grains market their products through local markets, general stores and even supermarkets and health food outlets in all important cities of Bolivia, such as La Paz, Cochabamba and Santa Cruz. Good improvements have been achieved regarding presentation, packaging and hygiene, as well as quality guarantees. Most products have been properly registered with the Sanitary and Health Agency, carry nutritional information, due dates and other label requirements for their sale for human consumption.

Table 2.19 shows the prices of transformed products based on Andean grains (the lower prices being in local markets and higher in supermarkets), quantities and presentation.

Looking at prices of transformed products based on Andean grains, we find that: quinoa in local markets is from Bs 10.0 to 12.0 per 454 g (1 pound); in supermarkets the same product retails for Bs 19.00 or more per 454 g (i.e. 58% more). Other products, such as flakes, flour and popped snacks show a similar price differential.

With cañahua, the most sold product in local markets is the powder, which costs from Bs 4.0 to 5.0 per 454 g, while in supermarkets it is Bs 2.5 more on average. Processed grain and popped cañahua are sold only in some specialized venues or supermarkets. Amaranth has a similar pattern. The most sold product in the market is popped amaranth, which is sold at Bs 5.00 to 8.50 per 200 g. Processed amaranth grain and flakes are only found in supermarkets and specialized health food stores.

**Table 2.19.** Prices and quantity of processed products based on Andean grains on different markets

Market	Processed products	Quantity	Cost (Bs)	Cost (US\$)
Tienda especializada Alimentos Naturales Orgánicos IRUPANA** y Super Ecológico AOPEB (San Pedro)	Quinoa grains		19.0	2.7
	Cañahua grains	500 g	10.0	1.4
	Amaranth grains		15.0	2.1
	Quinoa flakes			
	Cañahua flakes	200 g	9.5 - 12.0	1.3 - 1.7
	Amaranth flakes			
	Pipocas quinoa		8.0 - 12.0	1.1 - 1.7
	Pipocas cañahua	200 g	8.0 - 12.0	1.1 - 1.7
	Pipocas amaranth		9.5	1.3
	Softdrink Quinoa-Cañahua-Amaranth	450 g	10.0	1.4
	Quinoa flour	500 g	7.5	1.1
	Bread Quinoa-Cañahua-Amaranth	10 units	5.5	0.8
	Cookies Quinoa-Cañahua-Amaranth	14 units	7.0	1.0
Rodríguez	Quinoa grains (plastic bag)	454 g	10.0 - 12.0	1.3 - 1.7
	Quinoa (bulk)	454 g	8.0	1.1
	Quinoa flakes	225 g	3.0 - 3.5	0.4 - 0.5
	Quinoa flakes (bulk)	454 g	6.0	0.8
	Pipocas	1 kg	20.0	2.8
Supermercado KTAL (Miraflores)	Quinoa hamburgers	375 g (5 units)	31.5	4.5
	Pito quinoa	320 g	7.0	1.0
	Turrone Quinoa-Cañahua-Amaranth	6 units	10.5	1.5
	Quinoa grain (box)	500 g	19.0	2.7

\* grain, flakes, flour, pipocas – prices are similar to the ones in specialized stores

T/C 1 US\$ = 6.97 Bolivianos (october 2010)

SOURCE: J.L. Soto (2010). Elaborated using price probes and key informants, SINDAN-Sabor Andino (2010)

\*\*Specialized store in natural an organic food IRUPANA

As shown in Table 2.19, there are over 30 enterprises that commercialize Andean grains. Almost all are marketing the product under different brands available in grocery stores, local markets, weekly fairs, supermarkets and specialized venues.

### **Markets**

There is little information on markets (offer and demand) of these traditional crops. They are underutilized and have not been included in the production chains of the country. As a consequence they have been neglected in terms of studies regarding their commercialization and consumption potential, with the exception of the quinoa from the southern Altiplano.

In this context, it is important to identify the target markets and the means of accessing them. Also, the characteristics of such markets, of potential consumers (needs, preferences and requirements) and commercial channels have to be studied as well.

One thing is certain: international demand is not seasonal. Quite the opposite, as these crops (quinoa, cañahua and amaranth) are commercialized all year round.

### **Commercialization channels and volume**

One of the most important components in agricultural value chains is the commercial link or contact, and in this particular case the harvest and sale of the crops become bottlenecks for producers, which must be overcome through efficient strategies.

A number of commercialization channels have been identified in those areas where quinoa, cañahua and amaranth are produced. Production on the central and northern plateaux and inter-Andean valleys is mostly destined for home consumption (40–90%). The surplus production (10 to 60%) is either sold to local collectors, who use their own capital, or to intermediaries, who work for wholesale collectors. They collect and accrue the production throughout the year and later sell it to agro-industrial users of Andean grains.

The sale and purchase of the grains in some production areas occurs within the community, or even at the home of the producer. In some other cases, it occurs at weekly fairs. The local collectors have access to transportation means from community to community in remote areas, where producers have little or no chance to deliver their produce to markets. They are therefore forced to sell their product at the prices set by such collectors, with no alternative. Another scenario is where the intermediaries collect the crops to be later delivered to large, wholesale collectors or directly to industrial users.

Nevertheless, there are recent examples where the producers have organized themselves as cooperatives or producer associations in order to commercialize their products, such as the quinoa producers of the Jalsuri and CELCAV cooperatives in La Paz, and the cañahua producers in Llaytani, Cochabamba.

**Table 2.20.** Transformed products based on Andean grains, by company

<b>Company</b>	<b>Location</b>	<b>Transformed products offered</b>
El Principe	La Paz	Quinoa (grain and flakes)
Grano de Oro	La Paz	Quinoa (grain and flakes)
Productos QUINAL	La Paz	Quinoa (grain and flakes)
MER FRUT	La Paz	Quinoa, amaranth, (popped, marmalades and porridge)
Cambita	La Paz	Quinoa, cañahua, amaranth (popped, chocoquin, chocomill, multi-cereal)
Dely Postre	La Paz	Quinoa (popped)
Kollita	La Paz	Quinchoc, muesli, popped
El Ceibo	La Paz	Quinuachoc, energy bars
Industrias IRUPANA	La Paz	Quinoa, cañahua, amaranth (grain, flakes, popped, powder, biscuits, bread, energy bars)
Los Andes	La Paz	Quinoa, cañahua, amaranth (grains, flakes, powder, flour)
Princesa	La Paz	Quinoa (flakes)
Pachamama	Oruro	Quinoa (grain and flakes)
Pandela	Oruro	Quinoa (grain and flakes)
AAA	Oruro	Quinoa (popped, pastries)
Producto Lupuyo	Oruro	Quinoa (grain)
Productos Cocinero	Sucre	Quinoa (toasted, flakes, porridge)
La Glorieta	Sucre	Quinoa, amaranth (porridge, popped)
Punto Natural	Cbba	Quinoa (Flour, flakes, instant beverages)
PROANAT	Cbba	Quinoa (popped, instant beverages)
QUINUTRION	Cbba	Popped, energy bars
Andes trópico	Cbba	Quinoa, cañahua, amaranth (flour, candy instant products)
Industrial Blach	Cbba	Quinoa, amaranth (grain and flakes)
PROTAL	Cbba	Quinoa (grain)
Industria Coronilla	Cbba	Quinoa, cañahua (snacks, pasta, Andean Muesli)
CERETAR	Cbba	Biscuits, cheese puffs. muesli
NUTRICER	Cbba	Cerechoc
Productos WARA	Cbba	Quinoa (pastries, extruded)
TENATUR	Cbba	Quinoa soy
Productos Trigal	Cbba	Quinoa (grain, flakes, instant beverages)

Source: J.L. Soto, 2007, data collected through surveys, December 2007



### Sale and price systems

The most common sale system in the northern plateaus and inter-Andean valleys is cash, although barter still exists in some regions. Barter is not based on a specific unitary value; it is spontaneous and depends on the products that are exchanged, such as bread, rice, noodles or seasonal fruits.

Cash sales are made at local weekly fairs, and generally to intermediaries or collectors, who are usually the ones that set the price.

### Producer prices in community markets or regional fairs

Table 2.21 shows the sale prices for Andean grains at local fairs. The variations found reflect the season, with the lowest prices being within the harvest season, and a steady increase in price in periods where the demand is high and offer is low.

As can be seen from Table 2.21, the prices for unprocessed grains (quinoa, cañahua and amaranth) vary widely. The lowest values are the prices obtained by the farmers at community or local fairs, where the brokers or intermediaries are the ones to set the price, based on offer and demand. The product is usually not homogenous, but a mixture of grains of local varieties, and thus it is considered of low quality. In contrast, the highest values are for products that are commercialized in an organized manner to processing plants or exporters. The quality of such grain is considered high (with no mixture of varieties) and suitable for organic production or further processing.

**Table 2.21.** Variation in sale price for various Andean grains in local fairs in Bolivia

Market	Product	Price variation (Max-Min) expressed in Bolivianos (Bs)			
		Kilogram	Arroba (Bs/@)	Quintal (Bs/qq)	Quintal (US\$)
Challapata, Oruro	Quinoa (south)	13.0 - 14.8	150 - 170	600 - 680	86 a 98
	Pasakalla	26.1	300.0	1200.0	172
Batallas, La Paz	Quinoa (north)	7.4 - 8.3	85 - 95	340 - 380	49 a 55
La Paz	Cañahua	6.5 - 9.8	75 - 112.5	300 - 450	43 a 65
Chuquisaca	Amaranth	8.7 - 9.8	100 - 112.5	400 - 450	57 a 65

1 arroba (@)=11.5 kg; 1 quintal (qq)= 46 kg                      T/C: 1 US\$ = 6.97 Bs. (June 2010)

Source: J.L. Soto, 2010. Elaborated using Price probes and key informants, SINDAN, IRUPANA, ANAPQUI (mayo - junio 2010)

If we compare the prices at fairs with those paid by enterprises, we find differences of up to 100% in the case of the quinoa from the north Altiplano. The

price differential for cañahua can be up to 44%, and in the case of amaranth approximately 31%. This means that farmers have greater profits if the grains are commercialized directly to enterprises, eliminating the intermediaries, who in many cases work on a profit margin of 10 to 20%.

### Competition (Peru, Ecuador and others)

Other major producers of quinoa, cañahua and amaranth include Peru and Ecuador. They are Bolivia's main competitors in both production and export. Although Bolivia is considered the leading country for quinoa exports on a worldwide basis, both Peru and Ecuador pay close attention to the international markets for Bolivian quinoa, since their marketing strategy is based on the diversity of crops. In the case of cañahua, only Peru may be considered a serious competitor, based on harvest areas and volumes of production; however, there is no reliable information available on international sales. In the case of amaranth, the production of the Peruvian Andes is being exported to international markets. Although Bolivia has great potential for these export crops, greater effort and support are needed, especially for cañahua and amaranth.

### Main players in the value chain

#### Characteristics of the main players

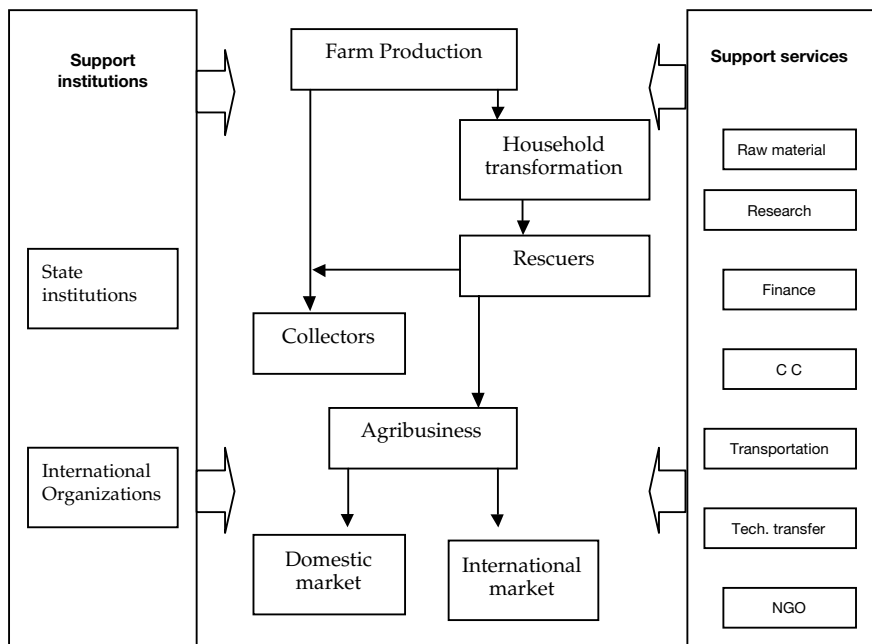
Direct players are those individuals directly related to the production of quinoa, cañahua and amaranth (whether small-, medium- or large-scale producers), rural collectors, intermediaries, wholesalers, processing plants and fractioning plants, as well as companies and individuals that commercialize the final products. At the same time there are indirect players involved in peripheral services to the production chain, such as research entities, technical assistance, organic certifiers, transportation providers and others.

The production chain of cañahua and amaranth is not yet fully developed, compared with that of quinoa, which has a highly developed chain particularly with regard to quinoa from the southern plateaux. Geographically, these chains are mainly located in the Altiplano regions of Bolivia (quinoa and cañahua) and the inter-Andean valleys in the case of amaranth.

Based on the scheme of Figure 2.1, a number of significant players within the quinoa production chain can be identified:

- **The farmer and his/her family:** They generally are involved in the provision of seed and fertilizer (guano), and actively participate in the entire production process. They are responsible for sowing, harvesting and post-harvest production activities for both home consumption and the market. The process varies according to the area, but traditional farming methods are generally used.
- **Producer associations:** These are usually present throughout the production chain, and in many cases give support regarding organic production. They play an important role in the collection of the crops, and have acquired experience in export procedures.

- **Private enterprises:** They usually take part in the collection, processing and commercialization of the crops.
- **Rural collectors:** They play an important role in the collection of large volumes of the production. They are present all around the production area and at local fairs, and they supply wholesale collectors and intermediaries.
- **Intermediaries:** These are individuals or family groups who are acquainted with the different commercialization channels, and who maintain good relations with producers. They are also well informed on current prices, and they deliver the collected crops to the domestic or Peruvian markets, or to export companies.
- **Support services:** This group involves institutions that give support either in research or transfer of knowledge and technology. This group includes those involved in transportation, certification and NGOs.
- **Support Institutions:** The support comes from the central government; prefectures (through their Servicio Departamental Agropecuario - SEDAG); municipal governments of Oruro, Potosí and La Paz; and international institutions, such as the World Bank, Cooperación Andina de Fomento - CAF, and others interested in the development of value chains. The crop that receives most support is quinoa.



**Figure 2.1.** Value chain structure of quinoa in Bolivia

Source: Plan Estratégico Integral para la Cadena Productiva de la Quinoa (Collao 2004)

## Product flows

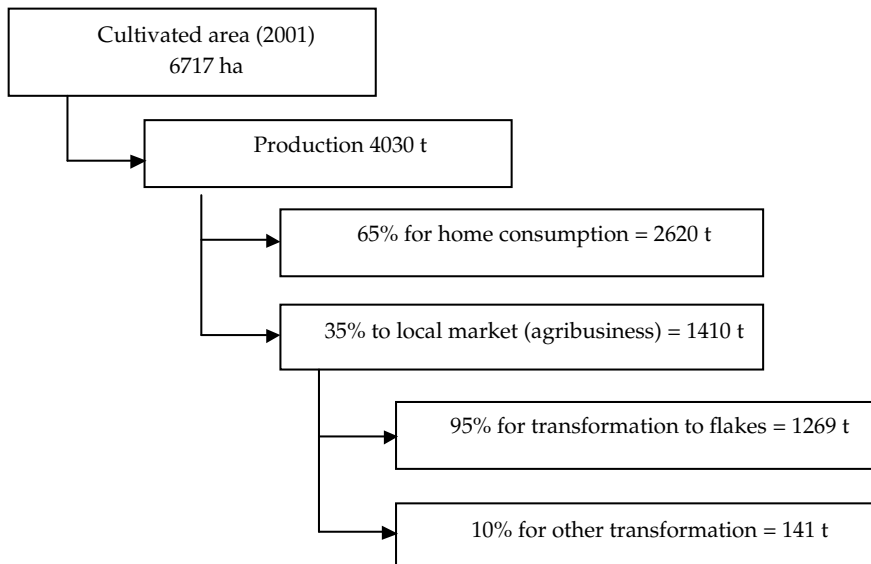
Figures 2.2 to 2.4 show the product flows for the three Andean grains. Destination and volume of production are based on the data used in this study.

The data refer to the northern Altiplano provinces in 2001, with an area of cultivation of approximately 6 700 ha and 4 030 t production, with 65% destined for home consumption and the remaining 35% goes to local agribusiness, which processes 90% into flakes and the rest as washed grain.

### The Cañahua product flow

The cultivated area of this crop was approximately 930 ha in 2003, with production of 666 t. Of that, was 80% for home consumption, and the remaining 20% for agribusiness and the local and international markets, with 17% manually transformed into powder. For 2005, 20 t worth about US\$ 20 million was exported.

### The quinoa product flow



**Figure 2.2.** Product flow of quinoa in North Altiplano provinces of Bolivia.

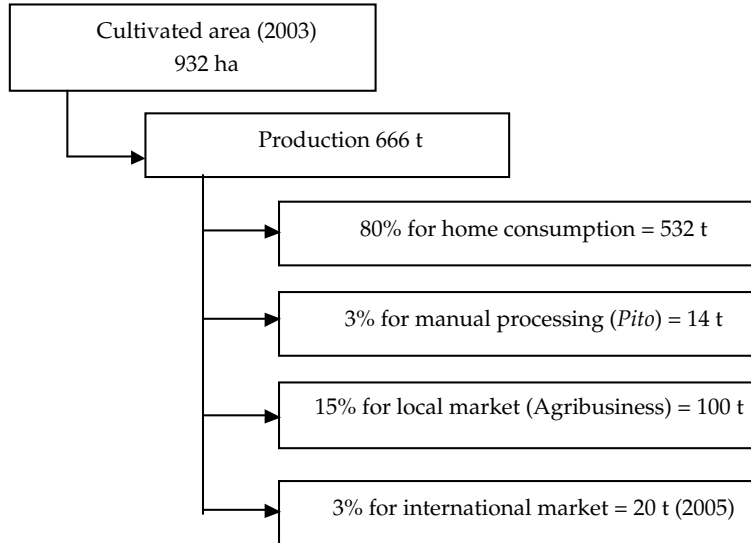
*Source: Present study, based on the model proposed by Medeiros, Crespo and Sapiencia 2007*

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**Figure 2.3.** Product flow of cañahua in North Altiplano provinces of Bolivia.

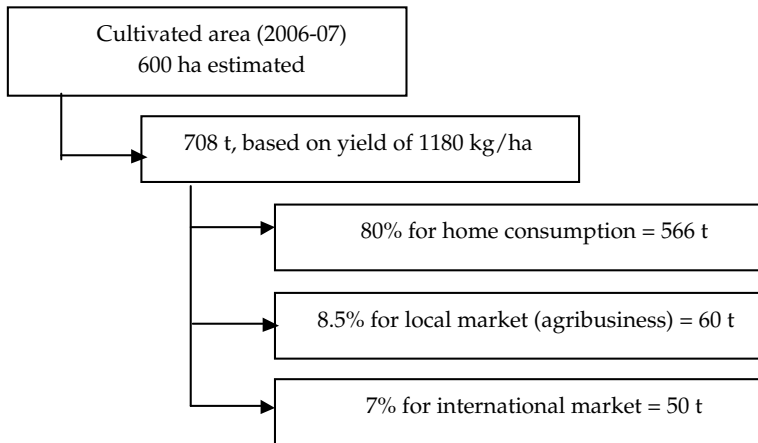
Source: present study, based on the model proposed by Medeiros, Crespo and Sapiencia 2007

### The amaranth chain

As mentioned earlier, in view of the lack of any official information, the data for this chain is based on surveys and information collected. According to these sources, the total cultivated area was over 600 ha for the 1996–07 season, with production of about 700 t; 80% went for home consumption and the remaining 20% commercialized in both local and foreign markets. This grain is usually destined for the production of popped grains and amaranth powder in the local market. According to the data issued by Cámara de Exportadores de Bolivia, CAMEX (2007), Bolivia exported 102 t, worth about US\$ 126 000. Note that Figure 2.4 shows production of only 50 t from Chuquisaca and Yungas; we assume that the 52 t difference is due to product which has been first imported into Peru, and then re-exported.

### International demand and requirements

The production of the Andean grains quinoa, (northern and central Altiplano), cañahua and amaranth is very important for the growth and development of the Bolivian economy. Increased production and export of these products, either in their natural state or processed, would be an important source of labour and income for small-scale farmers and all those involved in the value chain (in commercialization, conversion, transportation, export, etc.).



**Figure 2.4.** Product flow of amaranth in North Altiplano provinces of Bolivia.

Source: Present study, based on the model proposed by Medeiros, Crespo and Sapiencia 2007

### Opportunities in foreign markets

Andean grains (quinoa, cañahua and amaranth) are highly valued in foreign markets due to their nutritional values and potential for organic production. They are considered healthy, natural, exotic dietary products that come from the Andean region. They are easy to cook, very rich in proteins, and gluten and prolamin free. When comparing the three crops and their standing in international markets, we find that the so-called Quinoa Real, which comes from the southern Altiplano, is the most conspicuous of these grains in foreign markets. The official data for Bolivian exports show steady growth. Countries such as the United States of America, France and The Netherlands were the leading buyers of these products in 2005, with an export volume of 4,755 t worth about US\$ 5.54 million. The 2006 export volume exceeded 7,600 t, worth about US\$ 9 million (CAMEX 2007). Thus, quinoa exports increased by over 58% from 2005 to 2006, and productive capacity could be adapted to international demand.

Quinoa that originates in the central and northern Altiplano is characterized by its small- to medium-sized grains, which are usually used to produce transformed products (washed grain, flakes and flours) for the local market (domestic agribusiness). However, according to some sources (producers themselves) and others, it is sold at the Fair in Challapata-Oruro to Peruvian entrepreneurs, who smuggle it into Peru. The volume of this activity is calculated at approximately 6 500 t/yr, with an approximate value of US\$ 4.5 million at the Desaguadero market.

According to Soraide (2008) quinoa production in 2008 was priced in US\$ 52,748,420, being exported officially 10,300 t of Quinoa Real with a price of US\$ 23,308,900 and a non registered and illegal estimated volume of 9,000 t smuggled through the Peruvian frontier through the city of Desaguadero with a value of US\$ 20,367,000. The value of the internal market consumption is estimated in 4,350

t with a value of US\$ 7.920.500, highlighting the fact that due to the strong price increase in quinoa in the referred period, national consumption has decreased and the surplus has been exported through smuggling to Peru.

Amaranth is the next grain of importance in international markets. According to CAMEX (2007), 123 t were exported in 2005 worth US\$ 133,449; in 2006 the volume was 101 t, worth about US\$ 126,299.

Cañahua has been exported since 2003. Enterprises such as THUNUPA, IRUPANA ANDEAN ORGANIC FOOD S.A. and CORONILLA have channelled cañahua exports to the North with small volumes, which have increased through time. There are currently no data available for the volumes that have been exported; in many cases they have been subsumed in quinoa data. According to CAMEX, 20 t were exported in 2005, with an approximate value of US\$ 20,000.

Informally the authors have obtained information from different companies that in the last five years they have been exporting amaranth and cañahua mostly to USA and Europe. They have mentioned that there is a high demand for these products, but there are no official records currently stated in the Bolivian Institute of External Commerce. So there are no official data on exported volumes and prices for amaranth and cañahua, in contrast to the high amount of data that can be found for quinoa real produced in the Southern Altiplano in Bolivia

### **Bio-markets for the Andean grains**

In biological markets, all activities from production to collection, conversion and commercialization are based on the preservation and sustainable use of native biodiversity. Environmental, social and economic sustainability is an important prerequisite.

Andean grains are the second most important product group within the Bolivian bio market (IBCE 2007). The production of these crops not only feeds the farmer families in the Altiplano regions of Bolivia, but the crops are also commercialized in local, urban and national markets, and exported (generating export revenues of up to US\$ 10 million annually).

Quinoa is the most important crop due to its adaptability to extreme climates in the Altiplano regions of Bolivia, and, combined with its nutritional value, has been able to conquer markets in Europe, USA and Canada.

### **Sustainable development of native products**

The National Sustainable Bio-marketing Programme (PNBS) of Bolivia has been able to establish and identify 30 renewable products with a sustainable marketing potential, including amaranth, cañahua, maca, cacao and groundnut (Biocomercio 2007).

Distribution channels already exist for biological products. The Naturalia and Super Ecológico chain stores in Bolivia rely on the well developed sales and distribution networks for products manufactured by communities and producer organizations, facilitating their commercialization and making these chemical-free, environmentally sound products available in Bolivia and abroad at competitive prices. These outlets stock quinoa, amaranth, cañahua, maca, bread, coffee, medicinal herbs and others.



Export possibilities are very good, considering that these products benefit from preferential tariffs in most of the more developed countries, fact that enhances their competitiveness. With a focus on sustainable management, protection of the environment, fair trade and organic production, prospects could be further improved.

The sustainable use of biodiversity not only generates income for the country, but exports also benefit the economies of the producers as the fundamental players in this process, together with all those active in the different stages of the value chain. For these reasons, it has potential for greater revenues for their communities, relieving many of them from poverty, granting them a chance of a better life, education and training, and the opportunity to become part of the globalization process without abandoning their ancestral customs and traditional ways.

### **Norms for export of ecological products**

Due to stricter environmental legislation in many countries around the world, importers of products designated “ecological” have to meet strict requirements regarding the products themselves as well as the packaging and containers used. Annex 1 highlights such requirements, including eco-labelling.

## **Future opportunities and challenges**

### **National policies**

Having seen and analysed the many social, economical, nutritional and dietary advantages offered by the Andean grains, it is important to identify suitable steps towards achieving utmost benefits from them, especially in favour of the small-scale farmers that produce these grains, allowing them to improve their income and quality of life (MDRyT 2008).

To that end it is of great importance to establish a solid and sustainable strategy that allows all Andean crops in general, and particularly the three discussed in this study, to have access to fixed, secured national and international markets. This has to be done through state policies that support and aid the entire production chain, from sowing to production, export and commercialization.

The Bolivian government has formulated policies to favour all Andean crops in general, focusing on support for production, in order to expand domestic and foreign market presence. These policies are part of several frameworks, including the National Development Plan and the Sectoral Development, Rural Revolution, Farming and Forestry Plan of the Ministry of Rural Development and Environment (Ministerio de Desarrollo Rural y Medio Ambiente MDRyMA, currently Ministerio de Desarrollo Rural y Tierras-MDRyT), which complement each other. The Plans were developed for the period 2006–2010.

### **The National Development Plan**

The Farming Development section of the National Development Plan (NDP) establishes seven priority policies to aid the development of this sector, mainly in favour of small-scale producers. Among these policies, two specifically support neglected or underused crops, providing better income and the improvement of

the lives of small-scale producers. These are:

- **Policy 5: Production for dietary sovereignty:** “This policy will achieve dietary self sustainability, granting priority to those local crops that yield high nutritional values which have been replaced by alien foodstuff.” (...) *“This programme will be encouraged by an extension of the school breakfast programme from a four-month average to at least six months, and may include lunch as well. These State purchases will allow more dynamic production and the conversion of native crops with high nutritional value.”*
- **Policy 6: Rural Development:** The purpose of this policy is the strengthening of producers, manufacturers and domestic markets. *“... another programme that will aid in the development and creation of local, small- and medium-size enterprises (PyMES), producer associations, and peasant financial organizations (OECAS) who may participate in, and be awarded municipal public bids to generate further economic development (employment and income) at local levels. The State shall encourage the conversion of basic staple crops in rural areas, through training, support to those communities and Producer associations, OECAS and PYMES, as well as the supply of energy and productive infrastructure.”*
- Policy 6 contains a specific market promotion programme: *“Under the programme The Promotion of local and foreign markets, a market intelligence system will develop which will give access to timely and accurate information on volumes, areas of production, prices and buyers. Furthermore, the producer associations will be strengthened through funding of their business plans. All the foregoing shall be implemented through the execution of the following projects: The National Market Intelligence System – SIM; support to organize small- and medium-sized producers for commercialization within the framework of the “Buy Bolivian-made Products Law” (Ley del Compro Boliviano); the promotion and support of small- and-medium size producers in improving management of the School Breakfast programme; rural support to Production (APRU); and encouragement of foreign trade.”*

Another innovation within NDP is that related to the active participation of the State in several enterprises, mainly in training and development of capacities, and thus the support given to industrial conversion, manufacturing and handicrafts. The Plan emphasizes:

*“...among the most important potentials to make Bolivian production more dynamic, we find those related to natural renewable resources. In order to convert them into revenues within the framework of the export primary pattern, they need to go through conversion processes, adding industrial value, and the opening of new markets. Nevertheless, the foregoing requires the participation of several different players, who up to date have not been able to come together and create an adequate and efficient link. It is within this context that the participation of the State is compulsory, as a catalytic of these links by encouraging: a) the research of new or traditional uses—based on local native knowledge—of such*

resources, b) the development of different procedures of conversion up to its commercial form and its transfer to the productive sector, c) the execution of such processes within industrial production, d) quality control and certification procedures of all the stages thereof, e) the innovation in the process to open new markets and commercialization, and f) training in enterprise management. These activities shall be performed by areas, on the basis of already existent infrastructure and activities on national and departmental levels, performed by public and private agents. Nevertheless, within this context, the State shall favour small-scale producers and the associations thereof. The selected areas as a starting point are: Andean grains, tropical, exotic fruits, medicinal plants and nutraceuticals (EOS), camelids, oleaginous plants, exotic hides, precious woods and tourism.”

Finally, within the Framework of Strengthening and Restructuring of Technical Services for Production, several new programmes will be created. One of them is the Production Alternatives for Dietary Sovereignty Programme:

*“The lack of nourishments and foodstuff of our population is evident, and thus, it is compulsory that we alleviate such situation through alternative proposals in the use of highly nutritional products, support the elimination of malnourishment to zero, and the production of new foodstuff such as soy and its derivatives, tarhui, chestnuts, cañahua, maca, maize, quinoa, amaranth, cassava, dry llama meat, guinea pig and others.”*

These programmes and policies are a good basis for revitalizing the use of Andean grains by supporting their production and processing with technologies, resources and public-private alliances. Support interventions could be at the harvest and post-harvest stages with equipment and technology; at the conversion stage, with technology to add value to the products; at the commercialization stage, by facilitating the organization of solid and sustainable producer associations, the creation of new local markets pursuant to the “Compro Boliviano” and expanding in foreign markets through promotional strategies.

Therefore, the research and development institutions, particularly those working with neglected and underutilized species, must work closely with the State in order to contribute to the implementation of these plans and policies, allowing the benefits to reach the small-scale producers and allowing them to increase their revenues. Furthermore, these plans and policies are a great contribution to the prevention of genetic erosion of valuable Andean crops.

### **The MDRAyT Sectoral Plan**

The Sectoral Plan developed by the Ministry of Rural Development and Environment, within its policies, strategies and programmes aims to boost production, commercialization and consumption of native crops from the different farming regions of Bolivia, including, of course, the Andean region. With these policies and the Rural, Farming and Forestry Revolution, the government is trying to revitalize native Andean crops such as cañahua, amaranth and quinoa.

*“The revaluation of strategic crops: Granting priority to the coca leaves, its production, consumption and industrialization given its importance as means of life for rural populations as well as its symbolic and cultural value,*

*other crops specially those Andean crops with high nutritional values (quinoa, amaranth, tarhui, cañahua, etc.) which have been replaced at the local and national levels for alien products, allowing these populations to cease the intake of such nutritious and healthy products must also be emphasized and encouraged. It is within this context that there is evidence of the potential of such crops to contribute to the Dietary Security and Sovereignty plus the generation of revenues from international markets thorough their industrialization. These are great advantages that have caused the constitution and multiplication of organizations and association of small-scale producers whose purpose is to recover all local, ancestral produce and to re-introduce them into the dietary customs of these peoples. “*

As it can be seen, Andean grains are considered *strategic crops* and within this framework, the local and international market opportunities are quite encouraging. Opportunities will increase and farmers that grow Andean grains have the chance to improve their income.

Within the framework of the Sectoral Plan, there are other policies, strategies and programmes, which are considered in the following paragraphs due to their importance and their support to Andean grains.

**“Policy 2. -Change in dietary and farming patterns:** *This is designed to create a profound change in the productive systems used by rural farmers, granting them the support needed to consolidate more ecological and sustainable and efficient farming systems with social responsibility which may guarantee the Dietary Security and sovereignty, as well as the development of rural production. It is within this context that the role of the native, indigenous families based in communities will be strengthened and thus encouraged and the quality and quantity of the products grown by these farmers improved by acknowledging the real value of the consumption of such foodstuff and the favourable contact with the domestic market. It will also boost technical and mechanical procedures in farm production, the diversification of farm production and the development of small-scale conversion of produce. Therefore, the conversion procedures of the production and dietary patterns will be directly linked to the simultaneous development of production procedures related to Dietary Security, and the development of rural productivity.”*

Within this policy, several programmes will be developed, the most relevant are:

- **SOW – the human right to food:** The purpose of this programme is to encourage, within the framework of the National Council for Food and Nutrition (CONAM), coordination between private and public players in order to acquire a sense of identity of the nutritional requirements of the local population and its projection in time by permanently identifying and following up on the actions to be implemented by the local, departmental and national players in order to satisfy such requirements, thus contributing to the purpose of Dietary Security. Campaigns and educational activities will also be developed, as well as training and communication on the Human Right to Food.
- **BREED – dietary security (The creation of rural dietary initiatives):** This programme encourages food production for household consumption and

dietary security, through native, peasant family farming with a community base. The strengthening of community enterprises with initiatives intended for the production of fresh and quality products (dairy, fruits, fresh vegetables and other nutritious products such as tuber roots and grains) for sale at secured and local markets will also be encouraged.

- Nutrition and dietary security are clearly the main focus of this policy and its programmes SOW and BREED. The use of highly nutritional foodstuffs will be a priority, granting great market opportunities for Andean grains and crops.
- Another very important program is EMPOWERMENT, which is designed to provide resources to the foregoing initiatives. It supports producer organizations to improve rural production.
- **EMPOWERMENT (Organized Enterprises for the Self Managed Rural Development):** This programme falls within the framework of the strengthening of farming, non-farming and forestry productive initiatives of the rural producers through reimbursable and non-reimbursable financial support. A very important issue to encourage and support the use and recovery of neglected and underutilized species is undoubtedly funding.

Finally, another policy that is designed to encourage and boost the production and consumption of neglected and underutilized Andean and other regional crops is the following:

***“Policy 3. Support of the production and conversion of renewable natural resources:*** *This policy will promote the development of the support process to farming and dietary production and conversion of strategic produce in Bolivia; it is designed to encourage and generate greater aggregate value in order to increase profits and revenues to both the local production and population through new labour sources. The industrialization of the farming and forestry sectors is mainly based on the establishment of public social associations and enterprises through the close cooperation and alliance with producers. “*

### **A new market**

An increasing number of people in developed countries are becoming more conscious of organic production methods and the manner of use of fertilizers and other inputs. During the past 20 years these alternative consumers have created a differentiated market, based on “ethical consumption”, i.e. preferring organic coffee purchased direct from producers; acknowledging vegetables as healthy food; and regarding farmers as the builders of new social wealth.

The new consumer has become democratic, showing responsibility for the environment, and, above all, “fair” to producers.

As a result, a new “solidarity market” has emerged, where consumers are willing to pay a much higher price for organic or fair trade products, or both.

Bolivia undoubtedly has potential within this solidarity market, especially regarding handcraft products (e.g. wool products from llama, alpaca, vicuña and sheep) and foodstuff (quinoa, cañahua, amaranth, cacao, aromatic herbs etc.). It also has great opportunities in niches of foreign markets. A niche can be defined as the combination of several conditions that allow a unique product of a species

to thrive within a broader ecological or commercial environment. The market for Andean grains basically comprises quinoa and amaranth. But there are other grains, such as cañahua, that are produced on a much smaller scale, but that have comparable nutritional characteristics, even if the flavour is different. This could be a point of attraction (and in some cases already is) for different groups of consumers. These lesser known grains could be, and in some instances already are, sold with fringe benefits compared with quinoa. In sum, if the cañahua producers find and focus on a group of consumers, a niche has been born.

There are definitively market opportunities for Andean grains. Table 2.22 analyses in more detail the strengths, opportunities, weaknesses and threats (SWOT) associated with selling them in foreign markets. The case of cañahua has been especially looked at, as it is still a little known product.

### **International market opportunities**

The recent evolution of the world food market towards specific quality foodstuff in the form of nutraceuticals, organic, fair trade and traditional products has been boosted by the increasing demand of the consumers in industrialized countries, who are becoming ever more conscious of health, environmental and social issues. As mentioned earlier, this tendency offers great possibilities for introducing native products that have been ignored until now. One example is quinoa, which is grown in the Andes (Laguna et al. 2006); others are not only Andean grains like cañahua or amaranth, but also tuber, roots, fruits, etc.

The prospects offered by these markets should be considered whenever strategies are designed for marketing Andean grains and other products. While the USA market for quinoa is well established, European markets still offer interesting opportunities. The characteristics of the main European Markets are considered in the following sections.

### **The European market**

This is a potential market since the European consumer is quite demanding and is used to high quality products, and there is an ever growing tendency to prefer health foods and organic products. They have greater appeal if linked to a specific culture.

European consumer characteristics include:

- Demand high quality.
- Variety seeking.
- Require safety in products (in terms of both nutrition and general information).
- Look for certification.
- Recognize the importance of responsible and sustainable entrepreneurship.
- Well informed, sophisticated consumers.
- Purchase at supermarkets and specialized shops.

The European market has shown:

- An increase in the number of households of only one or two persons (for example, youths that leave home early), thereby increasing demand for healthy, nutritive fast food.
- A substantial growth of consumers of 45 years and older, which is the most interesting market due to its size and purchasing power; they own all the

**Table 2.22.** SWOT analysis for the export of cañahua, amaranth and quinoa

<b>STRENGTHS</b>	<b>WEAKNESSES</b>
<p><b>Physical aspects</b></p> <p>Nutritional value</p> <p>Cañahua and amaranth are saponin-free</p> <p>They taste good</p> <p>They are gluten-free</p> <p>They are easy to mix with other flours (wheat and barley)</p> <p>Conventional production of cañahua is very similar to organic production, little adaptation is required. They are easily conserved for long periods without preservatives</p>	<p><b>Physical aspects</b></p> <p>The harvest is quite laborious, and in the case of cañahua, it cannot be mechanized, since all grains have different maturity times</p> <p>Amaranth and cañahua have very small grains (smaller than those of quinoa); they are hard to select and it is even harder to remove any impurities they may have; they need very fine cloth bags for their transportation</p> <p>They cannot be consumed directly; they all need to be ground and converted into flours or powder, and be subsequently mixed with sugar, milk or water for beverages</p>
<p><b>Commercial and economic aspects</b></p> <p>Cañahua is cheaper than quinoa or amaranth</p> <p>Cañahua is a new, exotic product</p> <p>Quinoa and cañahua do not thrive easily in other climates (Only Altiplano)</p> <p>They carry a mythical image (The Andean grains of the Incas)</p>	<p><b>Commercial and economic aspects</b></p> <p>Sweet cañahua and quinoa are mainly home consumption products, with very little commercialization outside of the areas of production</p> <p>Cañahua is completely unknown in European markets; the introduction thereof could prove costly</p> <p>Cañahua needs to be certified as an organic product prior to its export to international markets</p> <p>High costs for collection and transportation due to the dispersed areas where the grains are produced and the small volumes of production</p> <p>Very high competition, especially in the case of quinoa and amaranth, since they are widely known in US and European markets</p>
<p><b>Other</b></p> <p>All three grains have the advantage of being neglected and underutilized species</p>	<p>Their derivatives: consumer specifications in the European market are an obstacle to industrialize and completely convert these crops (strict standards for quality, physical condition, phytosanitary requirements, packaging, etc.)</p>
<b>OPPORTUNITIES</b>	<b>THREATS</b>
<p><b>Physical aspects</b></p> <p>Growing markets for organic, gluten-free products (Dietary products)</p> <p>Growing markets for sweet products as a result of the ever increasing migration from arab countries (Turkey, Middle East, North Africa, etc.) to Latin America</p>	<p><b>Physical aspects</b></p> <p>Cañahua looks very much like quinoa and amaranth, and thus it will be hard to create an individual, separate identity</p> <p>Competition from traditional grains such as rice, maize and semolina, which are also gluten-free but are not organically produced; these products already count on established commercial channels</p>
<p><b>Commercial and economic aspects</b></p> <p>Greater demand on the part of consumers for a broader variety of products, mainly as a result of high living standards, specially related to bakery and pastry products</p> <p>Preferential agreements for the importation of Bolivian products (The EU General System of Preferences)</p> <p>Existence of an established market for Andean grains (quinoa and amaranth)</p> <p>Tendency to establish more intensive and aggressive promotion of healthy foodstuff in export markets (through government campaigns and health policies of insurance companies)</p> <p>Other, better known grains which could prove competition to Andean grains (rice, maize and semolina) have customs barriers in the European market</p> <p>High demand for products originating in dollar-based economies due to the Euro-Dollar exchange rates (High purchase capacity of European consumers). Bolivian products are quite cheap for European importers</p>	<p><b>Commercial and economic aspects</b></p> <p>The risk of default of commercial agreements when demanded volumes can't be met</p> <p>The risk of higher prices for the consumer in the case of reduced production volumes</p> <p>As a market niche, it could prove to be a very fragile "Crystal roof" as future developments are not known</p> <p>The exchange rate between euro and US\$, could negatively affect the cañahua exports into Europe</p>
<p>Once the processed products are developed for external markets, and in the event that such exports are not successful, there is a fall-back to local markets with a demand for processed cañahua products.</p>	



necessary household items and are increasingly more demanding in their food intake, with emphasis on healthy, natural foods.

- Open to innovative natural products that reflect foreign and diverse cultures and ways of life.

These characteristics offer great opportunities for Andean crops, particularly grains with high nutritional value, and the main opportunities within the European market are:

- High level of purchasing power.
- High demand for a great variety of products and services.
- Cultural and ethnic diversity of consumers.
- The presence of Latin communities.
- Represents one-third of world trade.
- A launch pad for distribution to North Africa and the Near East.

Current advantages of the European market include:

- Niche markets for fair trade and organic products, and therefore of interest for producer associations.
- Opportunities for non-traditional exports.
- Preferential tariffs.
- Many online market information services, e.g. CBI, Help Desk, SIPPO.

Within the European market there are variations, and three countries are considered in more detail below.

### **Destination market: Germany**

- Tendency to purchase natural products.
- Opposite seasons, which actually benefit farm products.
- Andean grains that are not produced anywhere else in the world.
- Increasing number of population suffer from coeliac disease, requiring gluten-free grains.
- German consumers are familiar with tourist attractions in Bolivia (Uyuni salt plains, Lake Titicaca, Tihuanacu, etc.).
- Good purchasing power.
- Strategic location, at the center of Europe, and a gateway to Eastern Europe.
- Very important logistic international hub.
- Careful with the environment, so natural and organic products are a priority for this market.
- Social responsibility, and opportunity for specialized exports ("Fair-trade" market, etc.).
- Large chains of retailers interested in direct purchase with no intermediaries.

### **Destination market: Spain**

- Andean grains are not produced anywhere else in the world.
- Increasing number of population suffering from coeliac disease, and Andean grains are gluten-free.
- Greater and better connections from Latin America to Spain than to any other European country (logistic opportunity).
- An important presence of Bolivian nationals.

- Cultural and language affinity.
- Great number of European tourists, enhancing export opportunities for Bolivian products.

### **Destination market: France**

- Andean grains are not produced anywhere else in the world.
- Increasing number of population suffers from coeliac disease, and Andean grains are gluten-free.
- The average increase of obesity is a great opportunity for Andean grains, vegetables and fruit as Andean grains are rich in dietary fibre.
- Big French companies with prominent presence in Europe are a gateway to other European countries (e.g. Carrefour).

### **Recommendations: Strategies for the promotion of Andean grains**

The logical markets to commercialize Andean grains, especially those less known such as cañahua and its derivatives, are the so called “fair-trade markets”. Another very important market is that of organic products. However, in order to access such markets these Andean grains must be certified as organically produced and processed. Then, for the introduction of these products, it is very important to have a good promotion campaign to reach those that are attracted by their appearance and taste.

Emphasis has to be directed on the products that have already been introduced and accepted in European markets, such as sweet crisps of cañahua, which are currently commercialized by Empresa Coronilla (Cochabamba) in Germany and Switzerland. There are also opportunities for these products in markets such as the USA, Japan and Canada. Nevertheless the markets in Bolivia and Peru should not be disregarded; quite the opposite, they must be used as laboratories to test and try different products and the acceptance thereof in order to prepare for export to foreign markets. Generally the most accepted products are probably crisps, muesli, flakes, powder and energy bars. They could be promoted by delivery of samples and information on prices and characteristics through exhibitions and trade fairs where the use of cañahua can be demonstrated. Informational brochures should be distributed throughout the “Fair Market” venues, which could in turn pass on this information to their clients.

A very important and relevant issue in accessing organic markets is that these products must be certified. Certification must be promoted and the relevant proceedings explained. Also, it is important to ensure that quantities given in recipes are adequate. There have been several bad experiences regarding the preparation of quinoa-based pasta, with misleading information related to the proportions of quinoa and wheat in flour mixtures.

Among the new products based on Andean grains to be promoted are those of traditional use, mainly those with medicinal qualities, which could be of interest to the pharmaceutical industry. Cañahua, for example, could be used to treat

dysentery and high-altitude sickness. There may also be uses as substitute for milk, or as other nutritional beverages.

The next step would be the organic certification and Hazard Analysis and Critical Control Points (HACCP) assessment of the conversion processes. It is important to plan time and resources, as well as funding. The selection of products could be based on the suggestions above. Products that have already successfully gained local or foreign markets (Bolivia and Peru) may be more promising. It is important to be aware of the characteristics of the European markets and the profile of the consumers, thus it would be better to start with products already known, such as muesli and crisps, where cañahua—an Andean grain little known in foreign markets—could be introduced.

Once the certifications have been granted, aggressive promotional campaigns must be developed in the media (radio, TV, newspapers and magazines, as well as Web pages). Exhibits at public venues and fairs are also very important. The cost of such promotion should be shared by importers and exporters as well as manufacturers and retailers. Another source of funds could be those institutions that support exports, such as the CBI of the Netherlands.

Commercialization channels must be selected for these Andean grains (mainly cañahua) in “Fair-trade” and organic markets. “Fair-trade” markets are the best option for organic products, alongside specialized health food outlets. Once the products and prices have been well established at these venues, supermarkets could be approached in order to extend economic benefits.

There are several aspects that should be considered for the different markets where Andean grains are sold. For example, accompanying information on cultural or traditional values and knowledge may be of interest in “Fair-trade” markets. Dietary, health and nutritional values should be emphasized, since they have great relevance in organic produce markets.

## **Acknowledgements**

The authors would like to thank immensely SINDAN ORGANIC srl, Sabor Andino, SAITE, Los Andes, IRUPANA Andean Organic Food S.A.-IOFSA, Andean Food Enterprise-ANFE, Procesadora de Cereales ANDINA, Asociación Nacional de Productores de Quinoa-ANAPQUI and many other colleagues and friends for their time, information and openness. Without their disinterested help, it would not have been possible to write this document. We would like to warmly recognize the work of these organizations in the elaboration, promotion, diffusion and positioning of products based on Andean grains in the internal Bolivian market as well as in external markets so helpful to the nutrition security of the populations.

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### 3. Livelihoods of quinoa producers in southern Bolivia

*Damiana Astudillo and Genaro Aroni*



*Photograph courtesy of S. Padulosi*

Mothers Club 'Juana Padilla Azurduy' community of Chita,  
Quijarro Province, Potosí. Southern Altiplano, Bolivia







## Context of the study: quinoa in Bolivia

Quinoa (*Chenopodium quinoa* Willd.) is an indigenous food that has been integral to survival and culture in Bolivia's Southern Altiplano (highland) region for at least 5 000 and perhaps as many as 7 000 years (Mujica et al. 2001). It can be cultivated at sea level and up 4 000 masl; from arid zones to the humid tropics; and it produces grain despite drought, frost and saline soils. Once established, quinoa can survive levels of drought, salinity, hail, wind and frost in which other grains would perish (Risi, 2001).

Quinoa has high levels of protein (10–18%) and micronutrients, especially compared with the world's most widely used grains (wheat, maize and rice). The grain is small and can be used as flour, toasted or added to soups. Dried, it can be stored for up to ten years. It contains high-quality protein, rich in particular amino acids that are scarce in other grains. Quinoa is also a source of a range of vitamins and minerals, and has particularly high iron content (Repo-Carrasco, Espinoza and Jacobsen, 2001).

According to guideline standards for human nutrition established by FAO/WHO, quinoa meets or exceeds requirements for all essential amino acids. Quinoa also has a rich genetic diversity, as it is a collection of very variable subtypes, which allows the different varieties to survive in an extraordinarily wide range of conditions.

In the Bolivian Altiplano region, approximately 19 600 families, of a total of about 25 000 in the region, cultivate quinoa. Farmers traditionally cultivate three or four varieties of quinoa, selected based on a farmer's assessment of productivity, size of grain, resistance to drought or pests, among others. Although potato and quinoa diversity has for centuries played a vital role in food security and farmer livelihoods, and despite the fact that farmers understand the importance of maintaining diversity, researchers and development practitioners are increasingly concerned that farmers now cultivate fewer varieties of both species. The reason for this erosion of diversity, they suggest, is market pressure. Market pressure drives changing dietary habits, whereby traditional foods are being replaced by imported cheaper foods with lower nutritional value, such as white rice and pasta, and markets demand homogeneity in products, leading farmers to use few varieties or landraces. (Hellin and Hgman 2005).

Quinoa is widely distributed in the Andes, from Colombia to northern Argentina. The greater genetic diversity is located on the shores of Lake Titicaca in Peru and Bolivia (Lescano 1994; Repo-Carrasco 1998; Soto and Carrasco 2008) and the surrounding areas of Coipasa and Uyuni in Oruro and Potosí-Bolivia departments. The spatial distribution of quinoa cultivated in the Andean areas is shown in Map 3.1, while Map 3.2 illustrates the geographical distribution of the collection of germplasm of quinoa in Bolivia (Soto 2010).

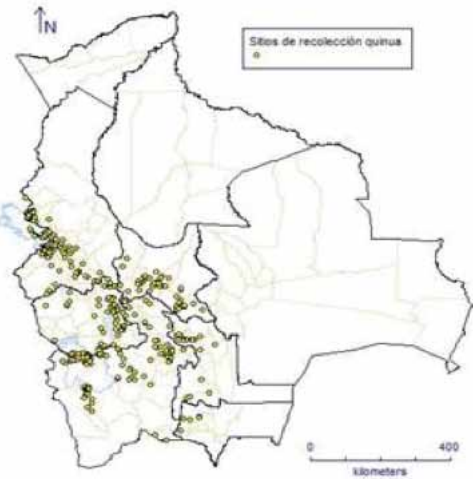
Quinoa in Bolivia is cultivated mainly in the Altiplano region (north, centre and south), including the salt-flat regions, and to a lesser degree in the Andean valleys. The production, commercialization or consumption of quinoa has wide variations among the regions due to different land tenure patterns, agro-ecological conditions, the varieties of quinoa available and market access. In the northern

Altiplano, farmers in general have smallish farms of less than 1 ha, in the central Altiplano farms range from 6 to 10 ha (Rojas et al. 2004) while in the southern Altiplano over 57% of farmers have farms larger than 10 ha.



**Map 3.1.** Areas where quinoa is cultivated area in the Andes.

Source: Soto 2010



**Map 3.2.** Geographical origins of quinoa germplasm accessions in Bolivia.

Source: Soto 2010

In the northern and central Altiplano, quinoa is less important in the household economy and agriculture is more diversified. In the Northern Altiplano, farmers produce potatoes, maize, wheat, barley, tarwi, fava beans, cañahua and quinoa. The production of all crops follows a rotation system, and production of quinoa is mostly for household consumption (about 70% of the harvest). In 2001 in the northern Altiplano, 6,717 ha were reported as dedicated to quinoa, producing 4,030 t; this represented 17% of total quinoa production in Bolivia. In the central Altiplano, farmers produce potatoes, barley, quinoa and vegetables. However the most important activity of the area is livestock raising (cattle, ovine and camelid), and thus their economic specialization is meat, dairy, wool and leather production. The region in 2001 had 8,561 ha under quinoa and produced 5,325 t. This represented 23% of total quinoa production in Bolivia. Also, in this region, a larger portion of the quinoa production goes to household consumption (85%).

In the southern Altiplano, quinoa production has a greater commercial importance than in the other regions of the country. The production of quinoa is the main source of income for some and the only source of income for over 85%. In 2001, there were 20,685 ha in the southern Altiplano dedicated to quinoa production, producing 13,549 t. It was estimated by the Ministry of Agriculture

of Bolivia that for 2003–2004 about 25,370 ha were sown to quinoa, of a total 43,000 ha in the country. Only about 8% of the quinoa production was consumed by the growers.

Table 3.1 shows the evolution of quinoa production in Bolivia from 1980 to 2001 by region, in both hectares and tons.

**Table 3.1.** Evolution of the production of Quinoa by region 1980–2001

Region		1980	1985	1990	1995	1999	2000	2001
Northern Altiplano	ha	2 225	13 938	7 839	7 129	6 717	7 129	6 717
	t	1 446	5 645	3 135	3 336	3 842	4 078	4 035
Central Altiplano	ha	2 835	17 764	9 960	9 086	8 561	9 066	8 561
	t	1 843	7 838	3 996	4 725	5 325	5 651	5 325
Southern Altiplano	ha	10 580	16 237	20 786	20 575	20 685	20 575	20 685
	t	5 639	7 680	8 938	10 740	13 342	13 271	13 549
Total	ha	15 640	47 939	38 615	36 790	35 963	36 790	35 963
	t	8 926	21 163	16 069	18 801	22 509	23 000	22 904

*Source: Prospecting the request of the production chain of quinoa in Bolivia. Fundación para el Desarrollo Tecnológico del Altiplano. La Paz 2002*

Lastly, the different socio economic and agro-ecological conditions in the subregions of the Altiplano lead to the production of two distinct types of quinoa. Quinoa dulce (sweet quinoa), produced in the northern and central Altiplano regions, and quinoa real, produced only in the southern Altiplano. Quinoa dulce is characterized by a significantly lower saponin content and smaller grains. The smaller grains of quinoa dulce make it less competitive in the market, particularly the export market, which demands larger grains. The removal of saponin from quinoa dulce in general requires only rinsing the grains with water three to four times. Quinoa del Salar or quinoa real is unique to the southern Altiplano region. The southern Altiplano in Bolivia is one of the harshest areas in which to live. Annual precipitation ranges from 110 to 250 mm and temperatures fall well below 0°C for 200–250 days per year. In response to environmental stress, the quinoa produced in the area has a high content of saponin and the grains are larger, making it more attractive to the market, but it is more difficult to process. The industrial processing plants have the technology to remove the saponin, but at the household level women remove saponin manually. It is a lengthy and time consuming process, which is one of the obstacles for consumption.

The following sections look at quinoa in the southern Altiplano of Bolivia. Rather than focusing on the economic potential of crops, it analyses the effects that the transition from subsistence farming to cash cropping has on the livelihoods of the farmers.

## Rationale and methodology of field study

### Rationale of the study

Many indigenous foods remain little more than objects of curiosity outside the areas where they are traditionally found. Although highly valued by the shrinking numbers of rural people who farm or harvest them, these foods are virtually unknown in the world's great markets for agricultural commodities.

Quinoa's fate has differed somewhat from that of other indigenous foods. Although historically, city dwellers and member of the higher social class had held this indigenous "peasant" food in low esteem, starting in the 1980s, non-governmental development organizations and research institutes, as part of their rural development projects, started promoting quinoa in international markets and niche local urban health food markets. These new markets offered the opportunity to improve the economic situation of the impoverished communities that have subsisted largely on quinoa for hundreds of years since long before colonization. Efforts to promote quinoa succeeded in transforming it in a new cash crop that was appreciated as a nutritional heavyweight. As international and domestic demand grew, production expanded. Quinoa research and development focused on improving production, developing processing technology and value chains, reaching new markets, gaining organic certification, and increasing the role of producer associations. These efforts, along with steadily increasing prices for quinoa, provided a new source of incomes to quinoa producers in the southern Altiplano.

The challenge is that higher incomes for individual households seem to have had very little effect on the difficult conditions in which most people live. People have more money, and they have the sense of empowerment that comes with participating in a cash economy, some for the first time. Yet over the years, health and nutrition statistics for the southern Altiplano have either remained at their relatively low level or declined further, especially among children. Moreover, it is not clear whether the natural resources that sustain the quinoa boom can withstand the pressures of commercial crop production in the long term. Quinoa-growing communities are losing people to economic and educational opportunities further afield.

In other words, the story of quinoa as a kind of "Cinderella crop", whose commercial success has enabled everyone to live happily ever after, should be examined with care. The study described here was undertaken to move beyond typical questions related to quinoa production and marketing to clarify the many ways in which the transition from subsistence to cash cropping has affected quinoa-producing households in the southern Altiplano. It explores a broad set of socio-economic issues to identify policies and approaches that could help quinoa farmers balance their participation in the global market with other important aspects of their livelihoods, such as health and nutrition, community institutions, the sustainability of their cropping practices, their newfound empowerment and their role as the custodians of quinoa diversity.

The fieldwork for the study was done in two municipalities, Salinas and Colcha K, with communities of Quechua and Aymara origin living around the



Uyuni Salt Flat. The area presents many constraints. First, alternatives for agricultural development are severely limited by continuous droughts, poor soils and the temperature extremes common to the high, mountainous tropics. Second, most settlements are connected only tenuously to the rest of the country and to each other by paths, dirt roads and limited bus routes that restrict the delivery and exchange of goods and services. Third, the area's geographical and social marginality means that it is deficient in basic services such as electricity, water, sanitation, education and public health.

In 2007, the Municipal Health Index (*Índice de Salud Municipal*)<sup>3</sup> in the two municipalities is relatively low: 0.38 in Salinas and 0.50 in Colcha K, compared with 0.79 in the capital city of La Paz and 0.80 in Oruro. Moreover, the prevalence of generalized malnutrition in children under five is above the national average of 22.93%. In Salinas the prevalence is 24.08% while in ColchaK is 25.66% in (Pan-American Health Organization, Bolivia 2007). Although data on chronic malnutrition are not disaggregated by municipality, local diets are high in simple carbohydrates and fats and low in micronutrients, which creates the potential malnutrition problem, especially among children. Malnutrition not only makes common child illnesses such as diarrhoea and respiratory infections more frequent and severe, but also diminishes children's' capacity to learn and adults' capacity to work productively.<sup>4</sup>

This chapter opens with a description of the livelihoods approach and the methodology used in the study. Next, detailed and multidimensional information on the two municipalities provides a basis for understanding the choices confronting rural households. The use of diversity in quinoa and its role in household nutrition and food security are described in relation to a changing economic context. Then quinoa production and marketing are described and analyzed, along with the environmental implications of quinoa production methods. The paper concludes with a summary of the findings and identifies entry points for mitigating the less positive effects of commercial quinoa production.

#### **Research approach and methodology**

The livelihoods approach makes it possible to understand how quinoa fits into the overall context in which households exist in the study communities: their entire range of assets (natural, physical, social, human and financial capital), vulnerabilities, transforming structures and processes, and livelihood strategies.

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3. The index was developed by the Pan-American Health Organization (OPMS), the Bolivian Ministry of Health, and the Association of Municipalities of Bolivia. It is used exclusively in Bolivia, so there are no international comparators. The index takes into account 10 indicators, including infant mortality, the rate of acute diarrhoeic illness in children under five, and the number of health workers for every 1000 inhabitants. Numbers closer to 1.0 suggest a better health status. Source: OPMS, 2007.

4. Vitamin supplementation programmes and the distribution of fortified foods reduce the effects of malnutrition, but these programmes are difficult to operate in remote, marginalized areas like the southern Altiplano, and they require continuous financial resources and commitment.



The livelihoods approach is useful for identifying which factors affect people's livelihoods, the relative importance of those factors and how they interact. This holistic framework goes beyond income to encompass other dimensions of poverty, including well-being, food security, and sustainable use of natural resources. It is useful for identifying appropriate entry points, policies and programmes to support the interrelated facets of people's livelihoods.

### Household Surveys

From April to December 2006, 275 household surveys were conducted in the municipalities of Salinas and Colcha K in the southern Altiplano of Bolivia. These municipalities were selected for the study because they are traditional quinoa producers. About 87% of the families in these municipalities earn their livelihoods completely through quinoa production. Table 3.2 gives details on the study communities.

**Table 3.2.** The study communities

Department	Province	Municipality	Community	Number of households	Percentage of participating households
Oruro	Ladislao Cabrera	Salinas (137 surveys)	Salinas de Garci	86	60
			Mendoza	14	77
			Jirira	6	40
			Irpani	6	40
			Thunupa Vinto	9	60
			Coota	3	38
			Ancoyo	3	42
			Pacocollo	4	40
			Colcaya	6	67
			Churacari		
Potosí	Nor Lípez	Colcha K (138 surveys)	Colcha K	90	75
			Copacabana	48	80

Source: Household surveys in Salinas and Colcha K municipalities, 2006. Project data

Although the original goal was to obtain a sample of 300 households, the final sample was only 275 households. Several logistical factors contributed to restrict the number of household surveyed and to imbalance among communities, including:

- In Salinas municipality the towns are close to each other, making access easier and to return when nobody was found at home on the first attempt.
- The rainy season delayed access to the towns and pushed back data collection schedules. In general, reaching the communities was very difficult due to long distances and poor roads.
- Uneven population density in the communities, ranging from seven families in one community to about 144 families in another.

- Temporary and permanent emigration of entire families eliminated a number of households from the survey.
- Farmer's fields are far from the community centre. Families spend days in their fields and return home for only two or three days each week. Enumerators made at least three attempts to contact a household for the survey.

The questionnaire was developed after working and living in the communities for about three months. In this way, the questions and their wording were adapted to the social, agronomic and cultural context. The questionnaire collected socio-economic and food consumption data from each household, including data on quinoa production and marketing. It had eight sections and 74 questions (collecting 74 variables), including a 24-hour recall questionnaire and a frequency questionnaire.

Local authorities from the municipalities and villages helped develop maps of communities, showing all of the households, and they helped to develop the sampling frame. People were excluded from the sample if they maintained homes in the communities but lived elsewhere most of the time. Because the study focused on families producing and consuming quinoa, households that were not quinoa growers were excluded. From the sampling frame, every other eligible home was selected, starting in the south and going north, and starting from east to west. This process was used for both sides of streets.

The questionnaire was tested with eight families and revised according to the families' and enumerators' suggestions. Eight enumerators and one assistant were hired to support the work. Enumerators received four days of training (two days of theory and two of practice). The rate of response to the survey was 90% (275 homes of 305 attempted). Households that participated in the survey received a publication with information about nutrition and quinoa recipes, showing alternative uses of quinoa.

#### **Focus groups**

Discussion sessions were held in both municipalities in four places: Colcha K town (the capital of Colcha K municipality); Copacabana; Salinas town (the capital of Salinas municipality); and Jirira. The participants of the focus groups discussed their knowledge of nutrition and quinoa production, consumption, use and diversity. Each group had 8 to 12 participants, mostly women. Men saw discussions about nutrition as a woman's domain and generally were unwilling to participate, with the exception of two men in Salinas, one in Jirira, one in Colcha K and two in Copacabana. To recognize participants' collaboration and to provide an incentive for attendance, they were invited to workshops on alternative culinary uses of quinoa, as well as to talks on nutrition. This initiative was suggested by people in Jirira and proved to be a positive incentive in the other towns.

In the sessions, people were divided into groups to work on questions, after which they presented the results of their discussions. The younger people, who were more comfortable reading and writing, were assigned to each group to take notes and be the moderators. After each small group presented its work, discussions with the entire group were held. Consensus views were written on easels for all to see. Coca leaves and fruit were shared with participants. On

the occasions when free listing and a display of knowledge were the goals, the smaller groups were part of an informal contest. Winning teams were usually given small bags of assorted fruits and other food items as prizes.

## Livelihoods in the southern Altiplano

### Natural capital and ecology

The southern Altiplano is an extensive plateau at 3,600–4,100 masl. It is surrounded by the eastern and western Andean mountain ranges, which reach 5,630 masl. The Uyuni Salt Flat, with a surface area of 12,500 km<sup>2</sup>, defines many ecological aspects of the area. The area is characterized by an arid climate—precipitation is very low at 140–250 mm/yr—and extreme temperatures that range from –11°C to 30°C. Frost occurs on 160 to 257 days annually. Soils, which are composed mostly of volcanic ashes, tufa and lava, are very saline and sandy, with very little organic matter (about 0.70%), poor levels of nutrients and retain little moisture (Gobierno Municipal Salinas Garci Mendoza 2007).

The area's water resources are also limited. The municipality of Colcha K has small permanent water flows and lakes that supply about half of the communities. In Salinas, groundwater (obtained manually) is the main source of water for most communities. One permanent river (Lakajaurira) reaches three communities dedicated to raising llamas and sheep, and other small but less permanent streams reach some other communities.

The southern Altiplano has a great diversity of natural vegetation, which has traditionally aided in soil conservation. It varies by microclimate and elevation, and provides fuel, fodder, medicine and seasonal fruits for the local population. Table 3.3 lists the most common species in the area and their uses.

**Table 3.3.** Useful native species of plants and bushes of the southern Altiplano

Common name	Scientific name	Uses
Thola, Thinti, or Pullica	<i>Parastrephia ledipophyla</i>	Fuel, forage, fruit
Ñaka thola or Thola Lejía	<i>Baccharis incarum</i>	Fuel, medicine
Supu thola	<i>Heterotalamus boliviensis</i>	Fuel
Anu thola	<i>Baccharis dacunlifolia</i>	Fuel
Pesqo thola	<i>Baccharis boliviensis</i>	Fuel
Muña	<i>Satureja parvifolia</i>	Fuel, medicine
Queñua	<i>Polylepis tomentella</i>	Fuel
Lampaya	<i>Lampaya castellani</i>	Fuel, medicine
Yareta	<i>Azorella compacta</i>	Fuel, forage
Paja Brava	<i>Festuca orthophila</i>	Forage
Paja Suave	<i>Stipa ichu</i>	Forage
Cactus	<i>Trichocereus</i> spp. or <i>Echinopsis</i> spp.	Construction, fruits

Source: Information collected by D. Astudillo from interviews with community members and field visits, and with the input of PROINPA local agronomists in the Uyuni office

Rapid desertification, caused mostly by the expansion of agriculture, has altered the landscape. Traditionally, crops were grown on slopes, with families planting at the most 2 ha. In the mid-1980s, when demand for quinoa started to increase, agricultural production moved away from the slopes and onto the flat lands, where tractors could be used to expand production. To grow crops on the flat lands, farmers removed the limited vegetation by slashing and burning, or with tractors, exposing the fragile soils to wind and water erosion. The use of disc ploughs on the loose, sandy soils further aggravated erosion. More than half of the families on the Southern Altiplano on average plant 4–10 ha of quinoa and as yield per hectare decreases due to soil erosion more or new areas are being brought under cultivation<sup>5</sup>. Across the southern Altiplano the level of erosion ranges from 4% to as much as 30% per year (CEPRODA 1999).

These new practices pose a challenge for sustaining any kind of agriculture in the long term. Farmers are aware that disc ploughs cause soil erosion, which in turn affects the productivity of the land. Farmers are also aware of other types of ploughs in the Bolivian market, like harrow ploughs, which may be more appropriate for the fragile environment in which they live. It may take a long time, however, before farmers can replace disc tractors with harrow tractors given the high investment required.

## **Physical capital (infrastructure)**

### **Water and waste systems**

Most homes in Salinas town have potable running water from a stream nearby. Residents pay a flat rate of 3 Bs (ca US\$ 0.38) per month for this service. The residents of other communities in the municipality obtain their water mostly from wells with manual pumps or common wells without pumps. In the municipality of Colcha K, thanks to a European Union development programme (Programa Quinoa Potosí-PROQUIPO), 36% of communities have running water in their homes and 27% have communal taps, but 37% still depend on wells or streams for water.

People communicate by radio because even cell phone service does not reach the area. In the capitals of the municipalities there are pay phones that are charged by solar power but they do not work all the time.

### **Roads and market access**

As mentioned, communities are poorly connected to major towns and each other. The town of Salinas connects all other communities in Salinas municipality to major towns. Salinas town has no market, but is located 162 km from Challapata, a major trading town, by an unpaved road. A bus connecting Salinas with Challapata covers the route three days each week, with the trip lasting 7–10 hours, depending on the weather and road conditions. The town of Uyuni, which has a small fair on Thursdays, is located about 180 km from Salinas. A

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5. 40% of the households plant 3 ha or less each year; 40% of households plant 4–10 ha; 20% plant more than 11 ha (up to 30 ha).

bus runs between Salinas and Uyuni once a week, leaving on Wednesdays and returning on Fridays. The bus ride is 8–12 hours and the road consists of a dirt path for part of the way and the Salt Flat (which has no road) for the rest. Like the town of Salinas, the town of Colcha K, the capital of Colcha K municipality, is also the municipality's only gateway to major towns. Colcha K is connected only to the town of Uyuni across the Salt Flat, a distance of 195 km. The bus between Uyuni and Colcha K takes 4–6 hours, depending on the weather and road conditions, and operates three days a week.

For most of the smaller villages and communities, access to major towns entails going first to the capital of their municipality, and then taking a bus. During the rainy season, communities are practically cut off from the major towns as the roads become impassable.

A trip to the market requires three days: two full days to travel back and forth and one day of purchasing. Most families spend on average Bs 80 (ca US\$ 10) on the trip alone, because they must pay for bus fare, lodging and meals while in town. The poor roads, long transportation times and cost cause many families to travel only very sporadically to the market. The information collected in this study indicates that 37.5% of households go to the market four or fewer times per year, 48% go once per month, and 14.5% go more than once per month. The Uyuni fair is significantly more expensive than the Challapata market, with most goods selling for double or triple the price.

Itinerant traders bring high-priced dry goods and processed foods (flour, rice, pasta, powdered milk, sugar, oil, soda and sweets) to some communities and purchase quinoa at the same time. They rarely bring fresh or perishable products (fruits and vegetables) because they do not have any cold facilities to keep the produce fresh.

## **Healthcare**

The municipality of Colcha K has one hospital, located in the capital. The hospital has one doctor, one dentist, one nurse and one pharmacist. It serves 11 communities. The staff mostly attends patients on the premises, although they do prevention outreach campaigns as well. The 77 communities in the municipality are served by 11 local health posts, each with a nurse's aide. A clinic for people who receive social security benefits (Caja Nacional de Salud) is open only to a small group of eligible people.

The Colcha K hospital is located on top of a steep hill and is very difficult to reach for the elderly, pregnant women or women carrying more than one small child. The hospital staff indicates that they do not receive that many patients, partly because of this obstacle. The hospital's location was decided through participatory planning, and community members decided to opt for the hilltop rather than locating the hospital next to a cemetery. Residents were also opposed to building the hospital in another location lower down because they hope that a tin mine<sup>6</sup> will set up business in town and want to reserve that site for residential

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6. One mining company about 20 minutes driving distance from town has started to operate. At the moment it employs only about 14 men from the town. A couple of upper-level managers from other cities in Bolivia live in the town.

development. According to the municipal authorities, the hospital and health posts lack basic medical equipment and medicines. The hospital has one ambulance, used in extreme emergencies, and one vehicle for vaccination campaigns. Nine health posts are equipped with bicycles, and two have motorcycles.

A health centre in Salinas town serves 18 communities, and three other health posts serve 91 communities. The Salinas health centre has one doctor, one nurse and two nurse's aides. Of the three health posts, one has a new building and a recently appointed nurse's aide but lacks equipment and medicine. The other two posts lack personnel and equipment, and the buildings are not in good condition. These health facilities cannot adequately cover this large, sparsely populated area with its bad roads. Moreover, some communities are not covered by any health facility. The single ambulance is used in emergencies, for vaccination campaigns and for limited outreach.

#### **Energy**

The town of Salinas has had electricity service since June 2006, although not all households are covered, because first they must buy and install meters for Bs 800 (ca US\$ 100). Before the electrification project, the municipal offices, quinoa processing plants and hospital relied on generators. About 17% of households in the communities use solar panels for their homes, while 69% use kerosene lamps. Fuelwood from bushes and shrubs is the most common source of energy for cooking. In the dry season, 89% of households use wood, whereas in the rainy season 37% of households resort to gas for cooking.

The communities of Colcha K and Copacabana have a generator that provides electricity to the town for three hours in the evening during the school year. Families pay a flat rate of Bs 30 for this service (ca US\$ 4.75). The homes in the town of Colcha K have running water, but few are connected to the sewerage system. Of the households in the municipality, 97% use wood from shrubs (*tholas*) for cooking in the dry season, while 35% resort to cooking gas in the rainy season. In the communities that do not have generators, 75% of households use kerosene lamps. The energy source chosen for cooking depends on the family's economic status and distance from a major town where gas can be purchased.

#### **Schools**

The schools in both municipalities are under the jurisdiction of National Educational Programmes and the central government.

Colcha K Municipality has 25 primary schools, 16 middle schools and 5 high schools serving 40 communities, divided into 11 school districts. The distance between some of the communities and the middle and high schools ranges from 6 to 106 km. The more remote schools house teachers on the premises. In Colcha K town, the Yachay Wasi centre, run by Fe y Alegría, an NGO, offers room and board to students from distant communities to facilitate their attendance at high school. Although most school buildings are in fair condition, they lack equipment and teaching materials. According to the Colcha K Municipal Development Plan 1999–2004, 2,720 students were registered (53% male, 47% female). The average

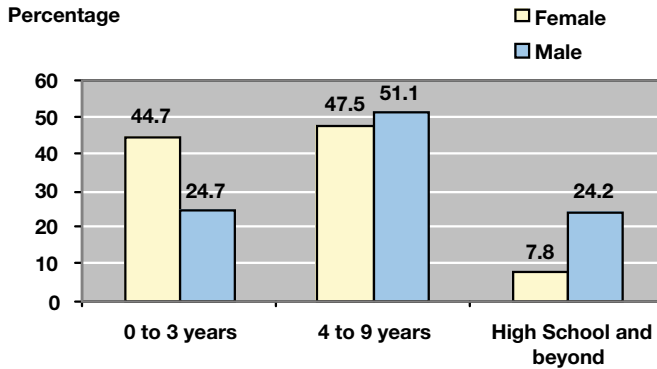
student–teacher ratio is 13:1, and the dropout rate is 15.36% (Honorable Alcaldía de Colcha K 1999).

Salinas municipality has 31 primary schools and 3 high schools that serve 134 communities in 4 districts. The distance between communities and the district middle and high schools ranges from 47 to 78 km. About 32% of the buildings are in good condition and the remaining 68% need repair. It is estimated that 80% of the schools do not have enough equipment and teaching materials. According to the Salinas Municipal Development Plan 2005, 1,295 students were registered (50% male, 50% female). The average student–teacher ratio was 12.45:1 and the dropout rate was 10.3%.

Since emigration has reduced the population in the region, some communities struggle to keep their schools open. A case in point is Jirira, a community included in this study. To keep its school open, a community needs a minimum of 10 students. The school in Jirira goes from first to sixth grade. Jirira has only 17 families, who have only 5 children aged 6–12. Fifteen children older than 12 years need to go to another town for schooling, and 5 were less than 5 years old. The town can recruit children from other communities that lack elementary schools, but the families of Jirira need to provide food, shelter and school supplies for the recruited students. Many families lack the time or economic means to care for an additional child. Families face this problem at the start of every school year. The Jirira School remains open for now, with two recruited students, but it might lose its teacher in the coming school year.

Data collected from the households indicate that adult women in the sample have an average of five years of education, while the adult men have seven years. There are differences in educational attainment between the two municipalities. On average, the men and women of Salinas municipality have a higher educational attainment than those of Colcha K. The difference between the two municipalities is more marked for women at the lower educational levels and for men at the higher level. Whereas 37.8% of the women in Salinas have three or fewer years of formal education, 51.1% of women in Colcha K have three or fewer years of formal education. In Salinas, 28.8% of men have a high school education or higher, whereas only 19.3% of men in Colcha K have a high school education. Figure 3.1 depicts educational attainment for the entire sample by gender.





**Figure 3.1.** Educational attainment of adults in Salinas and Colcha K Municipalities by gender

Source: Household surveys, Salinas and Colcha K Municipalities, 2006

The data for all sample households include the educational attainment of children as well as their parents, who are usually over 40 years of age. The data for household members aged 20–30 suggest an improved educational attainment for this age cohort. Of the 133 household members in this cohort, 74% had completed high school and 37% had completed education above high school. Education above high school includes degrees from normal schools (for teacher training), technical schools (for careers such as nurse’s aide), and regular colleges or universities. This generation belongs to the group of people educated after the initial development of the quinoa market, suggesting that one very positive outcome of the burgeoning market was that households could afford to invest in education of their children.

### Social and human capital

#### Ethnicity and language

**Table 3.4.** Primary language spoken at home (percentage of population speaking that language)

	Spanish	Aymara	Quechua
All sample	72.4	6.5	21.1
Salinas	84.7	13.1	2.2
Colcha K	60.1	0.0	39.9

Source: Household surveys, Salinas and Colcha K Municipalities, 2006

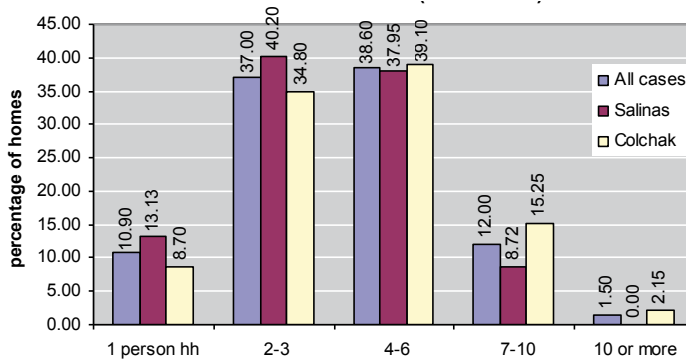
Although people in both municipalities are of mixed Quechua and Aymara cultural origin, most speak Spanish as a first language and a native language as a second language. Although some older people are monolingual in their native language, the majority of the elderly speak a native language as a primary language and Spanish as a second language. The exception is the community of Copacabana in Colcha K Municipality, where Quechua is the main language spoken among all age groups. The communities in Colcha K Municipality are predominantly Quechua, while those in Salinas Municipality are predominantly Aymara. Table 3.4 summarizes data on language distribution among all communities in the study.

### **Demography and population dynamics**

As mentioned before, population density is very low, and emigration is a key contributing factor to this dynamic. Population density was 0.40/km<sup>2</sup> in Colcha K and 0.69/km<sup>2</sup> in Salinas. Total population was 5,124 in Salinas Municipality and 7,321 in Colcha K. The number of families per community ranged from 8 to 123 in Colcha K municipality and from 7 to 144 in Salinas municipality. The average family size in the sample was four, yet close to 11% of households in the sample had only one person (mostly an elderly adult whose children had emigrated). In Salinas municipality, 13.13% of households consist of one person. Colcha K municipality had a greater percentage of larger families: 17.4% of families had seven or more members, compared with Salinas municipality, where 8.72% of families had seven or more members.

An interesting characteristic of the data collected in these municipalities is the ratio of those who produced quinoa to those who did not. Although the number of non-producing-household members was low in general, families in Colcha K had more non-producers than in Salinas. In Colcha K, 286 out of a total of 608 were under 17 years of age, and 322 were adult producing-household members, resulting in a non-producer to producer ratio of 0.89. In Salinas municipality, 192 of 500 were under 17, and 308 were adult producing-household members, resulting in a non-producer to producer ratio of 0.63. These ratios are rather small and unusual in rural settings, where the number of non-producers is usually high. In Salinas, 62 of 137 households (45%) had only adults, while in Colcha K, 35 of 138 households (25%) consisted only of adults. These household dynamics may partially explain the different production dynamics between municipalities. Agricultural production to a certain extent is determined by the ratio of members in non-producing to producing households. The larger the ratio, the less household labour is available to engage in agricultural production. Although production is helped by mechanization, no technology replaces human labour during the harvest. Perhaps this is one of the factors behind the higher level of quinoa production in Salinas municipality. Figure 3.2 shows the distribution of households by size.

Arriving at any of the small towns included in this study was like arriving at a ghost town. Many dwellings had long since lost their straw roofs and the walls were crumbling. The streets were normally empty and quiet, partly because people were inside their homes or away working in the fields, but also because so few people were left. Of the 11 towns included in the study, only three of



**Figure 3.2.** Household size for total sample and each municipality

Source: Household surveys in Salinas and Colcha K municipalities in 2006

the towns (the municipality capitals and Copacabana) had most of the houses inhabited, intact, or both. In Irirra, a town of 17 families, people remember that in the 1960s and 1970s the town had as many as 60 to 70 families. The growing economic importance of quinoa had brought back some families that left decades ago, but they did not live in the towns permanently and came only during planting and harvesting. They were called “residents” by the permanent town dwellers. Although residents were recognized by the towns and paid the required fees or taxes, their partial presence sometimes had a negative impact. For example, many permanent dwellers were certified organic producers and members of producer associations, but residents were not. Organic production was affected because most “residents” produce quinoa conventionally. If the permanent producers wanted to organize a community-wide lamp lighting campaign to reduce insect populations,<sup>7</sup> it would be ineffective unless everyone participates. “Residents” were not around during the critical months for pest control (December to February). Instead they sent money to pay a permanent dweller (normally a family member) to buy and apply chemical pesticides.

The limited opportunities and difficult living conditions in these towns continued to drive emigration, especially of younger people. Emigration was more common in Colcha K municipality than in Salinas, but most people in both municipalities were over 40 (about 70% of women and 72% of men). A study done by the municipality of Colcha K found that women aged 18–20 and men aged 19–25 were more likely to emigrate. The most common destinations for people from Colcha K were Chile (59%), followed by Argentina (10%), Uyuni (8%) and Cochabamba (8%). Other destinations included Santa Cruz (3%), Oruro (3%), Sucre (3%) and La Paz (2%). Although people often emigrated in search of work, significant numbers of young people left to pursue higher education.

7. A lamplighting campaign (campaña de lámparas de luz) is a technique for trapping some of the insects that lay eggs in quinoa plants. The community lights lamps (taking precautions to prevent fires) for a couple of nights, but it must be done in every plot to be effective. Each lamp costs about US\$ 25, and most farmers need at least two. Residents are rarely around to participate in this type of effort.

### Traditional institutions

Traditionally, several institutions were an intrinsic part of community life, including community work (faenas), reciprocal help (ayni), collective work for agriculture (minka), and a special community land management system called mantas. With the transformation of subsistence agriculture to commercial agriculture, these institutions were considerably eroded, and in some communities had vanished.

Faenas are mandatory community work. Each household sends a member to work on projects to improve the community (irrigation canals, building or fixing schools and health posts, and similar activities). Observations indicate that this institution was still present in the study communities.

Ayni is a practice of mutual help—mainly the free, reciprocal provision of labour for agriculture—that has been part of rural communities in Bolivia since time immemorial. Ayni was the traditional means of growing quinoa. All members of an ayni (a group of families and neighbours) took turns working in each other's plots. The owner of the plot was responsible for feeding the people working that day on their land. Through observation and conversations with community members, Colcha K and Copacabana still practiced ayni. Plots in these communities were relatively small compared with plots in Salinas municipality, and tractors used less often. In fact, ayni was still common in Copacabana, perhaps because the community had only one tractor, which had been introduced two years previously. In Salinas municipality, where quinoa production was more extensive, most agricultural activities (ploughing, planting) were mechanized. Tractor use was ubiquitous, so the need for reciprocal aid had disappeared. Farmers mourn the sense of community that had been lost along with ayni-based production, even though it probably would not suffice to meet the current and growing demand for quinoa.

Minka is a form of collective work, mostly for agriculture, but it is not reciprocal like ayni and not for the common good like faenas. Minka is used mostly during the harvest, when more labour is needed. It is a way of hiring labourers, but often the payment is made in kind (agricultural produce).

Mantas are large, continuous tracts of land where all families from a community have their plots. This land distribution system is fully recognized by the community and its authorities, and the land is communally managed. The mantas system was particularly useful for organizing land use. Traditionally a community would agree to leave entire mantas fallow for six to eight years to replenish soil nutrients, and all farmers respected the fallow. Mantas traditionally lined the hill slopes where crops were produced. Mantas were also used to designate pasture land. Animals were assigned to an area where no plots existed so that animals would not consume crops. Community members say that although they would like to plant potatoes on the hills as in the past, they no longer can because people let their livestock (llamas) to roam freely. With the commercialization of quinoa and related changes in land use patterns, the institution of mantas has disappeared. Its disappearance raises concerns about the sustainability of quinoa production. Farmers see its disappearance as a loss because they know that the land in the hills is a lot more fertile and less prone to pests. Now people were making individual decisions about land use and leaving land fallow for only one to two years. At the time of the survey, 47% of farmers had no fallow land.

## New institutions

While the transformation of agriculture has caused traditional institutions to decline or disappear, at the same time new institutions have emerged. One of the most important new institutions was the producer associations. These associations began to develop in the 1980s<sup>8</sup> with the support of international NGOs, which helped the associations to open niche markets for organic and fair trade products and helped to build institutional and management capacity. The associations offer farmers a venue to participate in the global economy and to confront the particular challenge of reaching enough volume, negotiating contracts and keeping production competitive enough to attract buyers. In Salinas and Colcha K municipalities, two of the main national quinoa producer associations are present: (1) Asociación Nacional de Productores de Quinua (ANAPQUI),<sup>9</sup> with its regional association Comunidades Productoras de Quinua Real (COPROQUIR), and (2) Central de Cooperativas Agropecuarias Operación Tierra (CECAOT), with two local subsidiaries, El Condor and Los Andes.

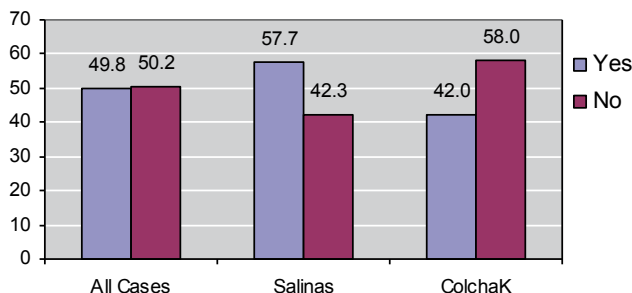
In addition to these two national organizations, other smaller producer associations or private companies operated in the area, including Andean Valley, Irupana, Jatari Tunupa, Quibolsur, Soproqui, and Aproquibica. Being a member of an association allows farmers to obtain better prices, but only about half of the households in the sample belonged to an association (Figure 3.3). The most common reasons for non-membership were (1) the trade-off between receiving a higher price versus immediate payment, and (2) the difficulties of the transition to organic agriculture, because most associations are certified organic. The “resident” families, who lived in the area only during planting and harvest, did not belong to associations because they could not comply with many of the membership requirements, such as attending meetings. Membership in a producer association was higher in Salinas Municipality, where production was more commercially oriented.

Another institution that has emerged in recent years is the Mothers’ Centre (Club de Madres). These centres are present in three communities (Salinas, Colcha K, and Copacabana). Their goal is to bring courses and training for women and help them to sell food and handicrafts at fairs and other events. The town of Salinas also has a knitting and weaving centre (Centro de Tejidos), where women learn to knit garments with textile machines. A textile engineer provides training two days per month, and about 35 women participate. The goal is for women to create a cooperative micro-industry that will allow them to earn additional income. Women also receive training in managing a small business, bookkeeping and budgeting. Additionally, the PAN Centres (Centros PAN—Programa de Atención Integral Niña–Niño) for early childhood education are now available for women to drop off their small children while they are away in the fields. The centres provide food, care and basic early childhood education. PAN Centres are only in the

8. ANAPQUI was formed in 1983 and a couple of years later started getting financing from SOS Faim Belgique to improve institutional capacity and marketing.

9. ANAPQUI had about 3500 members nationwide, and CECAOT had 500. Both associations had their own processing plants.

capital towns and are usually partnerships between the municipal government, the World Food Programme (WFP) and possibly NGOs. Interviews with the directors of the centres and municipal officials gave mixed information about whether the centres provided quinoa in their meals for children.



**Figure 3.3.** Producer association membership among surveyed households.

Source: Household surveys in Salinas and Colcha K municipalities in 2006

In Copacabana, all families came together to feed their children at school. The school received some donations of flour, lentils and oil from WFP, and families took turns feeding all 98 students at breakfast and lunch. Normally it is up to the family to choose the meals and pay for the other ingredients. It was observed (and parents explained) that there is healthy competition to provide the best food. This arrangement allows parents to go to the field for three to four days and not worry that their children will not eat properly.

The deputy mayor of Salinas municipality indicated that 18 NGOs (domestic and international) worked on different development projects in the community.

## Economic and productive conditions

### Sources of income

**Table 3.5.** Main income source (percentage of households)

Income source	All cases	Salinas	Colcha K
Agronomy	87.2	94.2	80.4
Livestock	1.8	0.0	3.7
Other	11.0	5.8	15.9

Source: Household surveys, Salinas and Colcha K Municipalities, 2006

The difficult environment and remoteness of the southern Altiplano have limited its agricultural and economic development. The economy is based on farming. Among the households surveyed for this study, 87.2% depend

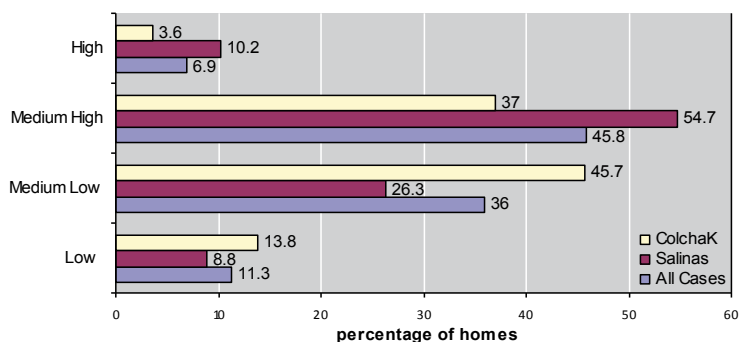
completely on agriculture (growing quinoa) for their livelihoods, 1.8% raise livestock (llamas and sheep) for their main source of income, and 11% rely on other sources of income, including migratory labour, labour in the community, mine work, tourism, remittances from family abroad, teaching and working in government offices. More than half (62.5%) of all households said that they worked outside of their own farms for at least two months per year, mostly as day labourers on other farms or as servants or construction workers in neighbouring Chile. The two municipalities had somewhat different sources of income. Salinas showed a greater dependence on quinoa production than on other activities, whereas in Colcha K some families relied primarily on raising livestock and receiving remittances from family in Chile. Table 3.5 summarizes the main sources of income of the households by municipality.

#### **Income and poverty**

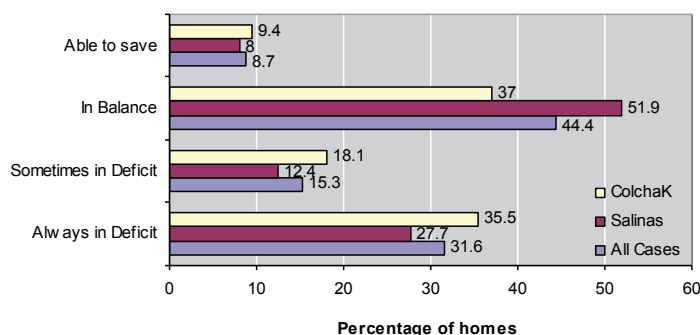
Average household income in the study area was higher than the average rural household income in the rest of the country. The difference was largely due to the high price of quinoa in relation to other agricultural products (like rice or wheat) and the importance of quinoa production as an economic activity. The annual reported income of a household, based only on quinoa production, was Bs 10,431 (US\$ 1,304), with a range of Bs 720 (US\$ 90) to Bs 97,920 (US\$ 12,240), with the mean being Bs 19,200 (US\$ 2,400). Most households (62.5%) also earned income outside their homes and farms. Emigration and casual labour within communities were central to the household economy, but unfortunately data on other sources of income were not collected.

Other economic data collected in the survey made it possible to assign each sample household to one of four economic strata (low, medium low, medium high or high). The classification was based on assets, income and family size. Assets included land holding; land under cultivation; livestock ownership; type, size, and condition of dwelling; and sources of fuel and energy. Data on income (such as income from quinoa production in the previous year) and expenditures (such as market purchases) were also considered. Family size was important for the economic classification because the number of family members determines per capita income. A section of the questionnaire asked people to describe the economic situation of their household by selecting one of four options (always in deficit, sometimes in deficit, in balance, or able to save). Based on the composite of assets, income and family size (to normalize income per capita), 52.7% of the households were in the medium-high to high economic categories, whereas the self-classification placed 53.1% of households in these categories (Figures 3.4 and 3.5). This concordance is not present in the lower economic levels. Based on assets, income and family size, 11.3% of households fell into the lowest stratum, whereas 31.6% of households identified themselves as belonging there. Perhaps people thought they would receive assistance based on the information they provided, a consideration suggested by some community members who were interviewed. As discussed in more detail below, this classification does not place people in the middle or upper class in the traditional sense, but rather is exclusive to the context of their communities, which are generally limited in terms of socio-economic development.





**Figure 3.4.** Household economic situation based on assets, income, and family size. Source: Household surveys in Salinas and Colcha K municipalities in 2006.



**Figure 3.5.** Household economic situation as described by household members. Source: Household surveys in Salinas and Colcha K municipalities in 2006.

**Table 3.6.** Calories consumed, and calories, protein, fat and carbohydrates as a percentage of Recommended Daily Allowance (RDA)

Nutritional indicator	Southern Altiplano	Northern Altiplano	Central Altiplano
Total calories consumed	800	3220	1580
Calories as percentage of RDA	-65	+25	-38
Protein as percentage of RDA	-26	+50	-1
Fat as percentage of RDA	-92	-67	52
Carbohydrates as percentage of RDA	-59	+55	-35

Notes: Data for southern Altiplano collected by Apaza from household surveys in Chacala, Chita, Jirira and Salinas. Source: Apaza, 2007.

Although the sample households on average earned more than other rural households in Bolivia and more than half (52%) fell into medium to high income

groups, these data must be placed in context. *Every person in the study communities lived in structural poverty.* In other words, their higher incomes were meaningless, given their isolation and poor access to a small number of limited basic services such as health, education, water and sewerage. Isolation eroded their purchasing power significantly. Any goods for sale in the communities cost significantly more than in the rest of the country because of the high costs of transportation. Only a narrow selection of dry goods and processed goods were sold. One of the more telling indicators of structural poverty was calorie consumption. Despite their higher incomes, adults in the southern Altiplano communities of Chacala, Chita, Jirira and Salinas were deficient in calories, protein, fat and carbohydrates (Table 3.6). According to data collected by a PROINPA nutritionist through household surveys in 2007, adults in these towns, on average consumed only 800 calories a day—only 60% of the recommended daily allowance (RDA) for an adult (Apaza 2007).

Data on life expectancy are also good indicators of people's socioeconomic situation. Life expectancy in Salinas Municipality was 56.43 years for men and 59.80 years for women; in Colcha K it was 54 years for men and 58 years for women. The national average was 61 (INE 2006).

### Access to credit and financing

People in both municipalities obtained credit through various institutions in Uyuni, including Banco de Crédito de Bolivia (BCP) (a traditional bank, subsidiary in Bolivia of the Banco de Credito de Peru), PRODEM (a private finance fund), and Asociación Nacional Ecuménica de Desarrollo (ANED) (an ecumenical non-profit organization for rural microfinance). ANED is used the most. Of the 275 sample households, only 40 (14.5%) said they had borrowed money the previous year.

**Table 3.7.** Credit access and use in survey households

Loan information	All cases	Salinas	Colcha K
Households taking a loan (no.)	40	19	21
Households taking a loan (%)	14.5	13.9	15.2
<b>Loan source</b>			
Bank or credit union (%)	63	44	80
Family (%)	8	6	10
Friend or neighbour (%)	29	50	10
<b>Loan use</b>			
Investment or production (%)	50	39	60
Consumption (%)	26	38	15
Medical emergency (%)	13	17	10
Home improvement (%)	11	6	15

Source: Household surveys in Salinas and Colcha K municipalities in 2006.

The majority (63%) borrowed from a bank or credit union. Half of the borrowers used their loans to invest in agricultural production. There was no or very little investment in business or processing. Most was for agricultural production to pay for soil preparation, labour and some inputs. Table 3.8 presents data on loans, loan sources and use.

### Land tenure and land use

Land tenure in the area is determined by families taking possession of the land and the community recognizing it. The land is then passed from parents to children. Thus people had their “own” land but most did not have formal, legal titles to the land and relied on the community to recognize their land use rights. The Salinas Municipal Development Plan (PMD) noted that legal titles existed for some tracts of land. These titles were in the names of grandparents or great-grandparents, however, and although the land had been divided by inheritance, the division had not been legally recorded. According to the Salinas PMD, only 29% of the land had legal titles, 61% did not, and legal titles were being processed for 10% of the land. Women were not restricted from holding land titles, but most titles were awarded to the male head of the household. The PMD for Colcha K indicated that 88% of the land was communal land and 12% privately owned. Communal land was divided into plots that families took possession of, but only if the community approved the use to which the land would be put. Grazing land in both municipalities was communal.

In the southern Altiplano, each household had more land on average for its own use than households in the northern and central Altiplano. The *minifundio* phenomenon (a process in which land is divided into ever smaller parcels through inheritance) in general was not a problem in the southern Altiplano. Given the falling numbers of people in the region it might never become a problem.

**Table 3.8.** Land tenure in Salinas and Colcha K municipalities

Land tenure	All cases (%)	Salinas (%)	Colcha K (%)
Sharecrop	2	3	0.7
Hold 3 ha or less	16	9	22
Hold 4–10 ha	37	28	46
Hold 11–20 ha	24	31	17
Hold 21–40 ha	16	19	13
Hold >40 ha	5	9	0.7

Source: Household surveys in Salinas and Colcha K municipalities in 2006.

Land tenure and land use were recorded in local measures for the survey, and translated into standard hectare measurements (Table 3.8).<sup>10</sup> The data collected from the households suggest that land distribution was more equal in Colcha K municipality than in Salinas. The percentage of homes that identified themselves as sharecroppers (*al partido*) is relatively low (3% in Salinas and 0.7% in Colcha K). Sharecropping households give half of their production to the land “owner” and keep the other half. Usually families that have moved away leave their land to other families to use under sharecropping arrangements. In Salinas, 59% of households had 10–20 ha; the figure was 63% for Colcha K.

Families use their land mostly to grow quinoa (Table 3.9). As noted, quinoa production is more commercial and more intensive in Salinas municipality than in Colcha K.

**Table 3.9.** Percentage of farmland dedicated to quinoa production by location and type of holding

Holding type	All cases	Salinas	Colcha K
3 ha or less	40	20	59
4–10 ha	40	49	32
11–20 ha	15	20	9
21–30 ha	4	7	0
>30 ha	2	3	1

Source: Household surveys in Salinas and Colcha K municipalities in 2006.

At the time of the survey, 59% of Colcha K households had 3 ha or less dedicated to quinoa production, compared with 20% in Salinas for the same size farm. About 27% of households in Salinas municipality had larger tracts (11–30 ha) under quinoa compared with 9% in Colcha K.

**Table 3.10.** Percentage of farms producing crops other than quinoa

Crop type	All cases	Salinas	Colcha K
Potatoes only	53	77	33
Fava beans only	3	4	2
Mixed vegetables	6	0	12
Potatoes and vegetables	25	0	29
Potatoes and fava beans	14	19	25

Source: Household surveys in Salinas and Colcha K municipalities in 2006.

10. Local measures of area include *tareas* (80 × 80 m), *cajones* (20 × 20 m), *cuartillas* (4 × 4 m), *eras* (4 × 7 m) and *tablonos* (12 × 21 m).

Households also used small plots of land—on average 6 cajones (about 1/6 ha)—for growing other crops. These plots were closer to their homes or next to their homes, where water was more accessible. Of survey households, 79% grew other crops, solely for their own consumption and not for market. More households grew crops other than quinoa in Colcha K municipality (85%) than in Salinas (72%). Also, a greater variety of crops were planted for household consumption in Colcha K (Table 3.10). In Salinas, most people planted only faba beans [broad beans], potatoes or a combination of the two, whereas in Colcha K people planted potatoes, faba beans and vegetables (most commonly onions, carrots, lettuce and garlic).

## **Knowledge and use of quinoa diversity**

### **Quinoa diversity in the southern Altiplano**

Over thousands of years, farmers have selected and adapted quinoa to develop types<sup>11</sup> that had special advantages that reduced the risk of growing quinoa, selecting for tolerance to extreme heat or cold, for example, or resistance to pests and diseases. They also developed types with specific culinary advantages. Farmers have been the custodians of these genetic resources, maintaining them through use. At the time of writing, the variety group that dominates the southern Altiplano, Quinoa Real, is also the most adapted to prevailing growing conditions. This variety group has at least 40 types, including: Real Blanca, Toledo, Pandela, Pisankalla (Ayrampu), Negra, Achachino, Huallata, Señora, Kellu, Hilo, Chillpi, Mañiqueña, Challamuro, Perlasa, Lipeña, Canchis Roja, Canchis Blanca, Timsa, Utusaya, Mok'ó Rosado, Tres Hermanos, Chipaya, Wilalaca, Mururata, Punta Blanca, Puñete, Romerilla, Tacagua, Chachahua, Jiskitu, Tupita, Imilla, Santa María, Carequimeña, Pucayua, Challamoko, Sorata, Intinayra and Ucaya (Aroni et al. 2003). All of the quinoa landraces grown in the southern Altiplano have been developed by farmers, not formal research programmes.

### **Farmers' knowledge of quinoa varieties and types**

Focus group discussions yielded qualitative data on the types of quinoa grown in the area, their origin and their uses. Each group was divided into smaller groups of three or four people to discuss and list all of the quinoa types they knew about, even if they did not have the seed (Table 3.11).<sup>12</sup> The groups usually named 10–14 types (although the Colcha K groups counted all small-grained quinoas as one type). Because the same quinoa type or cultivar can have different names, local names were verified carefully against a catalogue and with extension workers and agronomists working in the area.

11. The term types referred to quinoa in this chapter should be read as morphotypes. By morphotypes we intend any of a group of different types of individuals of the same species in a population.

12. This exercise was done as a contest. The winning groups had the longest lists of quinoa types (provided the names were recognized and accepted by everyone else). The prizes were bags of assorted fruit.

**Table 3.11.** Cultivars listed in focus groups, by municipality

Salinas	Colcha K
1. Kaslala (Chillpi)	1. Blanca
2. Toledo (Red or Orange)	2. Rosada (Pandela)
3. Pisankalla (Ayrampu)	3. Roja (Toledo)
4. Rosada (2 shades – lighter and darker)	4. Puñete (Hilo)
5. Amarilla (Yellow)	5. Utusaya
6. Sallami (Red with white)	6. Pisankalla
7. Elva	7. Wilacoimi
8. Blanca	8. Noventona
9. Coitu or Koiru	9. Rosa Blanca
10. Juchuy Mojo (refers to all small-grained types)	10. Kaslali Matizada
11. Ajara (wild quinoa)	11. Churo Iri (Red)
12. Muk'una (Puñete)	12. Granadilla (Red)
13. Negra	13. Tres Hermanos (Siete Hermanos)
	14. Negra

*Note: Alternative names are given in parentheses.*

*Source: Household surveys in Salinas and Colcha K municipalities in 2006*

The group discussions revealed that most farmers do not identify types by name but by colour. The names were confirmed only after the groups had discussed the shape of the panicle and other physical plant characteristics and looked at pictures from the catalogue. For example:

- Toledo is called “orange” (although some call it “red”)
- Kellu is called “yellow”
- Pandela is called “pink”
- Coitu is called “grey”
- Chillpi is called “glassy”

Some types were grown in both municipalities; others were not.

A couple of participants also mentioned Ajara, the wild quinoa that grows without being planted. For most farmers, wild quinoa is an annoyance, because they have to remove it to keep their plots pure. A couple of women indicated that they collect the grain of wild quinoa to prepare *pito*, toasted quinoa flour eaten with sugar and sometimes used to make a drink. This quinoa was described as sweet (in flavour) after the removal of saponin. In Colcha K, two groups that listed Quinoa Negra remarked that they know it exists only because others talk about it; they know that it comes from another region in the Salt Flat, and that traders who stop in their towns have asked them if they have any Quinoa Negra for sale. In Colcha K, three groups listed “*juchuy mojo*” as a type of quinoa, but they know it as just a generic Quechua term for all quinoa with small grains. Participants acknowledged that, practically speaking, they mostly used one to three of the most common types in the area (Rosada, Roja, Blanca, Elva and Amarilla). One small variation on the names in Colcha K was the use of the word *muk'una* (which

is also a preparation made with quinoa) to refer to the cultivar called Puñete or Hilo. Although Puñete is used often for muk'una, they say that the name comes from the panicle looking round like a muk'una. The other variation on names is for the cultivar Coitu, which in this locality is called Koiru.

### **Special agronomic characteristics of quinoa types**

When asked about their preferences for the different quinoa types, participants agreed that two types of quinoa had agronomic and production advantages. First, Puñete brings more money at the market because the grain is held more tightly in the panicle and thus weighs more. The downside is that Puñete takes more than 190 days to mature, and most farmers prefer types that mature more rapidly. Second, Noventona's name suggests that it matures in 90 days, and focus group participants said that it does mature relatively fast, but in 140 and not 90 days. They indicated that in general quinoa types with small grain mature faster, but they do not want small grains.

No variety was preferred for pest resistance; all types were equally susceptible to pests. Participants agreed that the only way to prevent pests is to plant on the slopes, where the land is more compact and the eggs laid by the *ticonas*<sup>13</sup> cannot hatch. *Many participants indicated that they plant very small plots of quinoa on the slopes so they can eat pesticide-free quinoa.*

*None of the participants grew non-commercial quinoa exclusively for the household to consume. They produce only the types that can be sold in the market and retain part of their production for home consumption.*

*Participants also agreed that all types of quinoa cost the same to produce, unless they were planted on the slopes and no money was needed for pest control. Although quinoa production on the slopes is not mechanized and takes more time, the yields are greater. Participants pointed out that despite the benefit of planting more than one quinoa type (to spread risk), there is an added cost for each additional type of quinoa produced: A separate canvas has to be purchased at harvest to thresh each type separately.*

### **Special culinary characteristics of quinoa types**

The question that generated most interest and discussion in the focus groups, particularly among the older women, concerned the culinary uses of quinoa types. Eight cultivars were highlighted for their culinary characteristics.

- The most commercial variety, Blanca Real, was least suited to making any dish except soup. Most women agreed that Blanca Real was “flavourless” yet it was the most widely grown for its commercial value.
- Kellu (yellow) quinoa was the starchiest and most appropriate type to use for dishes that require quinoa flour, such as muk'una and *lawá*, but the women no longer used it.

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13. Ticona is one of the most common pests that attack quinoa. It lays its eggs in the ground close to the plant.



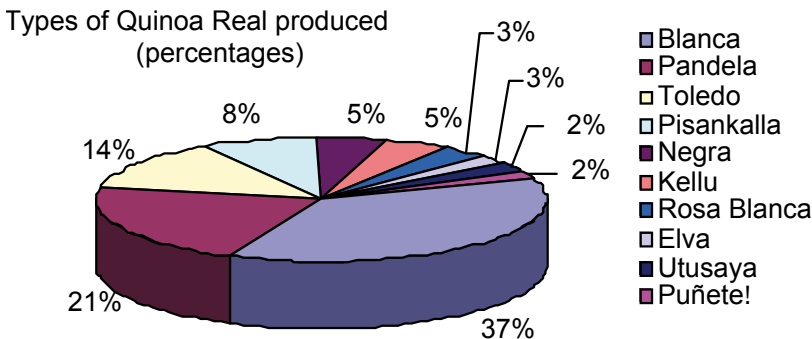
- Chillpi (Kaslala) was unanimously voted as excellent for pito and to make a drink (*cocho*, *ullpo* or *ullpada*, depending on locality). This quinoa also was described as tasting sweet after the saponin is removed. Women said they no longer used Kaslala despite its culinary advantages.
- Pisankalla (Ayrampu) is good for pito and ullpu.
- Toledo is good for *phisara* (a side dish) and for baking purposes.
- Rosada is good for phisara and soup.
- Amarilla is good for lawa, *p'hiri* (quinoa semolina) and muk'una.
- Elva and Blanca were good for soup, lawa and muk'una.

Despite the advantages and disadvantages of these quinoa types, the women regarded the steps involved in processing (the amount of toasting and treading and the texture of the milled grain) as more important for the quality of the finished dish than the type of quinoa used.

None of the focus group participants thought there were any differences in nutritional content among quinoa types. The lack of knowledge of these differences points to one more factor in the general indifference towards one type of quinoa versus another, although the knowledge effect perhaps is small compared with the market effect.

**Use of quinoa diversity, past and present**

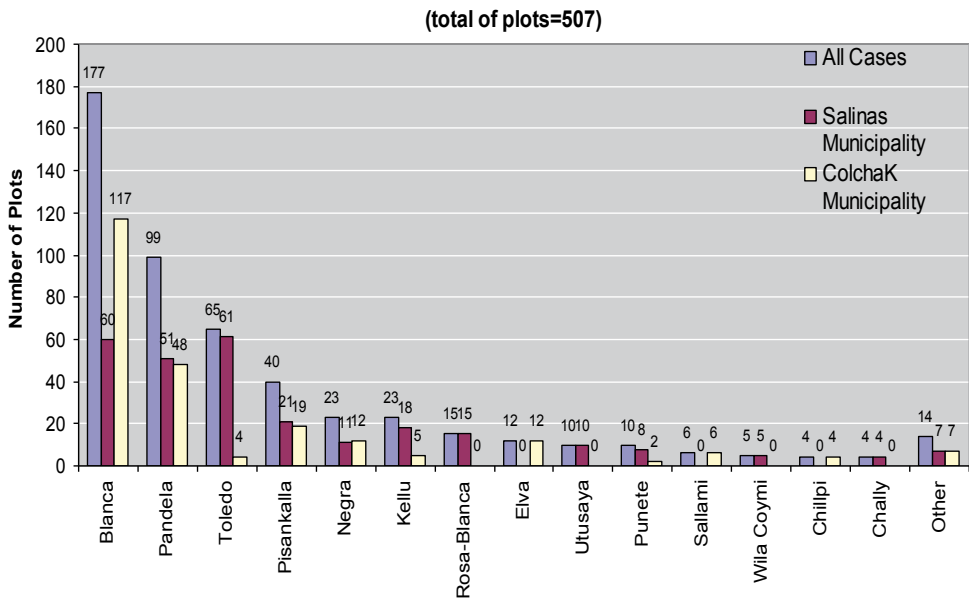
The survey yielded quantitative data on the current and past use of quinoa diversity. Farmers were asked how many types and which types of quinoa they had used in the most recent production cycle. For the households in Salinas, where surveys were done between May and July 2006, the reference point was generally the recently concluded harvest. In Colcha K the reference point was the current production period, because the surveys were done between October and December 2006. In Colcha K, a small number of farmers, especially elderly farmers, plant quinoa every other year. They were asked to provide information about the last production season if they did not have any quinoa in the field during the survey.



**Figure 3.6.** Diversity of quinoa used in Salinas and Colcha K Municipalities  
 Source: Household surveys in Salinas and Colcha K municipalities in 2006

Among the households surveyed, a great number planted several separate plots to quinoa. A plot was separate if it had a different type or variety of quinoa and it was physically separated from other plots, even if they were adjacent. The number of plots planted to quinoa was 507 (Figure 3.6). The most commonly used type of quinoa in both municipalities was Blanca Real (177 plots), followed by Pandela (99 plots) and Toledo (65 plots). Varieties sown on fewer than four plots were aggregated under the category of “other”. In Colcha K municipality, types such as Utusaya, Kellu, Rosa Blanca and Toledo were not used at all, or used very little in comparison with Salinas. In Salinas, but not Colcha K, people sowed plots containing a mixture of types for which seed was not selected (these plots were called “chally” after the name for this practice; thus chally is not the name of a quinoa type). Types such as Elva and Chillpi were produced only in Colcha K.

Of the quinoa produced in the study communities, 90% came from only five of the more commercial types or cultivars (out of the 40 types found in the area). These results resemble those of a 2001–2002 PROPINPA study on *in situ* conservation, which found that 96% of farmers planted 1–4 types of Quinoa Real, and the remaining 4% used 4–12 types. Figure 3.7 shows the use of quinoa by percentage of plots.



**Figure 3.7.** Quinoa types produced in Salinas and Colcha K municipalities

Source: Household surveys in Salinas and Colcha K Municipalities in 2006

Farmers select seed at the end of every harvest from the panicles where the grains are larger and more tightly held. Approximately 2–3% of the harvest is separated as seed for the following production cycle. Seeds can be saved for up

to two years, after which the yield decreases significantly. Bolivia has no quinoa seed market, and extension organizations provide no information about different quinoa types. Farmers belonging to COPROQUIR (a regional subsidiary of the national ANAPQUI producer association), had received about 8 kg of Quinoa Negra seed the previous year. Quinoa Negra is a traditionally improved quinoa that by most accounts comes from Llica Municipality on the other side of the Salt Flat. The association distributed the seed in response to demand for quinoa that maintained its dark red colour after processing.

Farmers were asked how long they had been producing quinoa for the market and asked to list the types or cultivars they grew before quinoa was a commercial crop. Although the long recall period (15 years) raises concerns about the reliability of the responses, they are nevertheless interesting (Table 3.12). In the past, 24% of farmers grew only one type of quinoa, versus 44% at present. Similarly, only 2% of farmers grew more than five types of quinoa at present versus 14% in the past. At the time of the survey the greatest number of quinoa types in production at one time was 6; previously it had been 10.

**Table 3.12.** Quinoa types used by farmers at the time of the survey and in the past

Number of quinoa types	Most recent production		At least 15 years back	
	Number of farmers	Percentage of farmers	Number of farmers	Percentage of farmers
0	2	1	2	1
1	121	44	67	24
2	98	36	83	30
3	30	11	46	17
4	16	6	39	14
5	4	1	15	5
6	3	1	16	6
7	0	0	2	1
9	0	0	3	1
10	0	0	2	1
Total	274	100	275	100

Source: Household surveys in Salinas and Colcha K municipalities in 2006.

While farmers clearly used fewer quinoa varieties than in the past, there were also regional differences regarding the use of quinoa diversity. Among all the communities surveyed, the town of Salinas had the highest number of farmers using at least three types of quinoa (32 farmers), followed by the towns

of Colcha K (17 farmers) and Copacabana (9 farmers). Yet when the types of quinoa grown are taken into account, only 10 of those 32 farmers in Salinas grew quinoa types other than the five most commercial ones (Blanca, Pandela, Toledo, Pisankalla and Negra). Colcha K had the next highest number of farmers using quinoa types other than the five most commercial ones (11 farmers). Even though Salinas and Colcha K are the largest towns and more surveys were done there, when the data are expressed as a percentage to take the larger size of these towns into account, they still have the second and third highest percentages of farmers using non-commercial quinoa types. Table 3.13 summarizes data for the seven towns where farmers grew more than three types of quinoa.

**Table 3.13.** Use of quinoa diversity by community

Community	Farmers growing more than 3 quinoa types		Farmers using quinoa types other than the 5 most commercial types	
	Number	Percentage	Number	Percentage
Jirira	5	36	1	7
Salinas	32	36	10	11
Coota	1	11	1	11
Pacocollo	1	50	0	0
Irpani	3	50	1	17
Colcha K	17	19	11	12
Copacabana	9	19	3	6

Source: Household surveys in Salinas and Colcha K municipalities in 2006.

### **Socio-economic determinants of farmers' use of quinoa diversity**

To explore the relationships between the use of quinoa diversity by farmers and socio-economic variables, regressions were run using the number of quinoa types a farmer currently used as the dependent variable. The following independent variables were included:

- varpast*: The number of varieties or types of quinoa produced in the past (assumed to be before producing for the market).
- memasso*: Membership in a producer association (binary variable – yes/no).
- mothage*: Age of adult female head of household (continuous variable).
- mothered*: Education level of female head of household (in years; continuous variable).
- fathage*: Age of the adult male head of household (continuous variable).

<i>fathered:</i>	Educational level of male head of household (in years; continuous variable).
<i>farmsmall:</i>	Area planted to quinoa $\leq 10$ .
<i>farmed:</i>	Area planted to quinoa is 11–20 ha.
<i>lowecon:</i>	Economic situation of household is low.
<i>midcon:</i>	Economic situation of household is medium.
<i>nativelang:</i>	Primary language spoken at home (binary variable: native language or Spanish).
<i>easymkt:</i>	A binary variable indicating relative ease of access to the market (capital towns) versus difficult access to market (all other towns).

Economic situation had three categories (low, medium or high), as did farm size (small,  $\leq 10$  ha; medium, 11–20 ha; and large,  $> 20$  ha). One of the categories was omitted in both cases to avoid perfect multicollinearity.

Because the dependent variable is a discrete variable with the number of varieties ranging only from 0 to 6, it was not appropriate to run a linear regression (no farmer in the sample produced more than six types). The literature on measuring and valuing crop diversity uses the Poisson regression model as the standard model to predict inter- and intra-crop variety counts or measure the diversity of varieties farmers choose to plant from those available to them (Wale and Mburu 2006; Gebremedhin et al. 2006).

Table 3.14 reports the results of the Poisson regression. The model dropped 93 cases because they had either a missing mother or father. Although many cases were dropped, it was important to include the variables for parental age and education. Including them made it possible to gauge their effect on crop diversity and also prevented the problem of having an omitted variable bias in the model.

The only statistically significant variables that predicted the number of quinoa types a farmer produced were the number of varieties a farmer grew in the past, membership in a producer association, the area planted of quinoa and father's education.

### Varieties grown in the past

This variable was significant at the 1% level. The relationship between varieties grown in the past and in the present was expected to be positive, especially given the lack of a quinoa seed market in Bolivia. Yet there are some nuances to consider. In the past, farmers used 1–10 varieties; thus, many farmers used many fewer varieties than they did before. At the same time, new quinoa producers had arrived. These were the farmers whose parents emigrated a generation ago and who have returned to benefit from the economic opportunity offered by quinoa. These farmers went from growing no quinoa types to growing one, two or more (some grew more than three types). The coefficient of 0.0771 in this model means that on average each additional type of seed held in the past represents 8% greater diversity in types at present ( $\exp^{(0.0771)}$ ).

**Table 3.14.** Results of Poisson regression (dependent variable = number of quinoa types)

<b>Poisson regression</b>				
<b>Number of obs = 182</b>				
<b>LR chi<sup>2</sup>(12) = 29.45</b>				
<b>Prob &gt; chi<sup>2</sup> = 0.0034</b>				
<b>Log likelihood = -251.53546</b>		<b>Pseudo R2 = 0.0553</b>		
	Coef.	Std. Err.	Z	P> z
necotype				
varpast	0.0771549***	0.028795	2.68	0.007
memasso	0.2785364**	0.1245451	2.24	0.025
mothage	-0.0079697	0.0089637	-0.89	0.374
mothered	0.0322153	0.0211403	1.52	0.128
fathage	0.0053937	0.0085073	0.63	0.526
fathered	-0.0310173*	0.0175451	-1.77	0.077
smallfarm	-0.405509**	0.1745199	-2.32	0.02
medfarm	-0.178402	0.1375762	-1.3	0.195
lowecon	-0.034565	0.3424976	-0.1	0.92
medecon	0.0104386	0.2542318	0.04	0.967
nativelang	0.0902276	0.1369862	0.66	0.51
easymkt	0.1048177	0.134108	0.78	0.434
_cons	0.4614198	0.4320924	1.07	0.286
poisgof				
Goodness-of-fit chi <sup>2</sup> = 63.59899				
Prob > chi <sup>2</sup> (169) = 1				

Source: Author.

### Membership in a producer association

This variable is statistically significant at the 5% level. The coefficient of this variable tells us that farmers who belonged to a producer association produced on average 32% ( $\exp^{0.2785}$ ) more types of quinoa than those who were not association members. The associations have to a great extent driven farmers to use the three most commercial quinoa types (Blanca, Pandela and Toledo). In the previous two years, in response to the market, associations had also distributed seed of less commonly used traditional quinoas, such as Pisankalla and Negra.

This type of relationship is problematic to analyse because there could be endogeneity (the variable is determined within the model). It is possible that the

farmers who are more likely to grow a greater diversity of types are also more likely to join producer associations; or it is also possible that joining a producer association leads a farmer to grow more types of quinoa. An analysis of farmers who grew more than three quinoa types and belonged to producer associations suggests that they mostly grew commercial types. Of the 137 farmers who belonged to producer associations, only 21 (15%) grew quinoa types that were not among the six most commercial types (Table 3.15). This suggests that the majority (116 farmers) grew the cultivars required by the association, including the two newer types (Pisankalla and Negra). Since only 15% of farmers who belonged to an association kept at least one non-commercial quinoa type, it seems that membership in an association enabled farmers to grow more types, but not necessarily the less commercial ones.

**Table 3.15.** Quinoa diversity used by farmers who did or did not belong to a producer association

Membership in producer association	No.	No. of farmers with more than 3 quinoa types	No. of farmers with quinoa types other than the 5 most commercial	Percentage of farmers with types other than the 5 most commercial
Yes	137	41	21	15
No	138	12	9	7

Source: Household surveys in Salinas and Colcha K municipalities in 2006.

### Area planted to quinoa

The small farm variable is statistically significant at the 5% level. The coefficient of this variable suggests that small farms on average had 50% fewer types or cultivars of quinoa than large- and medium-size farms. This result is consistent with the accounts of farmers with small farms. Because more plots are needed to plant separate types of quinoa, having a smaller farm could be a limiting factor, and having a larger farm could permit greater diversity. At first this result seems counterintuitive, because larger farms have mechanized production systems that favour the use of only one or two quinoa types. However, “greater diversity” is likely to mean that large farms would be planted to the four or five most common commercial varieties. The Blanca, Pandela and Toledo types are very similar from a commercial point of view. Smaller farms might actually be where the less commercial quinoa types were kept. Other explanations for these results include:

- *Difficulty obtaining seed.* Since there is no quinoa seed market in Bolivia, farmers trying to plant a large area might be obliged to use more quinoa types because they had to use whatever seed was available. The difficulty of obtaining seed was the most common reason given for the limited production of quinoa types, both in the surveys and the focus groups.
- *Risk reduction.* In agricultural investments, just as in any other kind of



investment, diversification diminishes risk. The variation in pest resistance, frost tolerance and time to maturity among different quinoa types can also be a consideration for farmers when deciding what to plant. The desire to reduce risk might lead farmers with large farms to plant a greater number of cultivars, which generally would be the more commercial ones.

### **Father's education**

Father's education was statistically significant at the 5% level. The coefficient of this variable suggests a rather small and very marginal effect: for each additional year of education, the father of the household would have on average 0.5% greater diversity in the quinoa types planted. If there were a quinoa seed market in Bolivia, this effect would be easier to explain, because education and thus better access to information could expand the range of varieties available to a person. The lack of a seed market makes it more difficult to understand this positive association.

### **Native language**

The language spoken at home does not appear to have a statistically significant impact in maintenance of diversity. However, language spoken appears to have an impact in consumption of quinoa. Households that spoke a native language at home were more likely to consume quinoa than homes that spoke Spanish. What this may suggest is that cultural factors and food preferences are deeply intertwined. At the same time, perhaps market forces are a stronger influence than culture and tradition. Producing non-commercial varieties or types of quinoa has an impact on the household economy.

### **Age of father and mother**

These variables were not significant at all. It was expected that older farmers would be more likely to use quinoa's diversity owing to their experience and knowledge. It might be that because there is no adoption of modern varieties (just adoption of more commercial traditional varieties), there is no relation between age and use of quinoa diversity.

### **Reasons for declining use of quinoa types: farmer opinions**

All of the focus groups discussed the declining number of quinoa types that they used, and identified several common reasons for this trend.

- Farmers are willing to plant only what they can sell. They do not lack interest in trying other seeds, but they have an economic interest in selling their production.
- Although some types of quinoa are better for certain preparations, any type of quinoa can be used for all dishes, so farmers do not plant specific quinoa types solely for household consumption.
- Farmers prefer to plant only one, or two cultivars at most, because the costs of production increase when more varieties or types are grown: more time, labour and canvas is needed for threshing. To these higher production costs the farmer adds the opportunity costs of allocating resources to plant more

cultivars, especially if they are not commercial cultivars.

- Farmers with small amounts of land say that they plant only one or two types because they need separate plots for each type and they have limited land.
- Farmers do not know where to purchase or exchange seed of different types or cultivars. They are willing to try other types of quinoa as long as they have large grains, which are more marketable, but they do not know where to obtain seed. Most farmers indicated that sometimes not even their neighbours wanted to sell or exchange seed when they had a different, attractive quinoa type. Quinoa fairs and seed exchanges do not reach small communities. Most farmers have to walk 4 to 8 hours to reach a town where a quinoa fair or seed exchange is held.
- Some farmers prefer to sow seed mixtures rather than to maintain separate quinoa types, despite the low price they receive. Farmers believe that mixed fields yield more because the different types must compete more to grow. This belief is not supported by quinoa research results.
- The concept of “luck” plays a role in the loss of diversity. Farmers get rid of “unlucky” types that do not yield well. Even if a neighbour does well by growing commercially accepted seed in the next plot, the belief in personal luck is more dominant.

To a certain extent farmers still conserve the diversity within quinoa, but market pressures, particularly the pressure to supply homogeneous grain, leads farmers to abandon some cultivars. As people in the communities eat less quinoa and more “modern” food such as rice and pasta, certain quinoa dishes may be consumed less over time, and the special types needed to make those dishes may fall out of use. Women maintain that it is not the quinoa type but the processing that really makes the difference in preparing quinoa.

**Table 3.16.** Nutritional value of 5 morphotypes of Quinoa Real

Landrace	Protein/100 g	Fibre/100 g	Fat/100 g
Kellu	16.32	4.89	4.67
Toledo	17.26	3.89	5.89
Pisankalla	15.31	7.54	4.83
Achachino	18.29	6.28	3.11
Lipeña	14.84	9.11	5.13
Pandela	13.34	5.79	4.78

Source: Aroni et al., 2004. PROINPA lab analysis provided by LAYSAA.

The decline in the use of quinoa’s diversity represents more than a biological or cultural loss. It can represent a nutritional loss, because significant nutritional differences exist among cultivars (Table 3.16). These differences may once have been an asset, because consuming a variety of types may have provided a better complement of vitamins and minerals.

The variation in quinoa’s nutritional characteristics and grain size makes it

suitable for a range of industrially processed foods that have yet to be developed or marketed. The smaller-grained types are better suited for breakfast foods such as cold cereal, since they are easier to texturize. Similarly, the water retention properties and starch content of some currently less commercial quinoa types (like Achachino or Kellu) make them better suited for making pasta or baking (Alcocer et al. 2004). Conversations with a food engineer in Bolivia suggested that the Chillpi (Kaslala) variety has great potential to produce quinoa milk with a taste and texture resembling rice or soy milk (E. Alcocer, pers. comm.). The development and marketing of new products relying on a wider range of quinoa cultivars with special characteristics would be one way to conserve at least a portion of quinoa diversity through markets.

## Household consumption of quinoa

### The typical diet

After living and sharing meals for a year with families in the communities, it is possible to describe the typical diet.

Breakfast normally consists of tea from plants that women collect in the nearby fields (*muña*, *rica rica* and *paico*), coca tea, or packaged herbal teas. Coffee or cocoa are also drunk, but less frequently. Most people use about four teaspoons of sugar per cup in their drinks. The drink is accompanied either by bread (normally made at home from bleached wheat flour) or by fried dough (*buñuelos*, generally fried in llama lard). In the past, families would accompany their herbal tea with either phisara (quinoa boiled until dry with salt and lard) or phiri (quinoa semolina). Most families said that no-one had sugar until about 25 years ago.

Morning soup is served, especially on the days that the family heads to the fields. It is served early in the morning, almost immediately after breakfast. Soups are normally made by boiling a dry bone or piece of dried meat (*charke*) to flavour the broth. The most common soups are rice soup, noodle soup, quinoa grain soup, quinoa flour soup, barley soup and wheat grain soup. In addition to the dry bone or meat, onions, potatoes (fresh or dehydrated) and salt are added. Sometimes one to two very finely shredded carrots go into the soup as well. Alternatively, families sometimes have *papa huayco* with *p'hasa* or *chaq'o* (boiled potatoes whose flavour is enhanced by white clay obtained in the area).

Lunch is normally soup again, as described above. If the family is in the field, they may take some solid food such as noodles, rice, quinoa or *chuño* (with scrambled eggs or peanut sauce). Sometimes meat or a fried egg accompanies this food. Alternatively the family may prepare a *huatía* (potatoes, faba beans, maize, and sometimes *charke* cooked in a pit with hot stones).

Afternoon tea, as breakfast, consists of herbal teas, coffee or cocoa, with bread or fried dough.

Dinner is generally a soup similar to the morning soups.

### Traditional quinoa preparations in Salinas and Colcha K

There is almost no variation in how the different communities prepare quinoa. The most common and traditional ways of cooking quinoa are shown in Table 3.17.

**Table 3.17.** Traditional modes of preparing quinoa

<b>Dish</b>	<b>Meal in which it is used</b>	<b>Types of quinoa used</b>	<b>Preparation</b>
Pito	snack, especially for children	Chillpi (Kaslala), Koitu	The grains are toasted lightly, trodden once, soaked overnight, washed, dried and then milled.
Cocho, Ullpu, Ullpada	drink (consumed especially at planting and harvesting)	Chillpi (Kaslala), Koitu	Made with Pito (see above) plus water, and sugar is added.
Soup (with whole grains)	lunch, dinner	Blanca, Rosada, Elva	Traditionally cooked with charke, potatoes, onions, and salt, although a modern variation uses a chicken or meat bouillon cube (usually purchased in the city) and carrots, green beans and peas, when available.
Lawa (soup with quinoa flour)	breakfast, lunch, dinner	Kellu (Amarilla)	A quinoa flour soup, also prepared with charke, potatoes, onions and salt. The difference is that the quinoa is lightly toasted, the grains are trodden once, and then they are coarsely milled.
Phisara	lunch, dinner	Toledo, Rosada	Quinoa is boiled like rice until all of the water is absorbed or evaporated, cooked with salt and llama lard, and served as a side dish. The grains are toasted more darkly than for soup, trodden twice (treading, winnowing, and treading again).
Piri (quinoa semolina)	breakfast	Toledo, Rosada	Made with quinoa that is toasted more darkly than for soup (like quinoa for phisara), trodden once, and coarsely milled.
Mu'kuna	special occasion - holidays (as appetizer)	Kellu (Amarilla), Elva	A preparation made from quinoa dough (using finely ground quinoa flour) formed into round balls, sometimes filled with meat, potatoes or vegetables, and then steamed. By all women's accounts, mu'kuna is the most labour-intensive, time-consuming preparation

Chiwás or Yuyos (quinoa leaves)	lunch, dinner	N/A (uses leaves, not grains).	The three most common ways of preparing quinoa leaves are in soup (with potatoes), salads (chopped finely and dressed with some oil and salt), and less often in stews ( <i>estofados</i> ).
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### Quinoa consumption, past and present

Conversations with community elders suggested that quinoa was the dietary staple before commercial production began; it was eaten for breakfast, lunch, dinner and as snacks every day. People in the area also believed that their elders were healthier than most adults today. The elderly lived healthily until late into their nineties, but now people in their forties and fifties begin to have health problems such as diabetes, hypertension and high cholesterol. Survey respondents were asked to compare the amount of quinoa eaten by the family currently and about 15 years ago. The possible answers were more, less, equal or never. Of the 275 households, 147 (53%) responded that they now ate less quinoa; 27 (10%) indicated they ate more; and 101 (37%) indicate they ate about the same amount.

The most common explanation for declining quinoa consumption is that it is a matter of household economics. Quinoa has become a cash crop, so its price is set by export markets. Undoubtedly quinoa’s market price has affected households’ food consumption decisions. A 46-kg bag of quinoa, depending on its quality and type, could fetch US\$ 25–40. A bag of rice the same size cost US\$ 16–18. It was therefore better to sell the quinoa and buy the rice. Yet this might not be the only factor in a household’s decisions about what to eat. Households were asked to identify the most important factor in deciding what food to prepare, based on price, flavour, nutritional value, ease of preparation or habit. Across the entire sample, 57% said that price or cost was the most important consideration and 43% identified other factors. In Salinas municipality, price was the most important factor for 47% of households, whereas in Colcha K, price was the most important factor for 67% of households. Table 3.18 summarizes the responses.

The survey also asked families to remember what they had eaten the day before, from the moment they woke until the moment they went to bed. The 24-hour recall is based on the assumption that the intake described is typical of daily intake. Although it has potential drawbacks, as not everyone may remember correctly or tell the truth, nevertheless, the 24-hour recall is one of the most suitable methods for evaluating people’s diets.

The data were coded as “quinoa” if the family reported that they ate any kind of quinoa preparation the day before, even if it was only a snack, and as “other food” if not. Among the 275 households, 102 (37%) had consumed some quinoa the day before (Table 3.19). The data suggest that households that were very poor or in the middle economic level ate more quinoa. This seems counter-intuitive, if quinoa consumption is driven solely by economic factors, then families in the higher economic level should consume more quinoa. Other factors such as ease of preparation, perceived nutritional considerations, taste preferences, and

association of food with tradition or modernity might also have influenced whether families chose to eat quinoa.

**Table 3.18.** Most important factors influencing food decisions

Factor	All households		Salinas		Colcha K	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Price	157	57	64	47	93	67
Flavour	21	8	14	10	7	5
Nutritional value	43	16	18	13	25	18
Ease of preparation	22	8	16	12	6	4
Habit	32	12	25	18	7	5
Total	275	100	137	100	138	100

Source: Household surveys in Salinas and Colcha K municipalities in 2006.

**Table 3.19.** Consumption of quinoa and other food by economic level

Food consumed	Economic level				Total
	Low	Medium low	Medium high	High	
<b>Number of households</b>					
Quinoa	31	14	46	11	102
Other Food	56	28	76	13	173
Total					275
<b>Percentage of households</b>					
Quinoa	11	5	17	4	37
Other food	20	10	28	5	63
Total	32	15	44	9	100

Source: Household surveys in Salinas and Colcha K municipalities in 2006.

Table 3.19 provides a general idea of household quinoa consumption by economic level, but it does not provide a very detailed picture of quinoa consumption versus consumption of other foods, taking all meals into account.

When all the meals eaten the day before are taken into account, the picture changes. Of 905 meals consumed in the survey households, 358 (40%) were prepared with quinoa. Of 546 meals that did not include quinoa, 42% were noodles or pasta, 37% rice, 17% chuño and 4% other foods (oats, barley,

potatoes or wheat). If quinoa consumption is examined by municipality, only 26% of all meals were prepared with quinoa in Salinas versus 51% of meals in Colcha K. On average, households in Colcha K were poorer than in Salinas. If their decisions to eat quinoa were based only on economic considerations, surely the poorer households in Colcha K would have decided to sell rather than eat quinoa, because cheaper substitutes are available. Although Salinas produces significantly more quinoa, clearly production does not translate into consumption. Table 3.20 shows quinoa and non-quinoa meals for the entire sample and by municipality.

**Table 3.20.** Meals prepared with quinoa compared with meals prepared with other foods

	All meals	No. of meals prepared with quinoa	No. of meals prepared with other food
In Colcha K	494	250 (51%)	244 (49%)
In Salinas	410	108 (26%)	302 (74%)
For entire sample	904	358 (40%)	546 (60%)

Source: Household surveys in Salinas and Colcha K municipalities in 2006.

As expected, vegetable and fruit consumption was very low across the board (Tables 3.21 and 3.22). If a household reported even one event of eating vegetables the day before, it was counted as consuming vegetables; the same procedure was followed for fruit. There were no significant differences in vegetable consumption between the municipalities. Slightly more fruit was consumed in Colcha K than in Salinas. The most common fruits consumed were bananas, apples and oranges. However, in neither of the communities did the surveys coincide with the local fruit season.

**Table 3.21.** Vegetables consumed in study households (24-hour recall)

Consumed vegetables	All households		Salinas		Colcha K	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Yes	60	22	28	20	32	23
No	215	78	109	80	106	77
Total	275	100	137	100	138	100

Source: Household surveys in Salinas and Colcha K municipalities in 2006.

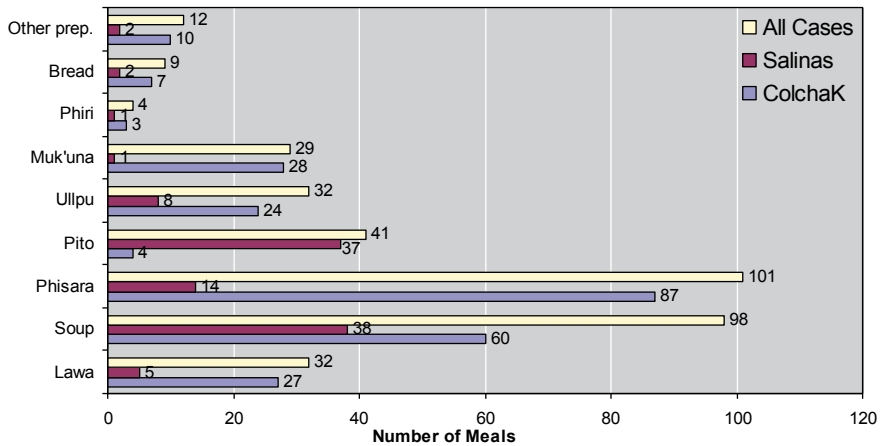


**Table 3.22.** Fruit consumed in study households (24-hour recall)

Consumed fruit	All households		Salinas		Colcha K	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Yes	31	11	11	8	20	14
No	244	89	126	92	118	86
Total	275	100	137	100	138	100

Source: Household surveys in Salinas and Colcha K municipalities in 2006.

When quinoa consumption reported through the 24-hour recall is analysed, the most commonly consumed preparations are very different in the two municipalities (Figure 3.8). In Salinas municipality, the most common preparation was soup (38 meals or 35% of quinoa meals), followed closely by pito (37 meals or 34% of quinoa meals). Considering that pito is not really a meal but a snack, consumed a couple of spoonfuls at a time, the real share of quinoa meals is even lower. In Colcha K, the most common quinoa preparation was phisara (87 meals or 35% of quinoa meals), followed by soup (60 meals or 24% of quinoa meals). The communities that are now more market oriented are consuming less of this nutritious grain and more of the easy-to-prepare but less nutritious modern foods.



**Figure 3.8.** Consumption of quinoa preparations in Salinas and Colcha K municipalities

Source: Household surveys in Salinas and Colcha K municipalities in 2006.

### Socio-economic determinants of quinoa consumption

To test hypotheses about which variables are correlated to quinoa consumption, a log-linear regression model (Table 3.23) was developed using “per capita

consumption of quinoa” as the dependent variable measured in percentage points (a log variable) and the following independent variables:

- logyield:* Quinoa yield from the previous agricultural period in percentage points.
- logyield2:* Quadratic term =  $\text{logyield} * \text{logyield}$ .
- mothage:* Mother’s age in years.
- mothered:* Mother’s education in years.
- famsize:* Family size as a continuous variable (number of members in household).
- no.minors:* Number of minors in the household (members under 18 years of age).
- easymkt:* Household’s level of access to market (binary variable: easy access or difficult access).
- highecon:* Household’s economic status (binary variable: high or not high).
- nativelang:* Primary language spoken at home (binary variable: native language or Spanish).

A log regression is an appropriate model for quinoa consumption, because it overcomes the problem of a lower-bounded dependent variable (which is the case for quinoa consumption). A linear regression assumes that the dependent variable can go from negative infinity to positive infinity, but given that quinoa consumption cannot be negative, a linear regression model is inappropriate. A log regression is also useful in measuring the elasticity of consumption.

After testing different models, the following had the best fit:

log per cap. consumption	= 2.093034	+0.8325136(logyield)* (3.72)	-0.0731511(logyield2)** (-2.25)	+0.0094486(mothage) (2.67)
		+0.0343935(mothered)* (2.77)	-0.1733004(famsize)* (-8.79)	+0.0606203(easymkt) (0.64)
		-0.5383398(highecon)* (-3.13)	+ 0.2785285(nativelang)* (2.87)	

$R^2 = 0.4317$ ; \* = 1% level of significance; \*\* = 5% level of significance; \*\*\* = 10% level of significance

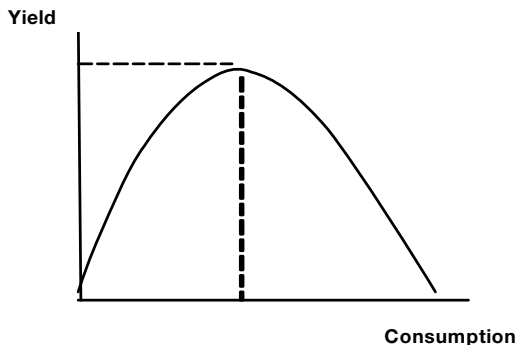
**Table 3.23.** The log-linear regression model

Linear regression		Number of obs = 244				
		F(8, 235) = 25.37				
		Prob > F = 0				
		R-squared = 0.4317				
		Root MSE = 0.63004				
logpercapita	Coef.	Robust Std. Err.	t	P>t	[95% Conf. Interval]	
logyield	0.8325136	0.2240888	3.72	0.000	0.3910341	1.273993
logyield2	-0.0731511	0.0325078	-2.25	0.025	-0.1371951	-0.00911
mothage	0.0094486	0.0035438	2.67	0.008	0.0024669	0.01643
mothered	0.0343935	0.0124143	2.77	0.006	0.009936	0.058851
famsize	-0.1733004	0.0197152	-8.79	0.000	-0.2121415	-0.13446
easymkt	0.0606203	0.0941292	0.64	0.52	-0.1248247	0.246065
highecon	-0.5383398	0.1717383	-3.13	0.002	-0.8766832	-0.2
nativelang	0.2785285	0.0971589	2.87	0.005	0.0871147	0.469942
cons	2.093034	0.4532161	4.62	0.000	1.200149	2.98592

Source: Author

This regression has an R<sup>2</sup> of 0.4317, indicating that 43% of the variance of per capita quinoa consumption is explained by the regressors of this model. This R<sup>2</sup> is within the average range for household surveys, particularly given the relatively small sample. The regression was run with Robust standard errors to control for heteroskedasticity (variance of the error term).

The results of the regression were the following:



**Figure 3.9.** Relationship between yield and consumption for quinoa.

Source: Author.

### **Quinoa yield**

Quinoa yield is statistically significant at the 1% level; in other words, a 1% increase in quinoa yield increases per capita consumption by 0.83%. It is assumed that quinoa consumption, like any other type of food consumption, is upper-bounded. The curve representing quinoa consumption is steep at low values and then flattens out as yield increases beyond a certain point (Figure 3.9).

A quadratic regressor was created ( $\text{logyield}^2$ ) to deal with upper-bounded consumption. This regressor is statistically significant at the 5% level, but it is not a constant term and has a marginal effect on quinoa consumption. The total increase in per capita quinoa consumption then depends on the increase of  $\text{logyield}$ , mediated by this quadratic variable ( $\text{logyield}^2$ ).

### **Mother's age and education**

This variable is significant at the 1% level but the coefficient is small. Thus, on average, each additional year of age of the mother increases per capita consumption by 0.009%. A positive correlation was expected, because older women would be more likely to include traditional food in the family diet than younger women. The mother's education is positively correlated with per capita quinoa consumption and is statistically significant at 1%. Each additional year of education of the mother is associated on average with an increase of 0.034% in quinoa consumption. Although the coefficient is also relatively small in this model, the direction of the relationship is as expected. A large body of evidence links educational attainment to virtually all development indicators, and nutrition is no exception. Mothers with higher levels of education are probably more aware of the links between nutrition and health and of the nutritional properties of quinoa.

### **Family size and ratio of producing to nonproducing members**

The family size variable suggests that larger families consume less quinoa per capita than smaller families. More specifically, the regression tells us that for each additional member in a household, per capita consumption decreases on average by 0.17%. This variable is statistically significant at the 1% level. Although the family size variable is important, it does not capture details such as how many people in the household work or contribute to the household economy. The literature on rural household economics suggests that the ratio of producing-household to non-producing-household members is important in production (income) and consumption outcomes. To see if the ratio between producing-household members and household size had any effect on quinoa consumption, a regressor was generated measuring the number of minors in relation to family size. A minor was defined as any household member less than 18 years of age, because almost all households members between 15 and 18 in the sample were enrolled full time in high school and participated only marginally in agriculture during the school year, except at weekends. The results of integrating the additional independent variable are shown in Table 3.24.

**Table 3.24.** Results of log-linear regression including additional independent variable (ratio of producing-household members to household size)

<b>Linear regression</b>		<b>Number of obs = 243</b>				
		<b>F(9, 233) = 22.55</b>				
		<b>Prob &gt; F = 0</b>				
		<b>R-squared = 0.4355</b>				
		<b>Root MSE = 0.62488</b>				
<b>logpercapita</b>	<b>Coef.</b>	<b>Robust Std. Err.</b>	<b>t</b>	<b>P&gt;t</b>	<b>[95% Conf. Interval]</b>	
logyield	0.7955216	0.223925	3.55	0.000	0.3543457	1.236697
logyield2	-0.0693981	0.032513	-2.13	0.034	-0.1334544	-0.0053417
mothage	0.0064365	0.003904	1.65	0.101	-0.0012554	0.0141285
mothered	0.0349191	0.012453	2.8	0.005	0.0103835	0.0594546
ratio	-0.3372903	0.214853	-1.57	0.118	-0.7605926	0.086012
famsize	-0.1539446	0.021234	-7.25	0.000	-0.1957802	-0.1121089
easymkt	0.0529829	0.09407	0.56	0.574	-0.1323532	0.2383189
highecon	-0.5645534	0.172297	-3.28	0.001	-0.9040124	-0.2250944
nativelang	0.2459836	0.097889	2.51	0.013	0.0531239	0.4388434
cons	2.363801	0.477698	4.95	0.000	1.422642	3.30496

Source: Author

Although the ratio was not statistically significant, its inclusion reduces the error from the equal treatment of adults and non-adults when measuring per capita consumption.

### Market access

A dummy variable was created to assign communities to one of two categories: 1 = easy access to market, and 0 = difficult access to market. This regressor was not statistically significant, perhaps because quinoa consumption is not affected by access to markets, given that most families (81%) sell quinoa locally through different channels and need not leave town. Poor market access may not matter if people can sell quinoa to itinerant traders with foods such as rice or noodles to sell or trade. Or perhaps most households, precisely because it is so difficult and expensive to travel to a market, stock up on foods that substitute for quinoa on their infrequent trips to the market.

### **Economic status**

The regression estimating per capita consumption also includes a binary variable for economic status. As mentioned, a household was classified as having a higher or lower economic level depending on several criteria, including the level of income from quinoa in the previous year (given that 87% of households indicated that quinoa was their most important income source); household assets, such as the amount of land under quinoa cultivation, livestock ownership, and housing size, condition and type; and the amount spent on food each month. Households at the higher economic level consume on average 0.56% less quinoa than those at the lower level. The notion that households consume less quinoa because their incomes are lower does not hold. It may be that some households consume more of their quinoa production because it is not very marketable (it could be a smaller-grained type, for example, which fetches a low price). Perhaps the quinoa is marketable, but households at the higher economic level may produce mostly certified organic quinoa, which receives the highest price. Although access to the market was not statistically significant, it may be that poorer households find it much more difficult to go to markets or fairs to buy other foods, especially since they do not really need to leave town to sell quinoa.

### **Language**

The final statistically significant variable (at the 5% level) is the language spoken at home. Households that spoke a native language on average consumed 0.24% more quinoa per capita than homes that spoke Spanish. It is generally accepted that cultural factors and food preferences are deeply intertwined. It makes sense that households where the traditional language is spoken also consume traditional foods.

### **Local knowledge of nutrition and health**

Focus groups provided information to deepen the analysis based on the quantitative data. Group discussions explored people's knowledge of nutrition, health and the nutritional contribution of quinoa. They offered a forum for detailed discussions about low quinoa consumption, obstacles to quinoa consumption, and possible solutions.

The participants may not have had sophisticated knowledge of nutrition and its links to health, but they had basic shared knowledge of the subject as well as general knowledge of quinoa's nutritional properties. The groups listed foods considered to be nutritious or healthful and foods considered to be less nutritious or damaging to health (Table 3.25). All groups regarded quinoa as nutritious, and three groups listed pasta and rice as less nutritious, along with fried and greasy foods. As a follow-up, groups discussed why they thought quinoa was nutritious (Table 3.26).

**Table 3.25.** Community assessments of foods that are less or more nutritious and healthful

Group	Nutritious or healthful foods	Less nutritious or healthful foods
Focus group 1	Wheat, barley, soy, quinoa, maize, beef, llama meat, carrots, cauliflower, potatoes, green beans, fava beans, pumpkin	Processed and packaged food, fried and greasy food, contaminated water
Focus group 2	Quinoa, vegetables, maize, barley, soy, fruit, llama meat, liver, eggs (eggs are only good for children, not adults)	Fried foods, pasta, rice, lamb, eggs (for adults), soda, candy
Focus group 3	Quinoa, fruit, lentils, soy, barley, oats, vegetables, meats	Bread, rice, pasta, potatoes, hot peppers, candy
Focus group 4	Quinoa, fruit, potatoes, soy, wheat, llama meat, chicken, beef, milk, lentils, eggs, fava beans	Lamb, fried and greasy foods, pasta, rice, and chuño

Source: Household surveys in Salinas and Colcha K municipalities in 2006

**Table 3.26.** Focus group responses to their classification of quinoa as a nutritious, healthful food

Group	Response
Focus group 1	Quinoa has protein, calcium for bones and teeth, and iron. It helps our children develop their intelligence.
Focus group 2	Quinoa is nutritious because it has calcium, iron, protein and vitamins. It is the most complete food for the family.
Focus group 3	Quinoa is natural and healthful because it does not have chemicals or other bad things added to it. Quinoa does not have cholesterol and gives us strength to work in the field.
Focus group 4	Quinoa has many vitamins, iron, protein, and is 100% more nutritious than rice and pasta.

Source: Household surveys in Salinas and Colcha K municipalities in 2006

The responses show that people in the communities, despite their lack of formal education, are aware of the nutritional advantages that quinoa brings to their diets. Three out of four focus groups mentioned the word protein, but when asked what it was or why it was important none could provide specific answers. Participants said that although they do not know exactly what protein is or how it works in their bodies, they know it is necessary for good health.

Once quinoa's nutritional superiority over pasta and rice was established, the groups discussed why most families eat more of the less nutritious foods:

- Laziness (*flojera*). Women suggested that laziness was one of the most important reasons for the reduced consumption of quinoa. They said that removing saponin from quinoa is too onerous and time consuming. They prefer rice and pasta, which are fast to cook, even though they may not be as nutritious.
- Nutrition is not always a consideration. Women admit that in day-to-day household activities and decisions it is very hard to always think about nutrition. Women say that it is also difficult to think about the impact of nutritional decisions because the negative impacts are not seen the same day or the next.
- Children and young people no longer appreciate quinoa as a food. They have grown accustomed to eat more modern foods such as rice, pasta, and hot dogs with fried potatoes (*salchi papas*). Women say children complain and leave quinoa on their plates when it is given to them. They are reluctant to invest so much effort in preparing quinoa if it is not appreciated.
- Money. Participants explained that economic considerations influence their choice to sell more quinoa and consume less at home.
- Dietary variety. Participants indicated that they cannot eat quinoa every day, all the time, because they get tired of it, even if it is prepared in different ways.
- More options. In the past, quinoa, chuño, potatoes, llama meat, charke and faba beans were the only foods available, partly because other foods did not reach their communities and partly because they could not afford other foods. The growing array of dietary options is viewed as not necessarily bad, because it makes meals more diverse in taste and also frees up time for the women.

## Quinoa production, processing and marketing

### Quinoa production systems

#### Characteristics of quinoa

Quinoa matures in 90–240 days. The colour of the plant (the panicle) varies by variety, type and maturation time, and can range from green to red, dark purple, yellow or orange. The panicles, which contain the grain, vary from 30 to 80 cm in length and 5 to 30 cm in diameter. Larger panicles can yield as much as 500 g of grain. The grains are rather small, varying from 1.04 to 1.70 mm in diameter (Benson, 2000). The plant grows erect, and its height varies from 40 to 300 cm, depending on the variety and the environment where it is grown.

Quinoa grain contains saponin, a compound that alters its palatability and needs to be removed prior to consumption. The level of saponin also depends on the quinoa variety and where it is grown, and it can range from 0.05% (considered the lowest content level of saponin found in quinoa; Fonturbel 2006) to 2.8%. In areas with harsher environmental conditions, quinoa generally contains more saponin and the grains are larger. Quinoa is classified as bitter (*amarga*) when



the saponin level exceeds 0.11% and sweet (*dulce*) when it is lower than 0.11% (Koziol 1993). Saponin cannot always be removed completely. Although it can inhibit the absorption of iron and zinc, saponin at low levels (0.8 to 0.12%) is beneficial for reducing cholesterol (Hernández 1997; Oakenfull 1981).

Quinoa leaves are edible and appreciated for their high nutritional content. The plant benefits from the removal of a portion of the leaves early in the growing cycle, because this practice directs more nutrients to the panicle. The colour of the leaves varies by region of cultivation and quinoa variety, from different tones of green to reds.

#### **Quinoa from the southern Bolivian Altiplano**

In the northern and central Altiplano, agriculture is more diversified, and quinoa has a less important role in the household economy. In addition to quinoa, farmers in the northern Altiplano produce potatoes, maize, wheat, barley, tarwi, faba beans and cañahua. The production of all crops follows a rotation system, and quinoa is mostly grown for household consumption (about 70% of production). In 2001, 6,717 ha were dedicated to quinoa in the northern Altiplano, which produced 4,030 t (17% of Bolivian quinoa production). In the central Altiplano, farmers produce potatoes, barley, quinoa and vegetables, but the most important activity is livestock production (bovine, ovine and camelid), and people specialize in meat, dairy, wool and leather production. The central Altiplano had 8,561 ha of quinoa in 2001 and produced 5,325 t (23% of national production). The lion's share of this production (85%) was for household consumption.

Lastly, it is important to highlight that sweet and bitter quinoa (quinoa dulce and quinoa amarga) are produced in different parts of Bolivia. Sweet quinoa is grown in the northern and central Altiplano and has significantly lower levels of saponin, with smaller grains. Saponin can normally be removed from sweet quinoa by rinsing the grain three to four times. Bitter quinoa, also called Quinoa del Salar or Quinoa Real, is unique to the southern Altiplano. In response to environmental stresses, it has a higher level of saponin and the grains are larger, making it more attractive for the export market. The high saponin content in Quinoa Real means that the grain must be washed approximately 18 times. Processing plants have the technology to remove saponin from Quinoa Real, but in the households of the southern Altiplano, women process the grain by hand in a lengthy process that, as discussed elsewhere, discourages household quinoa consumption.

#### **Quinoa production systems in Salinas and Colcha K**

Quinoa production in Salinas municipality, and to a lesser extent in Colcha K, is very intensive. As quinoa prices rose, households made the rational economic decision to allocate most of their land, inputs and labour to the exclusive production of quinoa. Quinoa was now planted continuously, without the traditional rotations or long fallows.

Most crop operations are done by both men and women, although mechanized operations using tractors and winnowing equipment are performed more often by men. Men also usually clear land for planting (*desthole*), and women winnow the grain.

Specific quinoa production operations in the southern Altiplano are described below.

### Ploughing and soil preparation

These activities are mostly done by tractor, given the size of the plots. A 1982 study in Salinas community indicated that 80% of the communities used tractors with disc ploughs (Liberman 1986). Soil preparation is done from January to March (the rainy season) to capture soil moisture. Very little fertilizer is applied, either because manure is scarce, there are few trucks to spread manure on large tracts of land, farmers have limited knowledge of soil conservation, or fertilizer is not very efficient in the southern Altiplano's dry soils. In Salinas and Colcha K municipalities, farmers pay Bs 100 (US\$ 14) per hectare to tractor owners for ploughing. In some communities of Colcha K, where people still plant on the slopes, ploughing is done manually through the *ayni* system.

### Planting

Quinoa is planted by hand or tractor in September and October. The crop is replanted in October if the first planting is unsuccessful (for example, if germinating plants are eaten by rodents).

### Protecting plants from the elements (tiznado)

This practice is done when quinoa plants are just germinating. Each small plant is covered with straw or bush branches to protect it from intense sun, wind, frost and birds.

### Hilling up (*aporcado*)

Farmers "hill up" or cover the growing plant with a mound of soil, believing that this practice raises yields. *Aporcado* is done in the middle of the cycle, in January-February.

### Pest control

In November and December, conventional farmers apply chemical pesticides. During the study, organic farmers expressed concern about their limited pest control options. Until recently, certified organic farmers could use a synthetic pesticide extracted from pyrethrum (*Chrysanthemum coccineum*), which has now been banned. Some farmers explained that a traditional way to combat pests was to boil the different bitter bushes (*tholas*), add the saponin dust from the quinoa, and spray the mixture on the plants. They admit that the effectiveness of this practice is limited, but so are other options and information about pest control. During a meeting in Colcha K, farmers showed great interest and willingness to buy any product that could organically control pests. They had received information on a product available in Santa Cruz<sup>14</sup> but no further assistance.

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14. Santa Cruz is a department in eastern Bolivia (the lowlands). It normally would take 28 hours by bus to get from Colcha K to Santa Cruz.

Farmers were frustrated because they had no way of purchasing the product from Santa Cruz. Many certified organic farmers resort to chemical pesticides when pests reach an otherwise uncontrollable level. It is a risky choice but viewed as necessary to save the crop.

#### Harvesting

The harvest (March and April) is still done manually, by pulling the plant out by the roots or cutting it, although some farmers have invested in small hand mowers. Pulling the plant out by the roots is common but damages the soil and causes the grain to be mixed with soil and pebbles. Farmers with larger plots and limited family labour normally hire day labourers. Farmers expressed concern that every year it is more difficult to find people to work as day labourers. A day labourer is paid Bs 30–50 (US\$ 3.75–6.25) per day, and the farmer must include *pensión* (food in the field). Normally the women cook *huatía* while they work in the field. It is also customary for the owner of the plot to provide coca leaves to the people working on their land. The chewing of coca (*pijcheado* or *acullicado*) gives the workers strength and helps suppress the appetite. Farmers generally consider harvesting to be the most demanding part of production. It is very common for families to work from 5 in the morning to 7 in the evening every day during harvest, and even longer on moonlit nights. Children are rather neglected during this time, as they are left by themselves while their parents are in the fields, sometimes for days at a time.

#### Drying (*emparvado*)

Farmers make arches or piles of quinoa so that it can dry before threshing. Quinoa remains in the piles for about eight days.

#### Threshing

Depending on the farmer's resources, threshing is done by hand (beating the quinoa with a stick or *huactana*), by driving over the grain with trucks or tractors, or by threshing machine. For manual threshing, the grain is placed on pieces of canvas (*lonas*), which have replaced the traditional threshing surfaces of clay and straw (*cayanas*) used in some communities.<sup>16</sup> The canvas cloth, as discussed above, is an economic obstacle preventing farmers from using more varieties.

#### Winnowing (*venteo*) and cleaning

If the grain has been manually threshed, it must be winnowed to separate the grain from the chaff. Winnowing uses the wind (*viento*—hence the name *venteo*) to clean the grain, which is heavier than the small particles. Now farmers can also use winnowing machines called *venteadoras*.

15. *Huatía* is a traditional way of cooking potatoes, faba beans, maize, and sometimes meat by putting hot stones into a hole dug in the ground.

16. The quinoa grain was rubbed on this surface with the arms, which were covered in a sort of long glove made of llama leather (from the neck of the llama) called *makeq'aras*. This is no longer practised.

Data from the household surveys show that a family farm produces on average 2760 kg of quinoa, within a wide range of 275–13 800 kg. The average amount of land planted in the previous year per family was 6 ha, but Salinas households had on average larger plots (7 ha) compared with Colcha K households (4 ha). The average yield per hectare was 552 kg and ranged from 230 to 920 kg. Most farmers indicated that on average the yield used to be 800–1088 kg/ha. They acknowledge that the land is “tired” or void of nutrients because of continuous production. At the same time they did not see any way of leaving land fallow for six or more years as they used to do.

### **Traditional and commercial quinoa production compared**

The switch from a traditional to a modern production system to meet the demands of a thriving new market has been profitable in the short term, but raises several concerns that are important for the long term. For example, community cohesiveness has been lost as traditional collaborative practices have become unnecessary. Current production practices deplete soils, make pests harder to control, and eventually will compromise quinoa farmers’ land. The transformation of agriculture in the southern Bolivian Altiplano and some of its effects are summarized in Table 3.27.

### **Quinoa processing**

#### **Removing Saponin (El Beneficiado)**

The process of removing saponin is called “*el beneficiado*.” Traditionally this work is done by women and involves the following steps:

- Toasting the grain on metallic sheets placed over the fire. Depending on how the quinoa will be prepared, this step takes 3–8 minutes.
- While the grain is still hot, it is placed in a bowl-like stone called a *saruna* (Quechua) or *tiwiraña* (Aymara), and women tread on the grain, adding white clay (*pok’era*) to improve friction between the grains and enhance flavour.
- Manual winnowing or removal of saponin dust (*el venteado*).
- A second treading of the grain (for some dishes) and a second winnowing.
- Washing and drying the grain.

The hardest and most time-consuming steps in this process are the treading and winnowing. It takes about 6 hours to process 12 kg of quinoa. In addition to being hard and time-consuming, treading the grain causes blisters on the feet, low-back pain, and joint pain, especially in the hips. To winnow quinoa manually, women have to wait for an appropriate wind, and since this work is done after the harvest from May through August, women sicken with influenza, bronchitis or pneumonia brought on by the extremely cold winter winds.

Industrial machines can process quinoa, but there are several obstacles to using them. First, most rural communities are very isolated and have no access to processing plants. Second, processing plants are not always willing to process 2–3 bags of quinoa for a household. Finally, the flavour of industrially processed quinoa is unacceptable to people in the southern Altiplano. Industrial processing removes the saponin simply by washing quinoa in water about 16–18 times and then drying

**Table 3.27.** Transformation of agricultural production in the southern Altiplano as a result of market development

Activity	Traditional method	Modern method
Crop rotation	Diversified agriculture with quinoa, potatoes, and fava bean production.  Effects/impacts: Spreads risk and breaks pest cycles.	No crop rotation. Quinoa is the only crop produced.  Effects/impacts: Promotes development of pests and increases risk to farmer if harvest is lost.
Rotation of cultivated lands (mantas system)	Multiple areas and ecological zones (slopes, hills, flat areas) used to grow crops.  Effects/impacts: Minimizes risk of adverse weather. Land rests for long periods, restoring soil fertility.	No rotation of cropland. Crops planted only in flat areas to use tractors.  Effects/impacts: Higher yields but higher risk from adverse weather. Lack of fallow depletes soil fertility.
Ploughing	Use of manual instruments (taquisa, liukana, yunta, similar to shovels and picks). No animals are used for ploughing  Effects/impacts: Soil texture is conserved and pest propagation minimized. Low production costs. Use of rural labour force.	Mechanized ploughing (tractors with disc ploughs).  Effects/impacts: Loss of vegetation and soil texture. Increased wind and water erosion. Propagation of pests.
Pest control	Crop rotation and use of natural pesticides (infusion of bitter shrubs like <i>muña</i> mixed with saponin dust).  Effects/impacts: Minimum pest attack and absence of environmental conservation.	Chemical pesticides used without controlling the concentration of chemicals and number of applications (farmer has limited information)  Effects/impacts: Environmental contamination (of groundwater), residual effects of chemical pesticides, health risks for farmer.
Social organization	Community solidarity and participation in agricultural activities through reciprocal assistance ( <i>ayni</i> ) and communal work in agriculture ( <i>minka</i> ).	Disappearance of community work and institutions mostly due to mechanization. Inefficient use of rural labour force which can exacerbate emigration.
Diet and food consumption	Based mostly on local production (quinoa grain and leaves, bitter potatoes, faba beans, llama meat, lamb and local seasonal fruits).	Less quinoa and llama meat; more white bleached flour products (bread, pasta), rice, sugar and processed foods ( <i>soda</i> ).

Source: Author

it. Women say that the washed quinoa lacks flavour because the most important steps in the beneficiado were not done—the toasting and treading with clay. Women from the study communities find that the industrially washed quinoa takes too long to cook and that the grain does not open up properly when it is cooked.

### Small-scale processing technology

Because the focus groups indicated that the work and time involved in processing quinoa was an important constraint on consumption, a small quinoa-processing machine was evaluated. Through collaboration between the United States Congressional Hunger Center and a local mechanic, a small processing machine was designed, built and evaluated for its potential to replicate the beneficiado process for removing saponin.

#### Specifications and operation

The machine is relatively small (about 70 cm long, 30 cm wide and 80 cm high) and weighs approximately 30 kg. It has a feeding chute, peeling cylinder (with steel mesh and an “unending” screw), a power transmitter with a pulley, two openings (2×6 cm) for the grain to enter and exit, and a third opening to expel saponin. The feeding chute, which slopes 30 degrees and has a 25-kg capacity, feeds grain into the husk-removing cylinder. The cylinder can be fed mechanically with a small device that opens and closes by pulling. The cylinder is 15 cm diameter × 60 cm long.

Within the cylinder, the screw constantly turns and moves the grain along the cylinder walls, so the quinoa grains rub against each other as they do when trodden. The stainless steel mesh lining the cylinder provides additional friction. The saponin dust is expelled through the mesh once the grain has progressed 20 cm along the cylinder. The screw is fitted with fan blades to help expel the dust. Part way through the cylinder, the grain is also rubbed with steel bristles to clean saponin from small, deep cracks in the grain. *Pok'era* can be used with the machine and grain can be processed toasted or untoasted. The machine can process 12.5 kg of grain in about seven minutes—a process that takes six hours when the same amount of grain is processed manually.

The machine can be powered by an electric or gasoline motor, and thus can be adapted if electricity (lacking in most communities) becomes available. The smallest gasoline engine available is 5.5 horsepower, although the cleaning machine operates on only 0.5 horsepower and thus uses only 0.25 L of gasoline per hour of operation. Depending on the type of engine that is installed, the machine ranges in cost from US\$ 560 (with a Chinese engine) to US\$ 800 (with a Japanese one).

#### Participatory Evaluation of the Cleaning Machine

The machine was tested in five communities: Salinas, Jirira, Colcha K, Copacabana and Chita.<sup>17</sup> Women already know about milling services for quinoa (in Salinas, Colcha K and the Challapata market), even if they do not use them and mill their grain by hand, on a stone. The women were asked to imagine that one day the saponin-cleaning machine could provide a similar processing service.

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17. Chita was not one of the study communities, but it is a quinoa-producing community near Uyuni and has a good relationship with PROINPA, which supported the research. Some activities related to nutrition are being implemented in the area, so it offered a good opportunity to test the machine.

The machine was tested with 62 users, whose remarks are summarized in Table 3.28. In each community, 8–14 people tested the machine (in Copacabana, where the machine remained seven days, 33 people tried it). People were asked to bring their quinoa, toasted to suit its expected use. Each household brought about 12–14 kg, and some brought as much as 25–50 kg. The first community to test the machine was Salinas, where the testing was least successful owing to limited experience in operating the machine, especially in calibrating how much quinoa to add and how rapidly to add it. As testing progressed, these technicalities were worked out. Men were generally more demanding and less satisfied with the machine's performance than women. They insisted that the machine yielded too many broken grains, whereas women said that treading the grain produced the same proportion of broken grains. The women, who were generally excited about the machine, insisted that the men complained only because they do not have to do the processing. In fact, in processing grain for *phisara*, the machine may have an advantage in retaining more of the rings in the grain. The rings are where protein and amino acids are concentrated. Treading causes many of the rings to break loose and be rinsed away. As part of the assessment, *phisara* was made with traditionally processed and mechanically processed quinoa. In a blind tasting, people could not tell the difference. This important step convinced most of the critics that the machine would be a good replacement for treading.

Families that participated in the evaluations asked if other small machines could be brought to the communities, such as a machine for rolling quinoa grain flat, like oats. With this machine, women said they could cook quinoa for their children's breakfast in five minutes. There was also great interest in small mills, because grinding quinoa by hand is too time consuming.

**Table 3.28.** Responses from 62 users surveyed about the use and results of the saponin-cleaning machine

Are you satisfied with the machine's performance?	Yes: 95%	No: 5%
If the machine were available in your community (for a fee), would you process your quinoa with it?	Yes: 98%	No: 2%
If you answered "yes" to the previous questions, how much would you be willing to pay to process an arroba (12.5 kg)?	Bs 6 (US\$ 0.75): 67%	Bs 5 (US\$ 0.62): 23%
	Bs 4 (US\$ 0.50): 5%	Bs 7 (US\$ 0.87): 2%
	Not sure: 2%	
How can the machine be improved?	Dislike Chinese engine; a better quality engine is needed: 39%	Yield fewer chipped or broken grains: 35%
	Remove the saponin better: 12%	Not sure: 14%

Source: Household surveys in Salinas and Colcha K municipalities in 2006

## Quinoa marketing

### A segmented market

**Table 3.29.** Types, prices and destinations of Bolivian quinoa

Type of quinoa	Price (US\$/t)	Destination
Organic Quinoa Real	1600	USA, Europe, Canada, Japan
Organic sweet quinoa	1200	USA, Peru
Conventional Quinoa Real	800	Local Bolivian market and Peru
Conventional sweet quinoa	700	Local Bolivian market and Peru

Source: *Fundacion para el Desarrollo Tecnologico del Altiplano (FTDA, 2002)*.

The market for quinoa in Bolivia is segmented. The type and destination of the grain largely determine its price (Table 3.29).

There are two main markets for quinoa in Bolivia: Challapata and Desaguadero. The market in Challapata is a traditional market that is relatively well connected to the centres of quinoa production in the southern Altiplano, considering the challenging road network. A few wholesale buyers buy most of the quinoa produced in the southern Altiplano through intermediaries—some 8–10 itinerant traders who pass through the communities to purchase quinoa and sell dry goods as well.

The Desaguadero market on the border between Peru and Bolivia is thought to handle about 70% of Bolivian quinoa production. Quinoa is exported through this market to evade customs duties. Trucks full of quinoa are unloaded and the grain is slowly transported in bags (quintales) over the bridge from Bolivia to Peru on the backs of day labourers. Because each person carries a couple of bags at a time, customs duties do not apply. Once the quinoa enters Peru, some of it is consumed domestically and some of it is cleaned, processed and exported as Peruvian quinoa. The trade in quinoa and other native products has continued for centuries in Desaguadero and is thus very difficult to control.

Other, smaller markets for Bolivian quinoa are found in La Paz, El Alto and Oruro. Quinoa destined for legal export is usually sold to producer associations, processing plants or export companies.

### Marketing quinoa produced in the study area

Of the 275 households surveyed, 24 households (6 in Salinas and 18 in Colcha K; 8.7% of all producers) did not produce quinoa for sale. They either produced very little or their quinoa was of poor quality.<sup>18</sup> Some families trade small portions (one

18. Either the grain can be very small (*chiñi*) or its quality can be poor because farmers have poor seed or have not selected seed for planting, with the result that different quinoa types are mixed.



arroba<sup>19</sup> or less) of quinoa for other products in small stores in their towns or with the itinerant traders who bring dry goods by truck. But they do not consider this selling or production for the market.

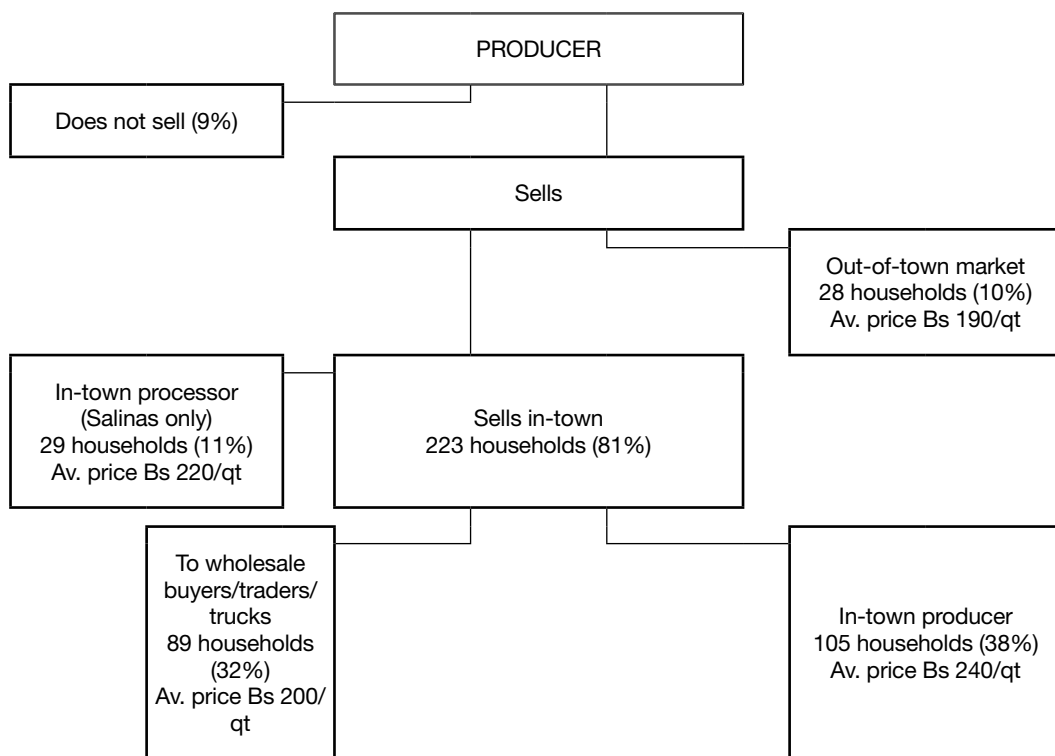
As mentioned, farmers can sell quinoa outside their communities in a market, generally Challapata but also Uyuni or Oruro. They can also sell quinoa within their communities to a producer association, intermediary, or processing plant. The last option works only in Salinas town, which has two processing plants: Planta Procesadora de Quinoa Salinas (PPQS) and Quinoa Boliviana del Sur (Quibolsur). People from other towns, even within Salinas municipality, do not sell quinoa to these plants.

Figure 3.10 shows the options for selling quinoa and the associated average price, with 81% of households selling quinoa in their own town, whether to a producer association, processing plant or itinerant traders (intermediaries for wholesalers). The other 10% sold the quinoa in fairs or markets out of town, and 9% did not sell their quinoa at all. The producer associations paid the highest price (on average Bs 240 (US\$ 30) per quintal), but some people, even if they are association members, preferred to sell either to the itinerant traders or processing plants because they were paid immediately. Some of the associations offered higher but deferred payment (by approximately two months). The processing plants offered the second-best price (Bs 220 (US\$ 27.50) per quintal), a good option if the farmer was located or lived near the town of Salinas. The itinerant traders were the third-best option (Bs 200 (US\$ 25) per quintal). The least remunerative option was to sell quinoa in the market at Challapata, Uyuni or Oruro. Producers on average got Bs 190 (US\$ 23.75) per quintal and have to pay to get themselves and their produce to the market. Producers choose the fair when they need money fast. The intermediaries' trucks do not follow regular schedules.

As mentioned, prices also depend on whether the quinoa is organic or conventional, on grain size, and on the variety or type of quinoa. Two varieties currently fetch high prices in the market: Pisankalla and Negra. Both have the special advantage of not losing their colour (reddish brown and black, respectively) after the grain is processed. Farmers selling these varieties received as much as Bs 340 (US\$ 42.50) per quintal, even if the grain is not organic.

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19. One-fourth of a quintal (25 lb, about 12 kg).



**Figure 3.10.** Marketing decisions of quinoa producers in Salinas and Colcha K municipalities

Source: Household surveys in Salinas and Colcha K municipalities in 2006

Conversations with producers in several communities confirmed that quinoa prices fluctuate seasonally, depending on availability, and when people have special expenses:

- December. Holiday expenses.
- February or March (Carnival).<sup>20</sup> People travel to other towns, participate in parades and dances (requiring costumes and special clothes), eat special food, and drink alcohol. After carnival most children start school (which technically begins weeks beforehand, but with very few children in attendance) and need school supplies and uniforms.
- April–May. Immediately after harvest there is a large supply of quinoa.
- June. Two important holidays. The Andean New Year (Machaq Mara) falls on 21 June and the Festival of Saints Peter and Paul on 29 June.

20. Shrovetide (Carnivale; Mardi gras): This holiday in the southern Altiplano extends beyond the usual Sunday–Monday–Tuesday celebration to an entire week, beginning on Sunday and ending on the following Saturday.

## Conclusions and recommendations

### Conclusions

Quinoa is a good instance of an underutilized species—underused by everyone who did not traditionally produce it—that is now widely accepted in international markets, which value its differences from other food grains, including its high complement of protein. The effort to commercialize traditional crops is certainly not unique to quinoa or to Bolivia. Throughout the world, in settings very different but just as impoverished as Bolivia's Altiplano, communities, development organizations and research institutes are examining the potential for local crops to break into lucrative international markets. This case study of agricultural livelihoods following the transition to commercial production of an indigenous crop offers insights into the kinds of changes that might occur, and the prospects for coping with those changes.

The transition from traditional to commercial quinoa production in the study communities has had a number of important and measurable consequences on socio-economic indicators (such as income, education and nutrition), quinoa diversity and the environment. Commercial quinoa production has also brought changes that are less tangible and more difficult to measure, such as the growing sense of empowerment that comes with participating in the cash economy, or the sense of loss surrounding the disappearance of traditional community institutions that bound people more tightly together.

### Income

The new market for quinoa has enabled producing households to raise their cash income from essentially nothing to a level that is higher than in other rural areas of Bolivia. Higher incomes and cash liquidity permit households to have more choices: the choice of what to eat (traditional or new foods), choices to further their children's education, or the choice to remain in the community rather than join the rising tide of emigrants from the southern Altiplano. The sense of empowerment derived from being able to choose how and where to live is a very important outcome in these marginalized communities.

Yet this very marginalization has reduced the impact of higher incomes. The remoteness, poor infrastructure and weak social services of the southern Altiplano remain unchanged. By these measures, people still live in poverty, and their money and effort have not improved a starvation diet of less than 800 calories per day. Higher incomes could have a more positive impact on health and nutrition if diverse foods, especially fruits and vegetables, were more accessible. The market for quinoa comes directly to producers in the form of itinerant intermediaries or community-based buyers, but markets where fruits and vegetables are sold are distant and expensive to reach. During their sporadic market visits, quinoa producers buy mostly dry and processed food that can keep well, thus creating a new pattern of consumption that exacerbates malnutrition and poor health.

### Education

Higher incomes from quinoa appear to have enabled households to invest in education. Household members aged 18–30, namely the generation educated after the initial development of the quinoa market, have more formal education than their parents. Almost two-thirds of this cohort completed secondary school, and almost half participated in tertiary education, such as teacher training, technical school or university. Most children under 18 do not leave school to work in the field with their parents.

### Nutrition

Economic considerations are an important but not the sole factor determining whether households consume more or less quinoa. Because quinoa can cost as much as 45–50% more than other staple grains, it is commonly assumed that households prefer to sell rather than eat quinoa. In other words, the poorest households will probably attempt to sell most of their quinoa and buy cheaper substitutes such as wheat or rice. Yet this is not the case. In the study communities, poorer households kept and ate more quinoa. Better-off families spent more income on food other than quinoa; perhaps they are including more meat, vegetables and fruits.

One of the most important reasons that households cite for eating less quinoa is that it is so difficult and time consuming to process. Small processing machines that replicate the traditional *beneficiado* process could increase quinoa consumption among producing households.

### Environment

Quinoa is unlikely to remain a successful cash monocrop in the southern Altiplano if current production methods remain unchanged. The extractive nature of these practices depletes soils, heightens vulnerability to pests, contaminates the environment with pesticides, and compromises the future of the land and of the families who live there. One of the most worrying practices—the use of tractors with disc ploughs—is actually one of the easiest to change, however. Farmers know that there are options in the Bolivian market, such as narrow ploughs, to permit more sustainable mechanized production, but the costs of changing to a new technology are high. Additionally, farmers seem to have a high rate of future discounting that makes the transition to more sustainable (as well as organic) agriculture difficult.

### Diversity

At the same time as quinoa and its diversity are more widely used by people who never traditionally grew or ate it, quinoa is used less by those for whom it has been a traditional crop and food. Most meals (60%) in the traditional quinoa-producing communities surveyed did not include quinoa, suggesting that quinoa is becoming an “underutilized” crop, displaced by foods that are easier to prepare but much less rich in protein and micronutrients.

The market has not served as a good way to conserve the wide range of diversity within quinoa. The Quinoa Real variety produced in the southern Altiplano has approximately 40 types. Of these, only five of the more commercial

types (Blanca, Pandela, Toledo, Pisankalla and Negra) were being grown on 90% of the 507 plots surveyed. Market and economic development historically have caused the diversity within staple food species to shrink, regardless of the crop, and quinoa, following a very similar process of agricultural development, has not escaped this fate. The international market demands very specific qualities, such as large and homogeneous grains, and farmers understand this.

Research has identified less-commercial types with great potential for processing as breakfast cereal, milk, pasta and baking products. But even if the food processing industry invests in these other types, the most frequently used types will increase from 5 to perhaps 8 or 10, leaving the other 30 or so less commercial types at risk of disappearing.

Tradition seems to encourage the consumption, but not the conservation, of quinoa. The more traditional families who speak a native language at home are more likely to maintain quinoa in their diets, yet they are not more likely to grow a wide range of quinoa types. There is a cost to the farmer for maintaining quinoa diversity: the opportunity cost of planting non-commercial varieties, the higher costs of producing more types, and the need to produce marketable varieties. Farmers lack strong incentives to keep the less-commercial types and consistently seemed indifferent to their uses. Although farmers know that some types of quinoa yield better or offer greater pest resistance, these positive attributes each have drawbacks which, coupled with the lack of a market, direct farmers toward the most commercial quinoas. Women insist that as long as the grain is processed correctly, any type of quinoa can serve for any preparation. While it is widely believed that diversity is better conserved through use, in this case the cost for individual farmers to conserve quinoa diversity is high and their continued maintenance of different varieties is unlikely.

#### **Intangibles**

The empowerment that comes with participating in the cash economy should not be underestimated as a positive result of commercial quinoa production, but nor should the effects of losing traditional institutions that fostered collective action. The declining traditional knowledge of quinoa types and their uses, in the field and the household, is not a loss that can be measured, but it does mark a change in rural people's traditional, close relationship with their crops, their land and the sustenance they provide for their families.

#### **Recommendations**

Quinoa now plays an essential role in southern Altiplano livelihoods in a different way and in a new global setting. The quinoa-producing communities in the study area have worked extremely hard to better their livelihoods, but their hard-won success appears fragile. Based on the very detailed information obtained in these communities, a number of actions could be taken to help quinoa farmers balance participation in the global market with other important aspects of their livelihoods, such as the sustainability of their cropping practices, health and nutrition, community institutions, their role as the custodians of quinoa diversity, and their newfound empowerment.

### **Maintain access to quinoa diversity and promote knowledge about it**

The loss of quinoa diversity is in theory a negative outcome, but it is not clear what exactly will be lost when these quinoa types disappear from farmers' fields. It is an advantage that Bolivia has a well-functioning genebank to preserve neglected quinoa types in the event that some of their special characteristics are needed in the future. It would be a further advantage if some mechanism could be developed for farmers to learn about and share new types of quinoa seed that might be useful for them.

### **Develop and use alternative production technologies**

No such safeguards are in place for the southern Altiplano's rapidly degrading soils. The environmental consequences of current production practices are quite possibly the greatest source of vulnerability for the study communities. If soils become entirely exhausted from current practices, then farming communities will suffer, as at present there are no commercial alternatives to large-scale quinoa production. Producer associations and research organizations should recognize the development, financing and use of alternative production technology to be a priority. It is difficult to believe that some segments of the international quinoa market would be content to learn that their demand for quinoa is actually harming the land where the crop is produced.

### **Improve nutrition with better infrastructure and small-scale processing equipment**

It is difficult to see how the very serious nutritional problems in these communities will go away until infrastructure, particularly transport infrastructure, is improved or supplementation programmes are more widely available. Even so, action at the local level can help people to re-integrate quinoa into their diets. People in the study communities may not be highly educated, but they know that they do not have the best selection of food available and they are likely to take advantage of affordable options for improving nutrition. Efforts to promote small-scale processing equipment could go a long way to making quinoa more accessible to households, especially the poorer households who choose to keep eating it. The time saved, especially for women, could make it possible for them to participate in other activities, including potentially lucrative activities. Reducing the toll that manual quinoa processing takes on women's health would also be a significant advance.

### **Use producer associations to promote innovation**

The sense of empowerment in the study communities could be tapped to bring additional services and support to these communities. For example, producers require information about pest control alternatives in organic quinoa production; about new types of seed; and about how to obtain inputs and equipment that would preserve their land. Could farmers induce producer associations to meet more of these needs? At present, farmer participation in producer associations, while positive, appears to be somewhat passive, in the sense that farmers' concerns do not appear to have as much weight as the demands from distant markets.

#### Invest in the development of rural communities

A final consideration is that the awareness of Bolivia's marginalized groups, including those in the southern Altiplano, has come to the forefront of the national dialogue as never before. The country is challenging years of inattention to indigenous people's rights and their consequent marginalization. Now is the time for policy-makers to examine innovative ways of improving the welfare of poor and indigenous communities. It is clear that the enormous lithium reserves under the Uyuni Salt Flat could alter prospects for people in the study communities profoundly, for better or ill, in ways too numerous to discuss here. If a lithium mining industry develops, however, it may be possible to direct some of the mining revenue to local development initiatives and ease the lack of infrastructure and social services in these communities. The lesson from the current study is that whatever development path is taken in the area in years to come, policy-makers must explicitly consider more than economic effects and look at the longer-term social and environmental implications for the region and its indigenous people.

Beyond Bolivia, in areas where the rights and choices of marginalized people are receiving much less attention, numerous programmes seek to promote "new" crops for new markets, especially export markets. The experiences described in this case study could be useful to such programmes. The experience in the southern Altiplano highlights many of the tradeoffs involved in moving from traditional to commercial agricultural systems. It confirms the need to pay careful attention to issues that extend beyond market access, production techniques and the provision of credit: socio-economic issues such as community cohesion, nutritional standards, the loss of natural resources (including genetic diversity), and land tenure. These issues are easily overlooked in the drive to achieve something for people with a long history of marginalization, but they must be considered if the escape from marginalization is to be real and lasting.


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## 4. Small-scale quinoa processing technology in the southern Altiplano of Bolivia

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AMRILLA  
MARONCA

Photograph by © SIPAM-FAO-MINAM-Alipio Canahua







## Production versus consumption

Historically, quinoa (*Chenopodium quinoa* Willd.) has been a crop that has played an important role for families in the Bolivian Altiplano or high Andean plateau. Recently quinoa has benefited from high prices in international markets and this has significant social, cultural, economic and environmental implications, especially in the southern Altiplano. Quinoa is an Andean grain with high nutritional value as it contains high quality protein with eight essential amino acids, and is rich in iron, calcium, phosphorous, magnesium and vitamins of the B complex (Astudillo 2006).

As a source of easily digestible plant protein it can help an organism's development and growth, and it also helps conserve body temperature and energy. Combined with other foods, it contributes to a complete and balanced diet that can substitute an animal-based diet (Rojas et al. 2010). The fact that quinoa has good nutritional qualities and is available in the Bolivian Altiplano communities gives it significant value as part of the diet of producer families and in this way contributes to strengthen nutritional well-being at all levels from the family to the region. This is a major contribution to food security.

The southern Altiplano is the highest-altitude quinoa producing region in Bolivia, but in spite of producing more quinoa than in the past, it is no longer being consumed as it was 15 to 20 years ago. In those years, quinoa was the basic food source and an average of 10–12 quintales<sup>21</sup> per family was stored for self-consumption. Quinoa was consumed for breakfast, lunch, dinner and as a snack between meals. Currently, most of the quinoa produced by families is sold, leaving on average of 2–3 quintales for self-consumption. This suggests that families have reduced the availability of quinoa for their own consumption by 75 to 80%.

The most common foods that have replaced the declining consumption of quinoa are white bread, pasta, rice, vegetables, fruit and meat as a result of the income generated by the cultivation of quinoa. Among the factors inducing this decrease in quinoa consumption, we can mention money availability and liquidity, which has enabled producers to purchase more elaborate food that can be easily prepared, but it has also created a resistance in younger generations to process quinoa traditionally.

This chapter describes the introduction of a small-scale processing unit—called locally *microbeneficiadora* in Spanish—that helps remove saponin from quinoa as a way to increase current consumption by the families of five communities of the southern Altiplano. This activity was executed with the support of the IFAD NUS II Project “Empowering the rural poor by strengthening their identity, income opportunities and nutritional security through the improved use and marketing of neglected and underutilized species”.

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21. Local trade is measured in pounds, which in local equivalence is usually 500 g. The units as recorded for this survey were in pounds, with multiples as arroba (25 pounds) or quintales (100 pounds). Due to the uncertainty associated with the recording, the values have been left as submitted rather than converting to kilograms and possibly introducing spurious accuracy. However, the values as recorded provide a good indication of proportional values.

Within the framework of this Project, five small-scale processing units were donated by Mr. Rolando Cup (Rowland Industries) to the communities of Copacabana, Colcha K, Chita (Potosí department), Jirira and Irpani (Oruro department) to facilitate the saponin removal process in quinoa, as the traditional technique involves a lot of drudgery. During two consecutive years (2008 and 2009), follow-up activities were carried out on the use of this equipment by the families that participated in the project. Criteria such as their contribution to the processing of quinoa and the consequent increase in consumption by the communities involved were taken into account. The objectives of the study were to increase the consumption of quinoa in producer families in five communities of the southern Altiplano and to promote the use of small-scale processing technology for quinoa.

### Traditional quinoa processing

Quinoa seeds are covered with a saponin coat that has to be removed before the seed can be consumed. In the southern Altiplano, there is an artisanal process that has been used traditionally by women to remove the saponin from quinoa. The process involves toasting the grains in metal bowls on fire lit with firewood, treading the seeds barefoot on a stone called “*saruna*” [Quechua] or “*tiwiraña*” [Aymara], and adding white clay to aid the friction process and enhance the final flavour after winnowing, washing and drying the grains manually (Aroni et al. 2008).



**Photograph 4.1. and 4.2.** Farmers testing the small-scale quinoa processing unit

The processing of an arroba of quinoa in the traditional way from toasting to drying takes six hours. Additionally, it is not only an activity that consumes a lot of time but it also has negative health effects on the women, as the treading of the warm grains can cause skin burns and the grain winnowing generates dust that causes eye and respiratory tract irritations.

Although industrial equipment can remove saponin from quinoa, there are several obstacles for small-scale producers, including physical access to industrial plants, and the fact that these plants process only large-volumes. At the same time, quinoa processed industrially is sometimes rejected by consumers due to differences in taste and texture compared with quinoa grains processed in the traditional way, limiting therefore its use for the preparation of various food

recipes. Industrial processing removes saponin through scarification and washing quinoa in buckets with water, in contrast to artisanal processing that includes toasting, use of *pok'era*, treading and winnowing (Astudillo 2007).

### Technical characteristics of a small-scale quinoa processing unit

Aroni, Villca and Astudillo (2008) noted that in order to enhance quinoa consumption in producer families, a small-scale quinoa processor that is relatively small and weights ca 30 kg has been designed (Photograph 4.3). The equipment is 70 cm long, 30 cm wide and 80 cm high and consists of a feeder hopper; scarification cylinder; input entrance hatch; pulley; electrical or gasoline motor; and two exit hatches, one for the saponin-free grain and one for removing the saponin layer detritus. The feeding hopper has a 30-degree inclination with a capacity of one arroba, feeding into the 15 cm wide by 60 cm long scarifying cylinder. The entry and exit hatches to and from the cylinder are 2 cm by 6 cm. The feed into the cylinder is controlled mechanically by the access hatch, and the cylinder is driven by a pulley power transmission from the motor. The saponin fraction exits through a hatch in the lower part of the equipment.



**Photograph 4.3.** Technical characteristics of the small-scale quinoa processing unit

The operating principle of this equipment is abrasion of the toasted grains, i.e. each grain is rubbed against another grain (just as in the traditional process, where women tread the grains) through an endless rotating screw that moves them through a meshed cylinder. Additionally the grains are rubbed against the cylinder walls. The cylinder is constructed with a mesh of stainless steel. The saponin layer detritus is expelled through the mesh. The “endless” screw has blades that generate an air current, aiding the process of expulsion of the waste. This machine also allows the use of the *pok'era* that is required to give the grains the taste that consumers expect. Another advantage of the equipment is that quinoa that has not been toasted can also have the saponin layer removed.

The equipment can be adapted to either an electrical or a gasoline motor, depending on the resources of the community. As most communities do not have



electricity, it is recommended that a gasoline motor be used. The motor can be later on changed for an electrical one if electricity reaches these communities. The equipment requires 0.5 hp to operate, so gasoline consumption is low (ca 0.25 l per hour).

This equipment can process quinoa at a rate of one quintal per hour, i.e. it processes one arroba of quinoa in 15 minutes, reducing processing time to one-twentieth of the time required with the traditional process that women carry out and which takes 6 hours with a similar quantity of quinoa.

**Table 4.1.** Participation at the donation of the micro-scale quinoa processing equipment sets in communities of the southern Altiplano in Bolivia

No.	Community	Participants		
		Men	Women	Total
1	Copacabana	5	15	20
2	Colcha K	27	17	44
3	Chita	4	13	17
4	Jirira	7	7	14
5	Irpani	5	7	12
Total		48	59	107

### **Donation of small-scale quinoa processing equipment sets to quinoa-producing families**

As a first step, Industrias Rowland in the city of Uyuni was contracted to construct five small-scale quinoa processing equipment sets, three with gasoline motors and two with electrical motors.

Once the equipment sets were constructed they were handed over to farmers in five selected communities in the southern Altiplano in the period 5–9 November 2007 (Table 4.1). During these events, 107 participants were taught how to operate the equipment (Aroni 2008a, b; 2009).

In the community of Colcha K, 44 farmers (27 men and 17 women) participated in the meeting where a small-scale quinoa processing unit was donated, and training to operate the equipment was provided.

In the communities of Copacabana, Chita and Irpani, proportionally more women participated in the event (Table 4.1). The donation of the equipment sparked the interest of women farmers in these communities, as they are responsible for preparing the food for the family.

In Chita there is a “Mother’s Club” that carries out various activities to enhance their families’ quality of life, and they were very eager for delivery of the new equipment.



**Table 4.2.** Persons initially responsible for the use of the small-scale quinoa processing equipment in five quinoa producer communities

Community	Responsible person
Copacabana (Nor Lipez, Potosí)	Dionisio Villca Choque Segundino Huanta Choque
Colcha K (Nor Lipez, Potosí)	Esther Martínez Francisca Colque López Gabriel Cayo
Chita (Quijarro, Potosí)	Eva Cruz Nilda Paucar Joaquín Villca
Jirira (L. Cabrera, Oruro)	Nemesio Pérez María Mamani Teodoro Laura Barco
Irpani (L. Cabrera, Oruro)	Javier Rodríguez Pánfilo Pérez Cruz

A temporary committee was formed in each community, with two or three responsible persons that would collaborate in the management and registration of the use and processing of the quinoa (Table 4.2). Some individuals have proven to be highly collaborative and dedicated, especially in the community of Chita, while some others have had some difficulties, but have also collaborated laudably.

## Use of the small-scale quinoa processing equipment

The small-scale quinoa processing unit facilitates the removal of the saponin from the quinoa grains, facilitating the preparation of various traditional dishes commonly consumed by producer families. From the perspective of the need to offer women in these communities technology that helps them process quinoa that will be used in their traditional food in their homes, this equipment has a great potential to enhance the use of quinoa for nutrition and quality of life enhanced.

Within the IFAD NUS II Project, the small-scale quinoa processing equipment was used according to a prior agreed schedule with the various families, mostly at weekends. The person responsible was in charge of registering the names of the families that carried out this task and, most importantly, recording the quantity of processed quinoa to be processed for the preparation of different dishes: soup, *graneado* and *pito* among other traditional preparations. To monitor the perception of farmers regarding on the use of the equipment, various meetings were held to record user perceptions. Comments and information regarding the usefulness and relevance of the equipment were obtained.

Table 4.3 shows the results of the quinoa processed using the small-scale quinoa processing equipment during the period from January 2008 to December 2009. After the units were handed over to the five communities, 32,753 pounds of quinoa were processed. Families in the communities of Chita (13,308 pounds) and Copacabana (7,871 pounds) processed most quinoa compared with the

**Table 4.3.** Number of families involved and the quantity of quinoa processed for various preparations between January 2008 and December 2009

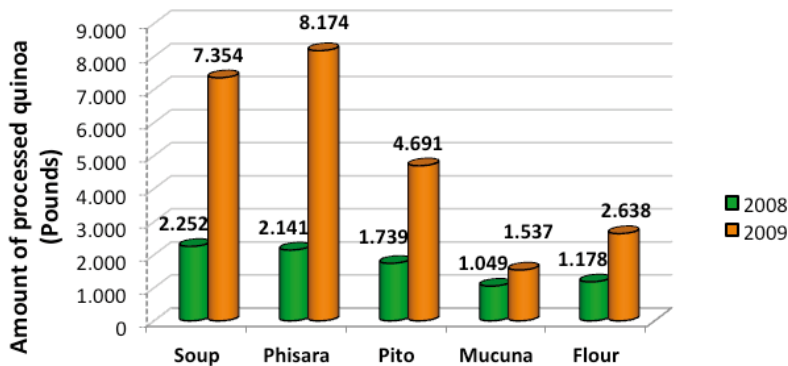
Community	N° Fam.	Type of preparation (pounds)										Total (pounds)
		Soup		Phisara		Pito		Mucuna		Flour		
		2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	
1	Copacabana	626	2 337	628	3 488	80	355	74	25	48	210	7 871
2	Colcha K	320	900	310	1 181	36	185	8	47	0	50	3 037
5	Chita	555	2 407	558	2 685	495	3 193	360	1 328	127	1 600	13 308
3	Jirira	195	1 440	250	630	100	958	80	112	79	778	4 622
4	Irpani	556	270	395	190	1028	0	527	25	924	0	3 915
<b>TOTAL</b>	<b>170</b>	<b>2 252</b>	<b>7 354</b>	<b>2 141</b>	<b>8 174</b>	<b>1 739</b>	<b>4 691</b>	<b>1 049</b>	<b>1 537</b>	<b>1 178</b>	<b>2 638</b>	<b>32 753</b>

other three communities, that only processed between 3,037 to 4,622 pounds of quinoa each.

In the five communities that participated in the IFAD NUS II Project, 170 families have benefited from this initiative, as they now had available more quinoa for food in comparison with previous years before the advent of the processing equipment that facilitated the removal of saponin from the grains.

According to Table 4.3, during 2008 and 2009 the families that participated (listed in order of number of pounds processed) have processed overall 13,308 pounds of quinoa in the community of Chita; 7,871 pounds in Copacabana; 4,622 pounds in Jirira; 3,915 pounds in Irpani; and 3,037 pounds in Colcha K. Generally speaking, between 2008 and 2009 thanks to the technological innovation introduced by the IFAD NUS Project, the communities of Copacabana, Colcha K, Chita and Jirira, achieved an increase in the use of quinoa between 72 and 82%. In contrast, in the community of Irpani, use decreased, possibly due to the presence of an industrial processing plant in the community, the vicinity of important food supply centres and some problems due to lack of interest and organization regarding the administration of the prototype in the community.

Figure 4.1 shows the amount of processed quinoa to be used in different traditional preparations during two consecutive years. In 2008 in all five communities, the tendency was to process quinoa mostly to prepare soup base (2 252 pounds of quinoa) and *phisara* (2 141 pounds), followed by *pito* (1 739 pounds), flour (1 178 pounds) and *mucuna* (1 049 pounds).



**Figure 4.1.** Increase in the quantity of processed quinoa used in different traditional preparations thanks to the small-scale quinoa processing equipment provided by the IFAD NUS Project

The usage during 2009 was very similar, as quinoa was processed mostly to elaborate *phisara* (8,174 pounds) and soup (7,354 pounds), implying an increase of more than 300% of quinoa processed for these two traditional types of preparations.

In the case of processed quinoa to be used for *pito* (4,691 pounds), an

increase of more than 260% was noted observed, with similar results for quinoa flour. An increase in the quantity of processed quinoa to be used for *mucuna* was also noted (Figure 4.1).

## Coordination with other projects

In the community of Chita in Antonio Quijarro Province of Potosí, the project worked with a group of women called the Mothers' Club "Juana Azurduy Padilla". This group of women farmers works on facilitating the processing of food for their families. The project therefore aided the group in developing and managing a project to gain access to German International Cooperation (GIZ) support and acquire a grain mill. To obtain the mill, several requirements had to be met: compilation of information regarding the activities carried out by the Mothers'



Club; the location of the community where the social organization is established; and, most importantly, the need and willingness of the women to pursue this work as a way to improve their livelihood conditions.

### **Photograph 4.4.** Quinoa milling trials in the community of Chita

After the visit in 2009 of a GIZ technician to the Mothers' Club, GIZ agreed to aid this group through the donation of a grain mill, which was presented in a ceremony on 7 September 2009 (Photograph 4.4). The mill, together with the small-scale quinoa processing unit will help enormously the Mothers' Club in the community of Chita to process and mill quinoa destined mostly for family self-consumption.

With the aim of providing an incentive to increase the consumption of quinoa in the participating families, between August and December 2009 four workshops were also held, in four communities, on "Nutrition and diversification of quinoa uses in food". Farmers in Irpani, the fifth community involved, were not interested in participating to the workshop. These workshops were carried out in direct collaboration with the project "Sustainable Quinoa Production" financed by the McKnight Foundation and implemented by PROINPA, which supported technical and productive quinoa research in the Altiplano communities of Bolivia.

Members from four of the communities (68 men and women farmers. 13 persons from Chita; 39 from Copacabana; and 8 each from Jiri and Colcha K)

participated in the workshops held on 26, 27 and 29 August and 1 December 2009 in preparing innovative products, such as quinoa nectar, quinoa chips and quinoa cakes.

## Participatory evaluation of the small-scale quinoa processing equipment

To assess the perceptions of farmers concerning the use of the small-scale quinoa processing equipment, various meetings were held in each community during which participatory evaluations were carried out. The method applied was an open evaluation, and the results obtained are shown in Table 4.4.

**Table 4.4.** Results of the open evaluation on the validation of the use of the small-scale quinoa processing equipment

Maintenance of the equipment	The units operate without problems and they do not need continuous maintenance. The manufacturers are willing to solve any operational problem equipment might present.	
Use frequency	The unit are available for use at any time, but however the use schedule has to be coordinated with the persons in charge. The equipment is not used very much in the months of December and January, but it's use is increased significantly between March and April.	In the communities of Colcha K and Jirira the project participants recognize that they are not using the equipment continuously.
Management of the equipment	The persons responsible for the equipment are managing with no problems and are learning how to regulate access. To obtain the peculiar flavour during processing with the unit, <i>pok'era</i> is added (white dust or clay that increases friction during the scarification of the grain). In most communities, the responsible persons have managed to adjust the equipment and significantly reduce the amount of broken grains.	Some women claim that when the persons responsible are not available, there is a need for the participants to also be able to operate the equipment in order to not lose opportunities.

Increase in quinoa consumption

In the 5 communities, the participants are using the small-scale quinoa processing equipment, although still at a moderate level. However, this permits contrasting processing done with the small-scale unit and processing in the traditional manner.

The person responsible for the operation of the equipment in the community of Chita mentions that for good quinoa processing, the processor has to select their best grains, separate them from the smaller, immature, green and poor quality grains as those grains reduce the overall quality of the batch, causing later problems with uniformity in cooking.

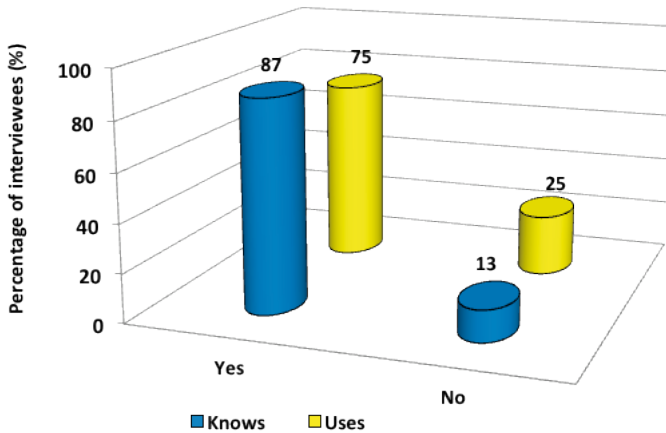
According to a women farmer in Colcha K, the processed quinoa does not cook evenly as some grains burst before others.

Another women farmer of the same community mentioned that her processing produced a lot of saponin detritus and therefore less quinoa.

**Questionnaires on the advantages and disadvantages of the use of the small-scale quinoa processing equipment**

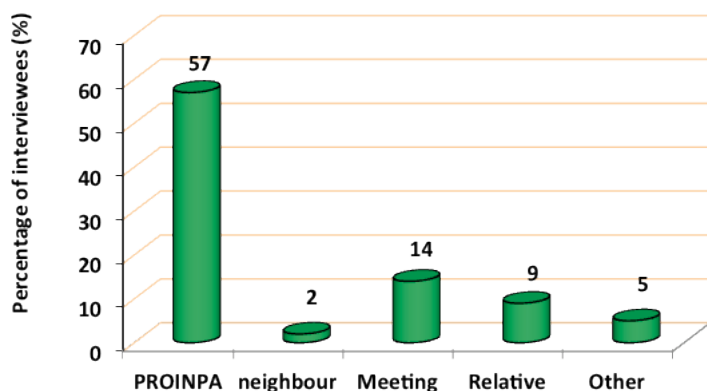
In order to carry out a final evaluation on the use of the small-scale quinoa processing equipment, surveys were carried out, reaching a quarter of 170 families in the five communities. The results are described below:

Figure 4.2 shows responses to the question “Do you know the small-scale quinoa processing equipment?” The results indicate that 87% of the respondents



were aware of it. Regarding the question “Do you use the small-scale quinoa processing equipment?” Most respondents (75%) answered that they used the equipment.

In conclusion, most interviewees mentioned that they knew and used the small-scale quinoa processing equipment, indicating that at the time in the benefiting communities, the equipment was well received and accepted and had become a technical alternative to process quinoa destined mostly for food for the families within the community. An important aspect is the location of the communities; the further away a community lies from a populated centre and food



sale establishments, the greater the use of the small-scale quinoa processing equipment, and, as a consequence, there is greater availability of the product for family self-consumption. There was, however, a need to continue to disseminate the results obtained with the small-scale quinoa processing equipment so that it could become better known and used by quinoa producers.

**Figure 4.2.** Percentage of families that know and use the small-scale processing equipment for quinoa

Figure 4.3 shows in percentage the answers given by interviewees on the question: How did you become aware of the small-scale quinoa processing



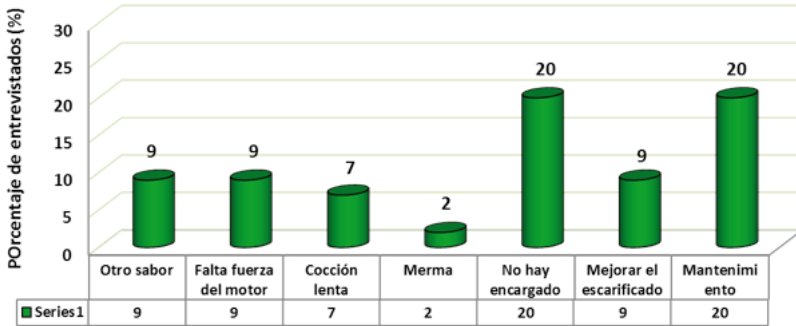
equipment? Most interviewees (57%) mentioned that they knew the equipment through PROINPA followed by community meetings (14%), relatives and family members (9%), neighbours (2%) and others (5%).

**Figure 4.3.** Information and diffusion sources of the small-scale quinoa processing equipment

The interviewees identified seven important advantages (Figure 4.4). More



than two-thirds of the farmers interviewed responded that the main advantage that the small-scale quinoa processing equipment had was the fact that it

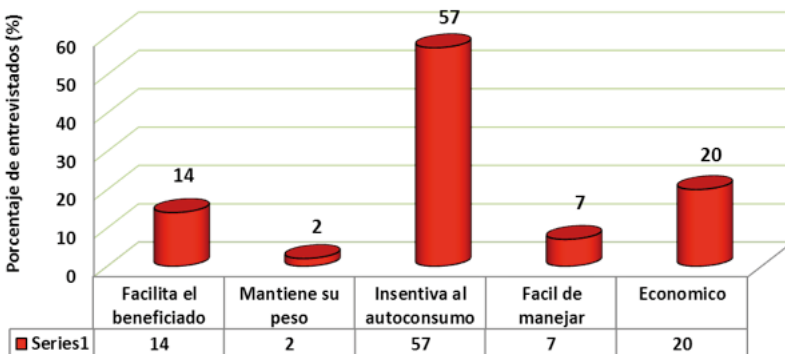


significantly reduced processing time. Another important advantage identified by over half of the farmers was that the equipment avoided the need to tread the hot quinoa grain, thus reducing the risk of women burning themselves whilst treading. Moreover, 38% of all interviewees noted that with the equipment they could process a greater quantity of grain in a simple and easy way.

**Figure 4.4.** Advantages of the small-scale quinoa processing equipment

*KEY:* Porcentaje de entrevistados = Percentage of interviewees; Fácil para beneficiar = Easy to process; Evitar pisar caliente = Avoids stepping on hot grains; Mantiene su sabor = Maintains flavour; Menor tiempo = Faster; Mayor consume = Increased consumption; Mayor cantidad = Greater quantity; and No hay pérdida = No losses

A quarter of the interviewees mentioned that the small-scale quinoa processing



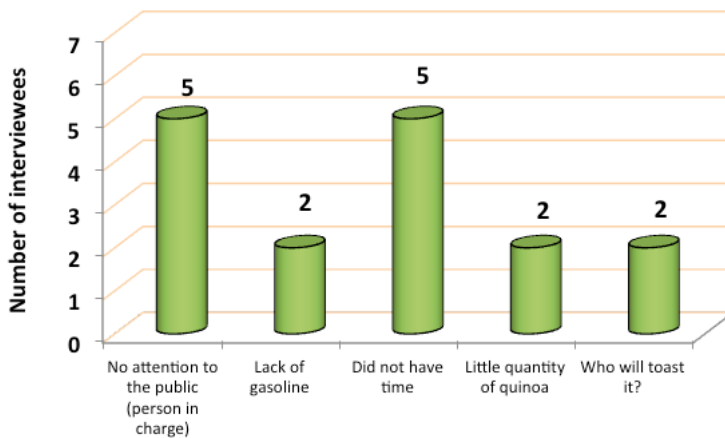
equipment indirectly promoted increased higher consumption of quinoa. At the same time, 7% of the interviewees noted that the equipment maintains the flavour and 2% mentioned that the process reduces product loss (Figure 4.4).

**Figure 4.5.** Disadvantages of the small-scale quinoa processing equipment

*KEY: Otro sabor = Another flavour; Falta fuerza del motor = Motor lacks sufficient power; Cocción lenta = Cooking takes longer; Merma = Decrease; No hay encargado = Nobody is in charge; Mejorar el escarificado = Greater scarification; and Mantenimiento = Maintenance requirement*

Seven disadvantages regarding the use of the small-scale quinoa processing equipment were identified by interviewees (Figure 4.5). The most common problem (one-fifth of respondents) was that the person in charge of the equipment sometimes was not available to allow the use, and one-tenth noted that there was no-one available to maintain the equipment when motor problems occurred. Problems such as lack of fuel were also mentioned, as well as the fact that processing grains with this equipment changes the flavour of the quinoa (9%), while some interviewees mentioned that the grain scarification process should be improved (9%).

**Figure 4.6.** Reasons to use the small-scale quinoa processing equipment



*KEY: Porcentaje de entrevistados = Percentage of interviewees; Facilita el beneficiado = Helps processing; Mantiene su peso = minimal weight loss; Incentiva al autoconsumo = Encourages self-consumption; Fácil de manejar = Easy to handle; and Económico = Economical in use*

The study identified five reasons for use of the small-scale quinoa processing equipment by interviewees (Figure 4.6). The most common response given by 57% of the farmers interviewed was that the equipment encourages the self-consumption of quinoa. Some farmers thought that it is very cheap—in economic terms—to process quinoa using the equipment (20%) and that it also aids the processing process (14%).

Regarding the question: Why don't you use the small-scale quinoa processing equipment?, five of the interviewees mentioned that there was no responsible person present or available, and that they did not have time to use the equipment. They also mentioned difficulty in guaranteeing availability of fuel when needed, only small quantities of quinoa to process, and nobody available to toast the quinoa (Figure 4.7).

**Figure 4.7.** Reasons why farmers do not use the small-scale quinoa processing equipment

## Interviews with producers

According to the interviews carried out with the families that benefited in the community of Copacabana, some producers mentioned having processed quinoa in sufficient quantity that they could take some to sell at the fair in the community of Avaroa. A similar case was mentioned by women belonging to the Mothers' Club in Chita, who processed quinoa for sale at the fairs in Uyuni and La Paz.

Another aspect worthy of note is that, according to information given by farmers in some of the communities benefited, such as Jirira, some of the community members that lived in other cities used the small-scale quinoa processing equipment after harvesting to be able to take processed quinoa to their residences.

Other regions, such as Jirira and Copacabana, mentioned that using the equipment to process quinoa eliminated health problems attributable to the constant friction and burning of feet when treading the quinoa in the traditional manner.

Finally, in Colcha K, a producer mentioned that the small-scale quinoa processing equipment facilitates a sufficient quantity of the processing of quinoa to be able to have a surplus to sell that enabled him to send his children to study in a bigger village.

In most communities, women noted that the equipment facilitates saponin removal from quinoa grains, and highlighted that treading on stone to scarify the grain is very hard. Due to this and to lack of time, women could not prepare sufficient quinoa as needed by their families for their weekly intake.

Members of the community of Copacabana mentioned that some families from the nearby community of San Juan also came to process their quinoa. This has also been occurring in other communities that participated in the study. Moreover, there are also some users from the communities involved but that live elsewhere, that also process their quinoa in these communities.

All the families that have been using the equipment mentioned that since they began using the small-scale quinoa processing equipment they were consuming more quinoa at home, although they were not able to quantify the percentage increase.

## Conclusions

When the surveys on the use of the small-scale quinoa processing units and the interviews were finalized, it was concluded that the equipment was of great utility to the communities of Copacabana, Colcha K and Chita in Potosí, and Jirira in Oruro. Unfortunately, in Irpani, the use of the small-scale processing equipment was not as successful as in the other communities due to lack of organization and coordination among participants, their easy access to food sale establishments and the presence of an industrial processing plant in the community.

Community location therefore plays an important role in the adoption of the small-scale quinoa processing technology, as the further away the community is from a populated centre and food sale store, then the greater the use of the technology.

According to the interviews, 87% of the families in the five communities that participated were aware of the small-scale quinoa processing equipment, and 75% used it.

Among the advantages of the small-scale quinoa processing equipment highlighted by the families that participated in the survey was that the consumption of quinoa among members of the families was encouraged as the equipment facilitates the processing of the grain compared with the traditional technique.

Among the disadvantages mentioned as in the use of the equipment were problems related to the administration of the facility, and some problems in the maintenance of the motor.

The use of the small-scale quinoa processing equipment in the communities of Copacabana, Colcha K, Chita and Jirira has had a positive impact as families now recognize the huge service that the equipment provides in processing quinoa.

In the communities of Chita and Copacabana, as the participants have become more experienced in operating the equipment they now are able to use supplements (e.g. white clay) to improve the finish of the processed grain.

In Copacabana, a custom of processing quinoa every Sunday is now in place, demonstrating to other farmers the importance of this technology in facilitating quinoa food preparations.

## Recommendations

In order to assure greater availability of processed quinoa for household food security, financing should be sought to construct more small-scale quinoa processing units for other communities.

There is a need for PROINPA to carry out follow-up activities on the use of the equipment, better understanding pros and cons associated to its use by the local communities.

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# 5. Novel products, markets and partnerships in value chains for Andean grains in Peru and Bolivia

Matthias Jaeger



Photograph by M. Jaeger





## Introduction

A key strategy in reaching Millennium Development Goal 1, which aims at eradicating poverty and hunger, is the generation of additional income; this is especially fundamental for improving the livelihoods of poor farmers. According to a UN assessment, 1.4 billion people still live in extreme poverty (United Nations, 2005). In Latin America, 123 million people subsist on less than US\$ 2 per day (World Bank 2008), with poverty pockets in the Bolivian and Peruvian Andes, and in the Upper Amazon.

Farmer incomes can be augmented by expanding cropping areas, improving productivity and by producing products with enhanced value, which yield greater revenue per unit area. Poor farmers cannot easily expand areas of small-scale production, and productivity increases tend to depress prices while requiring higher input levels. The soundest and most environmentally friendly option is to increase the value of harvested products.

There is a sizeable unexploited market potential for high-value Andean grain sub-products and by-products, such as high-value oil derived from cañihua, quinoa and amaranth; saponins; or oil-press cake for dietary supplement, which remain unexploited.

The identification of market opportunities for new products does not mean that the potential values of Andean Grains can be easily captured by farmers and their associations. Growing, harvesting, adequate processing technology and marketing agricultural products requires management skills, certification, quantification and co-ordination in order to deliver products to markets, access processing facilities, insure against price fluctuations and obtain good quality labour inputs. Small-scale farmers have limited access to capital, education, market information and marketing institutions, and are at a relative disadvantage compared with large-scale commercial farmers. Phytosanitary problems, low productivity and other constraints hinder small-scale farmers' ability to participate in high-value markets. Those supply-side barriers to successful participation of poor farmers in high-value markets can be addressed by value-chain oriented research.

Value-chain research and development has gained increasing attention in recent years as a tool for linking supply capacities to markets. The value-chain methodology is a conceptual means for illustrating the different stages that a product goes through from initial conception, to the provision of inputs, primary production, intermediary trade, processing, retail marketing, and finally to consumption, and the value added at each point in the value chain (Will, 2008). To unlock the full potential of products produced by small-scale farmers, value chain development aims at addressing the specific shortcomings they experience. Innovations can include new products and processes, new technologies or new institutions, and can benefit the actors directly or indirectly (Bernet et al. 2006). This methodology has allowed farmers to learn more about the demands and requirements of processors, and has allowed processors to learn about the varieties grown by farmers, leading to the exploitation of previously underutilized varieties (Hellin and Hignman 2005).

To target and exploit new market opportunities that both enhance farmer incomes and *in situ* agricultural biodiversity, the Marketing Approach to Conserve Agricultural Biodiversity (MACAB) method has been developed; it defines a pathway from discovering interesting product attributes to product launching (Bernet et al. 2003). The ValueLinks Methodology developed by the German Gesellschaft für Technische Zusammenarbeit (GTZ) (GTZ 2007) is a compilation of value-chain-oriented methods for promoting economic pro-poor growth. It provides essential know-how on enhancing employment and income in micro- and small-sized farm systems and related enterprises by promoting the relevant value chains. Additional guidelines and best practices for promoting value chains of neglected and underutilized species for pro-poor growth and biodiversity conservation (Will 2008) were published by Bioversity International through the Global Facilitation Unit for Underutilized Species (GFU).

With appropriate technology, information and documentation of commercially valuable traits of Andean grain diversity and improved market channels, poor Peruvian and Bolivian farmers organized into cooperatives and associations could enhance their incomes. Improving the marketability of these products will also create incentives for the on-farm maintenance of a broader diversity of Andean grains, currently threatened by genetic erosion.

Partnerships in the form of collaborative platforms between small-scale-farmer associations, research institutes, policy-makers, development agencies and NGOs build synergies and cooperation along the value chain in order to secure political support to promote greater use of Andean grains. In addition, collaborative platforms facilitate the adaption of existing technologies in order to produce high value Andean grain products in Peru and Bolivia and link producers to fast-growing national and international markets, such as those for cosmetic, pharmaceutical and food products.

The development of novel technologies and markets for new products, coordinated through a collaborative platform, can also contribute to enhancing the use of the genetic diversity of Andean grains, thus promoting their on-farm conservation while strengthening income generation and self reliance of local farmers in the High Andes.

Strategic, multi-sectoral collaboration, drawing on research, development and community-based organizations can create important opportunities for change. Lessons learnt, methods and approaches derived from research activities can be disseminated as public goods through public awareness materials and publications to all platform members.

## **Background and problem statement**

About 95% of cañihua, quinoa, and amaranth production from Bolivia and Peru is currently commercialized as a commodity in local, national and international markets without any added-value accruing to producer organizations and local traders. Concomitantly, crop diversity diminishes as Andean farmers in Peru and Bolivia turn to growing a few bulk crops for large commercial firms. Loss of Andean grain diversity means lost resilience against pests and diseases, climate

change and food shortages.

Owing to the market demand for seed uniformity (colour or size), 30–40% of the total cañihua, quinoa, and amaranth harvest is not suitable for export. Consequently it is sold at a low price, limiting income opportunities for poor rural farmers. However, such second- and third-grade grain is a perfectly suitable raw material for the extraction of high-value fatty oil. Cold-pressed oil and other sub- and by-products, commercialized by small-scale farmer associations as high value ingredients for high quality foods, natural cosmetics and pharmaceuticals, would boost incomes while preserving biodiversity. While a number of organizations are working on related fronts, their efforts are not linked and lack a focus on novel methods with regard to value chain promotion (Will 2008; GTZ 2007).

Indeed, a market exists for high-value Andean grain sub-products and by-products (Koziol 1993) such as oil, saponins or oil-press cake. These products remain unexploited due to a lack of adequate processing technology, market channels and appropriate strategies for successfully linking producers to markets. Furthermore, national quinoa and cañihua germplasm collections have been only partially screened (Soto and Carrasco 2008) for valuable traits based on functional properties and components (e.g. high lipid content, antioxidants). Highly commercial traits from these collections need to be identified and matched with specific market requirements for high-value products. A methodology of linking genebanks directly to high value markets can enhance the use of *ex situ* accessions and contribute to the on-farm maintenance of a broader diversity of Andean grains, currently threatened by genetic erosion.

### **Cañihua: the most neglected and endangered Andean grain**

The primary cañihua production area is located in Bolivia and Peru around Lake Titicaca. Market prices for cañihua are almost 50% lower than prices paid for quinoa. For that reason, cañihua production and diversity has decreased dramatically. Many farmers only maintain cañihua in their cultivation portfolio due to its outstanding performance regarding frost and drought resistance. Since they had experienced considerable loss cultivating quinoa (not frost resistant) during the last few years due to climate change, cañihua production can now be considered as an important part of farmers' risk management strategy to cope with climate change.

Farmers grow cañihua only because it resists frost and pests well, in spite of the poor market for this grain. Yet cañihua, with 15–19% protein, a higher lipid content than quinoa and an iron content greater than that of other grains, could be used to produce fine cooking oil, cosmetics and for other applications, such as in aromatherapy. Adding value to their cañihua production and finding better market channels would enhance competitiveness, income and even nutritional status were cañihua oil to be produced and included in diets at the household level.

### **Quinoa: cultivating diverse varieties in the northern Altiplano**

Demand for quinoa on international markets has dramatically increased during the last few years and Free on Board (FOB) prices for exporters and quinoa farmers have doubled since supply has not been able to satisfy the increasing

demand. Several value chain development projects financed through international cooperation have been working on quinoa field production, yield and post-harvest improvement, which should lead to higher productivity, especially for Royal quinoa varieties grown in the southern Altiplano and in demand on international markets due to consumer preference for its white colour and seed size.

This situation jeopardizes quinoa cultivation on the northern Altiplano near Lake Titicaca, where the Bioversity-coordinated IFAD-NUS Project is located. Although Royal quinoa varieties cannot be cultivated here, the highest quinoa diversity is found on the northern Altiplano. As quinoa production costs for this region will be higher than in the southern Altiplano, competitiveness will decrease.

For processed quinoa products, any variety is suitable, as Royal quinoa is not required. In the early 1990s, research on saponins from quinoa seed and quinoa oil showed that both have great market potential. Quinoa has seeds covered with a coating of bitter-tasting saponin. Beyond exploiting saponins, farmers could use their quinoa, with about 5.6% oil content (some varieties have 9.5%) to make oil for many applications. Approximately 55–63% of this oil is essential fatty acids (linoleic and linoleic), making quinoa oil a healthy cooking oil. In this case, research on high-value processed quinoa products and by-products such as oils and saponins, and finding new market channels, could improve competitiveness, decrease diversity loss and increase income.

Each year, quinoa producers and sellers throw away saponin with an estimated value of up to US\$ 5 million. The problem is that there is no access to specialty markets for this product. With appropriate technology, information and improved market channels, 15 000 poor farmers organized into cooperatives and associations could bolster their income by producing saponins.

### **Amaranth: at peril in Bolivia**

Another Andean grain oil showing great promise is amaranth oil. It contains about 77% unsaturated fatty acids (about 50% linoleic and linoleic acids, squalene, and vitamin E in the rare form of tocotriene). Consumers take amaranth oil for its active biological ingredients: amino acids, micro-elements, minerals, vitamins, proteins, polyunsaturated fatty acids, choline, gall acids, spirits, steroids and squalene, which makes up 8% of the oil. Since the body can store squalene without toxic effects (up to 100 µM/L), it has an advantage over other anti-oxidants. Squalene has a powerful anti-inflammatory and anti-cancer potential, and can penetrate through the skin into the body. The substance also helps the body to defend against bacteria, fungi and viruses and can reduce symptoms of autoimmune disorders.

Direct oil purchasing from any of these grains' country of origin would be an option if product quality and safety can be guaranteed.

The entire Bolivian amaranth production sector is at risk of disappearing. In order to improve market competitiveness and avoid the extinction of amaranth and its unique diversity in Bolivia, it is urgent to find alternatives for both processing high-value products and also markets where the cost of the raw material as percentage of the final price is less significant.

Andean farmers need specific knowledge on valuable traits of existing crop

diversity, and associated technology and processing equipment, as well as stakeholder coordination and market integration for extracting and packaging Andean grain sub-products and by-products. They need to develop know-how in quality management and in dealing with food safety regulations, certification and international marketing. Locked in established value chains, with little negotiating power, farmers lack demand-driven incentives to cultivate and maintain native crop diversity. So most native grains remain neglected.

### **Platform approach and methodology**

The last two decades have witnessed profound changes in farming systems and the way in which agricultural production is organized in many developing countries. While changes affect the whole chain from production to consumption, they are most clearly manifested in the manner in which food is being retailed. Agricultural producers now supply long and complex value chains that are marketing high-value fresh and processed products to mainly urban consumers. On the input side, farmers increasingly rely on commercialized transactions in market venues to obtain seed, fertilizer and agricultural chemicals as the demand for product quality increases. These changes, often referred to as the *new agricultural economy*, have led to new organizational and institutional arrangements within the food marketing chain, such as new forms of contracts (pre-established contracts versus spot markets) as well as the imposition of private grades and standards for food quality and safety (Dolan and Humphrey 2004; Reardon and Berdegúe 2002).

This increased orientation towards expanding agricultural markets can certainly offer farmers potential benefits, such as increased choices of input suppliers and product outlets, increased accessibility to credit and a better management capacity (Eaton and Shepherd, 2001). However, access to markets has proven difficult for many small-scale farmer farmers, who often remain on the periphery of this new agricultural economy. In fact, the process may even exacerbate poverty levels through marginalization of small-scale farmers and the rural poor who are disadvantaged in comparison with the larger and better endowed commercial farmers (Johnson and Berdegúe 2004; Berdegúe et al. 2003; Reardon et al. 2003).

In recent years, the importance of governing markets to improve efficiency and small-scale farmer accessibility has been widely recognized. Both researchers and development practitioners have started looking at the issue of overcoming input and output market inefficiencies and inequalities in the value chain in order to achieve increased small-scale farmer participation (Reardon et al. 2003; Barrett et al. 2001).

When small-scale farmers have no apparent advantage in production, the challenge is to reduce the transaction costs associated with purchasing from large numbers of farmers producing small quantities to make them relatively competitive or to devise a way to directly link small-scale farmers to high-value purchasers. This requires organizing small-scale farmers to overcome the costs of transactions, as well as providing them with the necessary information to meet market requirements. The *Plataformas* approach does just this by providing support for small-scale farmers from a range of institutions, through building

strong social capital. Social capital functions as a connector between groups and among individuals, facilitating co-operation and mutually supportive relations as an effective means to reduce transaction costs (Cavatassi et al. 2009).

A collaborative platform links producer associations, research institutes, researchers, development agencies, civil society, the business sector and policy-makers, promoting linkages, building synergies and cooperation along the value chain, and can advocate for political support for promoting greater use of Andean grains.

This approach shifts from the typical top-down approach of linking research to farmers through extension services, to a new paradigm, involving rural and agricultural innovation systems that link public and private sectors with farmers, civil society organizations and the scientific community. Thus the concept of 'innovation' encompasses not only the technological innovation itself, i.e. the diffusion of new products and services of a technological nature into the economy, but it also includes equally non-technological forms of innovation, such as institutional and organizational innovations.

By bringing together all the different stakeholders into a single platform, interactions between producers, local authorities, NGOs, extension agents, service providers, researchers and buyers are facilitated. In this context, each stakeholder brings their particular expertise to the table and each of their contributions supports the overall implementation of the value chain vision. Ultimately, this collective action should improve the prospects of small-scale farmers in agricultural markets (Cavatassi et al. 2009).

The *Plataforma* should be part of a comprehensive programme that involves practical intervention that pays special attention to improving the participation of low-income farmers in high-value producer chains by providing them with new technologies, by promoting their organization and social capital accumulation, and by involving them in a "value chain vision" of production and commercialization that directly links them with the market. In this regard, this facilitates knowledge sharing, social learning and capacity building, leading to improvements in small-scale farmer productivity and the quality of product supplied to market.

The establishment of a collaborative, multi-disciplinary platform brings together crucial value chain stakeholders, and is the primary vehicle for long-term impact of projects. The platform can undertake a variety of activities to create synergies, such as (1) joint mapping of current chain governance structure; (2) performing joint assessments of market opportunities; (3) drawing up a joint vision and value chain upgrading strategy; (4) compiling and systematizing existing information; (5) providing training; and (6) disseminating results of ongoing project research activities.

According to this approach, the establishment of multi-disciplinary and multi-stakeholder value chain cooperation through the creation of a permanent platform at the national level in both Bolivia and Peru would allow research institutes, small-scale farmer associations, development agencies, private companies, local and national governmental organizations to coordinate their individual research and development initiatives on Andean grains innovation.

Lessons learnt, and methods and approaches derived from research activities,



will be disseminated as public goods through public awareness materials and publications shared via a collaborative platform. An important innovation is the direct linking, according to specific market requirements, of underutilized genebank material to dynamic markets through the collaborative platform.

A recent study analyses the impact of participation in multi-stakeholder platforms (*Plataformas*) aimed at linking small-scale farmer potato farmers to the market in the mountain region of Ecuador (Cavatassi et al. 2009). It describes and evaluates the Plataformas' programme to determine whether it has been successful in linking farmers to higher-value markets and the effects that such connections have brought, particularly with regard to farmer welfare and the environment. This case study was then used to provide insights into the challenges of linking small-scale farmers to higher-value markets and to assess the possibility of meeting these challenges. The findings suggest that the *Plataforma's approach* successfully improved the welfare of beneficiary farmers. Overall, participation in the *Plataforma* suggests a successful way of linking small-scale potato farmers to the global market.

In Peru, there is a quinoa platform in place for the Puno Department, which has been involved in IFAD NUS II activities. In Bolivia, there is a regional amaranth and a national cañahua platform already established by governmental institutions, at an early stage of operation. No impact assessment of these platforms has been so far been reported. In November 2009, three workshops to promote these platforms were held (Jaeger et al. 2010; Polar et al. 2010a, b). The annex to this chapter shows the bottlenecks identified by actors participating in these workshops among the various links of the Andean grains productive system.

Further impact of platforms will probably now depend on available funds to effectively promote the potential benefits of collaborative platforms in terms of generating social capital and income.

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## Annex 1: Bottlenecks identified in the diverse links of the Andean grains productive system

**Annex Table 5.1.** Bottlenecks identified by each actor in the various links of the Andean grains productive system

Actor	Link				
	Production	Processing	Commercialization	Policies	Services
CIRNMA-Puno	Internal control system, organic production Production risk Raw material quality Production/ research cost	Raw material quality Production cost	High intermediation Market information	Little diffusion of technical regulations	High certification cost
Bioversity International	Genetic erosion Non sustainable practices	Lack of low cost technology Food safety problems	Lack of knowledge on opportunities and market barriers	Incoherent policies with no chain vision	
DGCA-MINAG	Weak associativity				
Green Export, Arequipa	Small areas, small-scale farmers Adequate volume acquisition	Few processing plants			
Sólo Ecológicos company	Limited use by producers of available technologies	Craft Technologies in agro-industrial plants	Insufficient material provided for gathering and commercialization by supported production associations	Distance between the speech and the action	Insufficient number of professionals
INIA	Limited investment to generate technologies and transfer			Unstable management policies in innovation institutions	
DGCA-MINAG	Small-scale farmers Weak associativity Scarce information	Weak rural agro-industry Weak associativity	Disorganised support Much intermediation	Little interest and certain confusion among beneficiaries	The decentralization process is not understood

## 5. Novel products, markets and partnerships in value chains for Andean grains in Peru and Bolivia

Actor	Link				
	Production	Processing	Commercialization	Policies	Services
APROAL- Altiplano	Raw material quality Lack of credits by local governments to improve production	Drying area Safety			
ALDEA QOSQO		Technology	Market		
Universidad Nacional del Altiplano (UNA)		Thesis works remain in shelves The information does not reach appropriately the interested actors			
Asociación de Productores de Puno y Cusco			Direct export Market		
Asociación Agronegocios Willkamayu de Calca			Product availability Quality standards, prices		
INDECOPI				Weak associativity Scarce or non existent control mechanisms	

Actor	Link				
	Production	Processing	Commercialization	Policies	Services
PROMPERÚ				Identification of national level supply Market access limitations Inadequate support prioritization to the chain at the regional and national level	
Bio Latina					Lack of knowledge regarding the Regulation and the internal control system. Lack of higher diffusion
Eusebio Chura					MINAG restructuration, constant changes in officials

*Source: Prepared from the matrix developed by the forum participants at the launch of a multi-stakeholder platform to promote the sustainable use of Andean grains, Puno, Peru, 11–13 November 2009 (Jaeger et al. 2010)*

**Annex Table 5.2.** Bottlenecks identified by each actor in the various links of the amaranth productive complex

Actor	Link				
	Production	Processing	Comercialization	Policies	Services
Bioversity International	Lack of high quality germplasm availability Postharvest losses Organic production difficulties Lack of coordination among producers			Lack of policies that promote local varieties with high nutritional value The identification of native varieties, their geographical distribution and nutritional characterization are unknown	
PROINPA	Lack of quality seed Low soil fertility Diseases Plague presence Low mechanization (technology) Lack of postharvest equipment Lack of irrigation systems		Breach of contracts	Lack of certification regulations	Natural product availability (Bio-inputs)
Mojotorillo producer	Quality seed Low soil fertility Lack of natural products for pest and disease control Harvest and postharvest technology		Fluctuating prices		
Instituto Nacional de Innovación Agropecuaria y Foresta - INIAF	Lack of <i>ex situ</i> grain conservation information (germplasm bank)			Incentive policies to conserve native varieties and local knowledge are not applied	
Municipio de Padilla	Lack of harvest equipment		Lack of price and market information		



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Actor	Link				
	Production	Processing	Comercialization	Policies	Services
Municipio Zudañez	Lack of crop knowledge		Little market knowledge		
Independent consultant	Lack of support regarding equipment as “threshing and winnowing” machines				
ITA					Not enough funds available for purchasing state-of-the-art equipment (technology)
ADIC		Lack of funding for infrastructure and equipment			
CIOEC CH		Lack of regulation compliance regarding: Quality Safety Information	Market location— Commercialization supply and demand studies		
Sobre La Roca		Uncertainty regarding raw material supply Amount Quality Price			
CACH Rural		Technology and equipment availability Coordination among actors of the amaranth productive complex	Product are not well presented	Domestic consumption of amaranth is not encouraged	

Source: Prepared from the matrix developed by the forum participants to the workshop for the multistakeholder analysis for the promotion of sustainable use of amaranth, Sucre, Bolivia, 19–20 November 2009 (Polar et al. 2010a)

**Annex Table 5.3.** Bottlenecks identified by each actor in the various links of the cañahua productive complex

Actor	Link				
	Production	Processing	Commercialization	Policies	Services
LAYSAA		<p>Low efficiency regarding the use of traditional primary processing technology on the field</p> <p>Lack of appropriate processing technology that conserves the functional integrity of the product</p> <p>Lack of plants' safety and quality systems</p> <p>Lack of functional characterization depending on its genetic variability for specific applications</p> <p>Lack of funding support for technology investments</p>	<p>Small enterprises with high market access barriers</p> <p>Lack of organized price supply, quality and stable volumes</p>	<p>Lack of dissemination in order to increase the domestic consumption of derived products</p> <p>There is a need to promote the crop and its products (breastfeeding allowance)</p>	
INIAF	<p>Traditional crop replacement</p> <p>Loss of consumption habits</p> <p>Loss of wisdom and ancestral knowledge</p> <p>Low productivity</p> <p>Research programmes are not articulated</p>				

Actor	Link				
	Production	Processing	Commercialization	Policies	Services
AGRUCO	Surface limitation Low performance Traditional technology Low labour availability			Little dissemination of legal regulations regarding ecological production Lack of support to small producers and enterprises There are no clear policies for cañahua cultivation	Little availability of technical human resource
SP-BOLIVIA	There is no quality seed production		Lack of a national promotion and commercialization strategy.		
Fundación ALTIPLANO (FDTA)					Funding Producers are not well organized There is lack of funding resources to publish documents that reach the public
Viceministerio de Ciencia y Tecnología - V. C. y T.				An International Centre for quinoa and cañahua in Bolivia must be created Policy for germplasm bank management (Regeneration Programme) Lack of production promotion policies	

## 5. Novel products, markets and partnerships in value chains for Andean grains in Peru and Bolivia

Actor	Link				
	Production	Processing	Commercialization	Policies	Services
Universidad Mayor de San Andrés -UMSA					There is no seed certification
Bioversity International	Lack of high quality germplasm availability Very high post-harvest loss	Lack of coordination and collaboration Lack of information and dissemination regarding techniques, methods and existing technologies		Lack of biodiversity and nutrition strategy Lack of a cañahua national strategy Lack of leadership in the organizational sector	
PROINPA	Crop with low grain persistency on the plant during physiological maturity There is no formal or informal system for seed production	Underutilization of existing genetic diversity		Scattered efforts among actors There is no adequate dissemination of generated information	Lack of product development
CUNA	Low provision of certified seed				

Source: Prepared from the matrix developed by the forum participants to the workshop for the multistakeholder analysis for the promotion of sustainable use of cañahua, La Paz, Bolivia 17 November 2009 (Polar et al. 2010b)

## 6. Conclusions

*Alessandra Giuliani*

*Photograph courtesy of W. Rojas  
Child of the Northern Bolivian Altiplano*









The recognition that agricultural biodiversity is a strategic asset in people's lives has supported over the last fifteen years the rediscovery of the so-called neglected and underutilized species (NUS) which, as in the case of Andean grains, have been marginalized for too long from mainstream research and development that has ignored promoting their continued and valuable use (Padulosi et al. 2008).

Recent studies have revealed the importance of underutilized species in the livelihoods of the poor (Naylor et al. 2004). Underutilized species play a large role in food security systems; plants that grow in infertile or eroded soils—as well as livestock that eat degraded vegetation—are often crucial to household nutritional strategies. These species usually require minimal inputs and are resistant to disease, while also providing nutritional diversity (Blench 1997). Underutilized species represent an enormous wealth of agro biodiversity and have great potential for contributing to improved food security and nutrition, and for combating the 'hidden hunger' caused by micronutrient (and mineral) deficiencies. This is relevant particularly for those areas where people are marginalized by poor access to natural and financial resources. Most of these species are still selected, adapted and multiplied by farmers in marginal environments (Horna et al. 2007). High proportions of the poor from developing countries live in such marginal areas, and underutilized species are often the only ones capable of coping with these conditions.

Changes in the global agricultural economy are providing farmers with new challenges and opportunities. The markets for underutilized species are gaining policy attention as a potential source of livelihood, and a means to conserve biodiversity. Though the market access for the products derived from these species is considered an opportunity both to reduce poverty and contribute to *in situ* conservation, the growing debate on enhancing farmer access to markets still tends to neglect underutilized plant products. Underutilized species have untapped market potential for several reasons. In terms of market access, unlike commodities and high value products, producers of underutilized products and those actors involved in all the market chain often face even higher transaction costs. They face additional challenges of poorly-defined markets and weak demand, precisely because their products are less well known (Hellin and Hgman 2009).

In the light of the recent increasing attention paid to underutilized species and their potential for income generation, poverty reduction, nutrition security and resilient production systems, several studies, projects and collaborative frameworks at national and international level have been launched in support of these species, contributing to a re-focusing of much-needed and deserved attention on these 'forgotten crops' and their market potential.

Andean grains are a typical example of underutilized plant species. People living in the Andes, in particular in the 'high climatic risk' areas, are threatened by a seasonal variation in climate that can bring drought, floods, frost or hail within one growing season, where poverty is widespread. Much of indigenous people's livelihood security has been based on the consumption of a range of local and traditional tubers, principally potatoes, and a mix of different grains (Dandier and Sage 1985; NRC 1989). The most common Andean grains are: quinoa

(*Chenopodium quinoa*), cañahua or kañiwa (*Chenopodium pallidicaule*), amaranth (*Amaranthus caudatus*) and lupin (*Lupinus mutabilis*). Farmers have adapted and selected different varieties of these crops in order to reduce their vulnerability to a range of environmental risks. These are strategic crops for the livelihood of millions of people in the Andes. Their valuable nutritional content, their adaptability to harsh environments, their diversity of uses, and the food culture and traditions associated with these grains, are at the basis of their extensive use in the Andes over centuries. The traditional Andean crops offer many advantages: they can be cooked or consumed in many different manners; and they offer culinary diversity, great nutritional value due to high protein contents, and relatively low prices if compared with animal sources.

The intra-species diversity of the Andean grains is very high and it brings differences in nutritional content, adaptability to the environment and culinary uses. Nevertheless, the role of these species as a staple food has dramatically decreased since the 1970s. All this valuable diversity is in peril due to the loss of genetic resources and the related knowledge. This decline has its roots in the Spanish conquest in the sixteenth century: traditional crops were repressed and replaced with European species such as wheat, barley and broad beans (NRC 1989), a culinary colonialism that continues to a large extent today, strengthened by the increasing urbanization of Andean countries. This loss is to be blamed on modern farming, national legislation and policies that usually encourage such farming, a change in consumer patterns, climate change, national political conflicts, migration and so forth. A further factor is that the introduced products are cheaper than domestically produced Andean grains. Moreover, lack of improved varieties, lack of enhanced cultivation practices, drudgery in processing and value addition, and disorganized or non-existent market chains have exacerbated this process (Tapia 1992). Andean crops are disappearing, although they could play an important role in dietary safety, nutrition and the economy of farmer families.

At the same time, there is recent interest in the great potential that the products derived from the Andean grains have for domestic and foreign commercialization. Consumers in developed countries are increasingly searching for new, better, healthier and nutritional products, not to mention associated cultural and historical values. Moreover, Andean nationals living abroad miss their native products (nostalgia produce). Significant export markets have opened up for these Andean products.

In the case of quinoa, an increasing number of products are successfully sold in national and international markets. In Bolivia, quinoa is cultivated on an area of about 70,000 ha (2012), with an annual production of about 44,262 t.

Of the total volume produced in 2012, 59% was exported (26,252 t) generating 79.9 million US\$ revenue for the country (IBCE 2013).

In Bolivia, the agribusiness of Andean grains, in particular for quinoa, is still small and family managed, with limited processing infrastructure. The most common activity is the transformation of grains into flour. Nevertheless, a growing number of products made of quinoa, but also of cañahua and amaranth, are sold throughout the country, such as biscuits, instant soups, drinks, pastries, candies, snacks and pasta. These products are currently sold in local markets, stores,

supermarkets and 'ecological outlets' in major Bolivian towns. An effort has been made to achieve proper packaging and good hygiene.

Quinoa, as well as all the Andean grains, is highly valued in foreign markets due to nutritional value and potential for organic production. Comparing the three grains and their situation on the international market, Quinoa Real, which comes from the Bolivian southern Altiplano, is the most evident. The official data for Bolivian exports shows a steady growth; countries such as the United States of America, France and The Netherlands are the leading buyers of these products. Quinoa exports increased by over 58% from 2005 to 2006, and the productive capacity could be adapted to international demand (export volume in 2006 was over 7,600 t, with an approximate value of US\$ 9 million (CAMEX 2007). There are a number of existing opportunities to export quinoa products and other Andean grain products through new market channels as native products and organic products all over Europe and North America.

Quinoa can no longer be considered a truly underutilized species, but its genetic diversity is suffering from heavy genetic erosion due to marginalization of hundreds of their landraces. What is happening to quinoa is similar to what has already happened to major staples such as wheat or rice in the aftermath of the green revolution through the introduction of high-yielding varieties. What we advocate today is a different approach, whereby the vulnerability of quinoa production system as a result of genetic uniformity is avoided through the valorization of numerous local varieties for their comparative advantages in terms of greater resilience to climate change, nutrition and health properties, food culture relevance and other traditional, cultural and spiritual benefits.

At the market chain level, small-scale farmers and poor actors in the market chain in the Andes face a great number of difficulties in identifying market opportunities for new products derived from Andean grains. Growing, harvesting, processing and marketing these products requires skills, such as good management and co-ordination, to sell products to markets, access processing facilities, and obtain good quality labour. The access capital, education, market information and marketing institutions for small-scale farmers are restricted, so they are at a great disadvantage compared with large-scale commercial farmers. Improving opportunities to access high-value markets by small-scale farmers so they can sell products derived from Andean grains are hampered by a number of constraints. Current research on the market chain has recently started to look at the importance of re-governing markets to improve efficiency and increase market access by small-scale farmers. Small-scale farmers need to overcome transaction costs and access the necessary information to meet market requirements. An example of efforts in this direction in the Andean Countries (Bolivia and Peru) is the establishment of collaborative, multi-disciplinary platforms of stakeholders involved in the value chain. A collaborative platform links producer associations, research institutes, researchers, development agencies, civil society, the business sector and policy-makers, promoting linkages and trust among the value-chain actors, and advocating for political support for promoting greater use of Andean grains. The platforms provide support for small-scale farmers through different

institutions, as well as helping build strong social capital, taking on a range of activities such as mapping of the value chain structure; assessing market opportunities; sharing market information; and providing training. Present and further impacts of established platforms will depend on funds available to promote the potential benefits of collaborative platforms in terms of generating social capital and income, in particular for small-scale, poor farmers.

Looking at the sustainable livelihoods of the communities producing Andean grains and at their impact vis-a-vis the increased national and international market potential, research shows that this success does not necessarily translate into clearly improved livelihoods for local communities. Taking the specific case study reported in this book concerning quinoa production in southern Altiplano in Bolivia, there is evidence that the promotion of domestic and international markets for quinoa alone does not substantially improve the situation of poor farmers without measures accompanying this market expansion. The transition from traditional to commercial quinoa production in the communities reported on the study in southern Bolivia brought several important and quantifiable consequences in terms of income, education and nutrition, and other socio-economic indicators, as well as on quinoa diversity and the environment.

This transition also had other effects, which are less tangible and more difficult to measure, including the growing sense of empowerment brought on by participating in the market economy, but also a sense of loss surrounding the disappearance of traditional community institutions that linked people and made them closer. The new market for quinoa has enabled producing households to raise their income, which should allow better nutrition, better education for their children, and the opportunity to remain in the community rather than emigrating from the southern Altiplano. However, their geographical remoteness, the poor infrastructure, and the weak social services of this area remain unaffected, keeping these people in poverty, with a starvation diet. Higher incomes could have a more positive impact on health and nutrition if diverse foods were more accessible (markets where fruits and vegetables are sold are distant and expensive to reach). Hence, to improve the nutrition of these communities, infrastructure and transport in particular, should be enhanced. Because quinoa can cost as much as 45–50% more than other staple grains, a common assumption would be that households prefer selling it rather than eating it. This study shows that poorer households consume more quinoa, while richer families buy food other than quinoa.

However, households consume less quinoa because to process it is so difficult and time consuming. Small processing machines that replicate the traditional *beneficiado* process (removing the saponin) could increase quinoa consumption among producing households. The study on the management of the quinoa micro-processing units in southern Bolivia indicates that such equipment is very helpful for the communities surveyed as using them saves processing time. This means more time to participate in other activities, including potentially lucrative ones (in particular for women). However, there are still some constraints to be overcome as they impede the use of these machines, such as coordination problems among the people in charge of the equipment, and maintenance of the machines. Besides the efforts related to ease the processing of quinoa,

supplementation programmes should be made more widely available to help people to re-integrate quinoa in their diets.

Another important issue is that related to the environmental impact of the increased production of quinoa, and its unsustainability. The production increases are often obtained through unsustainable production systems, and the current production practices may be the biggest source of vulnerability for the communities living in these areas (Jacobsen 2011). The impact of these practices on the fragile soils of the Andean region are still to be assessed, and more sustainable practices should be put in place to avoid negative present and future repercussions on the agro-ecosystems and consequently on the livelihoods of the families living there. Options for more sustainable quinoa production in Bolivian exist, and farmers are aware of them. However, the process of changing to a new technology is difficult and expensive. Producer associations and research organizations should as a priority objective analyse the present state of development, the potential for investing, and use of alternative and sustainable production technology.

Even though research has identified less commercial quinoa varieties with high potential for producing breakfast cereal, milk substitute, pasta and baking products, the conservation of the great diversity of quinoa is not supported by the market. The international market gives preferences to only 5 of the 40 Quinoa Real types that are produced in the southern Altiplano. Incentives are lacking for farmers to keep the less commercial types (Narloch et al. 2011). Although farmers are aware that particular quinoa varieties have higher yield or are more resistant to stresses, they do not keep them because they are less or not marketable. Quinoa is liable to follow a very similar process of agricultural development to where market and economic development have been the cause of diversity reduction in staple food species. Neglected quinoa types are conserved in Bolivia's well-functioning genebanks. Some mechanism should be implemented to help farmers learn about and share new types of quinoa that might be useful for them.

Without doubt, this increasing production of quinoa in the Bolivian Southern Altiplano raises reasonable concerns about social and environmental sustainability issues. Nevertheless, there is still a limited knowledge and evidence about the agro-ecological and social basis of quinoa sustainability in this region. Recent research programmes have started to investigate this complex issue to provide the right evidence and recommendations on how to address them (Winkel 2008; Winkel et al. 2012).

To conclude, and as shown by the Bolivian southern Altiplano experience highlighting the many trade-offs involved in changing from traditional to commercial agricultural systems, it is recommended that policy-makers should not only consider the economic effects deriving from improved production and marketing of Andean grains, but also look at the long-term social and environmental consequences for the region and its indigenous people. There is a need to pay careful attention to issues beyond market access and production techniques, such as community structure, nutritional standards, the sustainability of natural resources (including genetic diversity) and land tenure.

To celebrate 2013 as the UN International Year of Quinoa, Cornell University

students<sup>221</sup> in partnership with Bioversity International have conducted a press review of recent articles and blogs on Quinoa from 2011 to 2013. First results of this summary have become available just as we were about to finalize this publication for print. We felt it appropriate to include the preliminary results of this analysis since they provide updated information regarding some of the issues covered in the previous chapters of this book as well as relating quinoa production to the international context.

The bibliography itself has been organized into tables, where each table represents a separate topic, or source-type. Links to each source are also provided in the tables. The vast majority of the Western press sources and blogs present the quinoa controversy in terms of consumer choice. Therefore, the sources have been organized in terms of the conclusive suggestion made to the reader: “Don’t Eat Quinoa”, “Eat Quinoa,” and “Its Complicated.” Separate tables report the Western press (Table 6.1.) and blogs (Table 6.2.) and the Andean press (Table 6.3.). The reason for this is that the Andean perspective of the Quinoa controversy is hardly ever reported in the Western press or blogs.

22. *Charlotte Ambrozek; Martin Zorrilla; Abigail Augarten and Elizabeth Hoover. Students in the International Agriculture and Rural Development Department of Cornell University supervised by Dr Adam Drucker, Bioversity International. Cornell site with Bioveristy material: <http://bit.ly/1brn9y5>*

**Table 6.1.** Summary of Western press by main argument made

<b>Don't Eat Quinoa</b>	<b>Eat Quinoa</b>	<b>It's Complicated</b>
<p><b>New York Times Article-</b> "Quinoa's Global Success Creates Quandary at Home."- March 19, 2011. <a href="http://nyti.ms/11qsXSX">http://nyti.ms/11qsXSX</a>. Last accessed June 2013</p>	<p><b>Slate-</b> "It is Ok to eat Quinoa."- January 15, 2013. <a href="http://slate.me/13wUsOW">http://slate.me/13wUsOW</a>. Last accessed June 2013</p>	<p><b>Worldcrunch-</b> "Quinoa: How Bolivia's 'Mother Of All Grains' Became Hottest Organic Craze"- March 13, 2013. <a href="http://bit.ly/104K6rd">http://bit.ly/104K6rd</a>. Last accessed June 2013</p>
<p><b>The Guardian-</b> "Can Vegans Stomach the Unpalatable Truth About Quinoa."- January 16, 2013. <a href="http://bit.ly/11QvNAw">http://bit.ly/11QvNAw</a>. Last accessed June 2013</p>	<p><b>The Globe and Mail-</b> "Kill Quinoa? Time to Debunk These Urban Food Myths."- January 19, 2013. <a href="http://bit.ly/12AEGG8">http://bit.ly/12AEGG8</a>. Last accessed June 2013</p>	<p><b>NPR-</b> "Demand For Quinoa A Boon For Bolivian Farmers"- January 13, 2013. <a href="http://n.pr/14OIUWf">http://n.pr/14OIUWf</a>. Last accessed June 2013</p>
<p><b>Fox News-</b> "Popular Quinoa Energizing Bolivian Economy."- January 4, 2011. <a href="http://fxn.ws/15PGx6M">http://fxn.ws/15PGx6M</a>. Last accessed June 2013</p>	<p><b>TheGuardian-</b> "Quinoa Brings Riches to the Andes."- January 14, 2013. <a href="http://bit.ly/19Xabdx">http://bit.ly/19Xabdx</a>. Last accessed, June 2013</p>	<p><b>The Guardian-</b> "Quinoa: good, evil, or just really complicated?"- January 25, 2013. <a href="http://bit.ly/11u746a">http://bit.ly/11u746a</a>. Last accessed, June 2013</p>

**The Globe and Mail-** “The More You Love Quinoa, the More You Hate Bolivians.”- January 16, 2013.  
<http://bit.ly/11akcOa>.  
 Last accessed, June 2013

**Ottawa Citizen-** “Go Ahead and Eat Quinoa.” -January 17, 2013.  
<http://bit.ly/113qsuk>.  
 Last accessed, June 2013

**Columbia Journalism Review-** “Quinoa’s quagmire: One-sided Guardian article incites media scare.”- January 25, 2013.  
<http://bit.ly/12eCv9O>.  
 Last accessed, June 2013

**Rozanne Gold-** “Who Needs Quinoa More Than You Do.”- December 4, 2013.  
<http://bit.ly/14rlfMz>.  
 Last accessed, June 2013

**Bear Witness Pictures-** “ An Open Letter to NPR Regarding Quinoa and Their Myths.”- November 30, 2012.  
<http://bit.ly/104LkTw>.  
 Last accessed, June 2013

**The Guardian-** “Eating quinoa may harm Bolivian farmers, but eating meat harms us all.”- January 22, 2013.  
<http://bit.ly/13sHLDi>.  
 Last accessed, June 2013

**Daily News-** “Is It Ethical for Rich Countries to Eat Quinoa?”- January 22, 2013.  
<http://nydn.us/1bnmCH7>.  
 Last accessed, June 2013

**CBC news-** “Quinoa boom offers hard lesson in food economics.”- January 18, 2013.  
<http://bit.ly/18Zl8Je>.  
 Last accessed, June 2013

**Yahoo-** “How Many Bolivians Are Dying Because Foodies Love Quinoa.”?- January 24, 2013.  
<http://yhoo.it/15PHtlg>.  
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**ABC News-** “The Quinoa Boom is a Lesson in the Global Economy”- March 4, 2013.  
<http://abcn.ws/15PHvQr>.  
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**NPR-** “Quinoa Craze Inspires North America to Start Growing Its Own.”- November 29, 2012.  
<http://n.pr/12AFf2L>.  
 Last accessed, June 2013

**Truthout-** “Rectifying the Facts About Quinoa”- April 10, 2013.  
<http://bit.ly/1bnmzBA>.  
 Last accessed, June 2013

**Huffington Post-** “Quinoa Boom Puts Stress on Bolivian Economics, Environment.”- February 20, 2013.  
<http://huff.to/1637kgO>.  
 Last accessed, June 2013

**The Economist-** “Quinoa Selection.”- May 12, 2012.  
<http://econ.st/11u7zNz>.  
 Last accessed, June 2013



**Table 6.2.** Summary of Western blogs by main argument made

Don't eat quinoa	Eat quinoa	It's Complicated
<p><b>Alter Net-</b> "To Eat Quinoa or Not?: As the Controversy Continues, Are We Even Asking the Right Questions?"- 21 February 2013. <a href="http://bit.ly/ZEr9co">http://bit.ly/ZEr9co</a>. Last accessed, June 2013</p>	<p><b>AlterEco-</b> "If I Buy AlterEco Quinoa Can I Feel Good About It?"- 24, January 2013. <a href="http://bit.ly/12eDtCQ">http://bit.ly/12eDtCQ</a>. Last accessed, June 2013</p>	<p><b>Food for Thought-</b> "Quinoa Controversy."- 1 February, 2013. <a href="http://bit.ly/11quqso">http://bit.ly/11quqso</a>. Last accessed, June 2013</p>
<p><b>The Dish-</b> "An Unpalatable Truth."- 22 January, 2013. <a href="http://bit.ly/11u7Kso">http://bit.ly/11u7Kso</a>. Last accessed, June 2013</p>	<p><b>AlterEco-</b> "Edouard's Answer to Time Magazine's Article 'Quinoa: The Dark Side of an Andean Superfood'"- 4 April, 2012. <a href="http://bit.ly/113rXsn">http://bit.ly/113rXsn</a>. Last accessed, June 2013</p>	<p><b>Motherboard-</b> "The Motherboard Guide to Quinoa."- 22 February, 2013. <a href="http://bit.ly/19Xbsl3">http://bit.ly/19Xbsl3</a>. Last accessed, June 2013</p>
<p><b>Esquire-</b> "The Dark Side of Quinoa."- 22 January, 2013. <a href="http://bit.ly/15Plkcb">http://bit.ly/15Plkcb</a>. Last accessed, June 2013</p>	<p><b>TBD-</b> "Quinoa: Trendy, Controversial, and Hard to Pronounce."- 1 June, 2011. <a href="http://tbd.ly/19Xbzgr">http://tbd.ly/19Xbzgr</a>. Last accessed, June 2013</p>	<p><b>Tree Hugger-</b> "Quinoa, Commodities, and the Gentrification of the Food System."- 22 January, 2013. <a href="http://bit.ly/11CfrQi">http://bit.ly/11CfrQi</a>. Last accessed, June 2013</p>
<p><b>Care2Make a Difference-</b> "The More You Love Quinoa, the More You Hate Bolivians."- 18 January, 2013. <a href="http://bit.ly/19XbIR2">http://bit.ly/19XbIR2</a>. Last accessed, June 2013</p>	<p><b>Wellsphere-</b> "Quinoa Controversy"- 22 January, 2013. <a href="http://bit.ly/113st9S">http://bit.ly/113st9S</a>. Last accessed, June 2013</p>	<p><b>Agriculture, Development, and Food Policy blog-</b> "Quinoa Nonsense, or Why the World Still Needs Agricultural Economists."- 22, January, 2013. <a href="http://bit.ly/11QxxKe">http://bit.ly/11QxxKe</a>. Last accessed, June 2013</p>
<p><b>Fraggin' Civie-</b> "The Bad News About Quinoa."- 24 January, 2013. <a href="http://bit.ly/14Ooagd">http://bit.ly/14Ooagd</a>. Last accessed, June 2013</p>	<p><b>Cato Institute-</b> "If Poor People Get Richer, They Won't Have Anything to Eat."- 25 January, 2013. <a href="http://bit.ly/113sJFL">http://bit.ly/113sJFL</a>. Last accessed, June 2013</p>	
<p><b>The Atomic Carrot-</b> "The Quinoa Controversy: What's Not so Super About the Supergrain."- 16, March 2013. <a href="http://bit.ly/11aOXW">http://bit.ly/11aOXW</a>. Last accessed, June 2013</p>	<p><b>The Cardus Daily-</b> "Quinoa Strikes Help No One."- 25 January, 2013. <a href="http://bit.ly/11CfDPz">http://bit.ly/11CfDPz</a>. Last accessed, June 2013</p>	
<p><b>Environment Now-</b> "You've Probably Heard About Quinoa."- 22 February, 2013. <a href="http://bit.ly/19Xc5uM">http://bit.ly/19Xc5uM</a>. Last accessed, June 2013</p>	<p><b>Vegansaurus-</b> angry response to The Guardian article. "The Guardian obnoxiously asks, 'Can Vegans Stomach the Unpalatable Truth About Quinoa.'" - January 16, 2013. <a href="http://bit.ly/15PJsMS">http://bit.ly/15PJsMS</a>. Last accessed, June 2013</p>	

**Table 6.3.** Summary of Andean press by main argument made

<b>Quinoa Production in a Negative Light</b>	<b>Quinoa Production Positive Overall</b>	<b>It's Complicated</b>
<b>EIPeriodico-</b> “La quinua bajo presión del mercado y la tradición (Quinoa under pressure from the market and tradition).”- Guatemala, February 20, 2013. <a href="http://bit.ly/11CfLi9">http://bit.ly/11CfLi9</a> . Last accessed, June 2013	<b>La Razon-</b> “El consumo de quinua en el país se triplicó en los últimos 4 años (The consumption of Quinoa in the country triples in the past 4 years).”- Bolivia, February 17 2013. <a href="http://bit.ly/1639nRK">http://bit.ly/1639nRK</a> . Last accessed, June 2013	<b>Los Tiempos-</b> “Bolivia, gran productor pero poco consumidor de quinua (Bolivia, large producer but poor consumer of Quinoa.)”- Bolivia, July 26 2012. <a href="http://bit.ly/113tsXH">http://bit.ly/113tsXH</a> . Last accessed, June 2013
	<b>ElComercio-</b> “El Poder De La Quinoa (The Power of Quinoa).”- Peru, 22 September 2012. <a href="http://bit.ly/18ZJuU7">http://bit.ly/18ZJuU7</a> . Last accessed, June 2013	<b>El Diario-</b> “Oportunidades y Riesgos en la Quinoa Boliviana (Bolivia, Opportunities and Risks of Bolivian Quinoa).”- Bolivia, 21 March 2012. <a href="http://bit.ly/11qvEw">http://bit.ly/11qvEw</a> . Last accessed, June 2013
	<b>Notiboliviarrural-</b> “Seis mil familias pobres del altiplano apuestan a la exportación de quinua (Six thousand poor families bet on quinoa exportation).”- Bolivia, March 27, 2013. <a href="http://bit.ly/18mzPKu">http://bit.ly/18mzPKu</a> . Last accessed, June 2013	<b>Agencia Americana de Informacion-</b> “Quinoa: ¿Comprar o no comprar - será la pregunta correcta? (Quinoa: Is ‘To buy or not to buy’ the right question?).”- Ecuador, February 19 2013*. <a href="http://bit.ly/18mzUhi">http://bit.ly/18mzUhi</a> . Last accessed, June 2013 *written by a western ngo
	<b>LaPatria-</b> “Ironía Alimentaria (Food Irony).”- Bolivia, June 12, 2012. Editorial. <a href="http://bit.ly/11amuwz">http://bit.ly/11amuwz</a> . Last accessed, June 2013	

As a final note, we would like to emphasize our hope that the celebrations on the occasion of the UN International Year of Quinoa (<http://aig2013.org/en/>) in 2013 will be an opportunity to showcase the role of quinoa in fighting food insecurity and poverty around the world and in particular in Latin America, as well as proved a moment of reflection on lessons learnt regarding the sustainable promotion of underutilized crops, to which this publication aims to contribute.

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Biodiversity International  
is the operating name  
of the International Plant  
Genetic Resources  
Institute (IPGRI).

Supported by the CGIAR.

ISBN 978-92-9043-932-5



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