The Challenges of Developing a Sustainable Agro-Industry in Bolivia: the Quinoa Market

Prepared by: Katherine Antonio

Master in International Development Policy

Duke University

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Executive Summary

This document focuses on the quinoa market in Bolivia, its policy challenges and potential contribution to the economy, and the important and relevant issues that are affecting the value chain and sustainability of the quinoa industry in Bolivia. The analysis in this paper shows that there is a very good picture for the future of the industry. The value of Bolivian quinoa exports has risen from a total of US$2 million in 1999, representing about 1,500 tons, to more than US$46 million in 2010, or about 15,400 tons (INE, 2010). Recently, the boom of quinoa exports has attracted international customers and exporters willing to buy the grain at higher prices (the Free on Board (FOB) price for exports was more than US$3,000 per metric ton in 2010). The value of the crop is about five times that of soy beans, a similar food but of lower nutritional quality. There were 23 major quinoa exporters (part of the National Association of Quinoa Producers -ANAPQUI) whose combined 2010 revenue was about US$42 million.[1]

There are vulnerabilities to be addressed for future productivity and sustainability of the industry, however. The analysis shows that if the production and exports of quinoa in Bolivia are to be sustainable, the agricultural practices must be both ecologically and socially sound. This concern has been expressed by Andean plateau farmers, ecologists and policy makers, as well as other actors in the quinoa food chain in foreign countries. Producers face technical difficulties and environmental risks; and there are impacts on the social and environmental capital of the regional economy within the country that need special attention.

The policy problem is, therefore: The expanded growth of the quinoa industry represents for Bolivia both a great opportunity and potentially a serious threat to the environment and local nutritional levels among the poorer communities. The high prices and worldwide demand have put tremendous pressure on production, and this pressure has encouraged poor environmental

[1] (IBCE, 2010)

practices as well as illegal trafficking. However, there is also a chance for Bolivia to make several important gains: a stronger national economy through a sustainable agricultural industry in one of the country's poorest regions, and access to a traditional nutrition source especially for low income citizens.

There are three main causes of the problem: a) rise in domestic prices limiting (poorer) local consumers' access to this traditional nutritious food and resulting from drastic export price rise, b) negative environmental impacts from poor agricultural practices, and c) distortions in the market due to bureaucratic processes and government policies (resulting in illegal trafficking (to Peru) of the grain to avoid sale through formal government approved channels). These causes are interrelated and are analyzed in this document.

Thus, the policy question is: what can be done to mitigate the risks of environmental damage and low domestic nutrition access due to the boom in the quinoa market in Bolivia, while taking advantage of the opportunities to build a sustainable local industry and provide better nutrition? My paper considered the main stakeholders whose interests and influence could make a difference: ANAPQUI to promote and assist farmers to implement more sound environmental management practices, focusing on how to increase production by increasing the yield instead of expanding the agricultural surface. The government: For solving the trade issues and making the industry more competitive, the government has started reforming the quinoa law that was approved in March, 2011. The quinoa law was designed to establish property rights over the variety *Royal Quinoa* (the best quality for the product), and provides a mixture of support - credits and financing support for the development of the industry and regulation – sale through (less profitable) formal government approved channels. The government needs to improve the business environment, as well as trade conditions and infrastructure. Much synergy could happen if producers, traders, national and regional authorities, and external stakeholders

work together for better agricultural, environmental and trade practices in the quinoa industry, and develop all aspects of the industry. Research and Development (R&D) about organic fertilizers and improved land management is also very important in this context.

The main components that had to be considered under any policy alternatives, therefore, were: (1) food and nutrition safety net (relative to quinoa); (2) environmentally sound quinoa agriculture; (3) trade and business support policies. There were 3 alternatives considered: (1) Focus on productivity and environment: ANAPQUI with a major role, government with a supporting role; (2) Stronger government intervention with quinoa as part of food security; (3) Integrated quinoa -industry, environment and nutrition- approach implemented as a partnership among stakeholders. The alternatives were evaluated on the basis of effectiveness (addressing the components), efficiency and both political and administrative efficiency.

The paper recommends a combination of alternatives and stressed the strong partnership role needed by both ANAPQUI and the government, since there were complementary functions that could be best provided by each actor. For example, the government could help support good and local nutrition by providing quinoa to the most vulnerable groups,[2] incorporating quinoa as an input into the school feeding program run by the Zero Malnutrition Program (*Programa de Desnutrición Cero*) administered by the Department of Health Services.[3]

A note on the research for this paper should be made here since there was some inconsistent data on domestic consumption that this author needed to re-estimate. For the rest of the data, I explored a comprehensive collection of up-to-date and diverse sources of information about the quinoa industry, both in English and Spanish.

[2] http://www.lapatriaenlinea.com/?nota=72765. In this newspaper article we can read the demand for the department of Oruro of Nutrition Food in the School Breakfast.
[3] The Program is described in http://bolivia.nutrinet.org/areas-tematicas/materno-infantil/introduccion/estrategias/96-programa-multisectorial-desnutricion-cero.

1. Background and Introduction

Quinoa is a grain of very high nutritional value.[4] It is considered one of the most precious grains in the world. Scientific studies have shown that quinoa has a high protein content, balanced set of amino-acids, and a low level of cholesterol. It has become highly popular among health-conscious consumers throughout the world. Quinoa has even been declared the "Perfect Food for Humanity" by UNESCO, and an excellent food for human nutritional needs according to FAO. NASA Controlled Ecological Life Support System selected it as a food for long-term aerospace expeditions. [5]

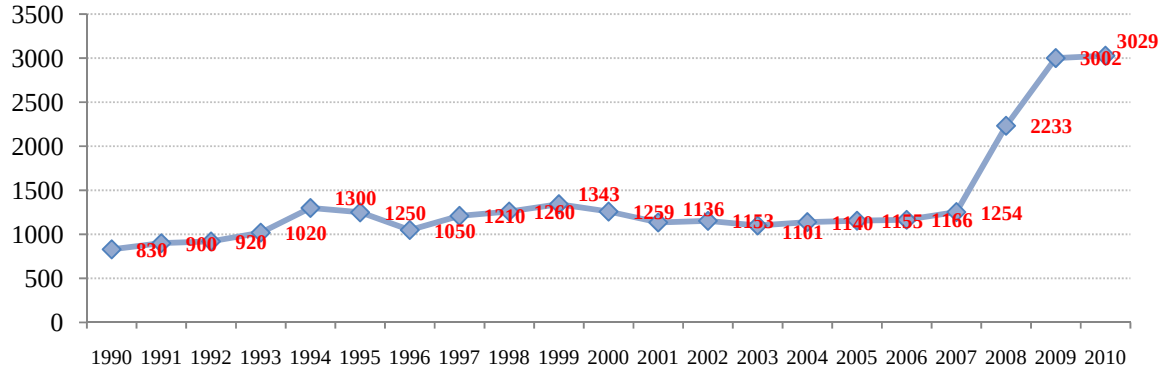
Quinoa is produced in the Andean regions of Bolivia, Peru, Argentina, Chile, Colombia, and Ecuador. It is also produced in small quantities in the France, Canada, United States, England, and recently in Egypt. Historically, the best quality quinoa has been produced in Bolivia, where it has been a staple crop since pre-colonial times. Quinoa production is commonly divided in two varieties *royal* and *conventional*. The first one only grows in the Southern Plateau of Bolivia, in extreme cold and dry weather (200 to 400 mm of annual rain), high altitudes (from 3,700 to 4,200 m. above sea level), and salty soils. (Alcala, 2009, p. 3).[6]

Organic quinoa is in growing demand in international markets because of its exceptional nutritional qualities. Currently, high-quality Bolivian quinoa is sold in North American, European, and Asian markets at relatively high prices. Since 1980, there has been an increase in the world demand for quinoa, as shown in increases in both world prices and exports from Bolivia. The world's number one exporter of quinoa is Bolivia, which supplies 42% of the quinoa found on the international market. Peru, Ecuador and Colombia produce a combined

[4] Generic name of quinoa is *chenopodium quinoa wild.*
[5] (Schlick & Bubenheim, 1993) The NASA´s Controlled Ecological Life Support System program has chosen quinoa as their most promising crop candidate, due to its nutritional properties and plant growth characteristics.
[6] These conditions allow the production of a bigger grain with increased nutritional values. Royal Quinoa is bigger in size (about 2.5 mm in diameter) when it is compared with the other varieties in Bolivia, Peru, Ecuador and other countries.

total of about 49% of the world's quinoa production. The principal importer of Bolivian exports is Peru, although the exports to the U.S. and Europe are growing. Bolivian quinoa is the most expensive and is considered to be of the highest quality. According to the Bolivia National Statistics Bureau (INE), the price of quinoa per ton increased from US$1,259 in 2008 to US$3,029 in 2010.[7]

Graph 1. Quinoa Free on Board Prices (USD per Metric Ton)



Source: Prepared by the Author based on Bolivia National Statistics Bureau.

The value of the crop is about four or five times that of soy bean, a similar food. Last year there were 23 major quinoa exporters (part of the Association), who altogether generated about $42 million in revenue.[8] The value of Bolivian quinoa exports has risen from a total of $2 million in 1999, representing about 1,500 tons, to more than $46 million in 2010, or about 15,400 tons (INE, 2010).

This is a very encouraging picture for the future of the industry, and this document examines the industry's prospects. However, there is also some concern over unintended impacts that a growing industry can have. In this document I identify four main issues: i) the potentially

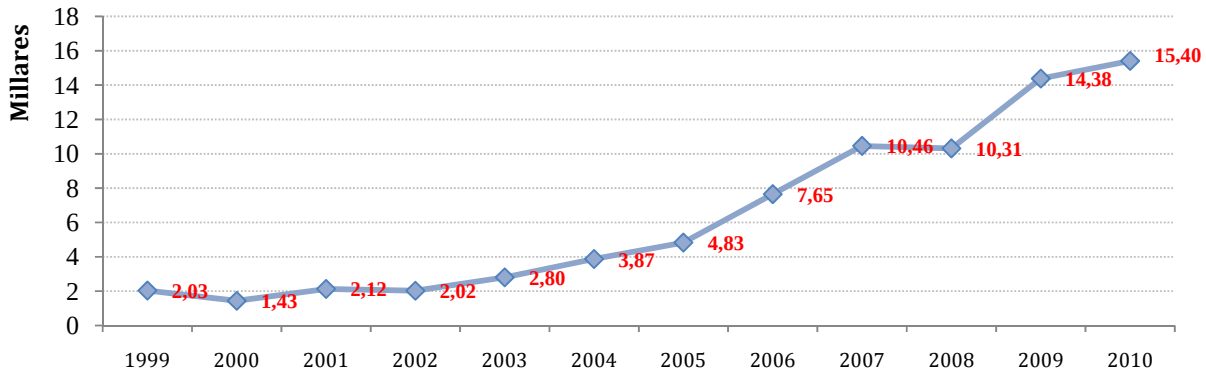
[7] (BBC News, 2011) (News Paper Los Andes) http://www.losandes.com.pe/Nacional/20110207/46152.html Accessed February 7, 2011. According to this article the quinoa prices increased by USD 1100 per ton in 2008 to USD 3000 in 2010.
[8] (IBCE, 2010)

harmful environmental effects of poor farming practices; ii) the nature of illicit exports and their institutional impacts on the national economy; iii) issues affecting the ability of local buyers to benefit from the nutritional value of quinoa, and; iv) the capacity of farmers to achieve long term benefits from the booming industry and create a sustainable local industry.

The overall amount of quinoa exports has continued to increase, especially from the Bolivian provinces of Oruro and Potosi, the main producers of this grain. Quinoa exports represent a very good opportunity for the development of that region. Oruro and Potosi have historically been Bolivia's two main mineral extraction regions. They are rich in non-renewable resources such as silver, tin, copper, and other minerals which have been a significant part of the economy of these regions, and even the Bolivian national economy since colonial times (see Annex 3, Graphs 1 and 2). The money made from the sale of the grain helps to reduce migrations to the city, but has not fully trickled down to the inhabitants and quinoa producers of the Oruro and Potosi provinces, who continue to be among the poorest people in Bolivia as measured by the HDI Index (see Annex 2, Table 1). In addition, the local natural conditions for agricultural production and climate are to some extent adverse.[9] Quinoa is cultivated in desert lands and at high altitudes, and it can resist very cold weather.

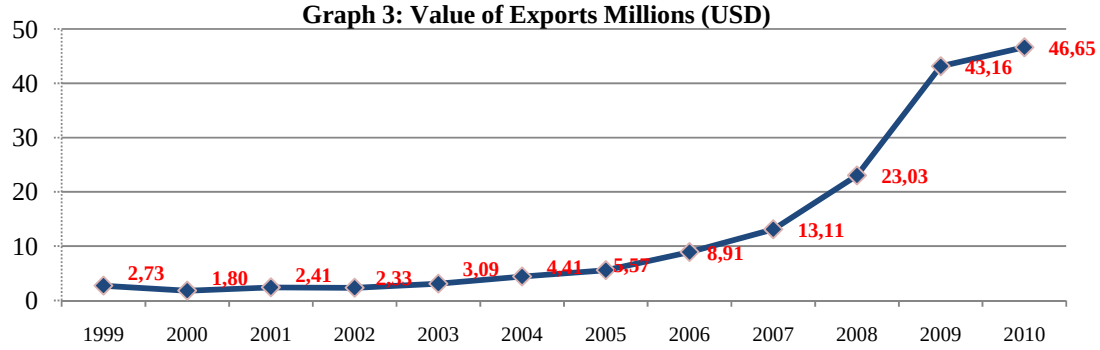
[9] "The Southern Altiplano is located in an area that is an extension from the two Bolivian salt lakes the Uyuni "Salar" and the Coipasa "Salar". It is an ecosystem which is located between 3.600 and 6.000 meters of altitude and that stands out for its extreme climatic characteristics (200 to 400 mm of annual rainfall) which therefore present a fragile ecological balance." (CABOLQUI & Vice Ministry of Science and Technology, 2009 p. 1)

Graph 2: Volume of Net Exports in Metric Tons



Source: Prepared by the Author based on Bolivia National Statistics Bureau.

Graph 3: Value of Exports Millions (USD)



Source: Prepared by the Author based on Bolivia National Statistics Bureau.

As quinoa exports increased exponentially, so did the environmental damage done to the soil,[10] seen in increased time between soil rotation, decreased nutrient content, and increased soil acidity of the producing regions (see Annex 3, Graphs 3 and 4).[11] These impacts are analyzed in this document.

Quinoa originates from South America. The main producer is Bolivia, a country with about 10 million people, and a GDP of $19.5 billion in 2010. The quinoa producing region in Bolivia is at a high altitude around the salt flats of Uyuni and Coipaza in Potosi and Oruro. It is a relative arid area where not much else grows.

[10] (Vallejos Mamani, Pedro Roman, 2011 p. 10)
[11] (INE, 2010) The overall exports in Oruro reduced in 19.16% in 2009 according to the National Statistics Bureau due to the negative variations in mineral international prices. But the quinoa exports increased in 82.38% and other food products in just 7.50%.

The principal center of collection, processing, and exportation of quinoa is the city of Challapata, which is in the Oruro province. There are other quinoa processing factories in La Paz and Cochabamba. The main concentration of new land for production is in the buffer area of Uyuni Salt Lake, located in Potosi province. The salt lake is considered a natural wonder of the world by local and international organizations. In the Challapata region, there are about seventy small quinoa producers clustered around the Uyuni Salt Lake. Only about 20% of their production is certified as organic (see Annex 4, Maps 1 and 2).

Recent studies have shown that in order to meet increased quinoa demand, Bolivian famers, who are mostly indigenous people, have started expanding the "agricultural frontier," which is the amount of land used to grow the crop (see Annex 3, Graph 4). According to a United Nations Food and Agricultural Organization report, Bolivian soil is less productive than that of Ecuador and Peru. By contrast, though, Bolivian quinoa is both organic and considered to be of higher quality. However, there is concern that soil quality is decreasing due to the increased agricultural activity. This study will analyze the consumption and production of this nutritious grain to see if small producers can benefit more, as well as asking if low-income consumers can have an adequate access to the nutritious grain.

A relatively undeveloped business environment may be affecting the flow of formal exports, resulting in "illegal" trade. Many producers, it seems, are taking advantage of the "Zero Tariff" Agreement between the Andean countries, allowing for free trade.

There is an extensive amount of literature about Bolivian quinoa, the most important of which comes from the 2001Andean Project of Competitiveness.[12] The study provides a comprehensive diagnosis of the quinoa cluster and discusses how quinoa exports from Bolivia

[12] The Project of Competitiveness was developed by the Center of International Development of Harvard University, the Andean Corporation (CAF), and the INCAE Institute in Costa Rica to study the Cluster of the Quinoa in Bolivia. The project was closed in July 1, 2002.

increased between 1980 and 2001, eventually comprising 45.6% of the total world production. The report also notes that Peru is responsible for 42.2% of the world's production. However, some of that is Bolivian quinoa marketed as Peruvian. The principal consumers of these exports are the United States and Europe (Brenes, et al., 2001 p. 12).

The report's authors describe the quinoa industry as an incipient market, located in five Andean regions on the Bolivian Plateau: Challapata, Oruro, El Alto, El Desaguadero and Cochabamba. These are the primary places where quinoa is collected, cleaned and packaged. According to the authors, the city of El Desaguadero is the principal center of collection for both legal and illegal quinoa exports.[13] (see page 11, you mention Challapata as the main center, so which one?) The main importer of Bolivian quinoa was the agro industry in Peru, which buys the quinoa to pass off as their own in order to improve the reputation of their own quinoa. According to the authors, approximately 20% of the total quinoa consumption in Peru is of Bolivian origin (Brenes, et al., 2001 p. 24).

The government of Bolivia wants to play an important role by promoting the industry.[14] However, even when the government tries to regulate the use of these natural resources by defining property rights for the commercialization of *royal quinoa*, the quinoa brokers have still incentives to buy quinoa and export it illegally. This results in the overexploitation of Bolivia's natural resources and has negative social and environmental consequences. These effects can be explained using the Copeland's framework, especially when the country's economy is relatively small and the government is unlikely to enforce the environmental regulations (Copeland, et al., 2009 presented a theoretical general framework about the relationship between regulation, trade, and environmental effects).

[13] (Brenes, et al., 2001 p. 13)

[14] According to the Transparency Report 2009 Bolivia is ranked as the worst country for doing business. The report said that establishment of a new business can take at least 500 days. However, the Government recently implemented a Program National for Quinoa to promote the domestic consumption and "regulate" exports.

Most of the quinoa fields are supposed to be on a three-year rotation schedule. The fields that are prepared in August-September, prior to the rainy season, remain fallow that year. They are fertilized and upturned, and this allows the land to absorb moisture and nutrients prior to the next year's planting. (Please see the chart in the Annexes that explains a year of life for quinoa, from field preparation to harvest and field cleaning).

These conditions and other factors have caused quinoa yields per unit surface to decline significantly. In general, domestic production of quinoa is recording low productivity, with a national average of 641 kg / ha (compared to more than *1000 kg/ha* for Ecuador). Among the main factors is the low fertility of soils that have little organic matter.

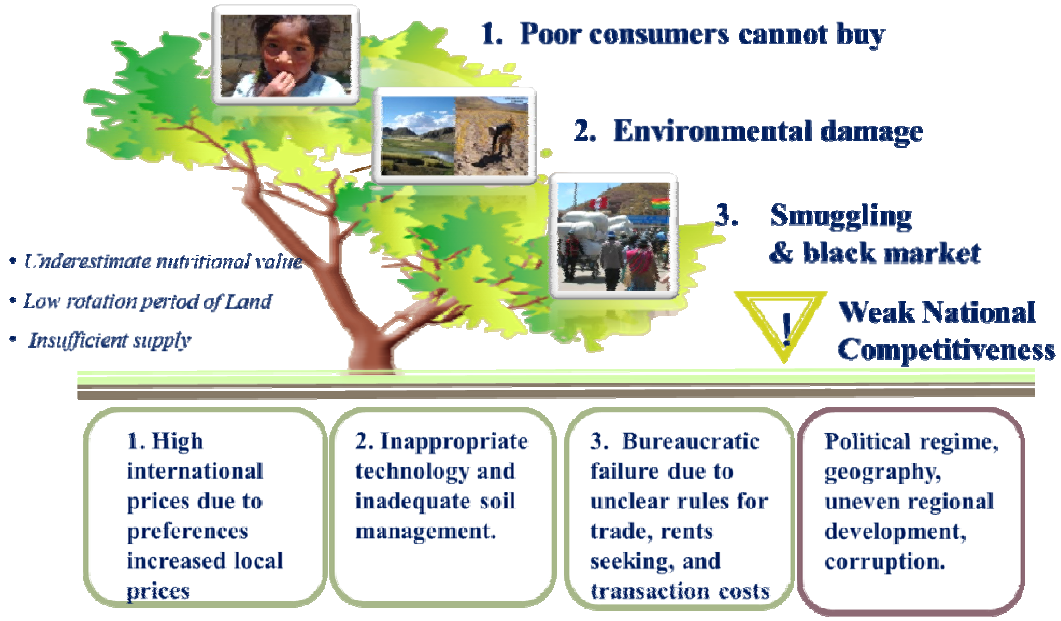
Other factors in the loss of soil fertility are the permanent monoculture of quinoa and the low application of organic matter and inappropriate harvesting system: plants are plucked from the ground, not leaving crop stubble to incorporate nutrients back into the ground. In addition to the problem of soil fertility, there are others factors that affect the productivity of quinoa, such as weather, pest attacks and insufficient practices for agronomic management. However, the problem of soil is the most important cause of low yields and loss of grain quality.

Quinoa yield on new land is from 0.8 to 1.0 tons/ha. However, these yields are increasingly diminishing. In some cases yields do not even reach 0.5 ton/ha. Quinoa performance during the 70s to late 80s shows a declining trend in yields, from 600 kg/ ha in the 70s to 445 kg / ha by the end of the 80s. It is noteworthy that in the areas where there is significant production of organic quinoa for export, the implementation of conventional chemical fertilizers to regain soil fertility are not used in this type of production system. In these areas, fertilization is done with animal dung and other soil management techniques.

2. Structure of the Problem and Impacts on Society and Economy

2.1 Causes of the Problem

There are three main causes of the problem: a) high international prices means that producers prefer to export, causing a rise in domestic prices and local consumers' lack of access to nutritious food, b) lack of oversight over environmental impacts, inappropriate and c) weak national competitiveness and government restrictions that result in illegal trafficking of the grain. The following chart summarized the root of the causes and the problems that results in the industry.



2.2 Description of the Problem and the Impact on Society and Economy

The production and exports of organic quinoa is now widespread and is well accepted in the international market, with high prices that show a tendency to increase. This scenario is favorable for farmers and for the regional economy of the producing areas. However, the unintended consequences should be addressed. The following chart summarizes the problem impacts:

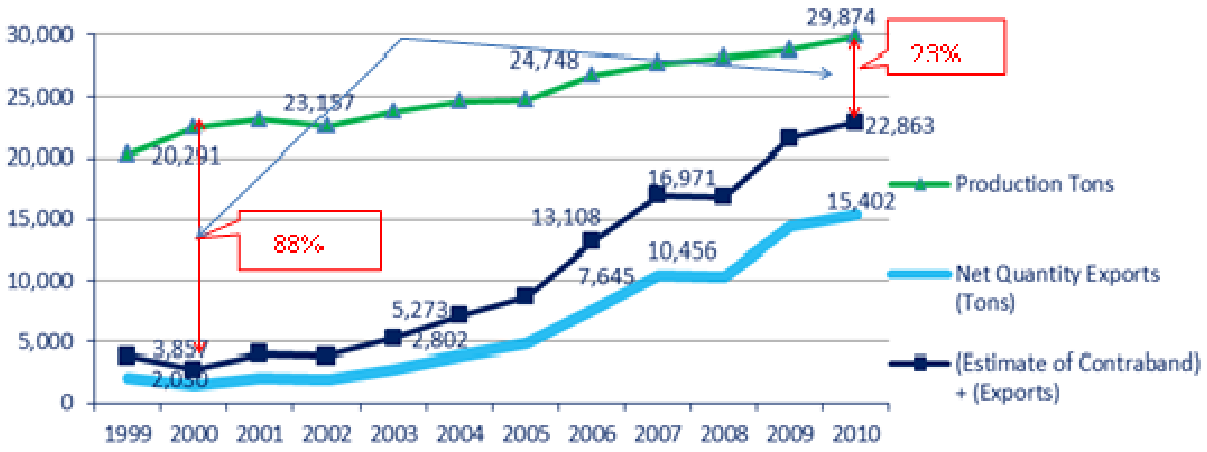
A. Domestic Consumers

Domestic prices of Bolivian quinoa have increased because of the success of exports, making quinoa consumption more difficult for many individuals in the domestic market, but the local consumption has always been historically lower than exports. Traditional consumers, such as the middle class and poor, have been particularly hard hit, as they can no longer afford to buy as much as before. The quinoa grown in Bolivia is more expensive than most quinoa from neighboring countries, especially for certified organic quinoa. According to a report from the International Foreign Trade Association, in 2008 the farmer gate price of organic quinoa was between $1,180 and $1,400 per ton, whereas the conventional quinoa price was between $680 and $750 per ton.

There are several studies about domestic consumption of quinoa in Potosi and Oruro. These studies show that very poor people are the ones most likely to consume the crop.[15] There are several articles that address the reduction in the domestic consumption, but there are no statistics of local consumption in the country. Quinoa is not a product of massive consumption among Bolivians.

[15] (Borja, 2007) and (Montoya, 2007). This studies was funded by the Netherlands Embassy in Bolivia.

Graph 4. Estimation of Domestic Consumption in relation to the production



Source: Prepared by the author based on National Statistics Bureau.

B. Environmental Damage and Sustainability

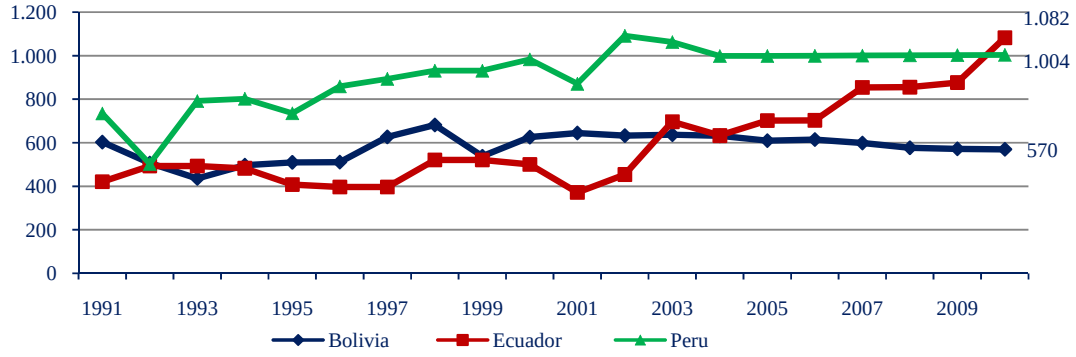
To reverse the environmental damages and ensure the production of quinoa continues in a stable and sustainable manner, it is necessary to perform soil remediation work from the incorporation of animal manure or plant-based fertilizer, promoting better use of machinery and agricultural implements for the type of soil (avoiding damage with the use of unsuitable attachments) to inducing other more sustainable techniques such as minimum tillage. Sustainability problems are also indicated in studies on quinoa production. The quality of the soil and its nutrient content is steadily decreasing, which is negatively impacting production levels. This has generated a discussion about the need to introduce chemical fertilizers, which is contrary to the organic nature of this high quality product. Several studies show that an increase

in quinoa production tends to increase the risk of soil degradation over time, and that the agricultural frontier is expanding to fragile areas (see Annex 2, Tables 6 to 8).[16]

We can see the second issue regarding environmental damage in this map (Annex 4, Map 1). For example, in 1992 there were very few agricultural areas around the Uyuni Salt Flat, but in 2010 the agricultural frontier had increased in an important way. A research study in the buffer area of the Uyuni Salt Flat shows that the agricultural frontier for quinoa production has expanded (from 876 has in 2000 to 17,216 has in 2010), representing a threat to the stability of this ecosystem.[17] The reason is that high quality quinoa production requires rich minerals that are extracted from the soil.

In looking at quinoa farming, we found farmers mostly used traditional practices of land cultivation, rather than modern technologies. As a result, yields are relatively low. Thus the adoption of new technology in quinoa production could shift the production possibilities frontier to a more organic agricultural industry. But the overall process must consider the farmers' adoption of the new idea in order to increase their income and make their production system more competitive.

Graph 5. Average Yields (Kg/ha)



Source: Prepared by the Author in base to Bolivia Ministry of Planning and Andean Community of Nations (CAN).

[16] (Vallejos Mamani, Pedro Roman, 2011 p. 14)
[17] (Vallejos Mamani, Pedro Roman, 2011) See the Graph 4 in the Annex 3.

Through soil recovery programs, the soil fertility in the southern plateau of Bolivia can be improved by increasing the regeneration capacity of the land, and production can be safeguarded with the application of appropriate technology in a system of organic production.

The total area of the southwestern provinces of Potosi is 75,012 km^2, representing 63.4% of the total area of the department of Potosi, which is 118,218 km^2. The population of southwestern Potosi according to the last census is 59,510 inhabitants, which represents 8.4% of the total population of Potosi. The southwestern area is sparsely populated, with a population density of less than one inhabitant per km^2.

Regarding the distribution between rural and urban areas, 82.3% of the total population of the southwestern area is considered rural and only 17.7% urban. The urban population is concentrated in the town of Uyuni, which is the largest urban center in the southwestern region of Bolivia and a very important tourist area.[18]

The agro-ecological conditions of the highland eco-regions, particularly in the Southern Plateau, allow the production of only a handful of crops, including a strain of Quinoa with a unique adaptation to withstand such conditions. Quinoa is a grain native to the Andes, and the Royal variety is the only variety that is produced in Bolivia, in the departments of Potosí and Oruro, specifically in Uyuni and Coipaza.

This grain, because of its nutritional qualities, had been the food base of the Inca population since ancient times, but most of the production was for a relatively small local consumption. Roughly three-quarters of the annual production was devoted for the consumption of the farmers, and the remaining quarter was for sale. Today, this grain is the main source of income for the families in the region. This represents a favorable method to eradicate poverty

[18] The data was extracted from the Bolivia National Statistics Bureau www.ine.gob.bo Accessed April 26 2011.

and a major source of productive employment. In the past 20 years, quinoa production in Bolivia has increased by more than three times. Despite the low share of participation quinoa production has in the Bolivian GDP, its importance lies in its contribution to the economy of the Southern Plateau farmers in Potosi, contributing between 55% and 85% of their income.[19]

Quinoa has begun to grow in consumers' preferences, and increasing demand mainly has developed in traditional areas where Royal Quinoa is grown. In the past 20 years, exports have increased from US$580,000 to more than US$47 million annually. This growth shows the interest in quinoa in the export market, which encourages the prospect of entering into new markets. The increase in demand for quinoa in the international market from the early 1980s has stimulated increased production in the Southern Plateau, causing an expansion of the agricultural frontier and a change from the traditional production system to a machine-intensive production system.

These factors put pressure on the productive capacity of soils, particularly in the intrinsic endowment of nutrients, especially for the organic nutrients that are deficient in most soils in the highlands: mineral nutrients (calcium, magnesium, sodium, potassium, and phosphorus) have values in these soils.

In these circumstances, an increase in production with higher yields means lower availability of land for future production. Additionally, quinoa has a comparatively higher nutrient allocation in relation to other foods, forcing the plant to obtain from other sources that amount of organic and inorganic components, which cannot come from anywhere other than the ground itself. These aspects require regular replenishing of the nutrients required by quinoa to maintain its competitive position as the most nutritious crop in the world.

[19] Data obtained from the Chamber of Quinoa Producers of Potosi Department. CADEQUIR (2010).

Soil is one of the most important production factors for the quinoa industry. The contribution of the soil to the production depends on its formation and composition. Because quinoa production is organic, it is very important to maintain the natural fertility of the soil. The problems related to the soil are three types of degradation: physical, chemical, and biological, all generated as a result of various activities carried out by groups of people. Through the use of organic fertilizers, we address the biological and chemical degradation, reducing the impact of human intervention in the soil, as well as producing positive externalities for reducing physical degradation.

Very little work has been done in relation to strategies for controlling erosion and soil degradation and the problems related to biological fertility. The emphasis was on developing techniques to reduce soil erosion, through practices improving fertility through the application of various synthetic fertilizers. However, the application of these fertilizers in monocultures tends to accelerate the levels of soil sterilization by directly affecting their natural productivity. Similarly, training activities and research have been very partial, focusing only on aspects of biological fertility.

Because of growing demand, more and more land is being given over to quinoa production, which has multiple harmful effects. This expansion of the agricultural frontier in the production of quinoa is affecting grazing areas of llamas and alpacas, whose dung is used to fertilize land for agriculture. The destruction of vegetation cover for the development of new areas for quinoa cultivation is accelerating the severe wind erosion processes, causing increased dune formation. The wind is very damaging on the land that is left to fallow, naked and without any protection once the native vegetation where the "tola" and straw have been removed. The creation of agricultural land on steep slopes, especially lower and middle slopes of the

mountains, hills, and the rest of the land, is causing erosion and accelerating the formation of grooves and gullies.

It is difficult to estimate the cost of quinoa production with organic fertilizer, because the cost should be determined according to the materials utilized in the fertilizer preparation, which varies according to local prices.[20]

As established before, quinoa production should ensure supply to domestic and foreign markets. Estimates show that production could increase by up to 50% as a result of the application of organic fertilizers in potato production.[21] But we are not able to provide an estimate about the resulting yield in royal quinoa production. It is very important to conduct further Research & Development. This can be done by developing a partnership with the local university, NGOs, and research centers. The research should provide information about the yield of royal quinoa resulting after the application of different varieties of organic fertilizer.

A research study was conducted in Puno about the application of three varieties of organic fertilizer (Bocashi) in five varieties of quinoa.[22] The project first determined the best formulation of Bocashi with respect to the nutrients NPK[23], and second evaluated the variety of quinoa with better response to different formulations. The process used three preparations of Bocashi at an altitude of 3,825 meters above sea level, and the seeds were sown at 3,830 meters above sea level. The table below shows the different formulations of organic fertilizer:

[20] http://www.misionrural.net/observatorio/alianzas/productos/quinua/cucaita-samaca/PreInversionQuinuaBoyaca.pdf
[21] PROMIC. How to produce and conserve better?
[22] Cahui (2009). Universidad Nacional del Altiplano. Puno, Peru.
[23] NPK rating is used to label fertilizer based on the relative content of the chemicals nitrogen (N), phosphorus(P), and potassium(K) that are commonly used in fertilizers to amend soil fertility. Fertilizers typically provide, in varying proportions: *i)* the three primary macronutrients: nitrogen (N), phosphorus (P), and potassium (K), *ii)* the three secondary macronutrients: calcium (Ca), sulfur (S), magnesium (Mg), and *iii)* the micronutrients (trace minerals): boron (B), chlorine (Cl), manganese (Mn), iron (Fe), zinc (Zn), copper (Cu), molybdenum (Mo) and selenium (Se).

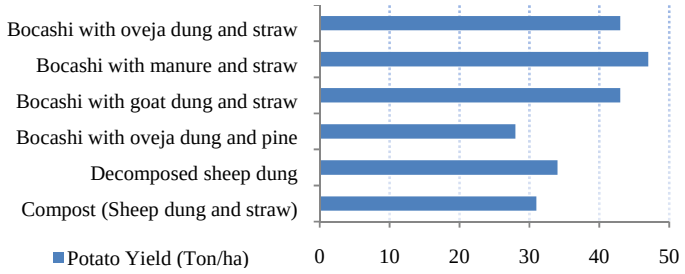
Materials Kg/Formulation Concentration (EM)[24]		*Formulation 1 (B1)*	*Formulation 2 (B2)*	*Formulation 3 (B3)*
Potato crop stubble		0	50	0
Quinoa crop stubble		50	0	0
Forages crop stubble		0	0	50
Cattle manure		30	30	30
Bran		15	15	15
Molasses		3.5	3.5	3.5
Yeast		1.5	1.5	1.5
Phosphate rock		3	3	3
Carbon		2	2	2
Manure (chicken)		15	15	15
Activate EM	Pure water chlorine free	36 liters	36 liters	36 liters
	EM solution	0,72 liters	0,72 liters	0,72 liters
	Molasses	0,72 liters	0,72 liters	0,72 liters
Time of elaboration		27	25	21
TOTAL WEIGHT		120 kg	120 kg	120 kg

Source: Cahui Churata pg. 2

The research concluded that the best nutrients for the soil are presented in the formulation 3 (B3), which includes forages in the preparation. This formulation also required the least time to prepare (21 days).

The quinoa varieties in which the fertilizer was tested are: Salcedo INIA, Pasankalla, Negra Collana, Blanca de Juli, and Illpa INIA. The study concludes that the variety of best response is the quinoa Pasankalla combined with the formulation 3 (B3). However, there is no conclusion yet about the average increase of the quinoa yields in this study.

The following graph summarizes the yield obtained of the application of different kinds of organic fertilizer in potatoes production that could be comparable:



Source: PROMIC. Potato yield as a result of the application of different organic fertilizers.

[24] EM refers to Microorganisms Efficacies from 0 to 100, as we explained in previous note; the minimum is Nitrogenous, Phosphorus, and Potassium.

C. Trade Gains and Illegal Trade

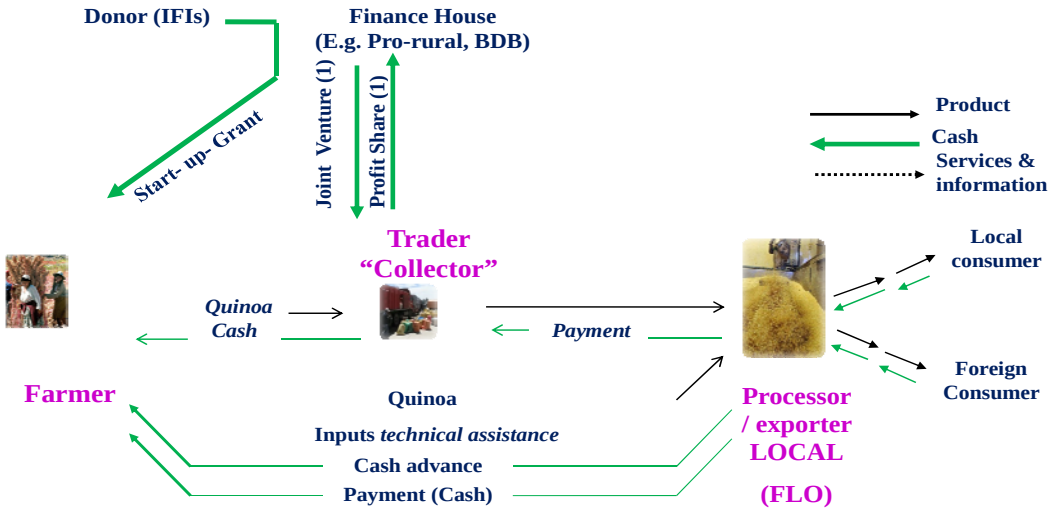
Another problem is the high degree of illegal trafficking of quinoa, because selling through formal government approved channels is not as profitable.[25] Quinoa farmers, who make up at least 40,000 households in Bolivia's Andean regions, earn their living through quinoa production. These farmers sell to associations (both exporters and producers) and middlemen who export quinoa, sometimes legally and sometimes otherwise. According to the Bolivian Institute of Foreign Trade, about 50% of the country's quinoa production is illegally trafficked to Peru. Although Oruro and Potosi are the richest provinces in terms of natural resources, (both minerals and quinoa), they are also the areas with the lowest Human Development Index (HDI) ratings, with an average of 0.558, which is significantly lower than the national level, which is 0.641 (see Annex 2, Table 1). Many producers are taking advantage of the "Zero Tariff" Agreement that allows for free trade between the Andean countries and results in Bolivian quinoa exports being passed off as Peruvian.[26] In other words, how a scheme of the business relationship between private firms and small producers in the quinoa industry in Bolivia linked rural farmers with international market benefits. The integration of the industry into the world market process resulted in an increasing challenge for resource poor farmers. Because demanding quality standards and potential competition (Alcala, 2009, p. 2)

Access to information and resources determine the ability of the stakeholders in the value chain to meet the world market requirements. The industry was relying on in an institutional framework liking the farmers to world market based on trust and a long relationship in order to reduce the transaction costs of access to those markets.

[25] (Brenes, et al., 2001)
[26] Andean Community Free Trade Agreement (Comunidad Andina de Naciones –CAN)

The value chain is supported by government offices, NGOs, international aid agencies, agencies for technical assistance, research and development, and export promotion, private organizations (issuers of certification), local and international transportation, and financial services. The quinoa cluster is formed by private companies and cooperatives or associations of farmers known as OECAs in Bolivia.[27] Until 1999 importers coordinated its supply chain through OECAs. Later, the expansion of the organic certification and the capital injection of new private companies in the agro-industry increased its interaction with private companies and they became key players in the supply chain (Alcala, 2009, p. 7).

Graph 6. Stakeholders in the Value Chain



Source: Prepared by the Author in base of the information of Royal Tropical Institute p.96.

The main actors of the value chain are integrated horizontally, they exchange products for cash. External stakeholders temporarily give financial support to the value chain, trying to integrate it vertically. IFIs provided startup grants to the farmers, and other financial institutions

[27] OECAs Economic Peasants Organization

tried to support the industry by establishing joint ventures with the traders, processors and exporters.

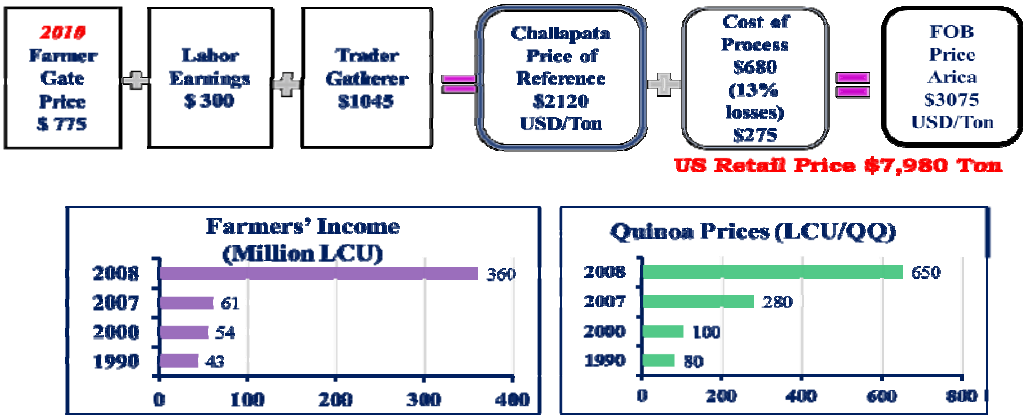
Fair Trade International initiated the price review for quinoa more than two years ago. The price review studies by Fair Trade Label Origen (FLO) were miscarried, being conducted without fully considering the environmental and social sustainability dimensions, two mainstays in fair-trade systems. Taking into consideration the stakes related, however, is complex in terms of standards. The stakes at the root level of the quinoa production chain are numerous, and refer to diverse themes such as food safety, agro-ecology, and land distribution. Considering the environmental stakes, the quinoa production chain is a pilot for the FLO system.

FLO established that the current demand on the quinoa market is such that integrating terms of reference promoting sustainable cultural practices is more of a burden than a benefit for quinoa producers. In order to be efficient, the initiative needs to be addressed at the community level, and needs to have a collective dimension and community approval.

D. ***Income Shares for Farmers.***

In the value chain, the farmer gate price represents US$775 per ton. Adding their labor earnings and share for the traders, we get the market price of quinoa in Challapata, where most of the crop is commercialized and prices are determined every week. Later, we add the cost of processing and 13% losses and we get the Free on Board Price that is 3 thousand dollars per ton. The retail price to foreign consumers is doubled, at $3.99 per pound (about $7,980/ton). Of that $1.10 goes to the farmers. It costs $0.25 to clean, $0.15 in freight and customs from Bolivia, $0.03 in quality control, and $0.80 in packaging. That leaves a 40% margin to be split between processing plant, importer, distributor and wholesaler.

Graph 7. Income Shares in the Quinoa Cluster



Source: Prepared by the Author in base to PAUTAPO, Andean Naturals Inc. & Ministry of Planning

It is a coincidence that quinoa grows where the poorest inhabitants of the country live. This represents a great opportunity for regional development. The farmers' income increased six times over between to 2007 to 2008, and the farmers' gate price more than doubled in just one year. The following tables show the detailed price calculation as an example:

Inputs (variables)	
Land Cultivated in Hectares	500
Yield Per Hectare in Metric Ton	0.75
Yield Per Hectare in Quintales (hundred weight)	16.53
Exchange rate (Bs/USD)	7.07
Farm Gate Price for Quinoa (Challapata Reference) 680 Bs per QQ	962
Workers needed per Hectare (3 months/year)	1.1
Labor Cost per person per year ($100*3)	300
Total Product harvested and sold (in MT/year)	375
Income Statement for Farm Product Sold per ha.	**1,590**

FOB Price Calculation (Per MT):	
Production Plant Processing Costs + profit margin	
Processing Plant (estimated amount that the processing plant charges for cleaning quinoa)	680
Raw Material Costs (Quinoa +13% loss)	2,395
Processing Plant A FOB Price (USD)	3,075

Costs per ha.	
Land Preparation (tractors rentals, diesel)	50
Planting (tractors renatls, diesel, seeds)	70
Harvest and Threshing/sifting (tractors rentals, diesel)	50
Cost of Capital	21
Technical Assistance (Agronomist)	9
Technical assistance, equipment (includes fertilizer and threshing equipment rental)	159
Total Costs	**360**
Gross Income	***1,230***
Labor Cost	330
Taxes (3%)	48
Net Income	853

Net income Per Farmer per year	775
Net income per farmer per month incl. labor earnings	1,075
Equivalent pro-rate per month earnings	90
Cost per MT	479
Cost per MT with labor	919
Cost per MT with labor and taxes	983
Challapata Reference Price	2,120
Estimated Profit per MT	1,137

Source: Data prepared by Andean Naturals, Inc. (USA) Jacha Inti Industrial S.A. & Cooperativa Ventilla (Bolivia).

E. Tradable supply

It is possible to conduct a sensitivity analysis and as a result, we can conclude the following:

When the price rises by $38 USD per ton, the quantity supplied increases by 1,914 tons on average. In 2009, the price rose by $768 USD and the exports rose 4,066 tons. On the demand side, in 2008 when the price rose up to $980 USD (the highest increase), and the quantity demanded fell by 145 tons.

We can use the old price and the old quantity exported to calculate the elasticity of supply. When the prices change from $3,029 USD to $3,002 USD and the quantity changes from 15,402 to 14,376 tons per year, we get an elasticity of 7.41. When we calculated the elasticity using the average price and average quantity, we get an elasticity of 1.29.[28] Thus we

[28] For further explanation about the formula and calculation of elasticity see Taylor 2010, pg.95.

can compute the elasticity of supply in different parts of the curve, and we can get different values.

We can extract some conclusions from this exercise, namely that the market of quinoa allows gradual increases year by year, but it reacts negatively to huge increases of prices, like in 2008, when the price increased by $980. However, a year later, the price went back down, and in 2010 the price slightly increased by $27 USD per ton. We can conclude that there is space for increases in prices of quinoa exports, according to the review of these numbers. However, the demand side will react adversely to huge price increases (Table 9 in the Annex presents the calculations of the elasticity).

3. Analysis

The increase in demand has resulted in a radical increase in the income of the producers of the mountainous zone, among the poorest and most neglected in the country, giving them an opportunity for a dignified and productive employment, and also preventing their systematic reliance on migration to improve their situation.

3.1 Problem Statement

The strong increase in the demand for quinoa has had an extremely important impact, mainly in the transformation of the traditional agricultural practices and the management of the land. All this has resulted in the degradation of the environment, and has produced an excessive exploitation of soils, leading to great erosion.

Therefore, the present issue of the quinoa in Bolivia becomes an environmental concern, and a social concern. The production of quinoa at the moment is the only source of income for many inhabitants of the mountainous zone, where other productive options are practically

nonexistent. This situation has moved the producers to extend the area of their crops, grow more intensively, descend to the less fertile lower lands or "Pampas", and use mechanization, among many other things, in order to assure their livelihood and to improve their income.

The traditional technology of quinoa production was conceived in order to respect the adequate land cycles of restoration. However, an agricultural system with intensive extraction of natural resources could cause two severe problems: i) environmental damage, ii) social conflicts.[29]

This analysis seeks to understand the economic processes behind quinoa production in order to achieve better productivity and competitiveness of the industry, especially in the three steps of the value chain: production, transformation, and commercialization.

3.1.1 Problem Definition

The expanded growth of the quinoa industry represents for Bolivia both a great opportunity and a serious threat. The high prices and worldwide demand have put tremendous pressure on production, and this pressure has encouraged poor environmental practices, as well as illicit exports and lowered the local consumption of the grain. On the opportunity side, there is a chance for Bolivia to make several important gains: a stronger national economy, a sustainable agricultural industry in one of the country's poorest regions and increased nutrition among all citizens, but especially the poor.

To mitigate the risks of environmental damage and the effects of illicit trade on the national economy, while taking advantage of the opportunities for building a sustainable industry and better nutrition, new interventions and new policies need to be implemented in close coordination with all the actors of the industry.

[29] (Pacheco Zamorano, 2004 p. 23)

3.1.2 The clients.

The direct clients of the project are the farmers located in the southwestern portion of Potosí, represented by the National Association of Quinoa Producers, ANAPQUI.[30]

> *"ANAPQUI was constituted December 3, 1983, as a result of the first congress of quinoa producers held at the headquarters of their factory in the city of La Paz…"*

The secondary clients are the Departmental Chamber of Quinoa (CADEQUIR), located in Potosi, and the Bolivian Chamber of Quinoa Royal and Organic Products Exporters (CABOLQUI). Both groups are interested in developing the quinoa industry in a sustainable way, and can lobby for policies that might be beneficial for the sector.
The third sets of clients are the Ministries of Environment, Rural Development and Land. These clients were chosen because both are involved in the supply and value chain development of quinoa products, as well as their marketing and exporting efforts.

3.1.2 Main Stakeholders

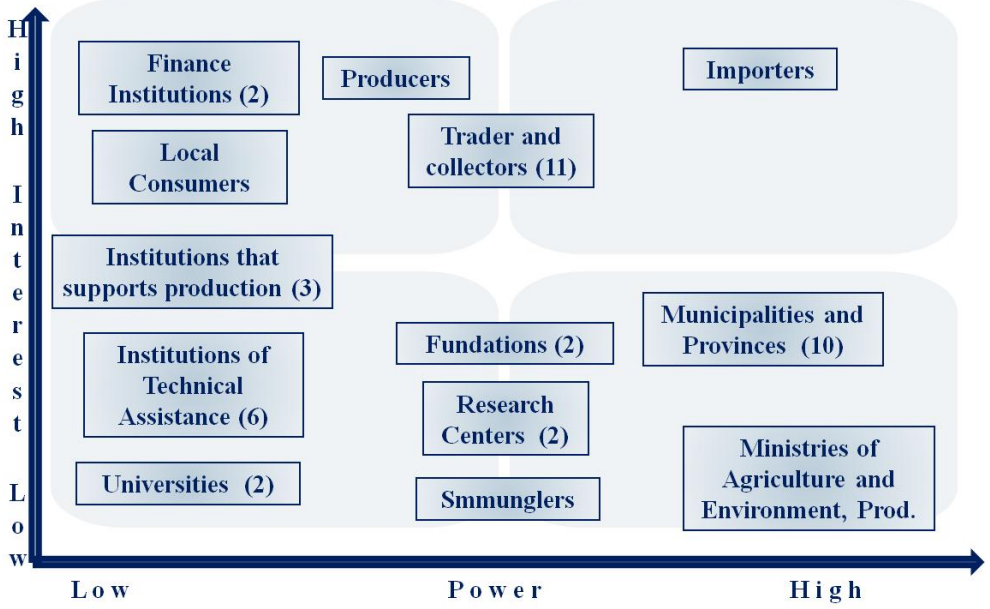
The stakeholders analysis shows that there are several stakeholders involved in the industry but most of them are external stakeholders. In parenthesis are the numbers of institutions that are concerned with the industry and need to address the issues.

It is required to redefine the role of the stakeholders as well as to improve the coordination among them. For example informal traders should integrate the formal economy. Local governments need to improve their role as coordinators among governments and actors of the value chain. The producers and traders need to take more active role regarding to foreign

[30] http://www.anapqui.org.bo/eng/anapqui.php

markets as well as address the environmental issue. Finally the local consumers need to be aware of the nutritional issues.

Graph 8. Number of Stakeholders in the Quinoa Cluster according their Nature



Source: Prepared by the Author

The list of stakeholders could be found in the Annex 6 at the end of this document (this follows from the CABOLQUI charter), but it is possible group them by their nature as follows:

Public Sector

The Bolivian Government has begun to prioritize, at different levels the issue of the quinoa and developed a Plan of Sustainable Management that goes beyond the concept of the Productive Chain of the Quinoa, which was used in the past. It considers demographic, economic and essentially environmental aspects. It is based on all the elements that comprise the Productive Integral Complex of the southern plateau such as the relation with the ecosystem of the production zones (camelids, native vegetation), the environmental and territorial management,

the power and hydrological resources, the availability of road and services infrastructure, the native indigenous communitarian structures, etc. All these elements should be included in all the policies and actions to support the production of quinoa, camelids, minerals and the development of tourism. The plan is a white paper that still needs to be put into practical application.

Ministry of Rural Development and Land (MDRT)

The MDRT is the ministry which is the leading institution of sector with regards to the production of the quinoa and therefore it has a fundamental role in setting the norms and planning the development of the sector. The most significant achievement with regards to a sustainable agricultural production is the Regulation and Promotion of the Organic Agricultural and No Timber Forestry Production (Law 3525). The objective of this law is regulating, promoting and strengthening the development of organic agricultural and no timber forestry production. Also the processes of production, transformation, industrialization and commercialization should not cause any negative impact or damage to the environment. This Law is important for the organic certification of quinoa. However, it has not prevented recurrent phenomena of environmental degradation linked to the production of the quinoa.

The MDRT is also in charge of the formulation and implementation of a National Policy for the Quinoa. This initiative arises as an answer to the concern of the organized groups of producers, especially from the National Committee of Competitiveness and Productivity for the Quinoa (CONACOPROQ), the Program of Support to the Quinoa Chain and from the Ministry.

Technological Innovation and inter-institutional coordination

In response to the importance that the quinoa has acquired in the governmental agencies and the subsequent environmental preoccupation in relation to the Southern Plateau, the Quinoa Cluster emerges within the philosophy of the Bolivian System for Innovation from the Vice

Ministry of Science and Technology. Its objective is to respond to the need of constituting a coordinating axis between the governmental sector (Ministries, Prefectures and Municipalities); the sector that generates the knowledge and the demanding sector.[31]

Local Governments - Planning

From year 2006 to year 2007, the Program of Support to the Southern Plateau Quinoa Chain, executed by the AUTAPO Foundation (FAUTAPO) and the Universidad Técnica de Oruro (Technical University of Oruro) did a study in the Southern Plateau that shows the main physical chemical characteristics of the soils of the region. This initiative was completed in year 2008 with the development of a Plan of Management of Soils for the quinoa producing area. This initiative was structured around the 11 producing Municipalities of quinoa of the Southern Plateau.[32] The methodology used was participative and the work covered the phases of diagnosis and planning and included the different stakeholders that are involved: representatives of organizations of producers, municipal and communal authorities, representatives of the Prefectures, Ministry of Rural Development and Land, NGOs, foundations, universities and organic production and export companies. This initiative have already budgeted resources in the Municipal Operational Action Plans since 2009 up to now. However there is small progress yet in the execution of the funds and the impacts has not measured.

Civil Society

There exist multiple initiatives in the quinoa sector carried out by the civil society. There is a significant support from NGOs like Agronomists and Veterinarians without Borders (AVSF) and AUTAPO foundation. Their work is described as follows:

[31] Universities, Institutes of Investigation: IIQ, IIDEPROQ, SELADIS, IIGEMA, National Herbarium. Foundations like: FAUTAPO, CPTS PROINPA, ALTIPLANO, LAYSAA, ANAPQUI, CECAOT, CABOLQUI, AOPEB, CONACOPROQ and others.

[32] In Oruro they worked in: Huari, Quillacas, Salinas de Garci Mendoza and Pampa Aullagas; in Potosí they worked in: Uyuni, Colcha K, San Pedro de Quemes, Tahua, Llica, San Agustín and San Pablo.

a) Communal normative and organization of the production

In 2001 AVSF started to support to the communities of farmers in the processes of reducing the degradation of the environment that is observed in the South Plateau region. The AVSF studied the individual practices of the mono cultivation of producers and the fertilization of the soil using their camelids manure. They found the disappearance or the weakening of the collective norms of management of the territory. Then, the work of AVSF in the zone has devoted a good part of its efforts to support the communities for the adjustment of the communitarian norms and rules of management of the territory so that they adapt better to the new socioeconomic and productive context of the zone and can overcome the degradation process. The norms are intended to contribute to guarantee a minimum rest of the soils, to limit the erosion of soils and to generate the proper conditions to foment cattle raising and so the use of animal fertilizers at the pampas.[33]

b) Center for the Promotion of Sustainable Technologies (CPTS)

The work of the CPTS begins with 5 diagnoses of clean production performed to quinoa processing companies during the period from 2001 to 2003. Based on this work the CPTS identified two main constraints to the massive development of the internal and external quinoa market; i) the lack of the proper technology for the sowing, harvest, trashing and cleaning of the raw grain, ii) the lack of the proper technology for the processing of the raw grain.

The work started with the development of technology of a cleaner production for the processing of the quinoa in such way that the companies and associations could respond to a constantly growing demand for processed quinoa grain. This work began with the development of prototypes for all the machinery needed for the processing of the raw grain in the plant of the company Andean Valley SA. At the present moment, this technology, 100 % made in Bolivia,

[33] www.avsf.org

has been widely successful and has been installed in six of the main plants of quinoa processing of the country, expanding the national processing capacity up to 18,000 tons per year.

Later CPTS developed the technology for the production and the after harvest of the quinoa. The activities of the CPTS were framed within the *Project Quinoa Alliance* that results from a joint effort of private institutions, producers and the international aid of the Embassy of Denmark and USAID. The main partners of the project are ANAPQUI, CECAOT, CABOLQUI and the CPTS. The CPTS has developed a complete technological approach that extends from the preparation of a compost based on llama's dung, inoculants and mineral salts; the machinery required adapted to the soils of the production zone, the use of organic pesticides based on sapotin, and a process of soil recovery. The validation of the technology has been done in 6 Pilot Productive Units (PPU), distributed among the main stakeholders of the sector: ANAPQUI, CECAOT, CABOLQUI and the Producers' Chambers.[34]

c) Program of Support to the Quinoa Chain

From May 2005 to December 2008 was executed by the Foundation AUTAPO the Program of Support to the Quinoa Chain of the Southern Plateau with funds from the Netherlands Embassy. Its objective was to position Bolivia as the leader and main supplier of organic quinoa to the international market, within the framework of the "Plan to Strengthen the Quinoa Chain". The actions to strengthen the Value Chain were distributed among five components: Training; Technological Development; Promotion and Export; Finance and Coordination.

Just in the field of Technological Development the Program has worked in the areas of soil management, mechanization, plague control, harvest and after harvest, agro biodiversity and seeds, traditional local knowledge and diffusion of information. This was done with various

[34] www.cpts.org

strategic partners and through many projects. Some of them still continue and are in the process of implementation.

Among the multiple achievements of the Program in the field of Technological Development is the accomplishment of a Soil Study of the zone of production; the validation of the biological controllers in quinoa plagues, the constitution and consolidation of quinoa seed producers who have become the main actors in the conservation and distribution of the different ecotypes of Quinoa Real seeds; the rescue and systematization of more than 100 local and traditional techniques of ecological production of quinoa and the creation of a website as a platform to disseminate the information.

It is important to point that the quinoa Program has been conducted again in a second phase under the name of Productive Complex Program of Southern Plateau, Bolivia. The target group of the program is formed by producers of quinoa with the objective is to improve their quality of life by means of the sustainable production of the Organic Quinoa Real, and encouraging the national consumption and later the export of products with greater added value. The operation of the Program is established in closed collaboration, and with a basic principle of horizontality, between the Technical Committee and the facilitating organization. This Technical Committee is formed by representatives of all the stakeholders of the chain; producers, traders, exporters, governmental institutions, universities, etc.[35]

Producers and the Quinoa Industry

In recent years there has been an important process of organization of the stakeholders who directly participate in the sector, namely the producers, processors and exporters of quinoa in Bolivia. Thus, have been constituted; the State Chamber of producers of Quinoa Real of Potosi

[35] www.fundacionautapo.org

(CADEQUIR), the State Chamber of producers of Quinoa Real of Oruro (CADEPQUI-OR), the National Chamber of Producers of Quinoa, National Committee of Competitiveness and Productivity of Quinoa (CONACOPROQ), the Bolivian Chamber of Exporters of Quinoa (CABOLQUI).

The existence of these stakeholders has facilitated the coordination of the activities of the different institutional actors especially within the framework of the Technical Committee created by the Program for Support of the Quinoa Chain. This has generated a direct bridge between the producers, the different institutional instances and their actions. The various Chambers of producers have been extremely active especially in the different planning processes and mainly in the formulation of the National Policy of Quinoa.

With regards to the processing and exporters stakeholders (mainly ANAPQUI, CABOLQUI, and CECAOT), they are actually mainly concentrated in the work to generate a more sustainable production system. This is accomplished under the scheme of the Programs of Development of Suppliers with which the different associations and companies provide a series of services to their affiliates and partners. These services cover diverse areas that go from technical assistance in agricultural techniques to the access to investment capital.

3.1.3 Policy Alternatives

In order to address the above problems and provide potential solutions, this study seeks to address the issues related economic, social and environmental effects of high domestic prices and agricultural frontier expansion in the production areas of Potosi and Oruro.

Therefore the direct policies selected for addressing the problems mentioned above are described as follows:

Policy Option I. **Food Safety and Nutrition Policies**

- Increase the local consumption by disseminating knowledge about the nutritional value of quinoa and making it affordable to most vulnerable groups. This task must be done in coordination of the national government, local governments, and the nutrition program Malnutrition Zero Program.
- Target subsidies for most vulnerable groups could be adopted; quinoa should be part of government policies to ensure the consumption levels of local consumers. (Quinoa Law approved March 15,2011)
- The Ministry of Productive Development and Ministry of Rural Development in coordination with Ministry of Health should integrate partially the industry into food safety and regional development policies.

The idea is increase the local consumption by making quinoa affordable to domestic consumers; this can be done through subsidies to most vulnerable groups like school feeding of children and pregnant women among others. This should be addressed by the government in coordination between the ministry of agriculture and health.

Policy Option II. **Environmental Policies in support of Organic Production**

The second policy regarding to the sustainability of the production, requires increasing the production by increasing the yield rather than expanding the agricultural frontier. This can be done by adopting the best formulation of organic fertilizers that fits the variety of quinoa. Also, producers need to respect the rotation period of the land in order to avoid the desertification of the soil.

- Research and adoption of Organic Fertilizers and search for optimal formulations with Royal Quinoa variety that is produce in the buffer area of Uyuni Salt Flat. Universities

are already implementing fertilizer studies in Peru and Bolivia as well. However the ANAPQUI and other producers' organization have to appropriate the technology that would be developed.

- Increase the production by improving the yield. Producers should invest in land preparation. The government should provide extension services and training in land management respecting the appropriate rotation period
- Maintain the high quality of the product and branding. Up to now the traders have played an important role in branding Royal Quinoa, but more active government support is needed for branding.

***Policy Option III*. Trade Policies and Improving the Business Environment**

This part of the policy package relates to trade and business environment, consisting in improving the trade regime by facilitating exports; reducing transaction costs by reducing the bureaucracy in diligences, and corruption. This should include renegotiating the trade agreements with the main buyers.

- Smart trade policies with US, EU; Origin certification could help as a solution of the problem of contraband, the government rather to put barriers to the trade should concentrate efforts in development of patents and high quality certifications.
- Improve trade regime and facilitation of exports. Instead of treating the quinoa as a commodity the crop should be treated as special product, making a campaign for branding quinoa as the case of Juan Valdez in Colombia where the government financed a campaign for promoting the coffee brand as a unique in the world.
- Improve infrastructure and cross border flows to reduce the high transaction cost.

4. Evaluation of the Alternatives

4.1 Criteria for Ranking of Alternatives

The criteria for ranking the alternatives were constructed according to their administrative cost and feasibility, the following table summarizes the options:

Criteria/Weight	**Policy 1** ***Food Safety***	**Policy 2** ***Environmental Policy***	**Policy 3** ***Trade***	**Optimal Policy:** ***2+3+1***
Effectiveness 30%	12	20	20	16
Efficiency 30%	8	20	28	17
Political Feasibility 30%	20	20	12	16
Administrative Feasibility 10%	5	8	3	2
TOTAL SCORE	**45**	**68**	**63**	**50**
RANK:	**IV**	**I**	**II**	**III**

The criteria of policy alternatives as the table above shows are effectiveness in order to achieve the goals that the policy tries to implement. Then applying environmental management to the soil is very likely to the yields increase at the desire level in order to increase the productivity of the land. But at the same time is true that the land issues should be taking into account with coordination among the actors. Regarding to trade policies the improvement of the overall trade

environment seems to have greater results as an indirect intervention in all the industries not just in the quinoa industry.

As the market is demand driven and this is very attractive for the Bolivian side at highest prices, then the markets are performing in an efficient way. In addition the cost of the quality and organic nature makes conventional quinoa become economically expensive and the cost of targeting subsidies in kind increases as well reducing the efficiency of the policies.

The optimal policy is implementing a combination of the three policies together, because they are designed as specific for addressing each one of the problems in the quinoa market. The ranking and priority would correspond to environmental policy followed by trade policy.

4.2 Description of Recommended Alternative

The best policy is implementing the three policies together, in order to do that the following strategy could be followed:

1. ANAPQUI should implement more environmental management practices. Increase the production by increasing the yield instead of expanding the agricultural surface. R&D about organic fertilizers and land management.
2. The government needs to improve the business environment as well as the trade conditions and infrastructure.
3. The government: Support local nutrition by providing subsidized quinoa to target groups. E.g. school feeding, elderly people and previous consumers that cannot afford as before.

In my recommendations the producers and traders should implement with public support more and better environmental practices in the production processes. The government needs to support the local consumption by targeting the most vulnerable groups. In addition, the government needs to improve the trade conditions and business environment.

4.3 Outline of Implementation Strategy

The implementation strategy, ANAPQUI in partnership with the actors of the VC and external support develop a R&D project in order to recommend the best formulation of inputs and outputs, the government develop a project of target subsidies for vulnerable groups, and finally the government implement the mechanism against smuggling by making transactions more transparent and less onerous.

Some event, called the “Day of Quinoa in Bolivia” plus a well organized workshop with the participation of main stakeholders, a well designed agenda and the input of experts and representatives of farmers, could trigger the formation of an action plan and alliance to start with some of the recommended policy changes and priorities for action..

1. ANAPQUI contracts R&D institutions that recommend the best organic fertilizer and land management that improves the yield and disseminates these practices it among producers.
2. The Ministry of Agriculture, Productive Development, Ministry of Heath, and Ministry of Environment coordinate their policies regarding the domestic market, production and environment in relation to Quinoa.
3. The government implement the Quinoa Promotion Plan (2011) and mechanisms against smuggling by making transactions more transparent and formal.

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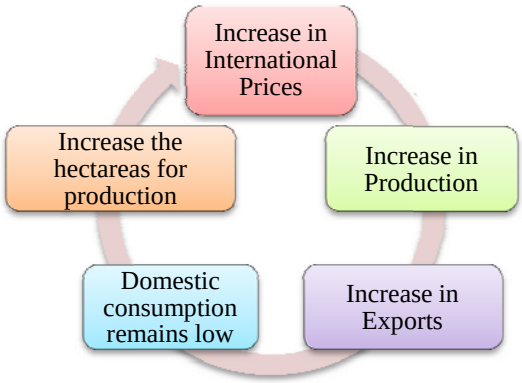
6. Acronyms

- AOPEB: National Association of Bolivian Ecological Producers
- CABOLQUI: Bolivian Chamber of Exporters of Quinoa and Organic Products
- CADEQUIR: State Chamber of producers of Quinoa Real of Potosi
- CADEPQUI-OR: State Chamber of producers of Quinoa Real – Oruro
- CECAOT: Farmers' Central Organization Operation Land
- CONACOPROQ: National Committee for the Competitivenes and Productivity of the Quinoa
- CPTS: Central Organization for the Promotion of Sustainable Technologies
- PROINPA: Foundation for the Promotion and investigation of Andean products
- AUTAPO: AUTAPO Foundation
- IIQ: Institute of Chemical Research
- IIDEPROQ: Institute of Research and Development of Chemical Processes
- MDRT: Ministry of Rural Development and Land
- SELADIS: Servicies in laboratories for diagnosis and health research
- SENASAG: National Service of Agricultural and Food Safety
- SIGEMA: System of Information of Environmental Management
- UTO: Technical University of Oruro
- VCyT: Vice Ministry of Science and Technology

ANNEX 1 CHARTS.

CHART 1. PROBLEM DEFINITION



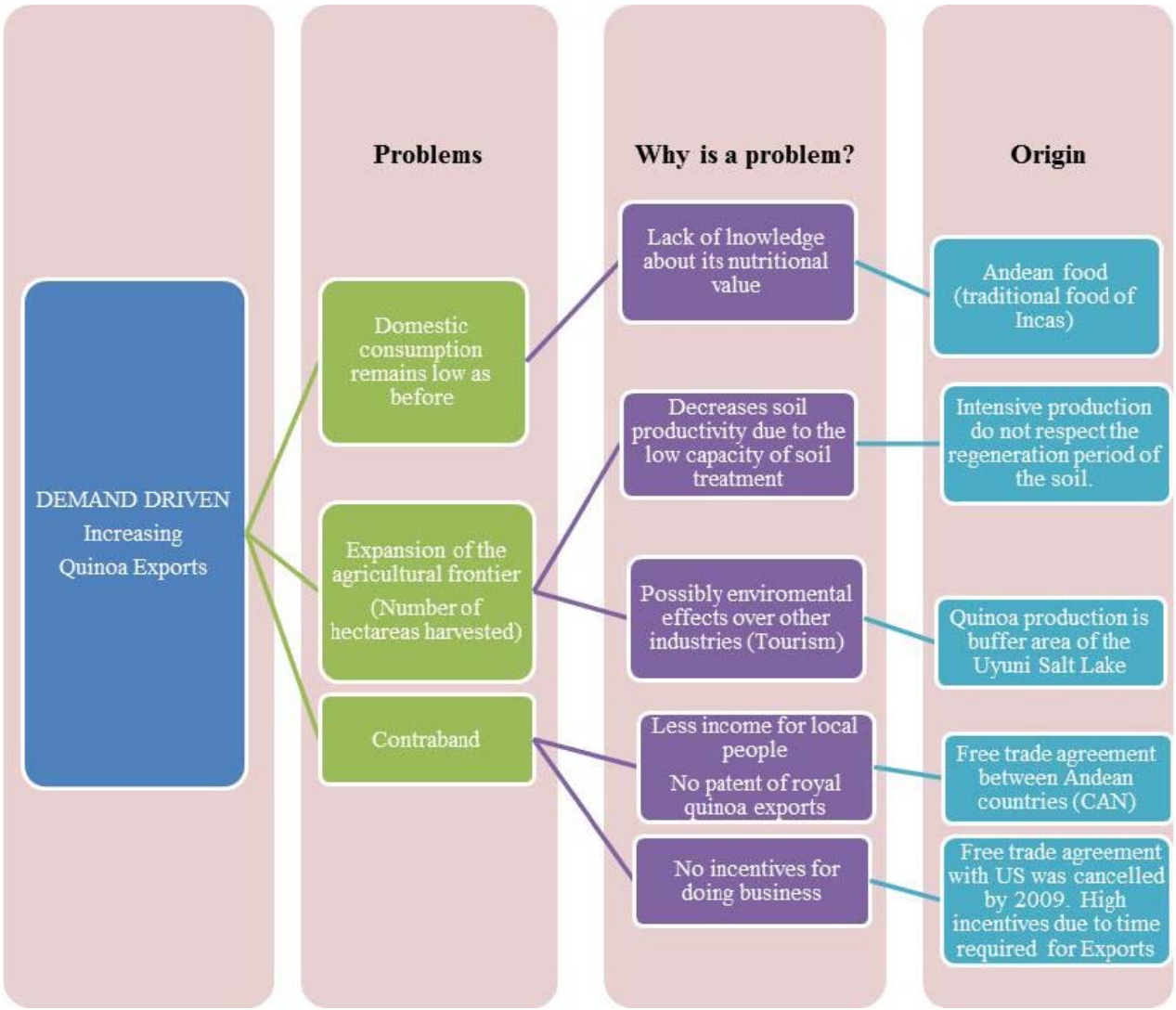


CHART 2. Quinoa Value Chain

ANNEX 2 TABLES.

TABLE 1. Municipal Social Development Indicators

Regional Development Indicators			Life Exp. Years	Literacy rate (% > 15 years)	Aver. school years	Enrollment at school (%)	Consumption per-capita (USD/year)	Inequality Index	Consumption Index (adjusted GDP)	HDI
Rank (314)	**Dep(*)**	**Municipality**								
45	P	Uyuni	61.8	86.9	6.8	92	1,126	0.299	0.49	0.627
53	P	Llica	62.4	96.8	8.6	94	639	0.216	0.38	0.620
108	P	San Pedro de Quemes	61.8	92.7	7.7	65	634	0.174	0.37	0.580
188	P	Colcha "K"	57.0	87.2	5.9	74	601	0.239	0.36	0.539
203	P	San Agustín	58.5	87.7	5.5	74	458	0.168	0.31	0.527
206	P	Tahua	55.4	92.0	7.1	59	550	0.181	0.34	0.526
217	O	Santiago de Huari	58.3	77.6	4.6	66	641	0.164	0.38	0.520
224	O	Salinas de García Mendoza	54.7	89.9	5.9	54	642	0.252	0.38	0.519
243	O	Pampa Aullagas	58.1	82.5	4.9	45	591	0.181	0.36	0.506
249	O	Santuario de Quillacas	48.9	83.7	5.2	73	746	0.193	0.41	0.498
261	P	San Pablo de Lípez	53.4	83.2	4.6	68	467	0.180	0.31	0.483
		BOLIVIA	***63.3***	***86.72***	***7.43***	***76***	***1,417***	***0.442***	***0.54***	***0.641***

(*) P = Potosi, O = Oruro

Prepared by the Author. Source: Bolivia National Statistics Bureau (INE Spanish)

TABLE 2. Bolivia Quinoa Exports and Value

Year	Quantity Expors (Net Tons)	FOB Value (Million USD)
1999	2,030.19	2.73
2000	1,431.34	1.80
2001	2,123.33	2.41
2002	2,019.34	2.33
2003	2,801.61	3.09
2004	3,867.89	4.41
2005	4,826.09	5.57
2006	7,645.19	8.91
2007	10,455.96	13.11
2008	10,310.92	23.03
2009	14,376.44	43.16
2010	15,401.57	46.65

Prepared by the Author. Source: Bolivia National Statistics Bureau (INE Spanish)

TABLE 3: QUINOA FOB PRICES	**Average Price**

	(USD/TM)
1989	790
1990	830
1991	900
1992	920
1993	1,020
1994	1,300
1995	1,250
1996	1,050
1997	1,210
1998	1,260
1999	1,343
2000	1,259
2001	1,136
2002	1,000
2003	1,530
2004	1,101
2005	1,139
2006	1,155
2007	1,166
2008	1,254
2009	2,233
2010	3,002
2011	3,029

Prepared by the Author, based on INE. Nandina Registers. Prices correspond to FOB Prices in Arica port.

Table 4. Industry Shares

EMPRESA	Part.	Totales	EEUU	Francia	Holanda	Alemania	Canadá	Brasil	Israel	Chile	RU	Australia	Argentina	Otros
IRUPANA ANDEAN ORGANIC FOOD S.A.	18,73%	1682899	586051	40000	0	506500	28328	98003	257750	0	44050	25356	0	96861
ASOCNAL DE PRODUCTORES DE QUINUA	16,10%	1446831	196090	511678	96644	320129	0	96150	0	1000	70820	46621	0	107700
SAITE S.R.L.	13,25%	1190675	689031	0	240000	15000	69485	113859	0	0	2000	0	0	61300
QUINOA BOL S.R.L.	12,46%	1120000	180000	0	800000	0	140000	0	0	0	0	0	0	0
JATARY IMPORT EXPORT S.R.L.	8,96%	804910	0	804910	0	0	0	0	0	0	0	0	0	0
ANDEAN VALLEY S.A.	8,87%	797232	703232	0	0	0	0	0	0	6000	0	0	0	88000
QUINOA FOODS COMPANY S.R.L.	5,74%	516104	516104	0	0	0	0	0	0	0	0	0	0	0
CENT. COOP. AGROP. OPERA CONTIERRA	2,54%	228170	0	20000	84000	40000	66000	0	0	18170	0	0	0	0
PROANBOL S.R.L.	1,94%	174566	114466	0	0	20100	40000	0	0	0	0	0	0	0
SONAPTO IMPORT EXPORT S.R.L.	1,58%	142000	20000	79000	0	0	0	23000	0	0	0	0	0	20000
COMRURAL XXI S.R.L.	1,56%	140000	0	0	60000	40000	40000	0	0	0	0	0	0	0
EXPORTERLAN	1,19%	106946	0	0	0	0	0	0	0	106946	0	0	0	0
EIPEA. S.R.L. EXPE.IMP.PRODECOLOGIC	1,07%	95875	19958	0	0	0	39917	0	0	0	0	20000	0	16000
PALACIOS ORTEGA ROSSIO	0,98%	88353	18000	0	0	22000	6282	13000	0	7000	0	0	0	22071
Otros	5,03%	451216	90079	20014	0	19116	39846	24851	33070	31023	20553	21100	105040	46525
Total mercado en Kg		8985777	3133011	1475602	1280644	982845	469857	368863	290820	170139	137423	113076	105040	458457
Total mercado en TM		8986	3133	1476	1281	983	470	369	291	170	137	113	105	458
Participaci–n mercado en total general			34,87%	16,42%	14,25%	10,94%	5,23%	4,10%	3,24%	1,89%	1,53%	1,26%	1,17%	5,10%
Participaci–n IAOFSA en mercado			18,71%	2,71%	0,00%	51,53%	6,03%	26,57%	88,63%	0,00%	32,05%	22,42%	0,00%	21,13%

Extracted from INPhO homepage: http://www.fao.org/inpho/

TABLE 5. Bolivia Quinoa Exports per State to Continent

		ORURO	ORURO	ORURO	ORURO	ORURO	ORURO
year	Measures	AFRICA	ASIA	EUROPA	NORTEAMÉRICA	OCEANIA	SUDAMÉRICA
1999	Peso Bruto (Kg.)		30.100,00	597.936,00	886.210,00		81.596,00
	Peso Neto (Kg.)		30.000,00	593.780,00	884.043,00		81.404,00
	Valor FOB ($us.)		41.500,00	836.407,00	1.186.261,00		65.450,00
2000	Peso Bruto (Kg.)		3.006,00	683.532,00	305.670,00		54.631,00
	Peso Neto (Kg.)		2.990,00	679.454,00	304.765,00		54.500,00
	Valor FOB ($us.)		3.501,00	925.848,00	361.275,00		55.451,00
2001	Peso Bruto (Kg.)		22.174,00	942.756,00	687.909,00		124.185,00
	Peso Neto (Kg.)		22.102,00	936.088,00	684.143,00		123.765,00
	Valor FOB ($us.)		28.316,00	1.178.287,00	736.935,00		105.405,00
2002	Peso Bruto (Kg.)		22.120,00	986.313,00	648.821,00		21.404,00
	Peso Neto (Kg.)		22.050,00	979.569,00	644.294,00		21.302,00
	Valor FOB ($us.)		24.313,00	1.223.006,00	686.271,00		16.059,00
2003	Peso Bruto (Kg.)		91.642,00	1.332.345,00	1.053.093,00		54.578,00
	Peso Neto (Kg.)		89.000,00	1.318.719,00	1.040.381,00		54.341,00
	Valor FOB ($us.)		94.507,00	1.619.260,00	1.057.104,00		23.592,00
2004	Peso Bruto (Kg.)		337.380,00	2.118.662,00	754.853,00	11.088,00	103.705,00
	Peso Neto (Kg.)		336.000,00	2.095.537,00	742.147,00	11.000,00	102.979,00
	Valor FOB ($us.)		435.253,00	2.514.833,00	790.483,00	11.640,00	53.499,00
2005	Peso Bruto (Kg.)		219.379,00	2.511.830,00	1.315.280,00	9.070,00	157.606,00
	Peso Neto (Kg.)		218.100,00	2.482.376,00	1.293.615,00	9.000,00	150.713,00
	Valor FOB ($us.)		249.618,00	3.067.279,00	1.414.725,00	9.831,00	121.043,00
2006	Peso Bruto (Kg.)		855.884,00	3.624.663,00	1.718.018,00	109.603,00	222.030,00
	Peso Neto (Kg.)		842.290,00	3.574.798,00	1.696.383,00	108.206,00	216.494,00
	Valor FOB ($us.)		881.103,00	4.383.483,00	1.926.540,00	134.874,00	206.592,00
2007	Peso Bruto (Kg.)	1.583,00	500.755,00	5.211.440,00	2.162.720,00	104.093,00	201.502,00
	Peso Neto (Kg.)	1.500,00	490.750,00	5.158.826,00	2.129.720,00	102.328,00	199.001,00
	Valor FOB ($us.)	1.800,00	567.582,00	6.523.175,00	2.675.124,00	136.030,00	167.264,00
2008	Peso Bruto (Kg.)	########	326.737,68	3.327.025,24	3.531.406,34	82.537,62	496.489,67
	Peso Neto (Kg.)	########	322.750,00	3.300.261,68	3.487.617,87	80.990,16	490.661,00
	Valor FOB ($us.)	########	541.978,27	6.802.477,29	8.572.834,51	180.322,44	850.742,33
2009	Peso Bruto (Kg.)	########	351.662,32	4.660.801,27	5.135.147,39	166.129,62	408.162,99
	Peso Neto (Kg.)	########	350.000,00	4.622.957,00	5.079.546,38	163.904,02	404.569,88
	Valor FOB ($us.)	########	1.061.310,00	13.921.202,82	15.300.697,23	537.847,96	1.015.664,59
2010	Peso Bruto (Kg.)		246.885,60	4.230.680,39	7.538.062,78	199.185,14	768.048,99
	Peso Neto (Kg.)		245.500,00	4.196.443,80	7.458.738,59	196.376,60	758.975,48
	Valor FOB ($us.)		714.303,00	12.540.999,21	22.946.539,38	713.462,48	1.927.288,79

Source: STATISTICS FROM NANDINA INE.
www.ine.gob.bo

		POTOSI	POTOSI	POTOSI	POTOSI	POTOSI
year	Measures	ASIA	EUROPA	NORTEAMÉRICA	OCEANIA	SUDAMÉRICA
1999	Peso Bruto (Kg.)	9.010,00	332.188,00	98.054,00		2.971,00
	Peso Neto (Kg.)	9.000,00	331.407,00	97.592,00		2.960,00
	Valor FOB ($us.)	13.050,00	443.802,00	139.200,00		773,00
2000	Peso Bruto (Kg.)		140.348,00	240.743,00		10.626,00
	Peso Neto (Kg.)		139.750,00	239.281,00		10.596,00
	Valor FOB ($us.)		160.300,00	292.300,00		3.209,00
2001	Peso Bruto (Kg.)		282.436,00	60.436,00		17.223,00
	Peso Neto (Kg.)		280.000,00	60.070,00		17.166,00
	Valor FOB ($us.)		290.758,00	64.307,00		7.332,00
2002	Peso Bruto (Kg.)		273.280,00	80.651,00		1.003,00
	Peso Neto (Kg.)		271.159,00	79.967,00		1.000,00
	Valor FOB ($us.)		290.097,00	88.465,00		182,00
2003	Peso Bruto (Kg.)		279.295,00	20.171,00		2.106,00
	Peso Neto (Kg.)		277.000,00	20.065,00		2.100,00
	Valor FOB ($us.)		271.025,00	19.600,00		285,00
2004	Peso Bruto (Kg.)	11.098,00	332.731,00	221.604,00		18.772,00
	Peso Neto (Kg.)	11.000,00	330.000,00	220.585,00		18.640,00
	Valor FOB ($us.)	12.980,00	360.080,00	215.600,00		13.777,00
2005	Peso Bruto (Kg.)	35.475,00	403.342,00	214.516,00		23.852,00
	Peso Neto (Kg.)	35.160,00	400.000,00	213.401,00		23.720,00
	Valor FOB ($us.)	42.638,00	438.156,00	211.571,00		18.446,00
2006	Peso Bruto (Kg.)	86.191,00	571.891,00	487.429,00	16.300,00	57.567,00
	Peso Neto (Kg.)	85.500,00	565.027,00	483.188,00	16.000,00	57.299,00
	Valor FOB ($us.)	88.720,00	700.976,00	510.382,00	19.200,00	59.177,00
2007	Peso Bruto (Kg.)	156.918,00	1.101.421,00	871.369,00	18.350,00	254.881,00
	Peso Neto (Kg.)	156.000,00	1.089.024,00	863.779,00	18.000,00	247.034,00
	Valor FOB ($us.)	162.406,00	1.514.953,00	1.038.528,00	22.236,00	298.156,00
2008	Peso Bruto (Kg.)	80.301,00	1.250.716,70	1.131.595,31	60.230,00	120.221,74
	Peso Neto (Kg.)	80.000,00	1.235.037,00	1.115.734,24	58.620,56	117.750,00
	Valor FOB ($us.)	179.944,00	2.764.061,70	2.699.362,46	146.337,30	259.261,20
2009	Peso Bruto (Kg.)	159.113,00	1.619.159,11	1.784.774,22	70.448,62	154.314,02
	Peso Neto (Kg.)	158.000,00	1.599.253,00	1.766.220,65	68.805,62	151.180,38
	Valor FOB ($us.)	483.331,00	4.937.895,35	5.280.782,91	217.584,48	365.503,71
2010	Peso Bruto (Kg.)	60.336,00	1.529.093,00	821.814,00	57.618,00	105.572,12
	Peso Neto (Kg.)	60.000,00	1.509.406,00	814.432,00	56.444,28	104.864,00
	Valor FOB ($us.)	180.208,00	4.713.664,55	2.514.817,72	171.613,00	223.871,20

Source: STATISTICS FROM NANDINA INE. www.ine.gob.bo

TABLE 6. Land Characteristics

Prov.	Municipality	Prodcution Indicators		Geography and Climate			
		Agricultural potential	Forestal potential	Highland a.s.l.	Rainfall (cm/year)	Droughts frequency/year	Ice cold days/year
Eduardo Avaroa	Santuario de Quillacas	Very low	Poor	3909	61.06	1 of 2	180-270
Sebastian Pagador	Santiago de Huari	Very low	Poor	4232	170.36	4 of 5	270-330
Ladislao Cabrera	Salinas de Mendoza	Very low	Poor	3674	165.63	4 of 5	270-330
	Pampa Aullagas	Very low	Poor	3730	159.9	4 of 5	270-330
Antonio Quijarro	Uyuni	Very low	Poor	3909	85.56	1 of 2	180-270
Daniel Campos	Llica	Limited	Limited	3694	23.14	1 of 2	270-330
	Tahua	Very low	Poor	3673	79.66	4 of 5	90-180
Nor Lipez	San Pedro de Quemes	Very low	Poor	4077	117.03	1 of 2	270-330
	Colcha "K"	Very low	Poor	3714	16.98	4 of 5	270-330
Sur Lipez	San Agustin	Limited	Low	4043	86.25	1 of 2	90-180
	San Pablo de Lipez	Very low	Poor	4590	69.04	4 of 5	270-330

Source: (Jaldin, 2010. p. 9)

TABLE 7. Quinoa Industry - Land Productivity

Year	Crop Surface (Has)	Yield (Kg/ha)	Production Tons
1,990	38,615	416	16,064
1,991	40,508	603	24,426
1,992	38,765	436	16,902
1,993	37,894	531	20,122
1,994	38,277	510	19,521
1,995	36,790	511	18,800
1,996	37,480	627	23,500
1,997	40,035	712	28,505
1,998	38,248	436	16,676
1,999	34,168	645	22,038
2,000	35,963	626	22,513
2,001	35,907	645	23,160
2,002	35,690	633	22,592
2,003	37,325	637	23,776
2,004	38,941	632	24,611
2,005	40,541	610	24,730
2,006	43,553	615	26,785
2,007	46,316	599	27,743
2,008	48,897	577	28,214
2,009	50,356	572	28,804
2,010	52,411	570	29,874

Source: Prepared by the Author in base of Ministry of Planning and Information

TABLE 8. Royal Quinoa Production Cycle

Climate and Agricultural Characteristics	2,500 -4,000 m.a.s.l.
	Rainfall: 150 and 300 mm/year
	Average temp. between 5 and 14 ºC. Winter Seasons 7 and 13 ºC.
Land Preparation	June and July: Cut, fertilized with manure from sheep and camelids.
	December and January: Fallow (manual plowing, machinery plowing)
	September and October: Sowing (Manual and machinery)
	February and March: "Cultural work" (weeding, spraying)
	March and April. Starting and drying (all manual)
	April and May. Hominy (manual and machinery)
Yields per hectare	500 to 600 Kg per ha. (Ideally 1500)
	Installed Capacity 1,200 tons / year
Processing	Used capacity 50% 600 tons / year

Source: Prepared by the Author in base of Ministry of Planning Information

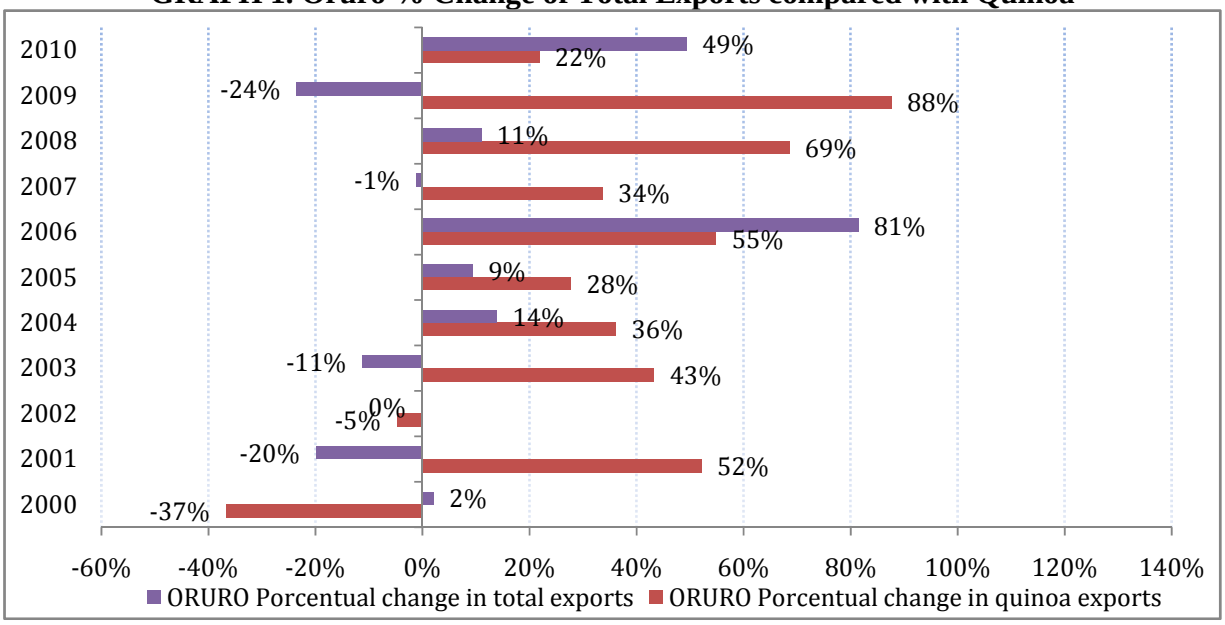
TABLE 9. ELASTICITY CALCULATION

ANOVA ANALYSIS **PRODUCTION TONS AND PRICES**		
	Coefficients	t Stat
Intercept	-6.80	-70.99
FOB Price	0.14	1.56
Net Quantity Exports (Tons)	0.00	1.40
Domestic Price	-0.14	-1.55
Crop Surface (Has)	0.99	104.64
Yield (Kg/ha)	0.99	269.24
Elasticity		
FOB prices	1.58	3.29

Source: Prepared by the Author

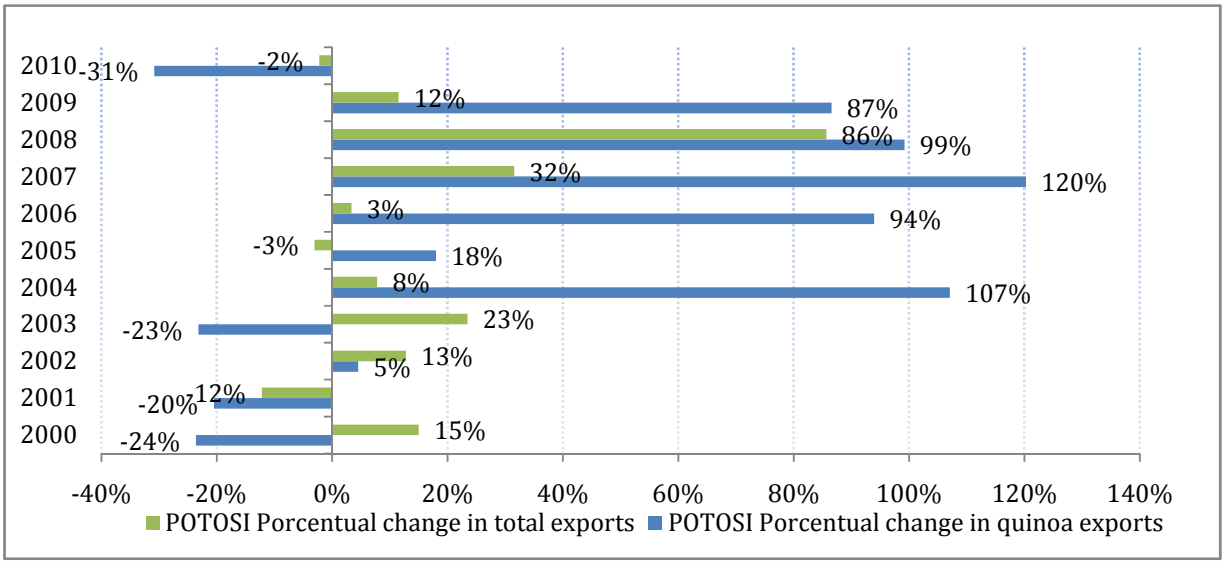
ANNEX 3 GRAPHS.

GRAPH 1. Oruro % Change of Total Exports compared with Quinoa



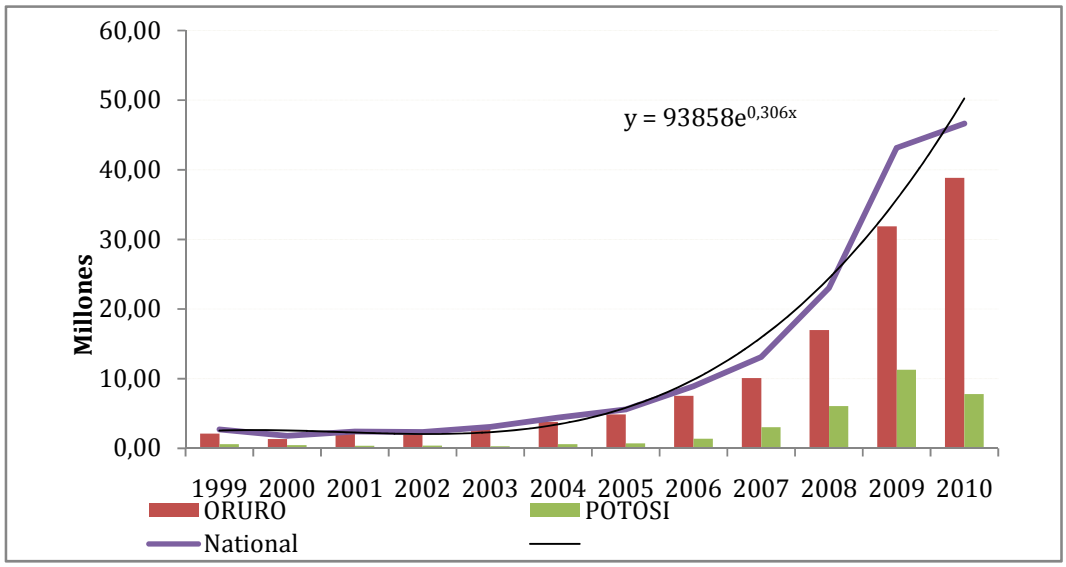
Prepared by the Author. Source: Bolivia National Statistics Bureau (INE Spanish)
http://www.ine.gob.bo/pdf/boletin/np_2010_7.pdf Accessed February 11, 2011

GRAPH2. Potosi %change of Total Exports compared with Quinoa



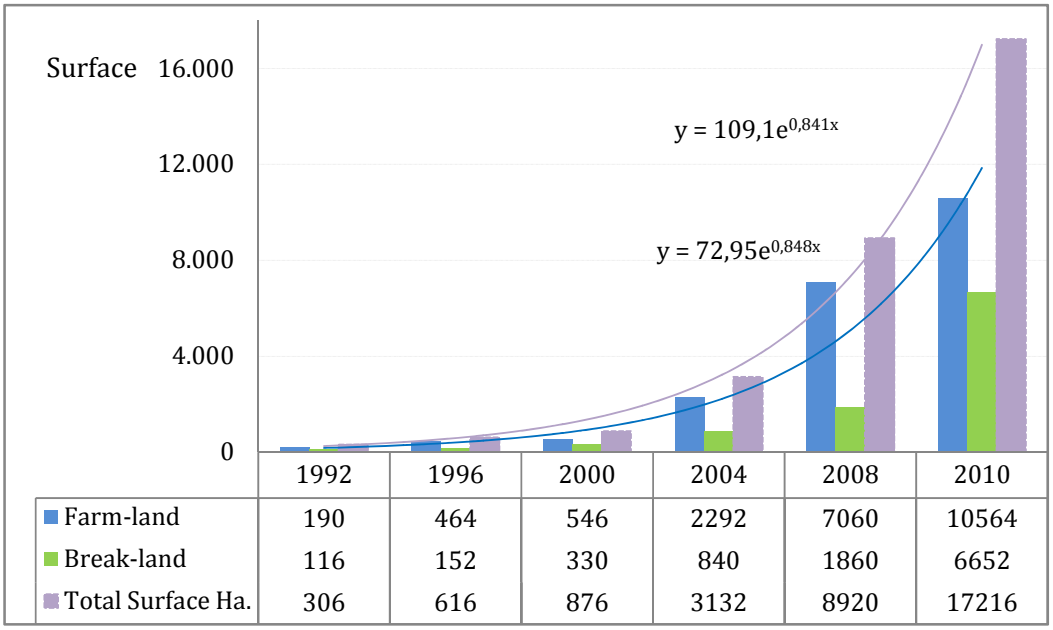
Prepared by the Author. Source: Bolivia National Statistics Bureau (INE Spanish)
http://www.ine.gob.bo/pdf/boletin/np_2010_7.pdf Accessed February 11, 2011

GRAPH 3. Value FOB of Quinoa Exports (Millions USD)



Prepared by the Author. Source: Bolivia National Statistics Bureau (INE Spanish)
http://www.ine.gob.bo/pdf/boletin/np_2010_7.pdf Accessed February 11, 2011

GRAPH 4. Expansion of Agricutural Frontier (Potosi -Ladisao Cabrera)

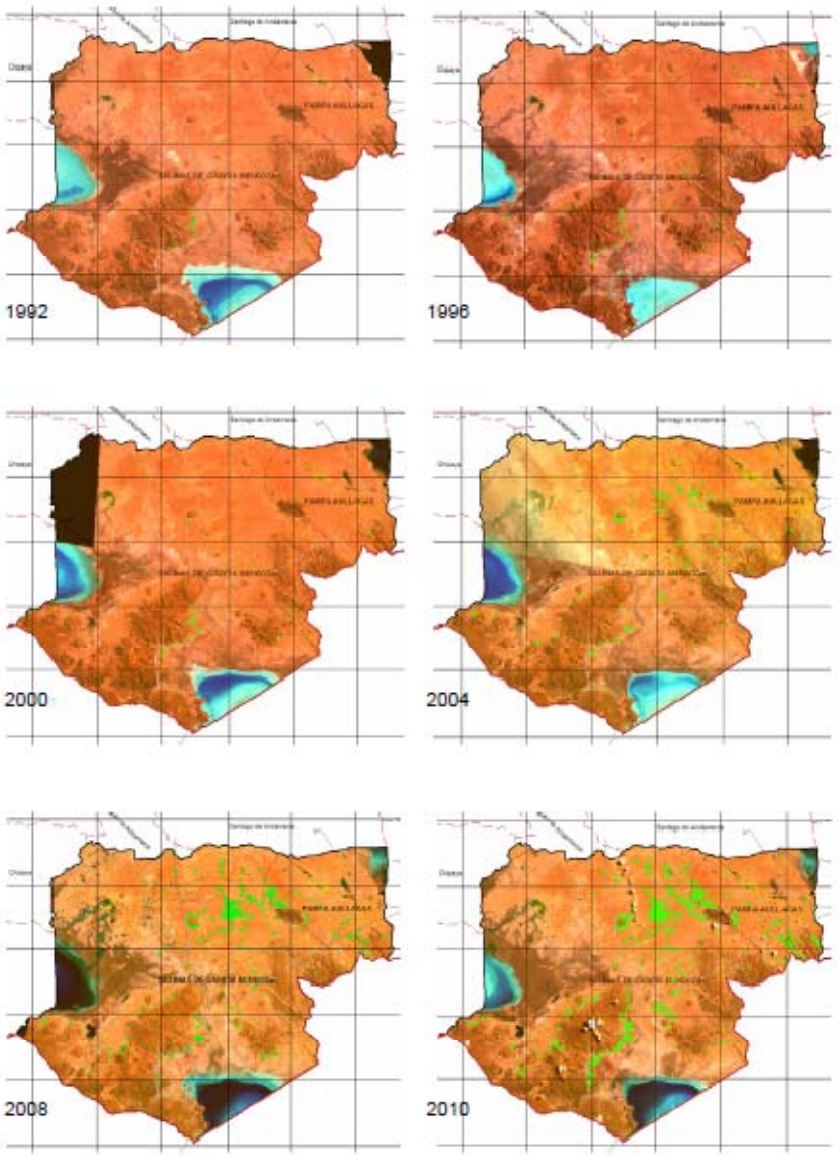


	1992	1996	2000	2004	2008	2010
Farm-land	190	464	546	2292	7060	10564
Break-land	116	152	330	840	1860	6652
Total Surface Ha.	306	616	876	3132	8920	17216

Source: EXTRACTED from Vallejos Mamani, 2011 (Programa de Investigacion Estrategica en Bolivia) http://www.pieb.com.bo/

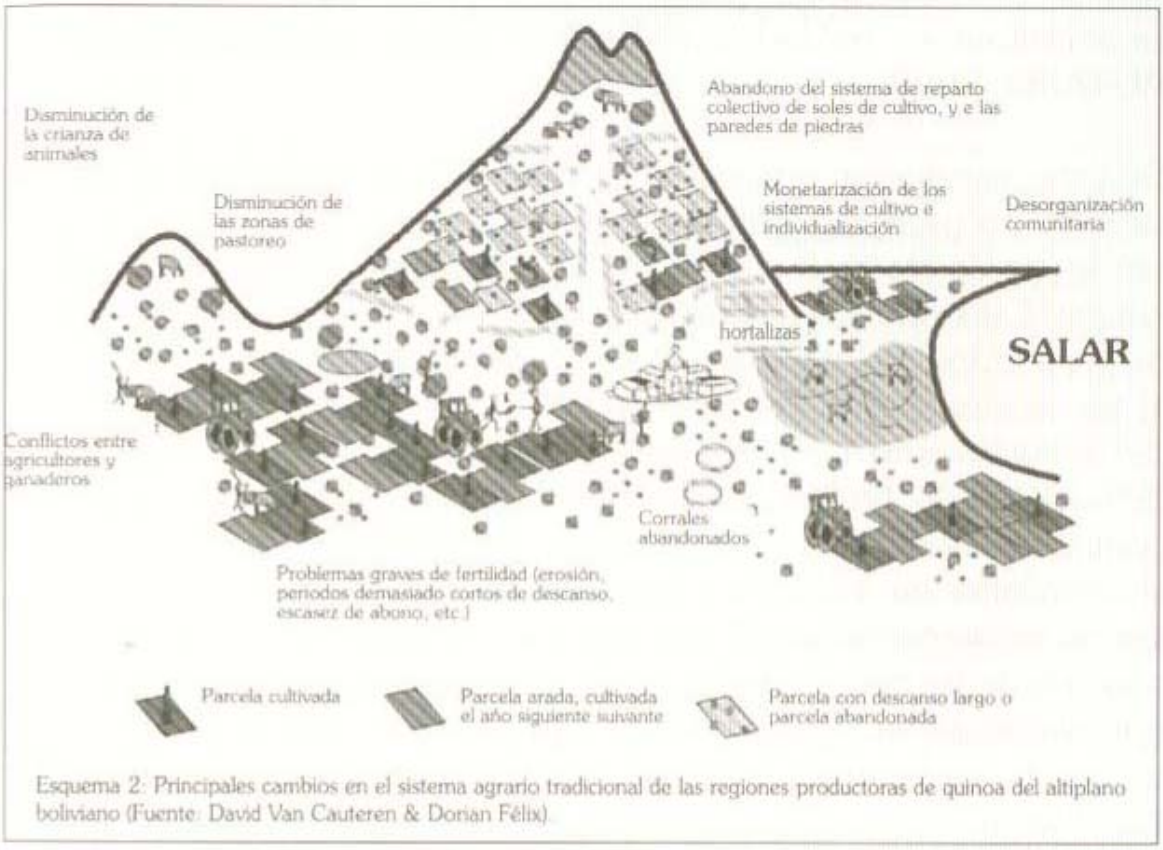
ANNEX 4 MAPS.

MAP 1. Agricultural Frontier Expansion in Ladislao Cabrera province Department of Potosi.



Source: EXTRACTED from Vallejos Mamani, Pedro, 2011 Page 14
(Programa de Investigacion Estrategica en Bolivia) http://www.pieb.com.bo/

MAP 2. Quinoa System in the Department of Potosi.



Esquema 2: Principales cambios en el sistema agrario tradicional de las regiones productoras de quinoa del altiplano boliviano (Fuente: David Van Cauteren & Dorian Félix)

Source: EXTRACTED from Jaldin 2010 Page 15
(Programa de Investigacion Estrategica en Bolivia) http://www.pieb.com.bo/

ANNEX 5: PROCESSES?.

Quinoa Production Processes. A year of life for quinoa: from field preparation to harvest and field cleaning.[36]

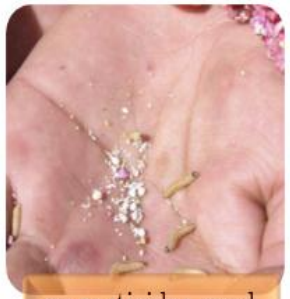
[36] Photo credits: Satellite Pictures - NASA, Google Earth. Mark Philbrick - Brigham Young University. Eric Bauer, one of the top Bolivian photographers. Brian Milder from EcoLogic Finance. French Development Research Institute (IRD). Website – Andean Nturals Inc. Courtesy of Sergio Nunez de Arco

Protection against frost

and against wind

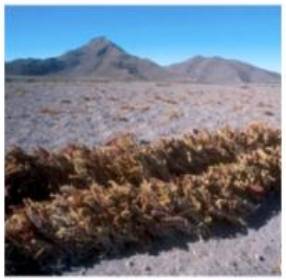
March are green
More color in April

Pests attack



no pesticides used against the worms

Harvest in May



Drying in May

Threshing with tractors

She's sifting quinoa to eat

"industrial" separation of seed and chaff