

Bolivia – Bolivian Highlands (Altiplano)

Project title: Managing sustainability of new quinoa production systems through farming systems management and market insertion

Case study site: Bolivian Highlands

Partner institution: Institute of Agricultural Research and Natural Resources of the Faculty of Agronomy, Universidad Mayor de San Andres

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Introduction

The present proposal refers to the application of the SUMAMAD project in the Bolivian Highlands. This area has the special particularity of being one of the few areas in the world where agriculture can be done above 3,500 m.a.s.l. thanks to its closeness to the equator. However, the aridity and fragility of the area pose particular challenges.

The Andean highlands are characterized by high poverty and a fragile ecosystem. Located at above 3,700 m.a.s.l., they are some of the very few areas in the world where agriculture is practiced at such high altitude. However, the highly variable climate and weather frustrates attempts of the rural families to accumulate assets and improve their living conditions. Periodic droughts and flooding as well as the occurrence of severe frost are characteristic of the climate of the highland and high plateau regions of Bolivia. Natural hazards undermine the attempts of many to improve their livelihoods. Families who lose the capacity to adjust to climate variability must temporarily migrate to the lowlands or to cities in order to survive. These adaptations threaten tropical forests, and add to the problems of cities. Since migration usually involves

young, active people, temporary migration may also undermine the ability of communities to recover after droughts and flooding because of the lack of labour.

Migration might also undermine the country food security since most staple food is locally produced. Few crops can be cultivated adequately under the harsh local conditions; one of these, Quinoa has been lately enhanced due to its highly nutritional profile both for export due to its high international prices and for national consumption given its high nutritional value. However, the previously traditional production, with slightly sustainable intercropping and livestock production are being highly disturbed by this new trend of exporting quinoa, due to a growing mono-cropping trend. A more intensive production is not well adapted to the environment. Although the problem is known, little is being done by government officials because little research has been done on the drivers and possible solutions.



Map of the Republic of Bolivia.

The circle shows the location of the highlands where quinoa is produced

Justification

Rainfall patterns and the high altitude of the Andes have always made agriculture in the region vulnerable to frosts, hail, droughts and floods. Being classified as semi-arid and arid areas,

farmers developed farming systems adapted to the harsh conditions which remained almost intact for the last centuries. Examples of the adaptation strategies are the local forecast using biophysical indicators, sustain biodiversity, risk spreading, integrated farming systems, etc. However these relatively stable systems are being highly disturbed by global change, namely changing climate and market conditions. Existing climate models predict that in the future there will be longer dry seasons and more frequent storm events. It is also expected that rain reception, although not expected to decrease, will be delayed with a consequent disruption of the traditional precipitation system. These patterns have been observed by farmers in the region as well. As a result, traditional crop rotations are being abandoned and the production strategies that have sustained populations for hundreds of years no longer function. Climate is not the only reason for these changes. Migration and the growth of a market economy have also made it more difficult to maintain traditional practices. Agro-ecosystems are becoming less diverse and more vulnerable to shocks. There has been a decline in the number of crops raised by farmers in the region as well as the number of varieties grown within farming communities and the changing towards the consumption of simple foods sacrificing the native crop consumption to put these products in the market. These changes have led to a decline in food security by reducing sources of protein available and increasing losses due to drought, frost, disease and pests.

A large part of the problem is the lack of proper evaluation and understanding of the reasons for the latest changes in the local production systems. Although climate is partly to be blamed, it is also true that social structures and economic development put pressure on the way how farmers decide about their future choices of how to manage their production systems. Unfortunately, some of the new production systems are not fully sustainable and not well adapted for the local conditions if some amendments are not carried out in the Bolivian highlands and if some agrobiodiversity is not maintained. This is the case for the newly adapted quinoa production systems which are cultivated more intensively than in the past, under much more pressure than before and with large tendency to present monocropping owing to the cash possibilities of the crop.

Apart from the environmental problems faced by farmers due to the reduced fallow periods and the more intensive use of land, market insertion and participation is also very poor, leaving the lowest gains coming from the quinoa commercialization to farmers with the largest part of the profits going to the intermediate parts of the chain.

This project proposes to address the above mentioned problems through *farming system conservation* and the *development of markets* for quinoa production, trying to look for locally integrated and technologically sustainable production systems. It seeks to increase the ability of quinoa producers in the Bolivian Andes to adapt to the changing climatic and economic conditions by supporting new technologies and amendments to their farming systems, especially related to maintain crop diversity and crop rotation. It also aims to strengthen local initiatives using participatory approaches at the farm and community levels to integrate biophysical, social and technical research combined with local knowledge.

Results of previously related projects

Previous actions on quinoa production systems played an important role in defining project objectives. The Universidad Mayor de San Andres (UMSA) conducted detailed technical and social appraisals in the Altiplano, especially in the central and southern parts, related to irrigation

of quinoa and adaptation to climate change. Results showed that several production systems, previously well integrated into their environment, were changing due to quinoa monocropping systems, with little sustainability. Under the present conditions, the quinoa systems yields are poor and to obtain more yields, farmers exert pressure to open new lands without foreseeable reposition of inputs. Related to technology management, scientific and technical knowledge has been developed that shows that application of irrigation and fertility soil amendments may possibly boost quinoa yields with reduced pressure on the land and therefore reducing land degradation. Additionally, these are services which are permanently requested by farmers, but use of irrigation is not traditional and therefore little knowledge of water management and much less on water collection or its optimization is available. Additionally, farmers are willing to understand new climate dynamics and to validate their traditional knowledge of weather forecast in order to better deal with the new climatic pattern.

Two common themes emerged from all of these results. First, some traditional cropping practices are no longer viable and/or accepted. Second, farmers are very enthusiastic for entering to a more market-related economy, but they need support to develop their local initiatives.

Project Implementation strategy

As a university institution, the basis for the implementation of the project is the coordination between researchers, undergraduate students and farmers. In this regard, most of the applied research will be implemented through funding for the preparation of undergraduate engineering theses on an honorarium basis. All research students have a research leader who is part of the project team. Finally, all decision for field implementation are discussed and taken jointly with farmers.

Specific objectives, expected outputs and activities of the project

The general objective of the proposal is to support the development of a frame for sustainable farming systems of two selected communities of the arid Central and Southern Altiplano of Bolivia, which have quinoa production as their main crop, through the definition of an efficient water and soil management system, as well as a crop diversity management system, and to support farmers' initiatives to market quinoa. This will complement previous quinoa water management knowledge obtained in the area as support for farmers. The main objective will be obtained through the following specific objectives:

***Objective 1.** Develop a shared understanding of the ecosystem, and the social, economic and environmental drivers of change in the farming systems prevailing in the communities. Understand how new livelihood strategies are being developed in response to perceptions of the risks associated with the changes as well as to newly identified opportunities; and how these perceptions and decisions are affecting the assets farmers possess (livelihoods).*

This objective intends to identify and define the local livelihood strategies before and in the light of the new climatic and economical conditionings. It pretends to evaluate how farmers react under different pressures in order to apply the “scenarios” to jointly define a more sustainable farming system and additional diversification activities. Together with the information coming from previous work in the area, the results of this objective will provide the solid foundation for actions of the project.

Activity 1. Evaluate recent and future climate variability in the Andean Highlands. Evaluation of past 35 years of climate data to determine exact nature of weather risks. Evaluation of the current validity of local weather forecasts and decision making.

There is a general perception held by farmers in the Altiplano that climate is changing, and this together with other sources of stress are strongly constraining agricultural production and food security in the region. Thus, using farmers' perceptions that climate is changing as a starting hypothesis, a study will be developed to examine and test this hypothesis with observations and model data analysis. In the previous assessments, daily precipitation and temperature from several stations having 35 years of record in the Bolivian Highlands, relationships between onset and seasonal precipitation, and dry spell and frost frequencies were examined, including their variations from the northern to the southern highlands. This daily observational data will be further utilized to examine the variability and trends during the 35 year period including onset, demise and season total rainfall frequency/ intensity of rainfall. Of particular interest is the clustering of rainfalls with increased intensity. The farmers traditional climate analysis and forecast will also be examined in relation to climate forecasts developed by sophisticated models such as those exposed by CIIFEN to test their validity and acceptance by farmers as well as the validity of these local knowledge. Finally farmers' traditional knowledge and indicators for climate prediction will be systematized.

Special remote sensing technique for mapping evapotranspiration and water consumption in the last 10 years will be applied to identify change in patterns of crop water uses. Since these are mostly rainfed farming systems, the results will be used to evaluate aridity evolution in time with enough spatial resolution to determine land use changes and mainly water use changes and land degradation to precisely identify the reasons for desertification. Results will be compared with farmers' perceptions of changes.

Activity 2. *Prepare a baseline assessment of community, household and individual livelihoods and risk perception.*

Community livelihood surveys in the selected communities will be carried out to measure household demographics, income domains (men and women), consumption patterns and potential for alternative activities to diversify livelihoods. Resources and production practices and risk perceptions and rankings will be performed to identify the importance of quinoa in the entire farming system. Data will capture household diversification strategies and assets, and measure the current degree of diversification related to previous patterns. The identification of the new strategies for farming systems related mainly to quinoa but also to the other important activities of the farming systems will be evaluated.

Participatory research activities with community members will be performed to:

- 1) identify sources of vulnerability;
- 2) determine characteristics of production systems;
- 3) capture the current knowledge and perception of change, attitudes, skills, and capabilities about climate, soil fertility and management, crops, and institutions, and change with the new production systems;
- 4) determine the perception of climate risk, farmer indicators and the role of such perceptions in decision-making as compared to objective measures of risk;

- 5) evaluate historical information of climate in relation to cropping decisions taken by farmers;
- 6) analyze farmers' perceptions of market conditions, prices, and comparison with actual prices and transaction costs;
- 7) perceptions of weed, pests and diseases problems and changes related to the new production systems and comparing them with actual practices;
- 8) identify possible common actions to increase sustainability, included diversification of the farming system as well as the possibility for non-agricultural economic activities.

These activities will be carried out with the community at large as well as groups sorted by age, gender and location. The information will be used to develop the indicators used in the community livelihood surveys, and the sampling frames will be used to assess soil conditions, pest and disease risks and market surveys. Participatory assessments will be used to define soil conditions, as well as pest problems. The survey results will be used to determine nature of vulnerability within each community and likely and accepted ways to address it.

Activity 3. Evaluation of soil and water management regarding fertility amendments and fertilizers use and drought management in relation with the needs of the newly dominating production systems

The principal scope of this research will be to determine changes in soil fertility and water management practices affecting production that may have occurred due to alterations in climate and/or production systems and impacted on the traditional agricultural practices in the Altiplano. Among the possible changes in practices affecting soil fertility, the increasing monoculture and a reduction in traditional cropping rotations, lower biodiversity in the number of cultivars used in agricultural production, increasing removal of organic materials and residues for fuel, and increases in soil erosion are included. The system reaction to water stress will also be evaluated under the new structure of the farm. This research will first evaluate the type and magnitude of changes in soil fertility and water management that have occurred in the region based on both the perceptions of community members and comparative measurements of soil fertility and water availability and soil water balance between differently cultivated and non cultivated soils. Later, soil amendments and water management options will be evaluated jointly with farmers.

Objective 2: Link local and new knowledge to produce practices and information that provide alternatives for adapting to change.

This objective address the need for support for soil and water management related to new agricultural production systems, oriented to a better water and soil management as well to a more sustainable crop rotational system. Suggestions will be given to farmers on the importance of crop rotation to maintain farm sustainability. However, this could only be supported upon the basis of better yields for the existing cultivation practices.

Water use: Irrigation is not a common and well known technique, much less is deficit irrigation. Therefore together with farmers, water application techniques will be promoted in strategic periods under deficit irrigation concepts. This will serve for farmers to adapt to new more sustainable water management concepts. For this, surface and furrows irrigation application systems will be tested with in field trials and under the local water availability systems (either groundwater or surface). The Deficit Irrigation principles of ensuring water for germination, no

intervention during vegetative period and, at least one irrigation (depending on water availability) during reproductive stages will be followed in all cases.

Activity 1. Settling of Farmers fields under Deficit Irrigation (DI).

Within the two selected communities, fields to be cultivated with quinoa will receive support for the installation of irrigation equipment in agreement with farmers. Strategies for DI will then be jointly defined and, in function of water availability, compared to fields with more and with less water availability.

Soils: The treatments included in the field experiments at each site will be selected based on the suggestions and interest of community members. These field experiments will also serve as important demonstration sites for community members to observe the effects of soil organic matter and different soil amendments practices on soil productivity (chemical and organic fertilizers). Field experiment sites will be established to assess the effects of different climatic factors (temperature and soil moisture), cropping systems and management practices on soil organic matter accumulation and rates of decomposition and fertilization techniques. Treatments will be selected with community input to determine relevant issues related to soil fertility and its perception in the community.

Activity 2. Management of soil amendments.

In function of the results of the first soil analysis, a strategy for soil fertility amendments will be established. This strategy will come also as a result of the interaction with farmers and the orientation of the market. This means that some farmers prefer to produce quinoa for organic markets (as in the Southern Altiplano) and therefore organic amendments will be added. In case quinoa could be also oriented to non-organic markets, combination of organic and mineral fertilizers will be considered. The key point is also to identify the potential interaction between water and fertility amendments as potential yield boosters.

Objective 3: Develop market access through strategies and institutions.

In previous research, some critical market points to do research were identified, as follows:

1. Local organizations are not strong to face national and/or international markets; therefore most of the product is sold to intermediate dealers who earn the biggest piece of the market chain.
2. Farmers do not have a clear concept of market development, since before most of their production was oriented to barter and self-consumption and not strictly to produce income.
3. Black market and smuggling is a big obstacle for strong position in the market, because farmers and dealers from neighbouring countries collect local production and sell it as their own production.
4. Production levels are not sustainable, therefore national and international markets do not trust local production.
5. Availability of financial institutions to provide access to credit is a critical constraint for the most vulnerable segments of society.

With this objective, the project intends to complete the analysis, including the exploration of better market opportunities and inclusion for quinoa products, but also for other crops or activities which farmers might be interested in and are necessary to identify.

Participatory market assessments will be carried out. There are on-going studies using participatory marketing analyses with stakeholders along the chain. The baseline survey will be used to determine current levels of household economic diversification and what are the assets leading to the strategies observed. Analysis will also relate household characteristics to the type of markets households engage in and the possibilities to expand markets for quinoa and other products.

The results will be widely discussed with farmers and with trade organizations to support further market development and training for farmers.

Objective 4: Ventilation of results and inputs for policy makers

This objective addresses the need for a strong relationship between the outputs of the project and the influence on policy makers. Although the University of La Paz is closely related to the government both local and national, some activities will be specifically performed within the frame of the project to maximize the impact of the project outputs.

In this regard, the project will support activities of diffusion and publication of results that will be addressed both to farmers and to policy makers. These activities include:

1. Publication of manuals related to soil and water management
2. Preparation and publication of scientific outputs to be widely distributed.
3. Organization of events such as workshops, meetings and fairs.
4. Participation in general discussion forums and committees such as the National Committee for Agricultural Production, the new Agricultural Research System, the Diversification council and others.

Relation to main objectives of SUMAMAD

The objectives and activities of the present proposal do relate to the 3 broad objectives of the 2nd Phase of SUMAMAD as follows:

(1) Emphasis on **scientific studies** related to the following key subjects:

- Improvement of dryland agriculture including rangelands and livestock, with biodiversity and sustainable use of natural resources as a minor component.

The proposal intends to reintegrate the agricultural production system to a more sustainable diverse crop rotation with an appropriate use of livestock and fertilizers manure as well as other fertility amendments.

- Restoration/rehabilitation of degraded drylands including sustainable water conservation and harvesting practices.

The proposal aims at optimizing the use of water for crop production under the basic concept of “more crop per drop”, having real alternatives for quinoa production and for other crops which are being neglected at present.

(2) Achieving greater focus on **policy-relevant analyses**, in particular paying attention to:

- Developing scenarios for land use change (also in the context of global and climate change) including the assessment of tradeoffs, economic valuation of dryland services, environmental education and outreach.

Climate, global and land use changes are basic concepts and drivers for this proposal. Farmers are feeling that new crops are needed to be inserted in the global market. They do also feel that the environment is prone to and capable of supporting other crops than the traditional rustic ones, but this implies to changing the land use to a more stressful type of production which has to be addressed. Once clearly identified the good relationship of the University with the institutional environment will be used to spread the results. Several events of diffusion as well as publications are foreseen to disseminate the results. Moreover, given that the Ministry of Water is strongly related to the University, it is, in fact, waiting for the results coming from the project to improve their policies related to climate change and desertification.

- Interfacing with the relevant policy formulation institutions and processes in the respective countries.

Quinoa chain and production is one of the top priorities for the government, however little has been done to achieve its potential production under sustained conditions. Several private and successful organizations of farmers have developed skills to be replicated partly in our area to insert the topic of quinoa production even more within the national policies. However, the project does not seek to affect only the quinoa chain but moreover it aims at valorizing other possibilities to be supported by national or at least local policies.

(3) Promoting **sustainable livelihoods** through:

- Development of alternative income generating activities – diversification of options including ecotourism, handicraft, medicine, forages.

Besides the quinoa production system, local initiatives are to be strengthened and farmers will be supported to be active participants of global markets not only for quinoa but also for all other possibilities which will also be identified. Within the baseline analysis, the project seeks to identify alternative livelihoods and in the second, third, and fourth year, to support these alternatives.

5-Year Work Plan

Year 1	Q1	Q2	Q3	Q4
Administrative and academic setup of the project	X			
Preparation of participatory activities		X		
Settling and running of first year experiments (soil and water management)		X	X	X
Initial Remote Sensing analysis		X	X	X
Initial downscaling techniques (training and understanding)				X

Climatic and climate change Analysis and evaluation			X	X
Year 2				
Evaluation of results of on farm trials	X			
Presentation and Discussion of results of on farm trials to stakeholders; Workshops		X	X	
Training for irrigation techniques		X	X	X
Second year trials		X	X	X
Identification of Market opportunities and constraints			X	X
Remote Sensing analysis and downscaling technique	X	X	X	X
Climatic and climate change Analysis and evaluation	X	X	X	
Year 3				
Evaluation of on farm trial results	X	X		
Presentation and discussion of results of farm trials to stakeholders; Workshops		X		
Identification of market opportunities and constraints	X	X		
Starting up of third year farm trials		X	X	X
Analysis of availability of financial institutions		X	X	X
Year 4				
Evaluation of farm trial results	X	X		
Settling of fourth year trials	X	X		
Presentation and discussion of results of farm trials to stakeholders; Workshops		X	X	
Initial ventilation of results to stakeholders and policy makers			X	X
Year 5				
Evaluation of on farm trial results	X	X		
Reviewing of impacts of previous years' work		X	X	
Report results of on-farm trials to stakeholder especially regarding soil amendments		X	X	
Diffusion of results to stakeholders and policy makers	X	X	X	X

Detailed work plan for 1st Year and proposed budget for the five years of the project

Activity	Product	Q1	Q2	Q3	Q4
Initial administration procedures	Agreement in force	X			
Initial hiring of degree students	Reports	X			
Field activities	Signed Documents of agreements with communities Report on settling of field work	X	X	X	X
Participatory evaluation	Report	X	X	X	
Initial soil evaluations	Reports	X	X	X	X
Application of soil amendments and irrigation techniques	Reports		X	X	X
Purchase of imagery; remote sensing imagery analysis	Images	X	X	X	X
Training on downscaling techniques	Training			X	X
Climatic analysis	Reports	X	X	X	X

Proposed Budget (in US\$):				YEAR					Local and other counterpart/year Value		
I.	Description	Quantity	Unit	Unit Price	1	2	3	4	5	Item	Value
Staff:											
2 Field technicians (10 days/month);		10*12*2	Honorarium/day	20	4,800	4,800	4,800	4,800	4,800	4 Staff ¼ time/month	14,400
Degree students		10*3	Honorarium	90	2,700	2,700	2,700	2,700	2,700	4*300*12	
Office Req.		Global	Global	--	800	800	800	800	800	Global 500/month	6,000
Computer and/or printer		2	Equipment	1000	--	1,000	1,000	--	--	2 * 1,000	2,000
Car rental		20/year 2,3,4 10/year 1,5	Days	50	500	1,000	1,000	1,000	500	---	---
Gas (*)		1000/year	Liters	0,6	600	600	600	600	600	1000 l/year	600
Participatory meetings support and workshops		Global	Days	15	500	2,000	2,000	5,000	2,000	500	500
Per diems		40	Days	5	200	200	200	200	200	40 Days*5	200
Remote sensing images		Global	--	500	1,500	2,000	--	--	--	---	---

Proposed Budget (in US\$):				YEAR					Local and other counterpart/year Value		
I.	Description	Quantity	Unit	Unit Price	1	2	3	4	5	Item	Value
	Soil analysis	100	Unit	30	750	750	750	750	--	10 Units	300
	Soil amendments	Global	Global	--	800	800	800	800	--	---	---
	Irrigation material	Global	Global	--	4,000	2,000	2,000	--	--	---	---
	Flowmeters	3	Equipment	500	1,500	--	--	--	--	---	---
	Pluviometers	3	Equipment	200	600	--	--	--	--	2	400
	Bicycles	2	--	120	240	--	--	--	--	2	240
	Production inputs (seeds, weed control, etc)	Global		--	2,000	2,500	2,500	2,500	--	Global	1,250
	Publications	Global	--	--	--	1,000	2,000	2,000	3,000	---	---
	TOTAL				21,490	22,150	21,150	21,150	14,600	Total/year Local counterpart	25,890
	TOTAL FOR THE PROJECT								100,540		

Counterpart contribution per year (in US Dollars):

	2009	2010	2011	2012	2013	Total
SUMAMAD Member State	25,890	25,890	25,890	25,890	25,890	129,450

Project Team Composition

- Team Leader: Dr. Magali Garcia, specialist in agroclimatology and remote sensing techniques for evapotranspiration analysis. Climatology and downscaling abilities.
- Economic Research leader: M.Sc. Jorge Cusicanqui. Specialist in economic analysis.
- Social Research leader: M.Sc. Cristal Taboada. Specialist in social studies.
- Field Research leader: M.Sc. Felix Mamani. Specialist in quinoa production.