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

Progress Report of SUMAMAD Activities

2011
UNESCO Project-SUMAMAD
Sustainable Management of Marginal Arid Drylands

Third Year interim report

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

Research institution, team composition and list of publications

The project partner institution is the Faculty of Agriculture of the Universidad Mayor de San Andres of La Paz, Bolivia through the project QUINAGUA.

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EXECUTIVE SUMMARY

The goal of the project is to develop knowledge and practices, especially related to the use of deficit irrigation strategies, to build resilient livelihoods in remote rural communities, where producers of quinoa in the Bolivian Altiplano are vulnerable to climate and market changes. In order to evaluate the limitations of deficit irrigation, we studied the dynamics of current agro-ecosystems to identify knowledge, practices and strategies that might help to reduce vulnerability and improve the effectiveness of irrigation of quinoa, thus helping to build natural and human capital in terms of farming systems in quinoa production.

To achieve this objective, it was critical to understand the impacts of drivers at multiple scales on Altiplano ecosystems, including: climatic characteristics of the area; the impacts of climate trends; the use and maintenance of traditional knowledge of climatic indicators; soil fertility limitations affecting the efficiency of the deficit irrigation of quinoa; and market trends affecting decision making. Understanding these factors contributes towards the development of information in terms of adaptive practices and strategies to be pursued in agronomic and market-research programmes, as well as climate policy.

The first two years of the project were carried out in one community (Santiago de Callapa), and in two experimental stations, Patacamaya and Choquenaira, sited in the Central Altiplano by the Universidad Mayor de San Andres (UMSA). The third year of research incorporated a new community interested in quinoa production under deficit irrigation. This enabled us to extrapolate our results to additional locations with different eco-climatic conditions within the Altiplano. As result of the first year of research, soil fertility was identified as a very influential factor in the crop’s ability to maximize use of the small amount water applied as deficit irrigation. As the QUINAGUA project had previously studied this issue in depth, the focus of the SUMAMAD strategy was to analyse fertility limitations with respect to either enhancing or reducing the water use efficiency of quinoa.

During the second year of the SUMAMAD project, two research sites were established to identify the nitrogen cycle in the Altiplano soils and ascertain the best moment to incorporate manure to maximize nitrogen use under deficit irrigation. The results were surprising. Previously, the standard recommendation for quinoa manure fertilization was up to 4 ton ha⁻¹, but the results demonstrated that those levels are useless for the crop and that significant increases in yields can only be obtained with over 12 TN/ha, but not more than 15 TN/ha. The third year is devoted confirming this result and extending the analysis to phosphorous and the study of soil microbiology. Finally, investigation of the integration of quinoa producers into the marked revealed weak links. An article has been accepted for publication and a doctoral dissertation is expected this year using these data.
Managing Sustainability of New Quinoa Production Systems through Farming Systems Management and Market Insertion

1. Introduction: The application of the SUMAMAD project in the Bolivian highlands

The Bolivian highland region is one of the few areas in the world where agriculture can be carried out at 3,700 m above sea level, as a result of proximity to the equator. However, the aridity and fragility of the area, coupled with the rates of poverty among its population, pose serious challenges. The highly variable climate and weather thwart attempts by rural families to accumulate wealth and improve their living conditions. Periodic droughts and flooding, as well as the occurrence of severe frost, are characteristic of the local climate. Natural hazards undermine attempts by many to improve their livelihoods and families who fail to adjust to the vagaries of the climate must temporarily migrate to the lowlands or to cities in order to survive. These migrations threaten tropical forests and exacerbate the problems of cities. As migration usually involves people who are young and active, temporary migration may also undermine the ability of communities to recover from droughts and flooding because of lack of labour. Migration may also undermine the country’s food security as staple foods, for the most part, locally produced.

Few crops can be adequately cultivated under such harsh local conditions. One of these, quinoa, has recently been enhanced both for export, due to its high international prices, and for national consumption, given its high nutritional value. However, this new trend in quinoa export is highly disruptive of traditional production, which is characterized by somewhat sustainable intercropping and livestock production. In contrast, new practices have a tendency towards mono-cropping to support additional inputs, with intensive production not well adapted to the environment. The problem is recognized, however, officials have done little in response because few research results are available on the drivers of the aforementioned problems and possible solutions.

2. Project objectives

Objective 1: Develop an understanding of the ecosystem, and the social, economic and environmental drivers of changes prevailing in farming systems in the Andean communities related to quinoa production.

Objective 2: Link local and new knowledge to create practices and produce information to provide alternatives for adapting to a changing environment.

Objective 3: Develop market access through strategies and institutions.

Objective 4: Publish results and inputs for policy-makers.

3. Project activities

Methodology

Scientists and agricultural producers rely on different knowledge systems to guide their decisions. Contributing to the well-being of agricultural producers and their communities means finding the links between these different knowledge systems. These links ensure that scientific
research is conducted to produce results that can be used to improve livelihoods. One of these links is the use of participatory research approaches, where farmers and researchers work together. This is the method of work used in the SUMAMAD project in Bolivia. This combination of fieldwork was undertaken in a typical Altiplano community, and replicated at two nearby university experimental stations, with climatic data analysis. During the third year research is being performed in the Patarani community surrounding the experimental station of Patacamaya and a controlled experiment takes place in the experimental station of Viacha. Figure 1 presents details of the locations where the project took place over consecutive years.

Figure 1. Location of the study areas, experimental stations

Since the agricultural year in the southern hemisphere runs from October to April, and longer under the Altiplano conditions, the technical activities involved run from one year to the next. As such, we are reporting the results of the actions concluded in 2011 for the agricultural year 2010-2011, and describing those being initiated for the agricultural year 2011-2012. The activities follow the work plan presented in March 2011 and are described in Table 1.

Results from Previous Agricultural Year

Objective 1: Fostering scientific drylands research

This objective required climatic and soil fertility research. To this end, the following actions were carried out:

1. The results of the field experiments were evaluated, systematized and consolidated in a joint book, which forms part of the doctoral research of Roberto Miranda (Annex 4), who is going to present it in March 2012. The main finding of the field plots is that reduced
applications of manure to quinoa fields (4 to 10 ton ha\(^{-1}\)) result in a marginal yield response, even with deficit irrigation, and will not justify the investment money and work hours. Conversely, applications above 15 ton ha\(^{-1}\) will not produce larger yields and constitute a waste of human resources and work.

2. The rate of mineralization of manure showed that applications of manure just before sowing it will have little or no effect on yields, especially under low application rates.

3. On the basis of the above, the suggested rate of manure application in very low fertility soils is of 15 ton ha\(^{-1}\), best applied within at least two months before the sowing period; that is, between June and September of each agricultural year.

**Objective 2:** The preparation of policy-relevant guidelines for decision-makers in drylands

Within this objective, publications and handbooks constitute the main way of presenting policy relevant guidelines. As such, the following actions were taken:

1. A joint publication with the QUINAGUA project on the results of research on deficit irrigation and soil fertility was finalized and has been published and distributed to a wide range of users.
2. A paper on factors affecting farmers’ choice of deficit irrigation and inputs for quinoa production was accepted for publication (Annex 3)

**Objective 3:** Promoting sustainable livelihoods in drylands

The results of the work were published and training workshops for farmers were undertaken.

**Actions in the Initial Phase**

The main activities of the project for this year are just beginning. Table 1 presents the details and some remarks.
<table>
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<tr>
<th>Objectives</th>
<th>Field research activities</th>
<th>Remarks</th>
</tr>
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<tbody>
<tr>
<td>1. Fostering scientific drylands research</td>
<td>1. Replication of field research on soil amendments in other dryland communities of quinoa producers 2. Extended research on phosphorous decomposition time for quinoa producers 3. Adjustment of a public software for quinoa fertility integrated with water management 4. Evaluation of community strategies to deal with the local, erratic climate</td>
<td>At the moment we are in the initial phases of establishing field plots and analysis for this objective, thus, all our activities are in progress. As such, the following research is underway: 1. Successful actions for our study location with a specific soil type are being replicated in other dry quinoa producers’ areas, specifically the community of Patarani in Patacamaya. 2. An additional controlled experiment is being carried out in Viacha (experimental station) to compare and confirm the results of the field communities. 3. The methodologies applied to evaluate nitrogen mineralization will be repeated for other soil types, and phosphorous contents will be evaluated to complete the fertility analysis. 4. Microbiological activity induced by manure incorporation will be measured in all field plots. 3. Projections on extreme events, especially dry periods, are being evaluated using the already processed climatic data.</td>
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<td>2. Preparation of policy-relevant guidelines for decision-makers in drylands</td>
<td>1. Preparation of a draft handbook on soil and deficit irrigation management for quinoa. 2. Re-publication of the crop calendar for quinoa 3. Preparation of a report including the systematization of local climate management, perceptions and loss of this knowledge.</td>
<td>1. There is a lack of quinoa manuals and handbooks on soil and water (deficit irrigation) management in Bolivia, and it is this gap we expect to fill with our results. This activity is already in draft form and publication is expected for June 2012. 2. A chapter on software handling will be included to complete the guidelines on quinoa deficit irrigation. 3. The successful crop calendar will be revised and reedited for wide distribution (under preparation) 4. A draft of the report on local knowledge for climate management will be made available. (draft under revision)</td>
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<td>3. Promotion of sustainable livelihoods in drylands</td>
<td>1. Support for sustainable management of quinoa fields regarding soil fertility and water management</td>
<td>1. This will be applied in our field research areas and calibrated with the adjusted software (this activity is in initial stage).</td>
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<td>4. National seminar</td>
<td>2. National seminar on soil management in the Altiplano region with a specific focus on soil microbiology in dry regions</td>
<td>1. Soil microbiology in dry areas is very important for the promotion of soil fertility. One of our associates ran a seminar to discuss the importance of manure and fertility management for soil microbiology. (This activity will take place in February 2012)</td>
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4. Problems and challenges
The relationship between the university and farmers is good and there are no problems to report. The only difficulty is the conflict between our calendar and the SUMAMAD calendar, which makes it difficult to synchronize activities.

5. List of publications and media coverage
The following publications are available:

1. Joint publication on the results of research on deficit irrigation and soil fertility was finished and is already published and distributed to a wide range of users.
2. Thesis document on manure mineralization, Bersenia Salluco
3. Thesis document on nitrogen balance, Pablo Osak Mamani
5. Scientific article on farmer’s willingness to irrigate and add inputs to quinoa production system, Cristal Taboada
6. Doctoral document on quinoa fertilization and nitrogen dynamics in manure addition integrated with deficit irrigation, Roberto Miranda.

6. Objectives for 2012
2012 will see the finalization of the work.
ANNEXES

ANNEX 1: Front and back pages and table of contents of publication on quinoa deficit irrigation and fertilization
ANNEX 2: Front pages of final theses from graduate students
ANNEX 3: Acceptance email and abstract of a scientific article by Cristal Taboada, (Commercialization researcher)
Disposición para adoptar tecnología de riego para quinua (*Chenopodium quinoa* Willd) en comunidades del Altiplano Central de Bolivia
Farmers’ willingness to adopt irrigation for quinoa (*Chenopodium quinoa* Willd) in communities of the Central Altiplano of Bolivia

Taboada Cristal
Mamani Armando
Raes Dirk
Mathijs Erik
García Magali
Geerts Sam
Gilles Jere

Resumen
Actualmente, se considera a la quinua como un cultivo estratégico debido a su capacidad de adaptación a las condiciones abióticas adversas que se presentan en el altiplano boliviano. No obstante, el rendimiento promedio es bajo. Estudios previos, han demostrado que, el rendimiento puede incrementarse haciendo uso de la tecnología de riego deficitario. Sin embargo, el uso de riego en quinua no es una práctica común entre los productores de la región altiplánica. Este estudio, ha examinado los principales factores que determinan la disposición de las unidades productivas para adoptar la tecnología de riego deficitario. Para ello, se ha entrevistado a 137 productores de siete comunidades del altiplano central. Los resultados del análisis estadístico, han demostrado que la disposición para adoptar la tecnología de riego deficitario para el cultivo de quinua, es mayor en zonas donde los productores poseen mayores superficies de tierra y donde ya existe cierta práctica de riego.

**Palabras clave**: quinua, riego deficitario, adopción de tecnología.

Abstract
Quinoa is considered a strategic crop because it is well adapted to the adverse abiotic conditions of the Bolivian Altiplano; however, the average yield is low. Previous studies have demonstrated that quinoa yields would increase with deficit irrigation technology. Nevertheless, irrigating quinoa is not a normal practice in the farming systems of the Altiplano. This paper examines the main factors that determine the attitude of farmers towards adopting deficit irrigation using a sample of 137 surveys in seven communities of the Central Altiplano. Statistical analysis demonstrates that the most important factors influencing farmers’ willingness for irrigation adoption are the acreage planted with quinoa, quantity of surplus production for trading, and having irrigation experience. Also, age and education level were important factors in willingness to adopt a new technology. Therefore, deficit irrigation is more likely to be performed in areas where farmers own larger fields and where certain types of irrigation already exist.

**Keywords**: quinua, deficit irrigation, willingness for technology adoption

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ANNEX 4: Front page of the doctoral document by Roberto Miranda (Soil fertility researcher)

UNIVERSIDADE FEDERAL DE SANTA MARIA
CENTRO DE CIÊNCIAS RURAIS
PROGRAMA DE POS GRADUAÇÃO EM CIÊNCIA DO SOLO

ADUBAÇÃO ORGÂNICA EM CONDIÇÕES DE IRRIGAÇÃO SUPLEMENTAR E SEU EFEITO NA PRODUTIVIDADE DA QUINUA (Chenopodium quinoa Willd) NO ALTIPLANO DA BOLÍVIA

TESE DE DOUTORADO

Roberto Miranda Casas

Santa Maria, RS, Brasil
2011