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Title:

Towards the evaluation of the environmental impact of Fairtrade scheme application: the case of quinoa production system in the Southern Bolivian highland

Abstract

The establishment of quinoa on the international market was associated with a significant change of the Bolivian production system. Such a change involved both the structure of producer associations and the agricultural practices implemented, which defined new agroecosystems gradually showing environmental and socioeconomic issues. In this framework, particularly during the 90s, the quinoa sector was characterized by the establishment of Fair Trade supply lines regulated by standards ensuring environmental and social sustainability. The evaluation of the environmental dimension of Fairtrade standards has so far received little attention by the research community even though environmental issues, particularly soil fertility reduction, are considered to undermine the sustainability of quinoa agroecosystems. This paper, therefore, presents the preliminary collection and analysis of soil related data including soil fertility assessment and soil management practices implemented in the municipalities of Colcha K, Tomave and Salinas de Garci Mendoza in the Southern Bolivian highland, currently considered as a spot highly vulnerable to environmental degradation. The present study, thus, contributes to develop an integrated soil related database at the community level that provides a baseline for the long term-assessment of environmental impact of Fairtrade standards applied to quinoa production. What is more, it supports the design of *ad hoc* measures to be implemented both at farm and producer organizations level with the aim of enhancing soil fertility and environmental sustainability.

Introduction

According to the latest estimates of the Food and Agriculture Organization (FAO), in the reference period 2012-2014, 805 million people suffer from hunger worldwide (FAO 2014a). Though this figure marks significant improvements with regard to recent past, still it points to a widespread problem far from being solved with complex underlying causes. Moreover, food insecurity is not evenly distributed worldwide but is rather concentrated in certain areas where some causes are preponderant. In this regard, Latin America and the Caribbean are particularly relevant as, despite a prolonged period of both economic and social progress, still a large share of population is food insecure and/or malnourished. A major cause of food insecurity in this region is the persistent inequity in income distribution and access to social protection networks that has historically characterized the area and sharpened in recent years (Giordano and Li 2012; Martínez et al. 2009).

Bolivia is the less developed country in South America and one of the poorest worldwide, being the 113th out of 187 in the world ranking according to the Human Development Index (UNDP 2014). As a part of the national strategy for poverty alleviation, Bolivian government has recently pushed on international trade in order to benefit from the financial flows deriving from the export of raw products. This trend is being achieved by signing trade agreements with other Latin American countries but also by affiliating to international organizations such as the World Trade Organization and Mercosur. In the early 80s, the basket for export begun including also quinoa, a cereal that was domesticated in the Andean region about 7.000 years ago and ever since cultivated on a small scale by local farmers.

Traditionally quinoa has been cultivated for self-consumption according to traditional practices; it turned to a commercial crop over the last few decades. In 2003, the harvested area devoted to quinoa production in Bolivia was found to range between 38,300 ha (FAO 2014b) and 45,700 (MRDyT and CONACOPROQ 2009). In 2013 such an area was reported to be 74,200 ha, thus almost doubling. The same occurred when taking count of the production volume that increased from 24,900 tons in 2003 up to 50,500 tons in 2013 (FAO 2014b). Both the increase in cultivated area and in production volume have been led by the strong increase in the price of quinoa over the last few years: from 2000 to 2008 price of raw quinoa increased by up to 650% (from 28.4 to 204.5 US$/100 kg of conventional quinoa), while price of processed quinoa almost doubled (from 105.1 to 255 US$/100 kg) (MRDyT and CONACOPROQ 2009; Medrano Echalar and Torrico 2009; CPTS 2008). Such an increase has been mostly driven by the international demand for this product, with Bolivia being the main exporter worldwide, especially to USA and Europe (MRDyT and CONACOPROQ 2009). Since the 80s, quinoa's popularity has been continuously rising, mostly due to the increasing interest from the countries of the North concerned about social, health and environmental issues (Cáceres 2005). The establishment of quinoa on the international market was associated with a profound change in the structure of the Bolivian production system both at the national and regional level. In this regard, Cáceres et al. (2007) identifies three periods marking the definition of the networks of actors participating in quinoa production and trade: i) between the 70s and the 80s the first producer organizations (e.g. CECAOT and ANAPQUI) were launched and consolidated. To their reinforcement contributed the wake of Fair Trade movements (Cáceres et al. 2007); ii) during the 90s the establishment of organic production standards for exports took place (Laguna et al. 2006; Cáceres and Carimentrand 2004), as promoted by ANAPQUI and supported by European NGOs (Laguna 2011). According to recent estimates, between 25% and 40% of the total production volume of quinoa real is commercialized as organic, with exports to Europe and North America being almost exclusively organic (MDRyT & CONACOPROQ 2009; Aroni et al. 2009); iii) the early 90s were characterized by the strengthening of the network involving quinoa producers, associations, and traders, in turn associated with the definition of organic and Fair Trade supply lines aimed to the main exporters. Carimentrand and Ballet (2010) note that during this period Fairtrade[1] and organic quinoa certifications *de facto* overlapped, with quinoa supply chain firmly structured around the two poles of Fair trade and organic agriculture.

Since the beginning of the 80s, when the demand for quinoa begun to grow, significant changes in the agricultural practices took place. This shift has been particularly evident in the Southern Bolivian highland where the core of quinoa production is located (Rojas 2011; Aroni et al. 2009). Due to the prohibitive environmental conditions in this area that includes the Salar de Uyuni, the Salar de Coipasa and the area in between (referred to as Intersalar), quinoa is the only commercial crop that is able to adapt to this context that is considered among the harshest ecological spots on earth characterized by an altitude of 3750 m, 200 mm of annual rainfall and about 200 frost days per year (Orsag, 2011; Gandarillas 1982). Here, quinoa has been traditionally cultivated on hillsides in systems based on crop rotation including fallow land and the use of llama manure, which has long ensured a balanced utilization of environmental resources (Orsag 2011). Over last thirty years, quinoa cultivation expanded over plains, where soils are generally characterized by a higher percentage of sand, low to very low content of organic matter and high vulnerability to wind and water erosion. The conversion of these lands originally covered by native species into agricultural lots, facilitated by the introduction of machinery and coupled with the reduction of llamas, significantly altered the biological processes ensuring the sustainability of local ecosystems (Medrano Echalar et al. 2011; Pouteau et al. 2011; Michel 2008; Joffre and Acho 2008). The reduction of soil fertility due to the intensification of quinoa production systems has recently received particular attention, as often mentioned as the leading cause of an alleged decrease of yields of quinoa, as well as a proof that quinoa agroecosystems are exceeding their carrying capacity (e.g. Jacobsen 2011; Felix and Vilca 2009; Cossio 2008). However,

[1] In line with Elder et al. (2013), we hereby use 'Fairtrade' referring to the certification released by Fairtrade International (FLO), whereas 'fair trade' referring to the broad fair trade movement.

crop yield should not be used as a proxy for measuring the degradation of soil as this is likely the result of other underlying factors including climate related events, agricultural practices and pest attacks. With specific reference to the Southern Bolivian highland, lower yields associated with the mechanization of sowing in the plain systems should thus be considered in light of the higher exposure to wind, frost and pest attacks that such systems have (Winkel et al. 2012). The apparent contrast existing in the research community in regard to the impact of quinoa cultivation on soil fertility could be attributed to the scarcity of studies exploring such a topic, as highlighted by Reynolds et al. (2008) and Winkel et al. (2012).

Such a lack of in-depth analysis also characterizes the evaluation of the environmental dimension of Fairtrade standards, which is far less known that the socioeconomic one and, from a research perspective, less investigated. In the present paper we focus on quinoa production in the Southern Bolivian highlands as certified by Fairtrade International scheme, thus regulated by the Fairtrade International (FLO, as former Fairtrade Labelling Organization) standards. These standards are followed by the European Fair Trade Association, to which Chico Mendes Onlus, the Italian ANAPQUI's commercial partner, is associated.

The Fairtrade International scheme was launched in 2004 by the World Fair Trade Organization (WFTO) with the aim of developing and reviewing fair trade standards. With environmental development listed as a common principle for achieving Fairtrade certification, Fairtrade standards do include requirements for promoting sound and sustainable agricultural practices aiming to reduce and safely use agrochemicals, properly manage waste, conserve soil fertility and water resources (FLO 2011a). Therefore, apart from economic and social standards, which require buyers to pay a guaranteed minimum price often coupled with a social premium to producers, in order for a supply chain to be Fairtrade certified, farmers have to comply with environmental standards of production (Elder et al. 2013). According to the Fairtrade Standards for Small Producers Organizations (FLO 2011b), environmental protection standards are designed with the aim of implementing safe and sustainable agricultural practices, while preserving biodiversity. In order to achieve this goal, specific requirements are provided in regard to: i) pest management; ii) soil and water resources conservation with a specific focus on the use of fertilizers, training of member to reduce and prevent soil erosion; iii) soil fertility conservation and enhancement by promoting agroforestry, crop rotation, intercropping, use of manure and groundcover; iv) waste disposal, reuse and recycle; iv) protect biodiversity by avoiding impacts on protected areas; and v) keep records of energy consumption activities reducing greenhouse gas emissions. Moreover, Fairtrade certified farmers are not permitted to use genetically modified organisms (GMOs) (FLO 2011b). Along with generic Fairtrade Standards for Small Producers Organizations, there are standards specifically set for cereals providing further specifications. Interestingly, in regard to pricing, when going in details as concerning Fairtrade Premium Price, specific reference is due to quinoa as it is reported that '*at least 30% of the Fairtrade premium (USD 78 / MT) must be dedicated to investment into environmentally sustainable measures for the production and the processing of Quinoa'* (FLO 2012a). Further explanation on what is meant by 'environmental sustainability' is provided in an additional document referred to as Standard Unit Explanatory Document for the Fairtrade Standard for Cereals (FLO 2012b). This document provides guidelines for implementing specific measures aiming at preventing and reducing soil erosion, optimizing fertilization, implementing pest management, and conserving and/or restoring biodiversity, both at the farm/community and producer organization level (FLO 2012b). Such a specific focus on the environmental aspects of quinoa cultivation is in line with the abovementioned environmental concern on the production of this crop, especially in fragile ecosystems as the Southern Bolivian highland (Medrano Echalar et al. 2011; Pouteau et al. 2011; Michel 2008; Joffre and Acho 2008).

While there is a growing literature examining the socioeconomic impact of Fairtrade certification (Valkila 2014; Ruben and Fort 2012; Elder et al. 2012; Raynolds 2012, just to mention few studies) very little is known on how it affects the environment (Elder et al. 2013). There is evidence that Fairtrade certification positively contributes to the implementation of environmentally sound agricultural practices (Arnould et al. 2009; Ruben et al. 2009). However, there is also evidence that the adoption of Fairtrade environmental standards did not have significant or positive impacts (Elder et al. 2013; Quispe Guanca 2007). Both the reduced number of studies focused on this topic and the contrasting results emerging from them suggest that the environmental aspect of the application of Fairtrade environmental standards has not yet been fully analyzed.

In the framework depicted above, the aim of the present study is the analysis of the environmental impact of Fairtrade certification scheme in quinoa production in the Southern Bolivian highland, by focusing on the municipalities of Colcha K, Tomave and Salinas de Garci Mendoza (Nor Lípez Province, Potosí Department, Bolivia). A combination of soil analysis and interviews with farmers involved in quinoa production is being carried out in order to provide a baseline with respect to soil fertility and soil management practices likely affecting it. The data collected would then constitute the core of an integrated soil related database aimed to launch and develop a monitoring system supporting the implementation of environmentally sound agricultural practices in line with Fairtrade standards, and promoting the sustainability of quinoa production in the long term.

In this sense, our contribution is twofold. On the one hand, it addresses an area of research on Fairtrade certification where efforts so far have been quite thin, as evidenced by the reduced number of studies on Fairtrade's impact on the environment (Elder et al. 2013; Nelson and Pound 2009; Ruben et al. 2009; Arnould et al. 2009). On the other, it sheds light on the environmental impact of the agricultural practices currently adopted by farmers in the Southern Bolivian highland, thus contributing to the thorough investigation of an area characterized by high environmental vulnerability (Medrano Echalar et al. 2011; Pouteau et al. 2011; Michel 2008; Joffre and Acho 2008).

Methodology

In line with the above-specified aim, the focus of the present study was the analysis of soil fertility in the three municipalities where the research took place. Such a focus was chosen as the reduction of soil fertility associated to quinoa production has recently been alleged as one of the main issues contributing to the environmental vulnerability of the Southern Bolivian highland. However, no evidence for this has been found so far, thus calling for the need to investigate on this topic. The municipalities of Tomave, Colcha K and Salinas de Garci Mendoza were chosen as they constitute a representative sample of quinoa production system, with both farmers associated to Fairtrade certified associations and non-cooperatively organized farmers. In this regard, producers taken into account in the present analysis in the municipality of Colcha K (Mañica and Villa Candelaria communities) are affiliated to CECAOT (Central de Cooperatives Agropecuarias "Operaciòn Tierra"). Farmers interviewed in the municipality of Tomave, instead, are not affiliated to any producer organization, but are currently supported by FAUTAPO (Fundaciòn AUTAPO). The two communities analyzed in the municipality of Salinas de Garci Mendoza present different features in that producers interviewed in Irpani are affiliated to ANAPQUI (Asociaciòn Naciònal Productores de Quinoa), whereas farmers interviewed in Cotaña are non-cooperatively organized. Both CECAOT and ANAPQUI are Fairtrade certified (since 2006 and 2001, respectively). In particular, ANAPQUI is the main national body dealing with marketing quinoa value-added products to international fair trade markets. This association has long been commercial partner of Chico Mendes Onlus, which is associated to the European Fair Trade Association (EFSA). EFSA, as member of the WFTO, follows the Fairtrade standards defined in the framework of the Fairtrade International scheme. In order to shed light on the impact of quinoa production system regulated by the Fairtrade standards in the Southern Bolivian highland, both certified and non-certified producers were included in the analysis in order to identify and assess differences possibly emerging.

Different analysis methods based on the collection of both qualitative and quantitative data were used. The collection of soil samples in the 6 abovementioned communities took place from December 2014 to March 2015. In the meanwhile, interviews were conducted with farmers involved in quinoa production to quantify their herds (mostly llama and sheeps), derive the availability of organic manure to be possibly used as

fertilizer and investigate the practice of applying organic manure as it is currently carried out by farmers. All quinoa producers that have been interviewed were earlier involved in the Complejo Productivo Altiplano Sur supported by FAUTAPO from 2009 to 2014. Since according to preliminary analysis of the questionnaires, the application of organic manure emerged as a consolidated practice, samples of llama manure were collected from the same communities. In respect to soil samples, two pitches were excavated and 10 soil samples were taken from the 6 communities under investigation. Physical and chemical properties were then measured, including soil texture, pH, organic matter content, carbon (C), nitrogen (N), phosphrous (P) and potassium (K) content. These indicators were then combined in order to determine soil fertility according to the Soil Fertility Table as adapted by the Instituto Geográfico "Agustín Codazzi". In regard to llama manure samples, collected from the *corrales* (livestock stockyard) where llamas are recovered overnight, pH, C, N, P and K content were determined.
Moreover, quali-quantitative data provided by the questionnaires, combined with a literature review including both scientific articles and grey literature, provided the material currently being analyzed with the aim to design an appropriate long-term strategy promoting soil management practices.

Results and discussion

Since according to previous study and interviews with farmers soil samples were collected from lots presenting homogenous conditions in terms of slope, orientation and exposure, soil depth, soil cover and soil management applied practices likely determining no significant differences, data hereby presented result from the analysis of the samples as a whole in order to identify some common features depicting a general framework of the area under investigation.
The texture of soil samples was determined by hand analysis in the field. Most of the samples (60%) were found to be loamy sand, followed by sandy (30%) and sandy loam (10%). As such, soil in the area being studied was assumed to be characterized by low water retention capacity, low cation exchange capacity and low organic matter content. The latter feature was in fact confirmed by soil analysis that provided evidence of a very low organic matter content (<2.8%) for most of the samples (40%), followed by low (2.9 – 4.0%) (40%) and moderate (4.1 – 7.5%) (20%). The generally low organic matter content, as well as the very high pH found in 90% of the samples (>8.1), can be explained by referring to the environmental conditions characterizing the area under investigation which is particularly dry, with very scarce precipitation and low mean temperatures. These conditions, in fact, affect the production of biomass and slow down its decomposition, thus turning into a reduced amount of organic matter in soil that is further exacerbated by a scarce return of nutrients due to inadequate agricultural practices still in use (e.g. harvest of quinoa by uprooting plants). Closely related to the abovementioned conditions is also the reduced amount of N that, in 90% of the samples, was found to be very low (<0.20%). The determination of the C/N ratio resulted high (between 15 and 20) in most of the samples (40%), thus pointing to a low edaphic quality with a very low organic matter mineralization rate associated with the presence of persistent humus components. P and K content were, instead, found to be moderately high in most of soils samples (7.1 – 15.0 ppm, and 0.71 – 1.20 meq/100 g respectively). In respect to K, a high content is likely to be found in soils derived from sands and volcanic ashes as those analyzed, therefore this result is in line with the context being investigated. By contrast, a low content of P would be expected in light of the low organic matter content that has been found. As this is not the case, with 40% of soil samples showing moderately high and 20% high P content, further investigation would be required in order to fully understand the factors underlying such a high value and determine the amount of P that is readily available. The integrated analysis of the data reported so far, *i.e.* soil texture, organic matter content, N, P, K content and C/N ratio, resulted in the preliminary evaluation of soil fertility based on the Soil Fertility Table by the Instituto Geográfico "Agustín Codazzi": according to it, 70% of the soil samples being analyzed is characterized by low to moderate soil fertility.
As abovementioned, by means of interviews to quinoa producers, the use of organic manure in crop production is a common practice. Specifically, 88% of the farmers interviewed in Colcha K declared they

use a combination of llama and sheep manure in agriculture, with 84% of them applying it to quinoa. In Tomave the share of farmers using organic manure in agriculture was found to be 80%, with 60% specifically using it in quinoa production. The higher gap observed in this regard in the community of Tomave is likely due to the fact that in this municipality crop rotation is commonly carried out, which is not the case of the community of Colcha K. Therefore, in Tomave organic manure is also applied to other crops, particularly potato that usually goes before quinoa in the crop rotation cycle. In Salinas almost all farmers interviewed use organic manure for quinoa cultivation (97% out of 98% using organic manure in agriculture). As concerning the quantity of organic manure that is usually applied to quinoa, no significant differences were found while comparing Colcha K and Tomave as in both municipalities about 10-12 t/ha was the value emerging from interviews to farmers. Such a feature was found mostly correlated to a mean yield of 28 q/ha[2], which is line with data found in literature (Vecchio et al. 2012). In Salinas the same yield was found to be correlated to the application of a higher quantity of manure (13-16 t/ha). When investigating about treatments possibly applied to fresh manure to produce humus and/or compost, in Tomave and Colcha K these practices were not found to be commonly in use, with 4% of farmers processing manure into humus in the former and none in the latter. In this sense, Salinas is an exception in that 36% of the farmers interviewed declared they process manure to produce compost and 10% produce humus.

In regard to the analysis of the chemical properties of llama manure, different features emerged while comparing samples taken from different communities. In respect to N content, it was found to vary between very low and low (1,14% in Machicado and 1,39% in Villa Candelaria, respectively). K content, measured as K_2O, instead, was found to show a very high variability, spanning from very high to low (1,51% in Opoco and 0,25% in Irpani, respectively). On the other hand, P content, measured as P_2O_5, showed a similar variability, from high to low (1,51% in Mañica and 0,12% in Opoco). All the samples were found to have alkaline pH, ranging from 7,44 (Opoco) to 8,51 (Mañica and Villa Candelaria). All the reported data are in line with previous study conducted in the same area (FAO-SNAG 1995: Ruíz and Bustamante 1988). The analysis of llama manure samples here presented were then combined with the investigation of the number of livestock units in each community in order to evaluate the amount of manure possibly available to be used as fertilizer and provide a quantification of nutrients possibly returned to soil. According to the most recent census conducted in the communities under investigation (APSA 2010), the number of llamas varied from 546 (Mañica) to 1311 (Villa Candelaria). However, according to the trend observed over last few years leading to the significant reduction of llamas in the Southern Bolivian highland (Winkel et al. 2014), these features may have significantly changed. Moreover, the chemical composition of manure, as well as its physical properties, closely depends on several factors, including sex, age, genetics, health conditions and nutrition, that have not been investigated in the present study.

Therefore, the preliminary results obtained so far depict a framework where still livestock breeding activities are integrated with quinoa production. In this framework, farmers are aware of the benefits of manure application, though they do not optimize its use as they currently do not process manure into compost or humus. A thorough evaluation of the amount of nutrients possibly returned to soil by incorporating the available quantity of manure still requires further investigation.

The present study, as well as the preliminary results that emerged from it, is in line with the growing literature currently being produced about quinoa which is mostly due to the environmental and social issues gradually emerging from the intensification of cultivation of such a crop (Bonifacio 2014; Soraide Lozano 2011; Aroni et al. 2009; Félix and Vilca 2009; Arce 2008; Cárdenas and Choque 2008; Michel 2008;). Amongst the studies currently available, particular attention has been paid to soil fertility related to land use and soil management practices, where mechanization, the abandonment of fallow land practice and of manure application have been alleged as the causes of an accelerated soil degradation (Winkel et al. 2014). However, there is no scientific evidence demonstrating a clear correlation of soil fertility reduction and

[2] *Quintal* is a unit of measurement commonly used in Bolivia corresponding to 45.36 kg. The reported feature (28 q/ha), thus, corresponds to 1270 kg/ha.

quinoa production associated practices. Such a gap in research does not prevent an active debate on how to reverse this soil degradation trend apparently consolidating in the Southern Bolivian highlands (Winkel et al. 2012; Jacobsen 2011; Félix and Vilca 2009; Cossio 2008). For instance, there is a wide consolidated agreement on the beneficial effects that the incorporation of organic manure would have on soil fertility (Soraide Lozano 2011; FAUTAPO 2007; Fuentes 1989; Fersini 1994) but, at the same time, some have argued about the effectiveness of such a practice due to observed limited effects likely caused by the immobilization of nitrogen and other nutrients (Miranda Casas 2012; Cárdenas and Choque 2008). Though it might be argued that soil would indirectly benefit from the application of organic manure as this would enhance both physical and chemical properties, still a complete analysis covering the effects of soil management practices on soil fertility, both in the short and long term, is missing. Such an analysis would be particularly relevant under the agroecological conditions of the Southern Bolivian highlands that, as pointed out by the present study and reported in literature (FAUTAPO 2008), is characterized by very low fertility soils and a shift from llama breeding activities to the establishment of quinoa monocultures, which is gradually replacing the long established practice of integrated production systems. Studies analyzing quinoa agroecosystems as implemented in the Southern Bolivian highlands do exist (Soraide Lozano 2011) and provide an extensive general picture of quinoa production in this area. However, more detailed studies conducted both at municipality and community level would provide the material to develop an integrated database collecting and systematizing both soil data and soil management practices likely affecting the status of soils in the Southern Bolivian highland. The development of such a database, to which the present study positively contributes by partially constituting a baseline for the communities and municipalities taken into account, would have manifold applications. In the first place, when applied to quinoa agroecosystems producing in the framework of the Fairtrade scheme, a database bringing together and correlating soil data and soil management practices would allow for the analysis of the environmental impacts of the implementation of this scheme, on which there still is little evidence (Elder et al. 2013). In this sense, the establishment, as well as the expansion and update of this database, would significantly contribute to closing a gap in research and provide the means for a comprehensive evaluation of the implementation of the Fairtrade scheme, currently mostly focused on socioeconomic aspects. Moreover, the availability of an integrated soil related database would likely have a positive spillover effect on the implementation of the Fairtrade scheme, as it would usefully facilitate the monitoring of environmentally sound practices being carried out by quinoa producers that adopt the Fairtrade standards. On the other hand, the evaluation of the effects of soil management practices on soil quality would also allow for the design of *ad hoc* measures, both at the farm and producer organizations level. Such guidelines would be aimed at ensuring the sustainability of quinoa production in the long term, thus contributing to address the environmental issues currently affecting Southern Bolivian highland ecosystems, as well as the vulnerability of producers that highly depend on quinoa cultivation in the area.

Conclusions

The present study, focused on three municipalities in the Southern Bolivian highland, was aimed to contribute to the evaluation of the environmental impact of Fairtrade standards applied to quinoa production. The quali-quantitative data on soil fertility and soil management practices collected in the communities being analyzed are in line with previous study conducted in the area, but constitute a step forward as they provide a more detailed level of analysis that could be positively intended as the core of an integrated soil database at the community level. Such a database would usefully support the implementation of a monitoring system ensuring the application of the environmental Fairtrade standards, while providing the means for a thorough evaluation of their impacts in the long run, which is currently missing in literature. Moreover, the collection and systematization of soil related data at the community level, to which the present study positively contributes, provide the basis for designing *ad hoc* measures to be implemented both at the farm and producer organization level. With this aim, further analyses are being performed in order to quantify the amount of nutrients removed by crops currently cultivated in the area and design accordingly appropriate soil management practices enhancing soil fertility. These measures are to be meant as guidelines to ensure environmentally sound soil management practices be applied by quinoa producers. Not least, the implementation of such practices should be envisaged in the framework of a strategy including also socioeconomic aspects involving different stakeholders participating in the quinoa value chain. As such, they would positively contribute to ensure the long term sustainability of quinoa production, thus addressing the high vulnerability of the context being analyzed.

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