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SHORT COMMUNICATION

The Sustainability of Quinoa Production in Southern Bolivia: from Misrepresentations to Questionable Solutions. Comments on Jacobsen (2011, J. Agron. Crop Sci. 197: 390–399)

T. Winkel[1], H. D. Bertero[2], P. Bommel[3], J. Bourliaud[4], M. Chevarría Lazo[4], G. Cortes[5], P. Gasselin[6], S. Geerts[7], R. Joffre[8], F. Léger[9], B. Martinez Avisa[10], S. Rambal[8], G. Rivière[11], M. Tichit[9], J. F. Tourrand[3], A. Vassas Toral[5], J. J. Vacher[1] & M. Vieira Pak[3]

1 IRD, CEFE-CNRS, Montpellier, France
2 Universidad de Buenos Aires, Facultad de Agronomía, Cátedra de Producción Vegetal, C1417DSE, Buenos Aires, Argentina
3 CIRAD, UR GREEN, Montpellier, France
4 INRA, UR MONA, Ivry-sur-Seine, France
5 Université Paul Valéry, UMR 5281 ART-Dev, Montpellier, France
6 INRA, UMR INNOVATION, Montpellier, France
7 Katholieke Universiteit, Department of Earth and Environmental Sciences, Leuven, Belgium
8 CNRS, UMR 5175 CEFE, Montpellier, France
9 INRA, UMR SAD-APT, Paris, France
10 ANAPQUI, Asociación Nacional de Productores de Quinua, La Paz, Bolivia
11 EHESS, CERMA, UMR 8168 MASCIPO, Paris, France

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Correspondence
T. Winkel
CEFE-CNRS/IRD
F-34293 Montpellier Cedex 5, France
Tel: +33 467613255
Fax: +33 467613336
Email: thierry.winkel@ird.fr

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Abstract

Reviewing the situation of quinoa production in southern Bolivia, Jacobsen (2011, J. Agron. Crop Sci. 197: 390) argues that the booming export market has a negative effect on the environment and on the home consumption of quinoa, thereby leading to an environmental disaster in the region. In view of the scarcity of scientific knowledge on the rapid social and environmental dynamics in the region, we consider that Jacobsen's review misrepresents the situation of quinoa production in southern Bolivia. Specifically, we argue that (i) the data presented by Jacobsen (2011, J. Agron. Crop Sci. 197: 390) do not support any drop in quinoa crop yield supposed to reflect soil degradation and (ii) his demonstration regarding home consumption of quinoa is ill-founded from both a nutritional and a cultural point of view. We suggest that the diffusion of the arguments exposed by Jacobsen (2011, J. Agron. Crop Sci. 197: 390), because of their flaws, might have strong negative impacts on those concerned with sustainable food production and fair-trade with developing countries. We conclude that, rather than reinforced agro-technical controls on local farmers, the rising competition in the international quinoa market requires a shift towards an ethical economy and ethical research cooperation with quinoa producers.

Introduction

A recent article by Jacobsen (2011) reviews the situation of quinoa production in southern Bolivia considering the environmental and socio-economic changes experienced by this native Andean crop since it entered in a booming export market in the late 1980s. On the basis of these major changes in quinoa production, it is argued that 'the development of an export market can have a negative effect on the environment and on the home consumption of the same product', thereby leading to an environmental disaster in the region. Quinoa production, as reviewed by Jacobsen (2011), is thus in need of urgent technical adjustments, such as sophisticated irrigation systems and reinforced controls on local quinoa crop production.

In spite of its rising commercial interest worldwide, the scientific literature on quinoa remains scarce in comparison with other staple crops, the more so if one focuses on a particular production zone such as the southern altiplano of Bolivia. Reporting the conclusions of an international workshop on the sustainability of the biological production in this region, Reynolds et al. (2008a: 11) pointed that very few data are available on changes in soil erosion in different landscape areas, and still less regarding the critical factors determining the sustainability of the biological production in the area. Considering this lack of scientific studies and the very rapid social and environmental dynamics in the region, we consider that Jacobsen's review misrepresents the situation of quinoa production in southern Bolivia. Here, we argue that:

1. a reanalysis of the data presented by Jacobsen (2011) does not support any drop in quinoa crop yield supposedly reflecting environmental degradation over the period of increased production; and
2. the demonstration by Jacobsen (2011) regarding home consumption of quinoa is ill-founded from both a nutritional and a cultural point of view.

After signalling some other flaws in the diagnosis and solutions exposed by Jacobsen (2011), we suggest that the diffusion of these arguments, although scientifically inconsistent, might have strong negative impacts on those concerned with sustainable food production and fair-trade with developing countries.

Evidence of an environmental disaster?

Soil degradation as a result of increasing use of tractors and reduced access to animal manure is the major environmental problem pointed out by Jacobsen (2011: 392, 393). To support his argument that 'severe degradation of soil fertility' has occurred as a result of quinoa crop expansion, Jacobsen cites publications by PIEB (2009) and APSA II (2008). However, the former document is merely a call for research proposals, and the latter an internal funding report, neither of which present scientific evidence of soil degradation in the region. In our opinion, the conclusions drawn by Jacobsen (2011) about these publications surpass the current knowledge of soil fertility in the southern altiplano of Bolivia, not to mention its potential underlying factors (fallow duration, manure application or tractor use). Nevertheless, referring to a figure showing the yield of quinoa in Bolivia over the period 1961–2009, Jacobsen (2011: 391) states: 'with the last 10 years' area increase, yield has decreased from close to 700 to 570 kg ha^{-1} in 2009'. He then suggests a direct relation between a reduced fallow duration and 'the progressive reduction in yield of quinoa over the last 20 years', citing Félix (2008). Apart from the fact that the development project report by Félix (2008) was not designed to scientifically demonstrate any causal relationship between fallow duration, soil fertility and crop yield, the quinoa yield data series presented by Jacobsen (2011) in his Figure 1 clearly does not support his assertion of a decreasing quinoa yield over the boom period. On the contrary, reanalyzing this data series (our Fig. 1) shows that the slope of the time regression does not differ from zero over the period 1961–2009 and is even significantly increasing over the last 20 years, actually contradicting Jacobsen's statement. In reality, this data series of quinoa yield alternates two periods of increase (1961–1975, 1991–1997) with two periods of decrease (1976–1990, 1998–2009). Such pluriannual fluctuations in quinoa yield are difficult to interpret without complementary information about climate trends, landscape changes, crop practices and soil fertility in the region. Indeed, with a 20 % coefficient of variation over the period 1961–2009, the national quinoa production in Bolivia stays within the normal range of interannual yield variability for a crop produced under low-input agriculture in an arid environment, without any decreasing trend that might suggest an environmental disaster.

In fact, propagating an error commonly made by other authors he cites (Cossio 2008, Félix 2008), Jacobsen (2011) makes a link between the supposedly decreasing trend in annual crop yield and the process of soil degradation, forgetting that, owing to many interfering phenomena (plague bursts, climate stresses, crop practices, etc.), a fast variable such as crop yield is inadequate to characterize a slow process such as land degradation (Reynolds et al. 2007, 2008b). Besides, gross national statistics, with all the limitations they suffer in a developing country like Bolivia, hardly constitute reliable indicators of an environmental crisis at a local scale. A conclusion of this reanalysis of Jacobsen's argumentation is thus that detailed, scientifically based studies are lacking and urgently needed to quantitatively characterize the

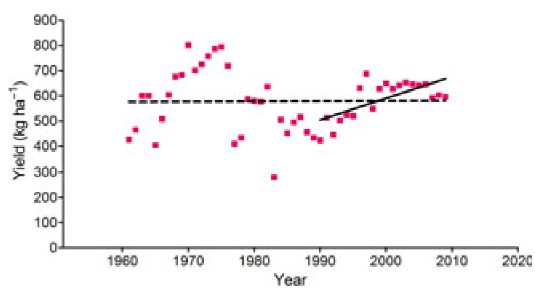

Fig. 1 Statistical regressions on the quinoa yield data series published by Jacobsen (2011, Fig. 1). Period 1961–2009 (dashed line): slope = 0.112 ± 1.18, P = 0.92. Period 1990–2009 (solid line): slope = 8.64 ± 2.18, P = 0.0009.

processes relating quinoa yield to soil management in that region undergoing rapid changes in land use and agricultural practices.

Quinoa home consumption

Turning to the problem of quinoa home consumption, Jacobsen (2011: 392) states that 'export of quinoa has increased since 2001 whereas domestic consumption has decreased', fitting national statistics. First, we would maintain that the practice of fitting a polynomial regression to a time series of only 12 data points, affected by high interannual variability, is highly unlikely to lead to statistically robust results. A much longer time series is needed to be able to draw any valid conclusion regarding significant changes in quinoa home consumption. Secondly, it is not at all clear how such gross national data could reflect the diet of the quinoa producers in the southern altiplano of Bolivia: this is the same problem, as mentioned above, of extrapolating conclusions drawn from national data to a local scale. Nevertheless, Jacobsen (2011: 396) alleges that 'the farmers in the southern altiplano region, where the large seeded quinoa Real is grown for export, are no longer consuming their own quinoa, because of the high market value', continuing: 'Data from household surveys have shown that the majority of meals during the survey time did not include quinoa at all, suggesting that perhaps quinoa is now becoming an underutilized food among quinoa producers'. However, no data from any anthropological or sociological study are shown to support this supposed change in local food consumption. Some recent data on the quinoa consumption by farmer families in the southern Bolivian altiplano do exist. Laguna (2008: 130) found that self-consumption of quinoa by farmers in that region is around 12 to 14 % of their own production. More recently, in a study on 275 households of the southern altiplano, Astudillo (2007: 24) reports that 40 % of the meals prepared the day before the survey included quinoa, with still higher figures in the families distant from the roads. Acosta-Alba (2007: 25) in a survey of 36 families from the north and the west of the Salar of Uyuni remarks that all the quinoa producers keep around 10 % of their total production for self-consumption and seed stock. Héran (2011) observes that whatever the volume of their production, quinoa producers from the east of the same region always keep a quantity of quinoa between 40 and 200 kg per year for their own family consumption. Ofstehage (2010: 23) in an ethnographic study in the south of the Salar of Uyuni (Los Lípez) states that 'A sizable amount of quinoa also remains in the Uyuni region in the form of self-consumption'. Finally, although centred on quinoa consumption in urban areas, the study of Montoya Choque (2007: 22, 25, 27) states that most of the quinoa produced in the Bolivian altiplano is consumed by the producers' families.

More generally, we would highlight here a confusion commonly made by those concerned by the weight of quinoa in the diet of local peasant families. It is a general observation that, on a quantitative weight basis, quinoa represents a smaller fraction of the diet than pasta or rice (Rojas et al. 2004). Many nutritionists, considering the high and balanced protein content of quinoa grain, regard a substantial increase in quinoa in the diet of local populations as highly beneficial for their health. However, we need to be careful in our appraisal of the role of quinoa in the local diet: a common intuition is that the weight of quinoa should be equivalent to that of other starchy foods, namely Andean tubers, legumes, maize, oat, pasta, bread or rice. Although quinoa is promoted in the markets of the northern countries as the 'rice of the Incas', Andean populations have never consumed it as a staple cereal, like rice in Asia or wheat in the Middle East and Europe. In fact, native Andean people regard quinoa as a 'heavy' foodstuff and, as a dietary rule, consider it harmful to eat it for dinner (Johnsson 1986: 107). Traditionally, quinoa is mostly used to thicken soups or drinks (*lahua, pesqe*) or in the form of small cookies (*kispiña, mukuna*), and less frequently as main dish (*phisara*) (National Research Council 1989, Tapia et al. 2000). Hence, quantitative comparison of the relative weights of quinoa, pasta and rice is an incorrect basis for evaluating the balance of the diet of the local populations. In our opinion, the unreferenced statistics shown by Jacobsen (2011: 396) stating that 'the consumption of quinoa in Bolivia is only 2 kg per person per year, whereas the same for rice and pasta is 25 kg' are thus meaningless on both a nutritional and a cultural basis. We agree with Jacobsen (2011: 396) that quinoa has tended to be replaced by pasta and rice, which, contrary to the quinoa grain commonly available in the villages and the urban markets of Bolivia, do not require tedious cleaning and washing before consumption. But this change occurred long before quinoa entered the export market (see Johnsson 1986: 167, referring to the early 1980s) and reflects a general trend among Latin American countries to import subsidized wheat products from North America, beginning at least fifty years ago (Hellin and Higman 2005: 168). It is thus incorrect, as Jacobsen (2011) and many journalists do, to relate decreasing home consumption of quinoa to the recent commercial success of that grain in the international food market. Furthermore, Jacobsen's assertion ignores the recent efforts developed by the Bolivian government to promote the home consumption of quinoa through its inclusion in the food security programmes of 'desnutrición cero', 'desayuno escolar' and 'subsidio de lactancia familiar' (MDRyT (Ministerio de Desarrollo Rural y Tierras) – CONACOPROQ (Concejo Nacional de Comercializadores y Productores de Quinua), 2009).

Flawed diagnosis and possible solutions… to put more threat on agricultural sustainability?

The diagnosis of the situation reviewed by Jacobsen (2011) is littered with inaccuracies or oversimplifications (e.g. on page 391, the range of extreme temperatures from −11 °C to 30 °C mixes a seasonal low temperature mean and an absolute high daily temperature, which is meaningless). More critical of his demonstration is the allegation that 'The agricultural frontier has been extended, as virgin land on the planicie is being ploughed' (Jacobsen 2011: 392). There is some confusion here, as the areas ploughed in the flat areas of the southern altiplano are not virgin lands but instead pasture lands, used since ancient times by local populations for their llama and sheep herding. Quinoa crops expand at the expense of pasture (not virgin) lands as the result of changing decisions made by the local farmers. A real problem, namely the conversion of common pastures into private croplands, with the consequent land tenure changes and marginalization of livestock, is thus oversimplified by Jacobsen (2011) into a process of agricultural expansion over virgin lands. This simplification allows the author to write later in the text: 'the incorporation of virgin lands into the production is in opposition to the basic standards of IFOAM' (Jacobsen 2011: 393). In our opinion, this is an undue conclusion distorting the complex socio-environmental issue of agricultural land use change in the region.

Various possible solutions are proposed by Jacobsen (2011: 394) to deal with the range of agro-technical problems that he identifies. Some of these solutions seem rather doubtful, and one wonders, for example, how high beds (*suka kollos*) could be established, as Jacobsen (2011: 395) suggests, in such an arid area as the southern altiplano of Bolivia since this pre-Hispanic technology was designed for wetlands areas near Lake Titicaca or in the Amazonian plains (Denevan 2001). Regarding irrigation, it is traditionally applied in the region, but on a very small scale only, using some scarce superficial water springs. This traditional irrigation is of an entirely different scale to that of the CPTS project (CPTS 2011) to drill 200 wells to irrigate 1 million hectares of quinoa croplands in the southern altiplano of Bolivia (to be compared to the approximately 52 000 ha currently cultivated in Bolivia as a whole). Should it become a reality, it is to be hoped that the agencies funding this project would conduct a scrupulous evaluation of its potential impact on environmental, social and economic sustainability in the region.

Supplementary irrigation is regularly presented as a possible solution for sustainable quinoa production, with the argument that the improved and more stable grain yield in irrigated fields would reduce the need to expand the cultivated area to increase total quinoa production. In fact, Jacobsen (2011: 394–395) broadly develops the potential benefits of focused deficit irrigation, especially in the form of alternate irrigation (ARD) and drip irrigation. Although briefly mentioning the potential risks of soil salinization or loss of aquifers by overpumping, Jacobsen (2011: 395) still concludes that supplemental irrigation has a 'great potential for increasing agricultural production and improving livelihoods in dry rain-fed areas'. Based on studies conducted in West Asia and North Africa (Oweis and Hachum 2006), his conclusion omits the results of the QUINAGUA research programme on deficit irrigation in the Bolivian altiplano (Geerts et al. 2008a). In the specific case of the southern altiplano where water resources are scarce and often saline, Geerts et al. (2008b) claim that 'deficit irrigation with poor quality water and cultivation of crops in fields with a shallow saline groundwater table pose a serious threat for sustainable quinoa farming'. The authors then conclude: 'although potentially beneficial, deficit irrigation of quinoa in arid regions such as the southern Bolivian altiplano should be considered with precaution'. Incidentally, a further unanswered question is that of how drip irrigation systems and sophisticated watering procedures like ARD would reliably work on a 3600-m-height highland exposed to extreme solar radiation and frequent night frost during the crop season (Pouteau et al. 2011). It is also not clear how, without large sources of external funding, such advanced techniques could be implemented and durably managed in one of the most disadvantaged area of Latin America.

Conclusion

The current booming production of quinoa in the southern altiplano of Bolivia raises legitimate concerns about social and environmental sustainability in the region (Reynolds et al. 2008a,b, Winkel 2008, Winkel 2011). In view of the rapid changes in crop systems potentially threatening the environmental basis for a sustainable quinoa production, some observers may have a tendency to use their 'personal impressions' as reliable evidences of an environmental disaster and impending threats to local food security. Leaving aside rough relationships between national quinoa yield statistics and local soil fertility, as well as poorly supported assertions concerning the diet of Bolivian farmers, we have very limited knowledge about the agro-ecological and social basis of quinoa sustainability in the southern altiplano of Bolivia. Recently, national and international research programmes have begun to investigate the complex issues of agricultural sustainability in this region (e.g. ARIDnet, EQUECO, IFAD-NUS, PIEB-MDRT-MPD, QUINAGUA). The preliminary results of these programmes have shown the importance of agro-environmental issues, in particular those related to the landscape structure and organization (Winkel 2011). But beside environmental preoccupations, the conclusions of these programmes emphasize the fundamental role of socio-economic issues such as land tenure and the conversion of collective pasture lands into private crop fields, or the intricacies of farming and non-farming activities managed by the households of quinoa producers in their search for a better standard of living (Chaxel 2007, Vassas et al. 2008).

We believe that diffusion of the arguments of Jacobsen (2011), although scientifically unsound, may have a strong negative impact on those concerned in sustainable food production and fair-trade relationships with small farmers in developing countries. Wrongly alarmed by the reported negative consequences of their consumption choices, some consumers in northern countries might reverse their support to Andean quinoa producers. We conclude that, rather than reinforced agro-technical controls on poor farmers, the increasing competition in the international quinoa market requires a shift towards more ethical economic relationships with exporters and ethical research cooperation with quinoa producers. The cornerstone of such ethical relationships in economy and research is the active participation of their ultimate beneficiaries, namely the local farmers. This implies focusing on their own needs and realities, and continuously associating them with the process of problem posing, knowledge building and decision-making (ISE 2006). As regards agricultural management and research, this approach would avoid what Holling and Meffe (1996) called the pathology of managing natural resources by 'command and control' (see also Stallman 2011) and, thus, will promote a perspective better grounded in the collective management of natural resources (Ostrom 1990) and the human right to adequate food (De Schutter 2011).

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