Land Use Policy 79 (2018) 475–480

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

The quinoa boom in Peru: Will land competition threaten sustainability in one of the cradles of agriculture?

Noelia S. Bedoya-Perales[a,*], Guilherme Pumi[b], Edson Talamini[a,c], Antonio Domingos Padula[a,d]

[a] Center for Studies and Research in Agribusiness (CEPAN), Universidade Federal do Rio Grande do Sul (UFRGS), Av. Bento Gonçalves 7712, Agronomia, CEP 91540-000, Porto Alegre, RS, Brazil
[b] Statistics Department, Universidade Federal do Rio Grande do Sul (UFRGS), Av. Bento Gonçalves 9500, Agronomia, CEP 91509-900, Porto Alegre, RS, Brazil
[c] Department of Economics and International Relations (DERI), Universidade Federal do Rio Grande do Sul (UFRGS), Av. Joao Pessoa 31, CEP 90040-000, Porto Alegre, RS, Brazil
[d] School of Management, Universidade Federal do Rio Grande do Sul (UFRGS). Rua Washington Luis 855/409, CEP 90010-460, Porto Alegre-RS, Brazil

ARTICLE INFO

Keywords:
Farming practices
Agrobiodiversity
Land use
Land use competition
Andes

ABSTRACT

For a long time, the Andean grain crop quinoa (*Chenopodium quinoa* Willd.) was just another example of the thousands of little-known and underutilized plants. Today, however, quinoa is considered a superfood due to its exceptional nutritional value and its international demand has soared. One consequence is that in Peru, due to its position as the world's largest producer of quinoa, questions have arisen regarding the extent to which the expanding global demand for the crop is compatible with appropriate natural resource management. Regarding this issue, the present study uses descriptive statistics for each region of Peru to calculate the mean variation in the percentages of harvested production and harvested area of a range of native Andean crops from 1995 to 2014. The findings show that the boom in demand has led to the emergence of a new geography of quinoa production in Peru, which has been accompanied by the transformation of traditional farming practices and a trend towards increasing competition for land use. For all those involved, this phenomenon warns of the urgent need to create a sustainable interaction between socio-economic and environmental demands. This warning is particularly relevant given Peru's historical role in agriculture as a center of crop genetic diversity.

1. Introduction

When, in 1492, Christopher Columbus set foot in the new lands that would later be called the Americas, it provoked a series of events that would forever transform human eating habits. The adventurers that followed him encountered a wide range of agricultural products consumed by the native peoples of the New World, many of which were then introduced to European markets. The new lands of the Americas came to provide a wealth of new food products that had been domesticated by the Neolithic peoples who lived there, of particular note among them are: corn, potatoes, manioc, various beans, tomatoes, pumpkin and sunflower (Mazoyer and Roudart, 2006).

The processes of occupying, colonizing and trading in the new lands allowed foodstuffs that had, until then, beenisolated on disconnected continents to begin to circulate around the world. There followed a profound transformation of traditions, customs, lifestyles and eating habits on a global scale. The documented history of agriculture in the Americas shows the Peruvian Andes ranks to be one of the original centers of Neolithic agriculture, having emerged independently at least 6000 years before present (Dillehay et al., 2005, 2007; Mazoyer and Roudart, 2006).

Distinct cultures in Ancient Peru learned to manipulate plants and in the process of experimentation managed to successfully domesticate them in territories with complex topographical and climatic features (Pearsall, 2008; Piperno, 2011). All this knowledge of plant manipulation was transmitted over millennia and reached a peak during the Inca Empire, between the 15th and 16th centuries (Covey, 2008; Cuellar, 2013). In the 500 years following Columbus's arrival in the Americas, and with the transfer to the New World of agricultural products originating from the ancient Fertile Crescent (the Middle–East), such as barley and wheat, competition for land use heightened. This led to a dramatic reduction in the production of local crops (Vietmeyer, 1986) and the expansion of today's commonly-known agricultural commodities (Defries et al., 2015). However, the ancient Andean cultures left a great legacy to the 21st century world in the form of an exceptionally nutritious grain, quinoa (*Chenopodium quinoa* Willd.),

* Corresponding author.
E-mail addresses: noelia.bedoya@gmail.com (N.S. Bedoya-Perales), guipumi@gmail.com (G. Pumi), edson.talamini@ufrgs.br (E. Talamini), antonio.padula@ufrgs.br (A.D. Padula).

https://doi.org/10.1016/j.landusepol.2018.08.039
Received 11 July 2016; Received in revised form 27 August 2018; Accepted 27 August 2018
0264-8377/

which has only recently been recognized by health-conscious consumers around the world (Repo-Carrasco et al., 2003; Abugoch, 2009; Nowak et al., 2015). As a consequence, Peru has emerged as one of the most important players in the world's health-food market. Hence, a question arises regarding the extent to which the growing global demand for quinoa is compatible with the appropriate natural resource management in Peru. Accordingly, to help answer to this research question, this study adopts three analytical dimensions: (i) the evolution of land use for the cultivation of quinoa; (ii) the transformation of agricultural practices; and (iii) the tendency towards competition for land use.

Analysis of the implications of changes in land use over time provides important insights into the process of designing strategies to strengthen food security (Rockson et al., 2013; Smith, 2013). This is relevant because one of the biggest challenges facing the future of global agriculture is how to reconcile the food production expansion while minimizing the negative impacts on biodiversity, ecosystem services and society (Hazell and Wood, 2008; Pretty et al., 2010; Lambin and Meyfroidt, 2011; Phalan et al., 2011; Tscharntke et al., 2012; West et al., 2014; Liu et al., 2015; Jones et al., 2016).

2. Materials and methods

2.1. Data sources

To achieve a deeper understanding of the evolution of quinoa production in Peru, data obtained from The Office of Economic and Statistical Studies of the Peruvian Ministry of Agriculture and Irrigation (OEEE-MINAGRI) regarding production volumes and harvested area (OEEE/MINAGRI, 2015), and from The Integrated Information System on Foreign Trade (SIICEX) regarding trade flows (SIICEX, 2015) were analyzed. As Peru is divided into 25 political regions, data were collected separately for the quinoa producing regions, of which there are 18 in total. Data were also analyzed on the production and acreage of the following neglected crops in Puno region: cañigua (*Chenopodium pallidicaule*) mashua (*Tropaeolum tuberosum*), oca (*Oxalis tuberosa*) and tarhui (*Lupinus mutabilis*) in the period from 1995 to 2014.

Due to the availability of data for the above-mentioned crops, the year 1995 was selected as the starting point for the analysis. It is worth mentioning that from 1990s, in terms of land tenure and the institutional framework, significant changes occurred in the Peruvian agricultural sector (INEI, 1997).

2.2. Data analysis

In order to characterize and visualize the evolution of quinoa cultivation, thematic maps have been designed considering the criteria described below.

All the figures presented here and in the Supplementary Materials were designed using the free R statistical software (R Core Team, 2014). For the maps, "rgdal", "sp" and "sfsmisc" packages were applied. The color palettes for the maps and the intervals for colors were constructed based on quantiles, which provided rough starting points for the intervals. Based on these, the intervals were constructed by the authors.

For each region, the percentage of variation was calculated with respect to the previous year, provided that the harvested area in the previous year was non-null. If, in the previous year, the harvested area was 0, to avoid division by zero, we calculated the percentage with respect to the last non-null harvested area (as was the case for Ica and Lima). If the harvested area in all previous years was null, then it was impossible to calculate the percentage for the first non-null year and we coded the percentage as null (as was the case for Lambayeque and Tacna).

For each region in Peru, the Supplementary Materials present both the harvested area by year in the period 1995–2014 (SM Fig. 1 (a)-(c)) and the annual variation in the percentage of harvested area (AVPHA) in the period 1996–2014 (SM Fig. 2 (a)-(c)).

In addition, descriptive statistics were used to calculate the mean variation in the percentages of harvested production and harvested area of Andean crops on the Peruvian Andean Plateau.

3. Results and discussion

3.1. The emergence of the new geography of quinoa production in Peru in the 21st century

Quinoa is one among a long list of Andean agriculture products that became marginalized following the arrival of Europeans in the Americas (Vietmeyer, 1986; FAO, 1994). The factors contributing to its marginalization include the introduction of cereals that replaced quinoa cultivation (such as barley and wheat), as well as technical, economic and social reasons. Thus, the continued cultivation of quinoa over centuries has largely been due to the knowledge held by the indigenous peoples in Andean rural communities (UNFAO, 2012). Over recent years, with its high nutritional value and purported health benefits, this crop has gained prominence worldwide and is now considered a modern superfood (Groeniger et al., 2017; Louie et al., 2017). As a result, Peru has undergone a transition from a country producing quinoa predominantly for local consumption, to the world's largest producer and exporter of the product (FAOSTAT, 2016).

Fig. 1 shows how land use has changed in Peru in response to the global demand for quinoa from 1995 to 2014.

Compared to 1995, the amount of quinoa produced in Peru in 2014 was approximately eight times greater, while the area under cultivation had increased fourfold. This spectacular expansion was partially the result of domestic initiatives, such as, the Peruvian Government demanding the inclusion of quinoa in food aid programs. Nevertheless, more decisively, there was an explosion in global demand for the product that led to a boom in quinoa exports, which increased almost 600 times, from little more than 61 tons in 1995 to more than 36,000 tons in 2014 (SIICEX, 2015).

As of 2008, production volumes rose rapidly, with a massive crop between 2013 and 2014, when there was an increase of 120% in the quantity produced, reaching close to 115 thousand tons, and 52% in the cultivated area, which reached just over 68,000 ha. According to Bedoya-Perales et al. (2018), this area would have been 43% smaller without the quinoa boom from 2009.

There is considerable diversity of quinoa´s strains in the Andean Plateau, adapted to different altitudes, especially in the areas surrounding Lake Titicaca in Peru and Bolivia (Mujica et al., 2001; FAO and CIRAD, 2015). On the Peruvian side, the Puno region is part of the Plateau, located at an altitude of approximately 4000 masl, and is known for producing the largest amount of quinoa in the country. With the increased demand of quinoa on international markets, its cultivation has expanded in other traditional growing regions and even to regions where it had not been grown previously, mainly on the Peruvian coast. An example being the Arequipa region in which the area under quinoa cultivation increased by 481% between 2013 and 2014.

3.2. The transformation of farming practices – from polyculture to monoculture

Although quinoa is able to adapt to the varied agro-climatic conditions at the different ecological levels (altitudes) in Peru, it requires large amounts of nutrients (Mujica et al., 2001). Therefore, appropriate soil management practices are vital for its sustainable production. Thus, quinoa farming has traditionally involved the use of crop rotation. According to Mujica et al. (2001) and FAO and CIRAD (2015), on the Andean Plateau, the ideal crop rotation is potato production in the first year; quinoa in the second year; cereals, legumes or tubers in the third year, followed by forage. After which, the land should lay fallow to recover soil fertility.