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Characterization of producers and quinoa supply chains in the Peruvian regions of Puno and Junin

Waldemar Mercado*; Karina Ubillus

Facultad de Economía y Planificación – Universidad Nacional Agraria La Molina, UNALM, Apartado postal 12-056, La Molina, *Lima, Peru.*

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Abstract

The present study aims to categorize quinoa producers and examine and compare quinoa supply chains in the Peruvian regions of Puno and Junin. This research was conducted in the provinces of San Roman and El Collao in Puno and Jauja and Huancayo in Junin using surveys of producers selected according to stratified sampling, along with interviews and workshops with traders and agents in the supply chain. Cluster analysis was used to examine the producers' attributes, the supply chain, and the profit margins of conventional and organic producers. In both regions, most producers were small and medium sized (100% in Puno and 91.6% in Junin). The supply chains in Puno and Junin comprised 24 and 31 channels, respectively. It was found that numerous collectors, formal and informal processors, and exporters mainly linked with organized producers participated in these supply chains and this made trade efficient and coordinated. In contrast, trade among individual producers in the domestic markets through agents in the supply chain was highly disjointed, tending toward high centralization and without added value. It is concluded that quinoa supply is complex, centralized, traditional, and somewhat inefficient since asymmetrical relations were found between agents favoring commercial intermediaries.

Keywords: quinoa; commercialization; production costs; agricultural markets; supply chains.

1. Introduction

Agrarian commerce comprises all activities undertaken to achieve the delivery of agricultural products from the point of production to the final consumer through internal and external markets (Martínez, 2005; Mendoza, 1991).

The supply chain is a network that allows the transfer of a product, representing the relationship among agents and the movement of the product from its origin to its destination (Coscia, 1978). According to Alarcón and Ordinola (2002), the typology of the network determines whether the chain is direct or indirect and whether the commerce is centralized (when one agent primarily dominates the network) or decentralized.

Production costs are the economic value of resources incurred for obtaining goods over a period of production; in other words, these are input costs associated with manual labor, land costs, and depreciation, among other variables (Álvarez and Sánchez, 1998). To determine the profitability of the producer, the production costs and the producer's selling price are required. In general, the larger and more complex the supply channel, the greater will be the marketing costs and the lesser will be the producer's selling price. The market tends to offer only one price at the point of sale.

Research on quinoa marketing in Peru has focused on the following aspects: (1) exports, along with the identification of

* Corresponding author
E-mail: wmercado@lamolina.edu.pe (W. Mercado).

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potential markets and the trends therein and determination of requirements to access wealthier countries (FAO and ALADI, 2014; MINAGRI, 2013); (2) the characteristics of quinoa demand in Lima, Peru, and its consumption across various socioeconomic strata (IMA Opinion and Mercado, 2013; Chacchi, 2009); (3) regional marketing and identification of Puno's production chain (Bermejo, 2009; IICA, 2015; MINAGRI, 2013; MINCETUR, 2006) and the commercialization of quinoa in Junin and Arequipa (IICA, 2015; Mercado and Gamboa, 2014); and (4) food security evidencing that producers prefer to sell quinoa and consume foods that are less expensive and less nutritious (IICA, 2015; Laqui, 2013).

In 2015, Peru exported 42 thousand tonnes of quinoa, whereas Bolivia, another great producer of the grain, exported 25.1 thousand tonnes. This made the country former the world's leading quinoa exporter (CCEX, 2016). In 2016, according to statistics from Agrodataperu (2016), the volume exported by Peru reached 43.8 thousand tonnes, with quinoa ranking 14/150 in terms of exports of non-traditional products. However, the free-on-board (FOB) value decreased 27% from U.S.$ 143.55 million in 2015 to U.S.$ 103.16 million in 2016. Despite this decrease, it must be recognized that in Peru, the extraordinarily dynamic promotion of quinoa over the past decade has resulted in the expansion of its cultivation from the Andes to the Coast.

Quinoa production in Peru has grown significantly, from 22 thousand tonnes in 2001 to 105 thousand tonnes in 2015, with an annual growth rate of 15% (MINAGRI, 2016).

In 2016, the Puno region exhibited the highest quinoa production, although its production has decreased relative to the national production (Table 1). In 2001, Puno was responsible for 81% of the national production, but by 2016, this share had fallen to 45.2%. Next, the Southern high mountain region in Peru (comprising four departments, including the departments of Arequipa and Ayacucho, which have larger productions) accounted for 40.6% of the total in 2016. In third place was the Peruvian Coast (with seven departments), which represented 5.1% of the total, followed by Junin in fourth place with 4.9%. The Central and North high mountain region came last, accounting for 4.1% of the total. In all cases, the mean annual growth rate over 2001-2016 was positive. In 2016, production in all regions decreased as a result of falling selling prices of quinoa producers. This study's objectives are to categorize quinoa producers and determine and compare quinoa supply chains in the principal producing regions of Puno and Junin. The Puno region "the Altiplano" is between 3812 and 5500 m.a.s.l. and has a cold but temperate climate because of nearby Lake Titicaca. The lake receives rainfall from December to March and determines the cultivating season (GRP, 2008).

Table 1
Quinoa production by region (2001–2016)

Region	Quinoa production (thousand tonnes)								Growth rate	Percentage in 2016
	Mean 2001-2005	Mean 2006-2010	2011	2012	2013	2014	2015	2016		
Puno	22.9	27.3	32.8	30.2	29.3	36.2	38.2	35.2	5.6%	45.2%
Junin	1.4	1.3	1.4	1.9	3.9	10.5	8.5	3.8	5.6%	4.9%
Southern high mountain (1)	2.8	4.7	5.5	10.2	15.1	49.5	47.1	31.6	15.4%	40.6%
Central and North high mountain (2)	0.9	0.9	1	1.2	1.6	5.7	4.8	3.2	8.7%	4.1%
Coast (3)	0.4	0.4	0.5	0.8	2.2	12.8	6.9	4.0	15.1%	5.1%
Total	28.4	34.5	41.2	44.2	52.1	114.7	105.6	77.8	8.7%	100.0%

(1) Arequipa, Apurimac, Ayacucho, Cusco; Puno is excluded in this list. (2) Huancavelica, Ancash, Cajamarca, Amazonas, Pasco, Huanuco; Junín is excluded in this list. (3) Lambayeque, La Libertad, Ica, Lima, Moquegua, Piura, Tacna. Source: Ministry of Agriculture and Irrigation (MINAGRI) (2016).

Table 2
Principal quinoa metrics for Junin and Puno regions (2008–2016)

	2008–2009	2009–2010	2010–2011	2011–2012	2012–2013	2013–2014	2014–2015	2015–2016	Growth rate
Puno region									
Sown area (ha)	26 110	27 047	28 360	30 265	31 258	32 929	34 640	36 430	4.87%
Production (t)	31 174	31 946	32 743	30 179	29 331	36 158	38 221	35 166	1.74%
Yield (kg/ha)	1 194	1 213	1 198	1 100	981	1 121	1 119	985	-2.71%
Farm price (soles/kg)	3.46	3.44	3.73	4.01	5.78	5.08	5.59	4.09	2.42%
Junin region									
Sown area (ha)	1 028	1 153	1 211	1 432	5 404	4 191	4 272	2 012	10.10%
Production (t)	1 454	1 586	1 448	1 882	10 551	8 040	8 518	3 800	14.71%
Yield (kg/ha)	1 414	1 375	1 216	1 314	1 998	2 002	1 994	1 893	4.30%
Farm price (soles/kg)	3.20	3.53	3.91	4.10	5.79	3.28	3.27	3.79	2.45%

Source: Authors' elaboration using data from DRAP (2017) and DRAJ (2017).

The agrarian sector represented 17% of the gross regional product in 2011. The area of land cultivated for quinoa expanded 4.9% annually on average from 2008 to 2016; planting occurs between August and November and harvests from April to May. During the same period, quinoa production grew by 1.7% on average and the yield decreased by 2.7% annually (Table 2). According to National Institute of Agricultural Innovation (INIA) interviewees, this reduction is attributed to the delayed rains that result in postponed sowing, particularly since the yield in Puno is influenced by climate and applied technology.

In Puno, in 2016, the land cultivated for quinoa was concentrated in Azangaro (8220 ha), San Roman (5,130 ha), Puno (4920 ha), El Collao (4728 ha), Huancane (3690 ha), and Chucuito (3500 ha). Further, quinoa is most important in terms of cultivated areas in San Roman (27%) and El Collao (22%) (DRAP, 2016). From 2008 to 2016, a positive correlation is established between prior farm prices and current sown area in El Collao (r = 0.76) and San Roman (r = 0.45) according to data from DRAP (2016).

Based on the National Agrarian Census (INEI, 2012), the Puno region had 56353 farmers dedicated to quinoa production, equivalent to 82% of the quinoa farmers in Peru. These farmers, on average, cultivated less than 3.0 ha, used traditional technology, and farmed a great variety of products to militate against climatic and geophysical risks (in the mountainous Puno region, the weather and altitude prohibit drastic changes in production). According to the same census, in Junin, there were 1601 farmers producing quinoa, which represents 2.3% of the national total; of these farmers, 75.8% cultivated the grain on less than 3.0 ha.

Junin is located in central Peru and has an altitude that varies between 400 masl and 5,730 masl. In terms of prevailing climate and biomes, the region varies from mountainous glaciers to tropical forests (GRJ, 2008). The agrarian sector represented 6.71% of the gross national agrarian product in 2016. The surface area cultivated with quinoa increased at a rate of 10.1% on average between 2008 and 2016; planting occurs from October to December, with harvests from May to July. Production has grown by an average of 14.7% annually and the yield has increased at a rate of 4.3% annually (Table 2). However, in 2016, the sown area fell by 53% compared with the previous year, and the total quinoa production decreased by 55%.

At the provincial level, quinoa cultivation is most concentrated in Huancayo (848 ha) and Jauja (669 ha). It is also cultivated in Concepcion (329 ha), Chupaca (147 ha), and Tarma (8 ha). Quinoa cultivation only represents 1.62% of the total cultivated land area in the region and only 0.14% of total regional production (DRAJ, 2016). According to data reported by DRAJ (2016) from 2008 to 2016, there is a positive correlation between prior farm

prices and current sown area in the provinces of Huancayo (r = 0.76) and Jauja (r = 0.89).

The present research used the following categories to differentiate between quinoa in terms of production regimes: (i) traditional quinoa, which is characterized by the predominant use of organic fertilizers and rain-fed irrigation in the production process; (ii) conventional quinoa, which principally uses chemical inputs as fertilizers and pesticides and is associated to under irrigation crop by the contour-furrow method; and (iii) certified organic quinoa, for which the production process has been adapted to standards required by certifiers.

2. Material and methods

This study considered the most representtative provinces and districts of quinoa-cultivating areas in Puno and Junin, where information was gathered by surveying quinoa producers in 2014 (Figure 1). Following Arvizu *et al*. (2014), a mixed-methods (qualitative and quantitative) approach was followed.

In Puno, there were 11388 quinoa farmers in the provinces/districts examined in the present study (INEI, 2014), 240 of which were sampled. Among the districts of San Roman, 22 of these producers were based in Cabana, 25 in Caracoto, and 6 in Cabanillas. Among the districts of El Collao, 136 producers were based in Ilave and 51 in Pilcuyo. The sample size was determined through an equation of finite sample populations. Additionally, 30 further surveys were administered to intermediate agents (collectors, wholesalers, millers, processors, retailers, nongovernmental organizations, and local government officials) to identify the relation between agents and market destinations. To estimate the production costs, 30 additional surveys were administered to traditional producers and organically certified producers: 21 in El Collao and 9 in San Roman.

In Junin, there were 1690 quinoa farmers in the districts covered by this study (INEI, 2014), of which 190 farmers were included in the sample by using a two-stage stratified sampling conglomerate, stratified with probability proportional to the size of the conglomerate that is used when the population is divided in groups that represent the total of the variable in the study.

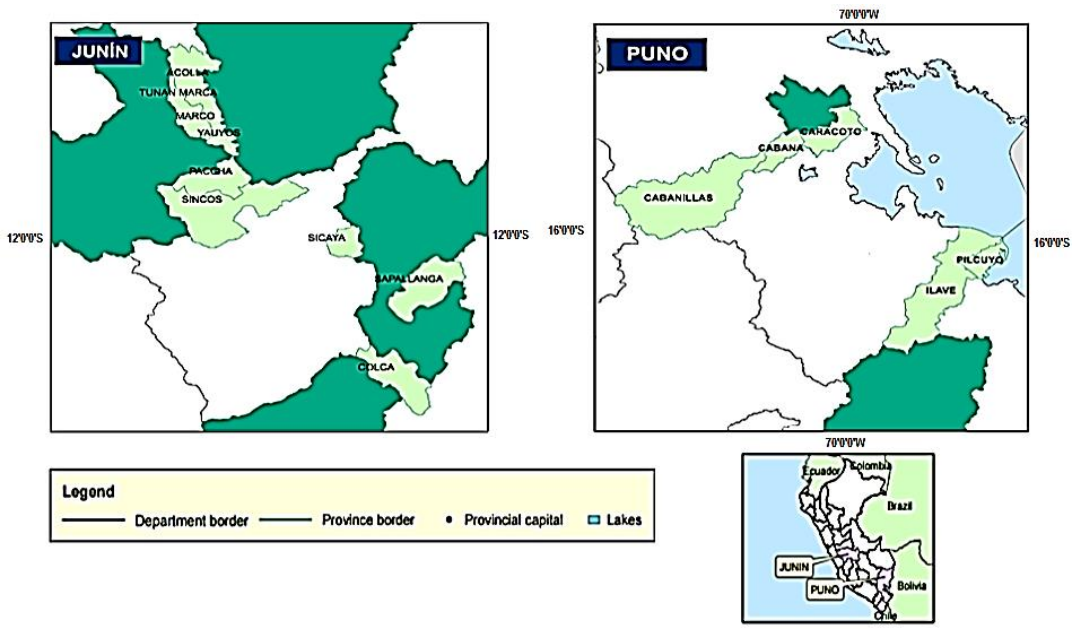

Figure 1. Maps of the main quinoa producer districts in Junin and Puno where the interviews were conducted.

Specifically, 47, 20, and 18 producers were surveyed in Sicaya, Colca, and Sapallanga, respectively (districts of Huancayo), and 34, 16, 12, 8, 15, and 20 producers were surveyed in Acolla, Marco, Yauyos, Tunan Marca, Paccha, and Sincos, respectively (districts of Jauja). Additionally, 36 additional surveys were administered to various agents in the supply channel. To estimate the production costs, information was gathered from various local associations of producers and governmental agricultural agencies in Jauja and Huancayo. This information was contras-ted with six surveys taken from producers in Jauja and Huancayo, who represented the average producers of those zones.

The surveys administered to producers covered the following topics: (i) information related to quinoa production (size of cultivated land, access to productive inputs, technical services, suppliers, and quantity of production); (ii) distribution of the harvest between sales, storage for later sale, self-consumption, self-supply, and destination of product according to the buyer and the market; and (iii) details of the producer.

The surveys administered to marketers covered the following topics: (i) type of agent and purchase volume; (ii) quinoa source, purchase price, varieties, and color; and (iii) destination, purchase price, volume, commercialized quinoa products, and certifications that are used (see Annex). The surveys concerning production costs covered the following topics: (i) details of producers; (ii) property details, harvested area, production and certifications; (iii) and production costs, renting and land preparation, sowing, agricultural work, harvesting, inputs used, applied fertilizers, cost of packaging and transportation, credit, and unexpected costs.

3. Results and discussion

3.1 Characterization of quinoa producers

Characterization, as per Tobar (2010), involves determining the particular attributes of someone or something and distinguishing them or it from comparable entities. Typing is the act of representing the subject or object using types, classes, or categories based on its principal characteristics (Bolaños, 1999).

The characteristics of quinoa producers in El Collao and San Roman are now discussed. First, 20% of them belonged to an association, whereas 98% of those surveyed were owners of their own land. The average area of land cultivated was 2.97 ha, distributed in 2 to 4 parcels. In El Collao, 35% of the cultivated land was dedicated to quinoa production, 30% to oats, and 21% to potatoes. In San Roman, 39% of the land was dedicated to the cultivation of oats, 27% to quinoa, and 14% to barley. On average, the producers had cultivated quinoa in Puno for more than 18 years.

Cluster analysis aims to classify individuals into groups so that there is more homogeneity within groups with respect to the observed variables. This methodology has hitherto been used specifically in the context of quinoa by Ton and Bijman (2006), coffee by Hernández-Martínez (2008), and agricultural products more generally by Santos (2014). This analysis allowed the quinoa producers to be classified in groups of small- and medium-sized producers. Of these, 65% were small-sized producers who, on average, dedicated 0.51 ha to the cultivation of quinoa for 2.49 ha that they cultivated in total, producing 314 kg of quinoa with an average yield of 603 kg/ha. Further, 35% were medium-sized producers with 1.33 ha of cultivated quinoa, producing 1 089.3 kg of quinoa with an average yield of 803.4 kg/ha (Table 3). Similar data were obtained by Flores and Chura (2015) for the district of Cabana-Puno.

Of the total interviewed in Puno, 91% produced traditional quinoa and 9% certified organic quinoa; in San Roman, 35% produced certified organic quinoa and 65% produced traditional quinoa. The varieties of quinoa cultivated in Puno were Kancolla (34.4%), Pasankalla (24.8%), Blanca de Juli (21.3%), and Salcedo INIA (18.4%).

Because of the market preference for white quinoa, only 1% of the cultivated quinoa was not white.

In Junin, 21.6% of the quinoa producers belonged to an association (2.4% were small-sized producers, 85.4% medium-sized producers, and 12.2% large-sized producers). The members of associations were able to sell approximately 15% of their quinoa through formal agreements for which they received the highest price. They also had greater accessibility to financing, machinery, and training (Ton and Bijman, 2006). Of all the producers 59% were owners of the land they cultivated, and 72% of them obtained their land through inheritance. On average, each producer owned 4.8 ha under cultivation, and all the Junin producers were characterized by having a lower level of information with respect to the market, such as buyers, markets, characteristics the buyers are looking for, and how prices are set.

Of the Junin producers, 24.2% were small-sized producers who dedicated, on average, 0.67 ha to quinoa cultivation (of the 1.9 ha under cultivation) to produce 780 kg of quinoa with a yield of 1279 kg/ha (close to the average yield of small familiar producers in Northwest Argentina) (Golsberg, 2013). They retained 25.9% of the production for their own consumption. The majority, i.e., 67.4%, were medium-sized producers who dedicated, on average, 1.42 ha to the quinoa cultivation (of the 3.9 ha under cultivation), produced an average yield of 2125 kg/ha, and sold 93.9% of their total production. Finally, 8.4% were large-sized producers who dedicated, on average, 9.23 ha to quinoa cultivation (of the 20.4 ha under cultivation), produced a yield of 2617 kg/ha, and sold 98.6% of their total production (Table 4). For comparison, according to Jacobsen (2003), the yield is, on average, 1000 kg/ha in the United States; 2280 kg/ha in Italy; and 3960 kg/ha in Greece.

Across all producers, 95.8% produced conventional quinoa and traditional quinoa and only 4.2% produced certified organic quinoa, the latter being produced in the districts of Sincos (Jauja) and Sapallanga (Huancayo). The varieties cultivated are white (84.7%), the two types being (1) Hualhuas and Blanca de Junin and (2) colored quinoa, black, and red (15.3%).

As seen from Tables 3 and 4, there are significant differences between the producers of quinoa in Puno and Junin. The producers in Puno tended to be smaller and produced smaller yields. In Junin, they primarily produced conventional quinoa, whereas in Puno, they tended to produce traditional quinoa and certified organic quinoa.

3.2 Chain of production and market destination of quinoa

Identified herein is the farmers' relationships in the chain of quinoa production "backward" and "forward" (Figure 2), demonstrating that access of the producers to the input providers and technical services is better in Junin than in Puno. Therefore, 86% of the farmers in Junin used machinery such as tractors compared with 82% in Puno (97% in Puno and 82% in Junin rented the tractor). Further, 29% had undergone training and 29% had received technical assistance in Junin compared with 16% and 6%, respectively, in Puno.

Table 3
Characterization of surveyed quinoa producers in Puno's provinces (2014)

	San Roman		El Collao		Total	
Variables	Small	Medium	Small	Medium	Small	Medium
Number of producers	51	6	103	80	156	84
% of total	90%	10%	56%	44%	65%	35%
Cultivated area (ha)	2.05	3.98	2.71	3.84	2.49	3.85
Cultivated area of quinoa (ha)	0.46	1.75	0.53	1.30	0.51	1.33
Production of quinoa (kg)	229.4	1,266.7	358.4	1,076.7	314.1	1,089.3
Yield of quinoa (kg/ha)	554.3	788.8	732.8	817.9	603.0	803.4

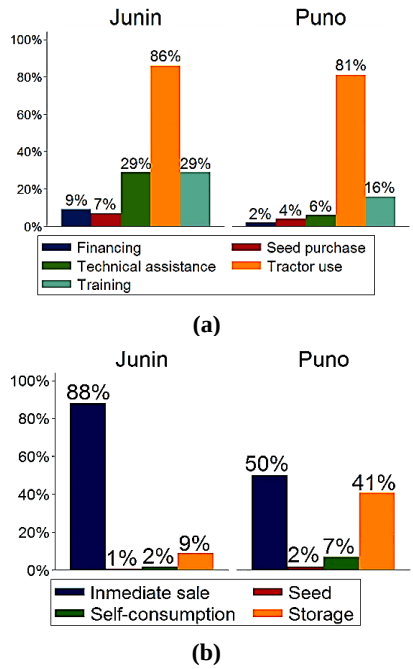

Figure 2. Articulations of surveyed quinoa producers in the supply chain in Puno and Junin (2014): (a) Access to productive inputs; (b) Destination of quinoa production.

Private financing was opted for by only 2% in Puno and 9% in Junin. Regarding seeds, 96% of the producers in Puno obtained them from previous production processes and only 4% bought them from the INIA; producers also exchanged seeds among themselves. In Junin, 93% obtained seeds from previous production processes and 7% bought them from the INIA. In Puno, producers tended to use local inputs and had limited access to providers of finance and technical assistance; this situation is in contrast to the case of producers in Bolivia (Montoya *et al*., 2005), Colombia (Dueñas, 2014), and Argentina (Golsberg, 2013). Production "forward" represents the possible destinations of the produced quinoa. Although some quinoa was stored for later sale in both regions, this was more evident in Puno than in Junin (41% versus 9%). Hence, in Junin, 88% of the quinoa produced was sold upon harvesting and 9% was stored for future sale; this means that 97% of the production was commercialized. In Puno, a relatively higher portion of the quinoa produced was consumed by the producer and set aside for the seeds (9%) than in Junin (3%). In Puno, the stored grain was sold when the producers required capital. The harvest was sold to Type I collectors (called "K'ato"), who operated in local fairs (3.8%) and to Type II collectors, who operated in urban areas (93.2%).

In Puno, the producers delivered the product to the point of sale 2.9% of the time. In Junin the harvest was sold to Type I collectors (22%) wholesalers (21%) retailers (14.5%) and businesses (16.4%). The remaining 14% was sold directly to consumers at fairs (3.3%) the Jauja market (0.6%) Huancayo (7.2%) and mills (2.9%). The market destinations of quinoa from Puno were as follows: (1) the regional market in Puno accounted for 10.7% (including the quantities consumed by the producer and set aside for seeds) of the total; (2) markets in other departments (Arequipa Cusco and Tacna) represented 4.4% of the total; (3) the national market in Lima received 24.4% for urban consumption or processing for later sale to consumers; and (4) international market accounted for 19.5% (Table 5).

Table 4
Characterization of surveyed quinoa producers in Junin's provinces through cluster analysis in two phases

Variables	Huancayo			Jauja			Total		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Number of producers	12	63	10	34	65	6	46	128	16
% of total	14.1	74.1	11.8	32.4	61.9	5.71	24.2	67.4	8.4
Cultivated área (ha)	2.52	4.27	20.37	1.65	3.5	20.33	1.9	3.9	20.4
Cultivated area of quinoa (ha)	0.76	1.75	9.37	0.64	1.1	9.00	0.67	1.42	9.23
Production of quinoa (kg)	739	3 771	24 095	795	2 493	21 367	780	3 122	23 072
Yield of quinoa (kg/ha)	1 080	2 180	2 583	1 349	2 072	2 674	1 279	2 125	2 617

The market destinations of quinoa from Junin were as follows: (1) the regional market in Junin accounted for 44.1% (including the quantities consumed by the producer and set aside for seeds) of the total; (2) markets in other departments (Jungle) represented 0.1%; (3) the national market in Lima accounted for 42.4%; and (4) international markets received 3.8%.

Under the assumption that the stored quinoa for later sale (41% and 9% in Puno and Junin respectively) is sold to destinations similar to those sold to after harvesting in 2014 Puno's production would have first supplied the Lima market (24.4%) followed by the international market (19.5%) and regional markets including nearby departments (15.1%). For Junin the main destination was the regional market (54%) followed by the Lima market (42%) and the international market (4%). Thus, Puno's production exhibited better performance in dynamic markets positioning the traditional quinoa and the certified organic quinoa. Meanwhile Junin's production of conventional quinoa mainly served regional markets and given to its proximity to Lima its destination markets were mostly the popular ones.

3.3 Intermediary agents in the quinoa supply chain

Puno's quinoa supply chain is illustrated in Figure 3 representing all commercial agents therein.

a) Producers sold 22.02% of the total quinoa produced to Type I collectors in local fairs (well known as K'ato) and 22.17% to Type II collectors at regional fairs. The latter also bought from Type I collectors (1.09%) and commercialized 23.25% of the total volume. There were also direct channels wherein the producer sold 0.01% to retail markets in Ilave and Juliaca (channel 1) and 5.80% was commercialized by organized producers such as Cooperativa Agro Industrial Cabana Ltda (COOPAIN) which sold traditional quinoa (channel 21, 0.26% of the total) and certified organic quinoa (5.55%). COOPAIN exported quinoa to the U.S.A., Germany, Canada, the Netherlands and France (channels 22, 23 and 24) via the Cabana 3901 Organic Whole Foods brand.

b) Collectors gathered produce for wholesale. Type I collectors collected quinoa in local fairs and sold to millers and processors in Juliaca (13.2% of the total) and to Type II collectors in Juliaca (1.1%). Type II collectors were provided by producers (22.17%) and Type I collectors who in turn sold to Lima processors (Channel 9, 10.5%) wholesalers (6.43%) exporters (4.9%) Juliaca processors (0.9%) and Arequipa and Cusco markets (0.52%). According to the calculations from collectors interviewed in Juliaca in 2014 30 collectors existed in Juliaca and around 80 in the province of San Roman this number is higher than reported by Sierra Exportadora (2013).

c) Among the processors Juliaca millers channeled 1.9% of the output (channel 3) consisting of washed white quinoa (90%) and colored (10%). They also bought recently harvested quinoa at prices between 8 and 10 soles/kg and sold the product washed between 13 and 15 soles/kg. Of the total production 24.63% was channeled through processors that transformed the product into quinoa pearled washed in flakes and in flour among other processed products. There were 13 companies identified at that level that commercialized organic and traditional quinoa. Exporter companies based in Puno (there were 11 in 2013) exported washed quinoa organic colored quinoa tricolor quinoa and other processed products; traditional white quinoa quinoa flakes precooked quinoa gourmet pearled quinoa and colored quinoa in the fair-trade market (Flo Fair Trade) (Adex Data Trade, 2015).

d) Processing and exporting companies in Lima were supplied from several parts of Peru. In 2013 there were 86 such companies that exported 13301 tonnes of quinoa in total; 9% of Puno's production was delivered to these companies.

Table 5
Destination markets of quinoa produced in Puno and Junin based on survey of quinoa producers

Characteristic	Puno			Junin		
Markets	Type of agent	%	Total	Type of agent	%	Total
Seeds	Producer	2.0%	2.0%	Producer	1.2%	1.2%
Self-consumption	Producer	7.0%	7.0%	Producer	1.9%	1.9%
Storage	Later sale	41.0%	41.0%	Later sale	9.0%	9.0%
Intra-regional	Ilave and Juliaca retail	0.0%	1.7%	Local fairs	8.6%	41.7%
				Huancayo and Jauja markets	23.1%	
	Juliaca wholesale	0.3%		Social programs	9.8%	
	Puno wholesale	1.4%		Huancayo Municipality	0.2%	
Inter-regional	Arequipa and Cusco processors	1.1%	4.4%	Social programs	0.1%	0.1%
	Other wholesalers	3.3%		Markets in Jungle		
National (Lima)	Collector in Lima	0.2%	24.4%	Markets in Lima	42.3%	42.4%
	Wholesaler	8.3%				
	Processors in Lima	11.4%		Supermarkets	0.1%	
	Exporters	4.5%				
International	U.S.A. Germany Canada Netherlands and France	10.6%	19.5%	Exportation	3.8%	3.8%
	Exporters	9.0%				
Total		100%	100%		100%	100%

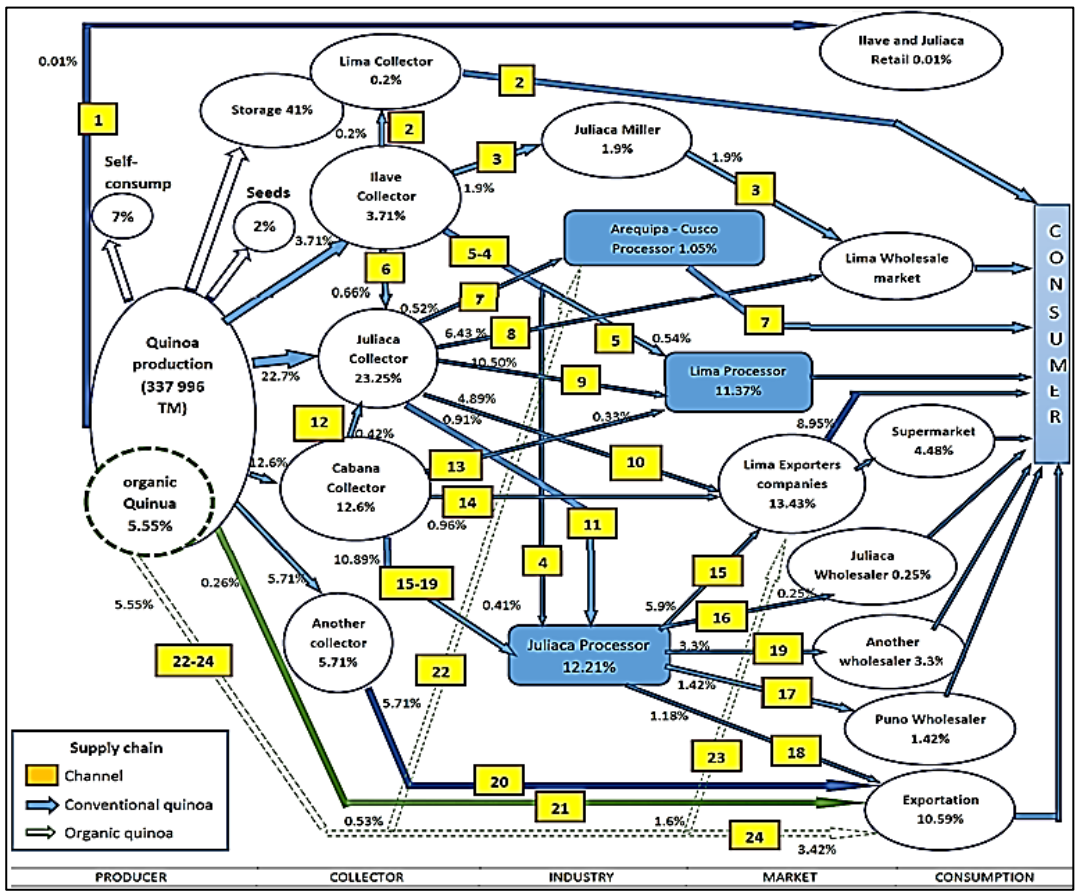

Figure 3. Quinoa supply chain in the region of Puno based on surveyed producers and suppliers.

e) Wholesalers allocated 8.33% of Puno's quinoa production to markets in Santa Anita and La Parada in Lima where they sold the product washed pearled in flakes or in flour to retailers and consumers. Moreover, they also supplied to wholesale

markets in Juliaca and Puno (1.42%) and to extra-regional wholesalers in Arequipa Tacna and Cusco (3.3%).

f) Supermarkets in Puno and Juliaca (Plaza Vea and Via Market) and Arequipa and Cusco (Plaza Vea) along with the supermarket network in Lima (which received 4.48% of Puno's production) sold pocketed pearled quinoa and quinoa as flakes grains energy bars breakfast items candies and other variants. District fairs and the retail trade in municipal markets in El Collao Puno and Juliaca where quinoa was marketed jointly with other grains beans and cereals accounted for 0.01% of the total sold. The local governments of llave Cabana and Juliaca used to buy quinoa for social programs; this was terminated in 2014 because of rising prices.

Therefore, the quinoa supply chain in Puno comprised 21 indirect channels involving individual and organized producers collectors millers processors and export markets (Fig. 3). The quinoa supply chain was mainly centralized and governed by collectors (Type I and II) who comercialized 39.56% of the total production (50% of which was commercialized at harvest). The direct organic marketing channels (channels 1, 21 and 24) of producer organizations were also identified. Channel 1 was short and with close spatial proximity thereby guaranteeing availability to the Juliaca market of Ilave and local food security therein. Channels 21 and 24 were short channels but far in spatial terms because they consisted of an intermediary for the international market through COOPAIN which sells with certifications and incorporates added value through product brands.

Junin's quinoa supply chain is presented in Figure 4.

a) Producers sold at local fairs 22.02% of the total quinoa through indirect channels to Type I collectors (small) next 20.97% was sold to Type II collectors (medium) 14.53% to Type III collectors (wholesalers) and 2.88% to millers. Through direct channels 16.43% was sold to Type I companies that transformed and sold directly to Lima's market which were exporters 3.31% in fairs (channel 1) 7.17% to the Huancayo wholesale market (channel 3) and 0.59% to the Jauja market. Finally, 12.1% was allocated for self-consumption storage and seeds.

b) Collectors gathered produce to sell it directly without intermediation. Type I collectors gathered quinoa at fairs and sold directly to final consumers (1.55%) millers and processors in Jauja and Huancayo (10.76%) and wholesalers (9.72%) (Type II collectors). Type II collectors were supplied by producers (20.97%) and Type I collectors with the main destination being processors in Lima through Type III collectors (channel 26 12.16%) and direct means 6.62% (channel 19). The retail Type III collectors sold to Type II companies that supplied quinoa to social programs (17.17%) Type I companies (0.95%) and markets in Lima (12.16%). According to interviews to collectors and processors calculations 67 such collectors consisting of at least 30 millers and 30 processor companies which agrees with data obtained by SNV (2013).

c) Millers of Huancayo transformed up to 22.47% of the produce (20.53% washed and 1.94% pearled). They were supplied by Type I collectors (10.76%) producers (2.88%) and Type III collectors (6.81%). Of the total production 20.08% was supplied to formal processors (Type I companies) that transformed the quinoa into pearled washed extruded and processed quinoa and as flakes and flour. A total of 20 companies were identified at that level that commercialized conventional quinoa in small proportions. Four of these companies were exporters based in Junin that exported 3.78% in grain (Adex Data Trade, 2015). Type II companies only packaged the quinoa and branded it for comercialization prior to serving social programs such as Qali Warma. These companies sold 16.72% of the processed quinoa to markets in Lima.

d) Wholesalers allocated 6.62% of the quinoa production to markets in Santa Anita and La Parada in Lima (channel 19)

where commercialized the product for retailers and consumers as washed and pearled quinoa or as flakes and flour. A further 6.12% was allocated to the Huancayo market (channel 22) and 0.66% to Type II companies. Retailers supplied mainly to Type II companies (17.17%) markets in Lima (12.16%) and Type I companies (0.95%).

e) Supermarkets sold quinoa pocketed and pearled and as flakes grain energy bars breakfast items candies and other variants in Huancayo (Plaza Vea) and the network of supermarkets in Lima which received 0.082% of the production. Social programs in Huancayo received 9.81% extra-regional social programs accounted for 0.051% and local government received 0.22%.

Junin's quinoa supply chain comprised 28 indirect channels involving individual and organized producers collectors millers processors exporters and traders and target markets (Figure 4). It was a centralized supply chain and governed by Type II collectors (who commercialized 37.31% of the quinoa production) and companies (both Type I and Type II which comercialized 51.9% of the production). Three direct channels existed from producer to consumer (channel 1 at local fairs channel 2 to Jauja markets and channel 3 to Huancayo markets). These channels were short and close in spatial terms guaranteeing availability to local markets and providing a basis for the maintenance of food security.

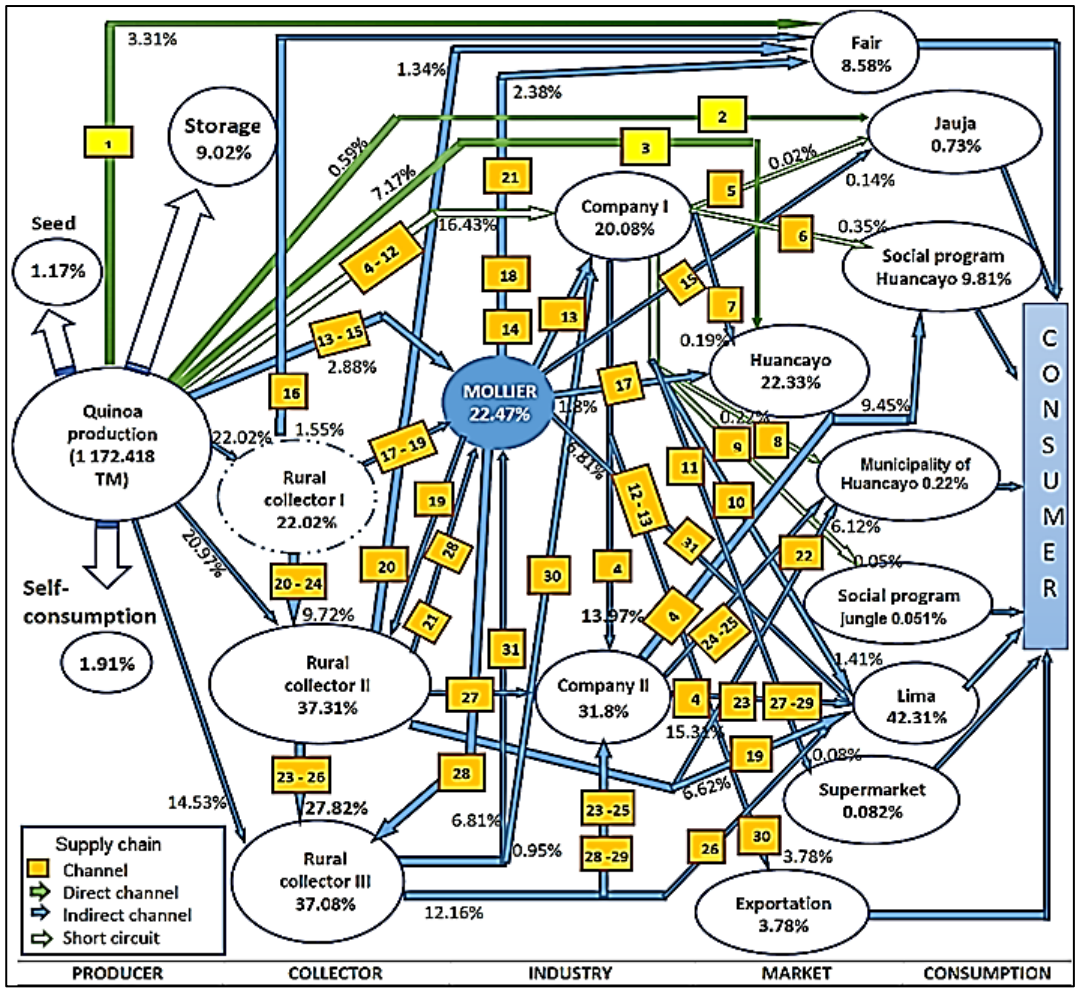

Figure 4. Quinoa supply chain in the region of Junin based on surveyed producers and suppliers.

The principal bottlenecks in the comercialization of quinoa were fourfold: (i) the lack of unity and strength among producer associations and their links with other agents in the supply/production channel which reduced their ability to decrease costs and increase efficiency (Ton and Bijman, 2006; Arvizu *et al.*, 2014); (ii) the lack of producer power vis-à-vis negotiation results in increased profits for intermediaries and decreased profits for the producers; (iii) problems with quality not meeting minimum standards of presentation traceability proof of origin (organic conventional or traditional) thereby impeding penetration into markets and reducing competitiveness (Fairlie, 2015; OIT, 2015) while simultaneously undermining local food security; and (iv) the absence of support and incentives for modernization and guaranteed access to input products and technical services that could be implemented through public policy.

3.4 Costs of quinoa production in Puno and Junin

Quinoa production costs in Puno and Junin are delineated in Table 6. The calculations were standardized to a per-hectare basis to facilitate comparison. Direct costs include land rent (opportunity cost at local value); preparation of land; labor and machinery used (sowing labor and harvesting); and inputs such as seeds fertilizers packaging and transport. Indirect costs consider administrative and unexpected expenses as 5% of the total direct costs and social laws as 46% of labor costs (VLIR-UOS, 2013). Thus, total costs per hectare of quinoa include direct and indirect costs.

In Puno, traditional small-sized producers and small-sized organic farmers incurred costs 11.1% and 8.3% respectively higher than their medium-sized counterparts. Yields are reported by surveyed farmers and costs per kg are derived from them. Income depends on the crop performance and the price received because it fluctuates throughout the year. Prices reported in DRAP (2016) were used for regional representation. Profitability indicates how much producers earn for every sol spent; it was high in 2014 for the traditional crop because of higher performance and lower costs. Meanwhile the profitability for certified organic producers was higher because performance was reflected in price similar to the findings reported by Fairlie (2015).

For Junin total costs incurred per hectare include direct and indirect costs. (For data collection costs based on activities and activity-based costing methods were used.) Small-sized producers incurred costs 2.07% lower than medium-sized producers (because many small-sized producers incurred lower equipment and labor costs). However they incurred costs 12.47% higher (highest costs incurred) than large-sized producers because the latter can obtain higher yields per kg of quinoa.

There is an important difference between the price received by small-medium- and large-sized producers because of their relative bargaining power and because a group of medium- and large-sized producers can sell their produce to companies (e.g. Álicorp Ecoandino) that set the price according to the quality of quinoa produced. Since prices reported in DRAJ (2016) were used producers' size made a difference. Profitability in 2014 was higher for medium- and large-sized producers because of higher performance compared with that for smaller-sized producers.

Therefore, the profitability of quinoa in 2014 was high because of prices received by producers. It was the highest in Junin where producers responded more quickly to market signals to increase production that year. In 2015 production was lower in Junin because of lower producer prices. In Puno production is still growing because there is little scope for alternating between commercial crops in the Peruvian plateau region. Moreover, quinoa is positioned in the local culture and has lower total production costs; this grain provides local food security and finally reaches domestic and foreign markets which are relatively more dynamic and demanding of the final product.

Table 6
Total costs per sown hectare and economic metrics associated with quinoa rates in Puno and Junin based on surveyed quinoa producers in Puno and Junin

Characteristic	Puno				Junin		
	Traditional		Organic		Conventional		
	Small	Medium	Small	Medium	Small	Medium	Large
Total costs (soles)	2410	2190	2420	2234	5423	9301	9861
Yield (kg/ha)	732	792	701	735	1279	2125	2617
Cost (soles/kg)	3.29	2.77	3.45	3.04	4.0	4.0	4.0
Prices (soles/kg)	6.5	6.5	7.2	7.2	6.0	7.0	7.0
Average income (soles)	4758	5148	5047.2	5292	7572	15714	19106
Profitability	97%	135%	109%	137%	140%	169%	194%

For producers to obtain a greater portion of the price paid by consumers they must establish more direct relationships with purchasers of quinoa in the supply channel. Additionally, the government should purchase quinoa for food programs directly from the producer and promote local programs to finance quinoa producers and add value to quinoa as proposed by Furche *et al.* (2013). It is also necessary to create a system that would identify the traceability of the collective brand of Puno and Junin because these are the only two Peruvian regions that continue to produce native varieties of quinoa.

4. Conclusions

(i) In Puno, the principal destination for quinoa was outside of the region although the local market was also significant. In this region producers tended to use local inputs and had limited access to providers of finance and technical assistance. In Junin the farmers enjoyed greater access to these providers and were able to respond more rapidly to market/price changes. However, they still lack the ability to penetrate larger markets and negotiate with local commercial agents. Further there is no possibility of adding value to the raw quinoa resource and the local producer associations are weakly organized.

(ii) In general, when producers interact with the supply chain at a smaller level (individual) rather than through an organized association the supply channels are centralized through collectors. Consequently, the supply chain leading to the final consumer is highly disorganized and inefficient characterized by asymmetries. Further the limited ability of the small-sized producers to negotiate impedes cooperation between producers and other members of the supply chain. In contrast when producers are well organized they sell through supply chains that are more efficient and have direct links to processors as demonstrated in Puno.

(iii) In the production of traditional and organic quinoa in Puno the costs for small-sized producers were greater than those incurred by medium-sized producers. This demonstrates the possibility of reducing costs through economies of scale and stronger producer associations. The profitability of organic production was slightly higher than that of traditional production owing principally to the reduced price received upon sale. In Junin the medium- and large-sized producers obtained greater profit owing to their greater yields. In both cases cultivation was profitable but could be improved if crop yields were improved through financing technology training and research.

Taking this study's findings into considerations the following recommendations for future research: (a) broaden and deepen the typology of producers by for example recognizing that because different categories exist differentiated public policies are necessary; (b) further explore supply chain nuances and complexities by identifying interactions between agents so that public policies can promote productive improvement and added value through trade; (c) identify new alternatives as vertical integration between producers and marketing agents; and (d) examine the short-circuit promotion at the regional and national levels and its relation with food security public purchased fair market and the boom of gastronomy.

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Anex

Survey administered to quinoa marketers

Name: Districts of provenance: N°

A. Type of agent

( ) Producer ( ) Transformer (new products)
( ) Collector ( ) Retailer
( ) Processor (post-harvest) ( ) Wholesaler

B. What is the volume of quinoa you bought in the last campaign and/or year? ___Kg/year

( ) Certified _____ ( ) Conventional _____ ( ) Both___

C. What is the origin the volume and purchase price of quinoa?

Agent	Region	Province	District	Volume (kg)	Price (soles/kg)
Total					

D. What is the destination volume and sale price of quinoa?

Agent*	Region	Province	District	Volume (kg)	Price (soles/kg)
Total					

* Agroindustry processor export market (local/regional) and fairs

E. Which products are marketed (in %)?

Products	%	Certification			
		Organic	Sanitation	Quality	Others
At harvest					
Flour					
Flakes					
Pearled					
Washes					
Others					

F. What kind of activities do you undertake before selling quinoa?

Why?

	YES	NO	
Washing			
Selection			
Packing			
Storage			
Transportation			
Others			

G. Are there purchase contracts or agreements? With whom?

	YES	NO	
Collector			
Producer			
Wholesaler			
Retail			
Financial entity			

H. Do you provide some kind of proof of payment for buying and selling? ( ) Yes ( ) No