



# Quinoa value chain, adoption, and market assessment in Morocco

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## Abstract

Agriculture faces many challenges such as climate change, droughts, and salinity, which requires urgent interventions for fast adaptation and diversification of the sector. In this context, introduction of new crops that tolerate stresses and generate high added value such as quinoa would allow simultaneously to address two interlinked challenges: abiotic stresses that limit agricultural production and poverty that impacts negatively the rural people. The quinoa Rehamna project funded by the International Development Research Centre aims to contribute to the development the quinoa value chain toward achieving food and nutritional security of rural poor communities. The obtained results from the farmer's survey show that 14% of surveyed farmers already grow quinoa and 2/3 never heard about quinoa, among them 96% are interested to grow quinoa. The marketing study reveals that the psychological price that satisfies most of consumers is ranging between 2 and 2.6 USD/500 g of processed quinoa seeds. The findings indicate that quinoa has a great potential for both producers and consumers in Morocco and can be a judicious solution toward achieving food and nutritional security.

**Keywords** Psychological price · Nutrition · Marketing · Morocco · Rehamna · Gluten-free

## Introduction

Quinoa (*Chenopodium quinoa* Willd) originated from Latin America, a crop with a range of climate condition requirements, with different varieties adapted to different agro-climatic conditions. Some quinoa genotypes are tolerant to extreme drought, suggesting resilience to this unfavorable factor (Tapia 1997). Other varieties are adapted to more humid

conditions. The nutritional value of quinoa, its resistance, its great adaptability, and its multiple uses consist of a great interest toward this crop not only in Latin America but also worldwide. The permanent global increase in demand for quinoa is not covered by the increase in production in the Andean countries alone. The importing countries (USA, Europe) have therefore started production, and today other non-importing countries are also starting to produce quinoa (Bazile et al. 2016a). Quinoa production can greatly contribute to food security because of key aspects related to quinoa, such as the low inputs and cost of its production, its adaptation and resilience to extreme and varied conditions, and mainly its nutritional value (Bazile et al. 2016b). Quinoa can provide a rich and nutritious diet, particularly in areas where the production of other nutritious crops is not always possible or limited because of stress factors (Jacobsen 2003). In Andean region, countries have increased their exportation in terms of quinoa without affecting local food security as local quinoa consumption has also been increased due to high augmentation in local production (Bazile 2016). The cultivation of quinoa in the Andean countries involves a hereditary access to communal lands, and it allows the self-sufficiency of local populations, which is completely different from the sale of their labor force

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in urban areas or mining industries. This shift was rapidly understood by the rural population, who then adopted a patrimonial logic and tried to accumulate as much cultivable area as possible, within the limits of the customary rules of land tenure (Winkel et al. 2016). The market demand for healthy, environmentally friendly and safe products has been growing, and it is widely agreed that these influences will keep increasing over the next few decades (Larsen and Gilliland 2009). It is important to point out that food insecurity is still present and often affects areas that have long been exposed to malnutrition, as well as areas where agriculture is the main sector for economic income. Water resources in Morocco are becoming scarcer due to effects of climate change, irregular and low rainfall, and successive years of drought (Schilling et al. 2012). Furthermore, irrigated agriculture sustainability in Morocco is also threatened by salinization problem that affects both soil and water resources. As a consequence, it is estimated that the average yield losses can reach 50%, with economic costs exceeding 0.2 USD billion per year (Taleb 2006). In this context, introducing high-value and stress-tolerant crops would tackle two interrelated challenges simultaneously: the issue of poverty in rural areas and abiotic stresses that limit agricultural production. More recently, quinoa has caught much interest in Morocco (Choukr-Allah et al. 2016). It remains one of the most nutritious crops currently known and is classified as a Super Food because it contains all the essential amino acids necessary for human health. In addition, it is gluten-free, has double as much protein as corn, wheat, and barley (Repo-Carrasco et al. 2003), and has more micronutrients than most staple seeds, including barley, wheat, and rice. Quinoa seeds are a good source of protein (12.51–14.50 g/100 g DM), fiber (NDF, ADF, ADL, and cellulose), and unsaturated fatty acids (Marmouzi et al. 2015). Quinoa is rich in vitamins, including vitamin A precursor ( $\beta$ -carotene), riboflavin/vitamin B2, thiamin/vitamin B1, niacin/vitamin B3, ascorbic acid/vitamin C, folic acid/vitamin B9, vitamin E ( $\alpha$ -tocopherol), and pantothenic acid (Kozioł 1992). The whole quinoa seed contains 825.7 ppm K, 452.6 ppm Mg, 121.3 ppm Ca, 359.5 ppm P, 9.5 ppm Fe, 3.7 ppm Mn, 0.7 ppm Cu, 0.8 ppm Zn, and 1.3 ppm Na (Ando et al. 2002). The role of various components of quinoa, such as oil, starch, saponin, and dyes, is being explored, with the potential to supply a raw material to the chemical, cosmetic, and pharmaceutical industries.

In Morocco, quinoa has been studied since 2000 as an alternative crop tolerating drought and salinity that could contribute to achieve food security in rural communities (Benlhabib et al. 2014).

A project conducted by the Hassan II Agronomic and Veterinary Institute (*IAV Hassan II*) and funded by the European Union (EU)—Sustainable Use of Water for Food Production in the Dry Areas of the Mediterranean Region (*SWUP-MED*)—showed that quinoa grown under drought and

salinity stress conditions has higher water-saving and economical values, as well as higher seed and straw yields than wheat (Choukr-Allah et al. 2016). The findings indicate that quinoa needs only half the amount of water requirements of wheat. During the *SWUP-MED* project 2009–2013, quinoa was tested in several fields in *Bouchane* (a rural commune located in Rehamna region where the present project works are conducted) with promising results. It was shown that it could generate acceptable yield under rainfed conditions and achieve high production when irrigated. Quinoa has been implemented in several areas all over Morocco, and the number of producers of quinoa is rising every year, namely, in Berrechid, Laayoune, Rehamna, Fez, Boulmane, and Marrakech.

The *SWUP-MED* project conducted a farmer's survey in Rehamna Province to investigate their perception of quinoa as alternative crop to be introduced into their cropping pattern (Pedersen et al. 2013). It demonstrated that farmers would envisage introducing quinoa in their farming systems if there was a high and stable demand from the market. The project *SWUP-MED* also examined the market potentials and social acceptability of quinoa through surveys conducted at the national and regional level. The findings indicated that quinoa can be an important product on the Moroccan market especially if popular products such as couscous, bread, and sweets are made out of quinoa. Thus, more efforts in terms of promotion are necessary to raise awareness among Moroccan consumers. Some local women cooperatives have already started processing quinoa-based products (e.g., couscous and quinoa flour) including *Chabab Mkhalf* (Bouchane in Rehamna Province), *3rd Millennium Cooperative* (Bourros in Rehamna Province), *Sahara Agricultural Cooperative* (Tinjdad Province of Errachidia), *Association Tirsal for Social Development* (Agoudim commune in Khénifra), *Association Moullablad* (Ait Sbit in Rommani), and *Association of Cereals Producers* (Berrechid). A few startups such as *Amendy Food* (Chichaoua) and *Domaine Lion* (Marrakech) are also involved in quinoa production, processing, and marketing.

Several researches have been conducted on quinoa since its introduction in Morocco. First works were focusing on quinoa introduction and screening of its accessions. Those works resulted in selecting about 30 performing accessions which were further screened in 2008–2009 season (Benlhabib et al. 2015). Several cultivars such as Puno and Titicaca were retained for further upscaling (Benlhabib et al. 2014). In Agadir region, several works have been conducted to evaluate quinoa performance under organic amendment, deficit irrigation, and salinity (Hirich et al. 2014b, 2014c). The finding indicated that combining organic amendment with deficit irrigation maximized crop water productivity and improved yield. However, quinoa resisted to salinity up to an EC (electric conductivity) level of 10 dS/m without notable yield. Other works were focusing on quinoa physiological and biochemical responses to various stresses

including salinity (Brakez et al. 2013; Hirich et al. 2014c) and drought (Fghire et al. 2015; Ali et al. 2019). Quinoa was also tested under several sowing dates (Hirich et al. 2014a), and finding indicated that November and early December were the optimal sowing dates in the Agadir region. Benlhabib et al. (2014) tested quinoa under several rotation combinations and concluded that rotations that include legumes and quinoa can improve soil fertility and productivity, optimize fertilizer use of organic manure, and improve water use efficiency.

Quinoa has a high market potential due to increasing demand on healthy food especially in high-income countries, it generates an income per kilogram that is ten times higher than that of wheat, while its production cost per hectare remains twice higher than wheat due to processing intensive labor needs (Farfán 2017). As such, quinoa is an excellent solution for solving issues related to food and livelihoods in marginal environments. The average price of dehulled seeds at the supermarket is about 4.0USD/kg. The products sold are dehulled cereals, flour, pasta, biscuits, and breakfast cereals, but new markets for industrial products have been analyzed (Johnson 1993).

Morocco still imports quinoa; thus, there is a need to locally produce quinoa in order to achieve self-sufficiency which could be possible in the near future. However, to improve food security in marginal areas, farmers should cultivate resilient crops such as quinoa to satisfy their self-consumption and sell quinoa seeds to generate more income in order to afford other commodities. Developing quinoa value chain will not only

improve farmer’s income but also will have direct positive impacts on livelihoods of women operating in valorization and transformation cooperatives and consequently all value chain actors. Food security can be also achieved when opportunities for quinoa export are generated especially through organic quinoa production (first group of organic quinoa producer has been created and received certifications according to EU and Morocco organic farming laws).

The purpose of this study is to evaluate the adoption of quinoa and its market in Morocco providing analysis of its value chain, production/processing costs, and marketing assessment attributes.

## Material and methods

### Farmer’s survey

Data related to quinoa seed importation were provided by Exchange office, an entity in charge of tracking and regulating import and export of commodities in Morocco.

A farmer survey in several rural communes of Rehamna was conducted, interviewing about 500 farmers including 318 men and 182 women out of a population of 6000 farmers. Women were interviewed due to their involvement in agricultural product processing and their adherence to agricultural product valorization cooperatives. The confidence level and error margin used in this survey were equal to 95% and 4.2%.

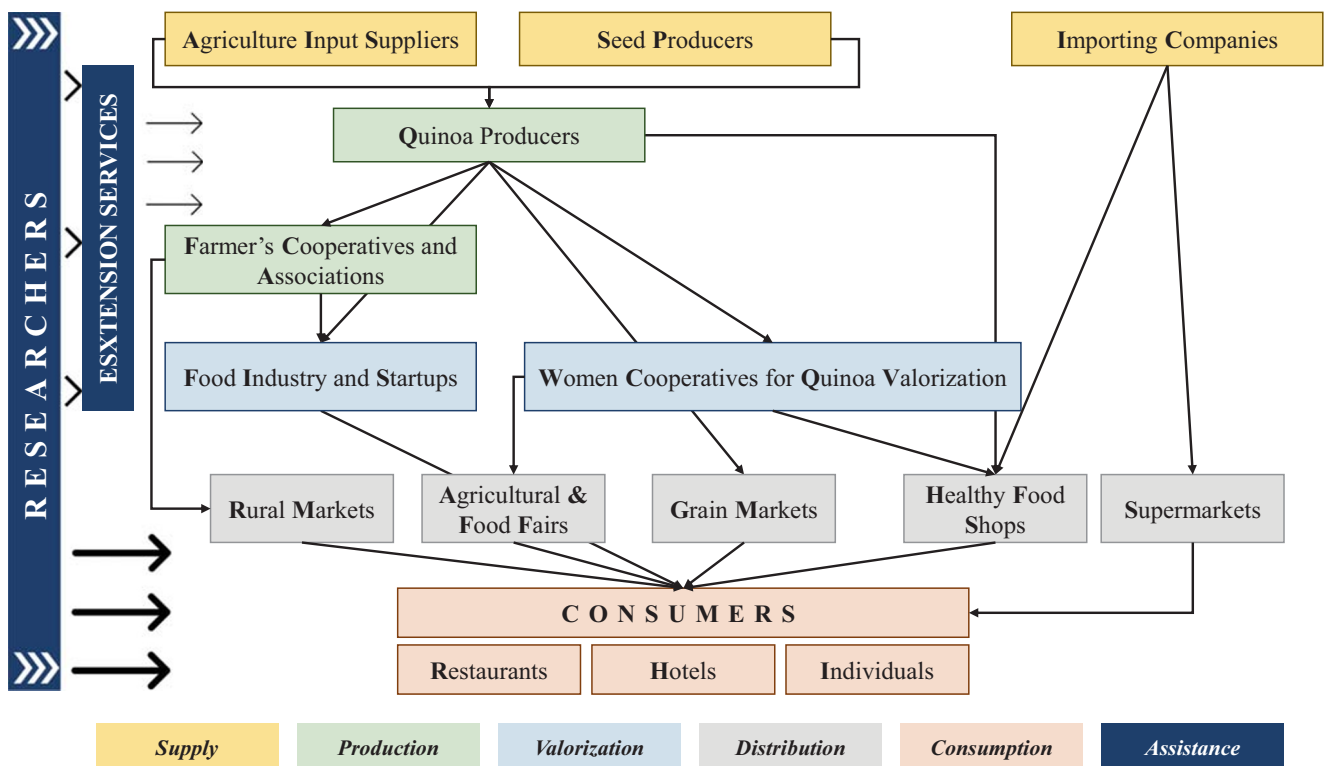
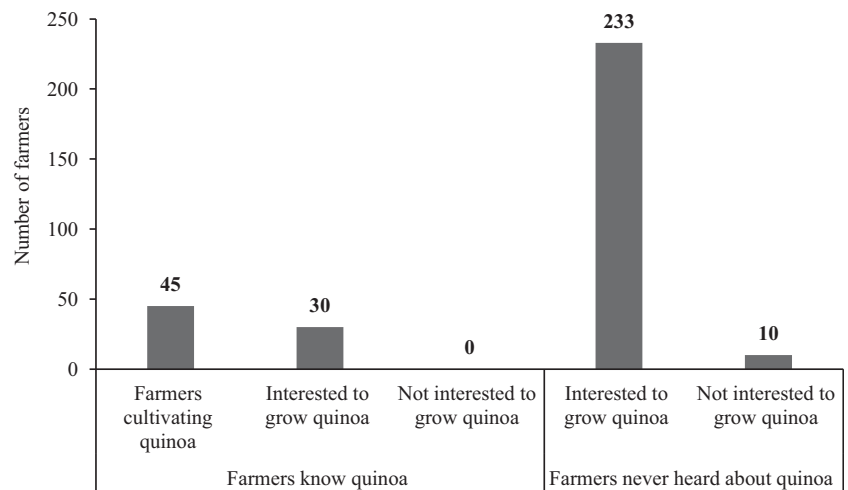


Fig. 1 Quinoa value chain mapping in Morocco

**Fig. 2** Distribution of surveyed farmers according to their knowledge about quinoa and interest to grow quinoa



Questions about quinoa adoption, cultivation, and farmer’s interest to adopt quinoa were included in the questionnaire as the following:

- General questions about the farmers (gender, age, education, address, etc.) and the farm (area, cultivated crops, varieties, seed source, auto-consumption, cropping pattern, water source, etc.).
- General questions about women: contribution to farming activities, involvement in quinoa production and transformation, revenue, training received, used tools, and willingness to receive trainings.
- Specific questions about quinoa production: varieties, areas, seed source, seed price, labor requirements, fertilizers requirement, irrigation dose, amendments, weeding, phytosanitary treatments, harvest, post-harvest process, storage, and seed loss.
- Specific questions about quinoa transformation: pearling, washing, drying, cleaning, packaging, labor requirements, inputs requirements, quinoa uses, quinoa products, etc.

- Specific questions about markets: selling price, clients, logistics, market types, constraints, etc.

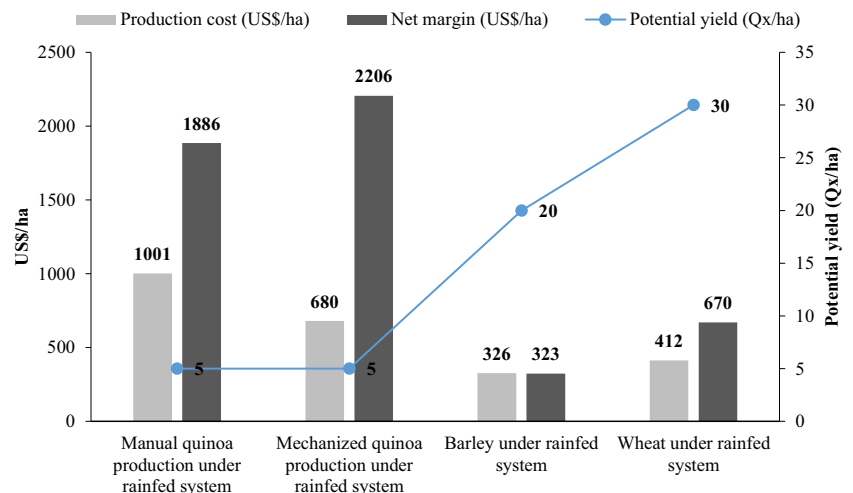
Data collected from farmer’s responses about quinoa production and transformation about cost of labors, inputs requirements, technical practices, required time for each production, and transformation operations have been used to calculate and determine production cost and margins.

This survey allowed us to generate the quinoa value chain map in Rehamna region, including different actors involved.

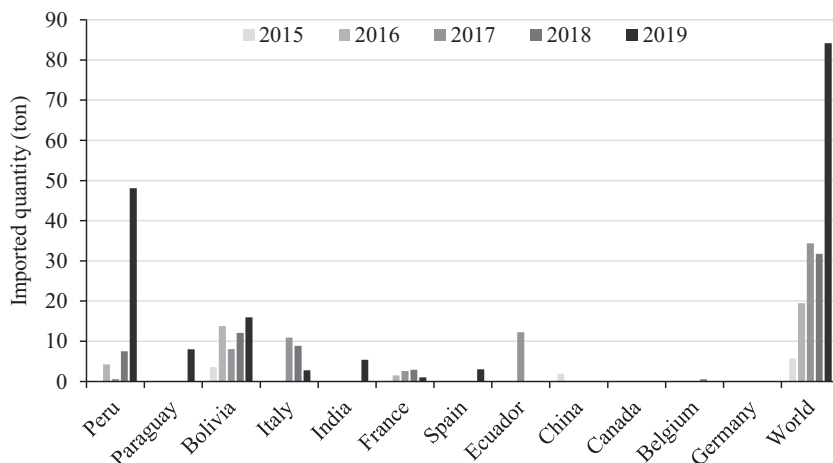
**Market assessment**

A marketing study targeted the population, including both current customers who have already consumed quinoa and potential customers: a sample of 544 people were interviewed. Questionnaires were administrated using face-to-face interviews (43%), mainly inside and outside the quinoa selling points (supermarkets, shops, restaurants, etc.) in big cities (Rabat,

**Fig. 3** Quinoa, barley, and wheat production cost and potential yield under several cropping systems



**Fig. 4** Evolution of quinoa import quantity in Morocco by exporting countries



Casablanca, Marrakech, Fes, and Tangier), and online (57%), especially through social networks and emailing lists. The main purpose of this study is to assess the behavior of the Moroccan consumers toward quinoa, their expectations of this product, and their degree of satisfaction of the market offer in quinoa.

**Results**

**Value chain mapping**

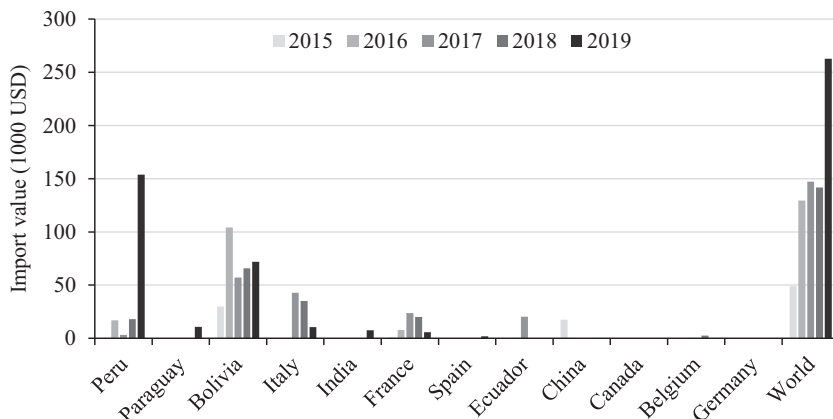
Figure 1 shows the quinoa value chain actors involved in all value chain components, including input supply, upstream production, valorization, and commercialization at local level (fairs, supermarkets, exhibitions, and shops). Besides, institutions providing technical assistance, researches and development institutions operate all along the quinoa value chain to provide their services for all actors especially in quinoa production, valorization and marketing. Most of quinoa production in Morocco remains traditional with few farmers who use mechanical operations (sowing, harvesting, and seed processing). Women are now dominating the quinoa transformation in Morocco with few cooperatives operating in Rehamna

region and producing basic quinoa products such as semolina, flour, and couscous. There are few actors such as industries and some start-ups who started developing quinoa-based products such as noodles and sweets. Recently, several efforts were deployed by researcher and extensions services to raise awareness about quinoa virtues conducting trials to show its agronomic and nutritional benefits. The quinoa value chain actors in Morocco still need to be linked in a way to better valorize quinoa seeds as most of farmers sell directly their seeds to final consumer without passing by the transformation actors which risks to impact quinoa seeds quality, especially farmers who perform a very superficial seed processing.

**Quinoa adoption**

Extension and awareness sessions were conducted about the economic interest of this crop in marginal areas suffering from abiotic stress (Rehamna region), as well as facilitating access to seeds for farmers who would like to try this crop for the first time. The farmers’ survey shows that more than 2/3 of farmers never heard about quinoa and 96% among them are interested to grow quinoa (Fig. 2). The data also indicate that 14% of farmers have already grown quinoa.

**Fig. 5** Value of quinoa import to Morocco evolution by country



**Fig. 6** Variation of quinoa import quantity and value in Morocco in 2019

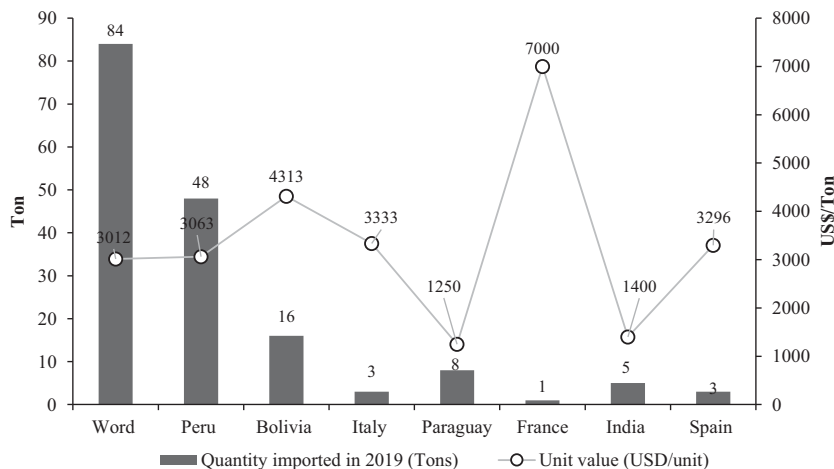


Figure 3 presents production cost, net margin, and potential yield of quinoa compared to other traditional cereals cultivated under rainfed system in Rehamna region. The presented data clearly indicate that quinoa with a relatively lower yield can generate more income compared to other cereals; it can generate 7 and 3 times income compared to barley and wheat, respectively. It was also found that using mechanization for quinoa production can increase net margin by 17% compared to manual production mode.

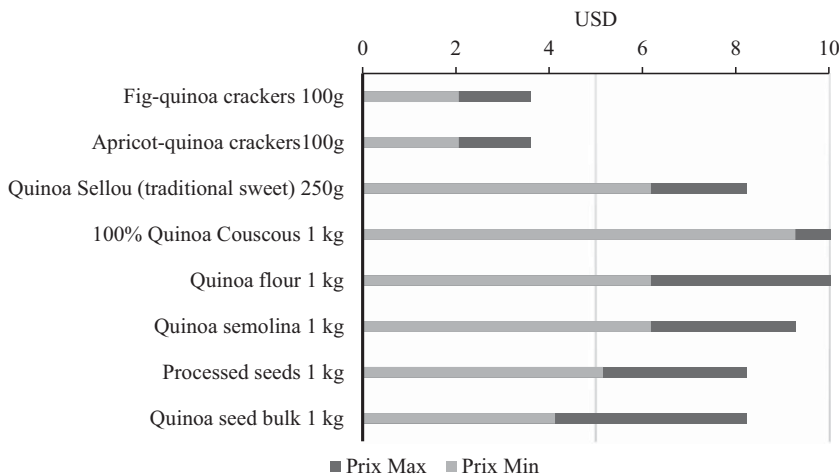
**Quinoa market analysis**

Figure 4 shows the evolution of quinoa imports quantity in Morocco by exporting countries. Presented data show that the main quinoa exporting countries to Morocco are Peru with 34%, Bolivia with 30%, and Italy with 13%. The total imported quantity has evolved from 6 in 2015 to 84 t in 2019, which justifies that there is a local demand from different customers (hotels, restaurants, cooperatives, companies, athletes, gluten-free intolerant, households, vegans, etc.). There are several outlets for quinoa commercialization in Morocco including:

- Organic stores and green grocery stores (La Vie Claire, Nait Hamou, etc.): they often sell imported quinoa products.
- Grain halls: the raw quinoa seeds are offered next to cereals, legumes, and other products.
- Village markets: weekly or bimonthly markets which are held in large cities and are often frequented by consumers that are concerned about the quality of products they consume.
- Supermarkets (Marjane, Marjane Market, Aswak Assalam, Carrefour, etc.).
- E-commerce platforms (Jumia.ma, MyMarket.ma, greenvillage.ma, epicerieverte.ma, CityMall.ma, [Goprot.com](http://Goprot.com), etc.).
- Agricultural fairs and exhibitions (International Agricultural Exhibition in Morocco (SIAM), regional fairs, etc.).

Figure 5 shows evolution of quinoa import value per exporting countries during the last 5 years. The total import value during the last 5 years amounts to 730 kUSD and

**Fig. 7** Price range of some quinoa products made and commercialized in Morocco



**Table 1** Distribution of quinoa couscous production costs by operation made by a women’s cooperative in Rehamna Province

Costs MAD/kg		Percentage		
Raw matter	Quinoa semolina	21.64	28.14	80.40
	Quinoa flour	40.2	52.26	
	Salt	0.0042	0.01	
Water	Seed washing	0.025	0.03	0.04
	Saponin elimination process	0.0028	0.00	
Labor force	Sorting	5.15	6.70	13.57
	Hydration	5.15	6.70	
	Packaging	0.125	0.17	
Energy	Electricity	0.0575	0.08	0.48
	Gas	0.3	0.40	
Transport	Transport	1.03	1.34	1.34
Packaging	1 kg package	1.5	1.96	1.96
Machine depreciation	Dryer	1.69	2.20	2.22
	Heat sealer	0.01	0.01	
Total costs		74,63		100.00

evolved from 49 kUSD in 2015 to 263 kUSD in 2019. The share of main exporting countries in the total import value is 45% for Bolivia, 26% for Peru, and 12% for Italy.

Data presented in Fig. 6 show that in 2019, Morocco imported a total of 84 t with an average price of 3012 USD/ton (3 USD/kg). In terms of import distribution, we found that 58% of the total imports come from Peru, with a selling price of 3.06 USD/kg and 27.3% from Bolivia with a selling price of 4.3 USD/kg. It is observed that selling prices varied from one country to another, the highest price was that of France (7 USD/kg), and the lowest price was that of Paraguay (1.2 USD/kg). Morocco’s trade balance related to quinoa in 2019 is negative which clearly indicates that Morocco should limit its importations by producing quinoa locally.

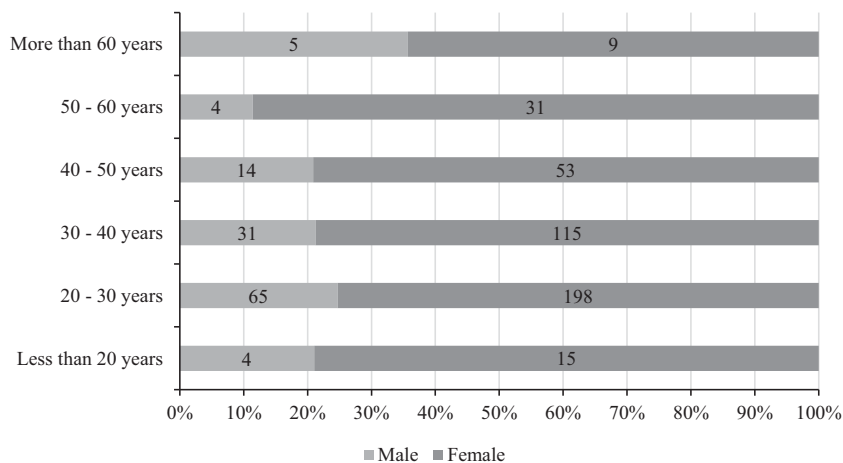
The prices of quinoa products made in Morocco remain relatively expensive. Figure 7 shows the price range of the main quinoa products made and commercialized in Morocco. The presented data clearly indicate that quinoa is better valorized after transformation. Products of second

transformation such as couscous, “*Sellou*,” and crackers valorize better quinoa in Morocco. These products can generate a significant net margin if the cooperatives get access to the raw quinoa at a convenient price (1.5–3 USD/kg) and generate more profit to women cooperatives which are the main producers of those products in Morocco.

Table 1 shows the cost distribution by production operation for the quinoa couscous made by women’s cooperative in Rehamna region. Obtained data show that raw material such as quinoa seed and flour cost is the most important due to its high price from farmers (80% of the total cost price). We also found that labor cost represents about 14% of total cost, and this is explained by the fact that the product is prepared manually.

Distribution of interviewed population according to their age range and gender shows that females represent more than 2/3 of interviewed sample (Fig. 8). While in terms of age range, young people (less than 30 years old) represent about 52 of interviewed population. However, old people (more than 60 years old) participated in this survey represent 3%.

**Fig. 8** Distribution of interviewed population according to their gender and age range (number and percentage)



**Fig. 9** Percentage of males vs. females knowing, consuming, and willing to purchase quinoa in Morocco

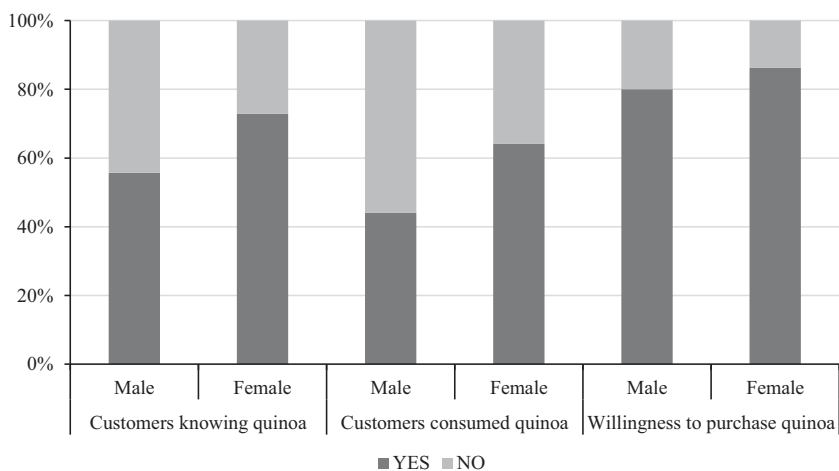


Figure 9 presents percentage of males and females regarding their knowledge, consumption, and willingness to purchase quinoa. Data indicate that 73% of females and 56% of males have already heard about quinoa. In terms of quinoa consumption, about 64% of females already consumed quinoa compared to 44% for males. Regarding the willingness to purchase quinoa, 86% of females are likely willing to purchase quinoa versus 80% for males.

Perception of Moroccan customers, vis-à-vis, quinoa price, taste, and packaging, is presented in Fig. 10. The obtained data indicate that 60% of interviewed customers disagree with the price of quinoa in Morocco, which means that the Moroccan consumers find it expensive. While more than 50% of customers are neutral toward taste and packaging, less than 17% are not satisfied with the taste (quinoa bitter taste) and packaging of quinoa. Many consumers have declared a bitter taste of quinoa because of the lack of control of saponin removal processes responsible for the quinoa seeds bitterness. The finding clearly indicates that more efforts need to be made to reduce the quinoa price in the Moroccan market.

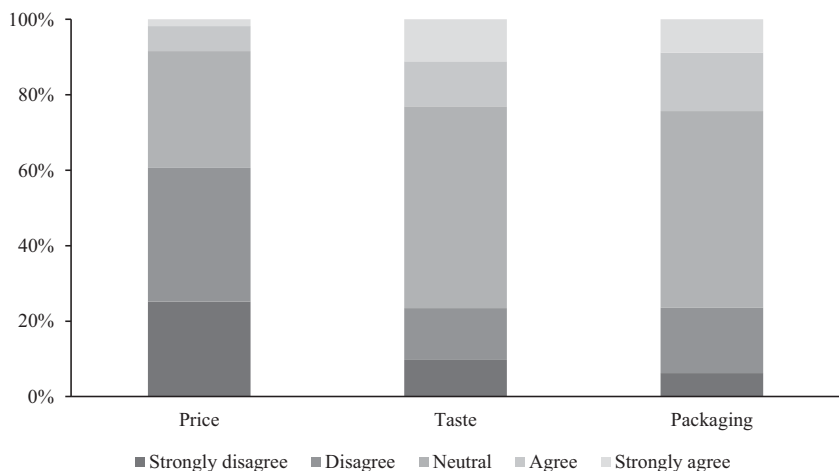
The interviewed customers were asked to give weight for several criteria including brand, price, quality, packaging, ease

of cooking, and availability that impact their decision to purchase and consume quinoa (Fig. 11). Findings reveal that both quinoa product brand and packaging are not impacting the decision to purchase and consume quinoa, while other criteria such as price, quality, ease of cooking, and availability are impacting this decision with more than 60% as weight for price and ease of cooking and more than 70% as weight for quality and availability.

After analyzing the production costs and prices of imported quinoa, we are going to focus on the psychological price (Fig. 12). This tool was developed by marketing specialists to calculate the price or price range that satisfies the maximum number of customers. It corresponds to the optimal price where the perceived quality is high enough and the perceived price is low enough. It was found that the optimum psychological or acceptability price is between 2 and 2.6 USD for 500 g package, which is between 4 and 5.2 USD/kg.

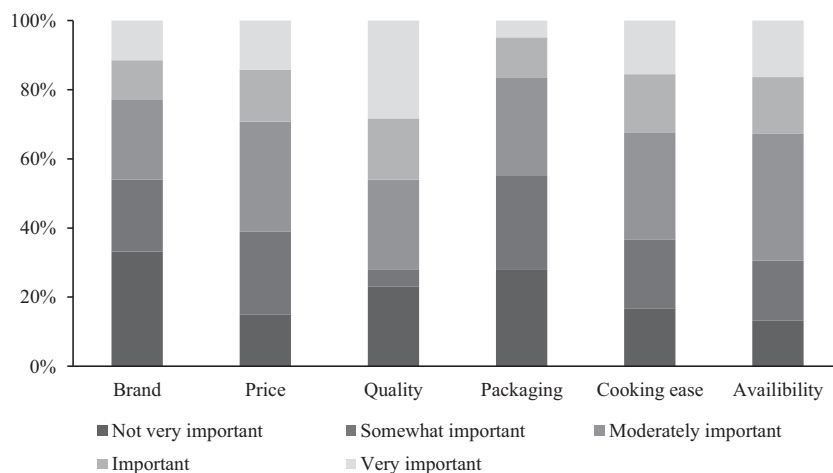
Social networks are nowadays used massively, and companies can gain benefits through using them in marketing; they can achieve a better understanding of the customer needs and behavior. Data regarding the use of

**Fig. 10** Perception of Moroccan customers, vis-à-vis, quinoa price, taste, and packaging





**Fig. 11** Weight of quinoa brand, price, quality, packaging, cooking ease, and availability in the decision of Moroccan customers to purchase and consume quinoa



social networks by interviewed customers are presented in Fig. 13. Findings indicate that Facebook is the most frequented network followed by Instagram, WhatsApp, and YouTube. Thus, quinoa marketing in Morocco using online systems should focus on those platforms to reach a maximum of potential customers without ignoring traditional media supports such as television and written supports.

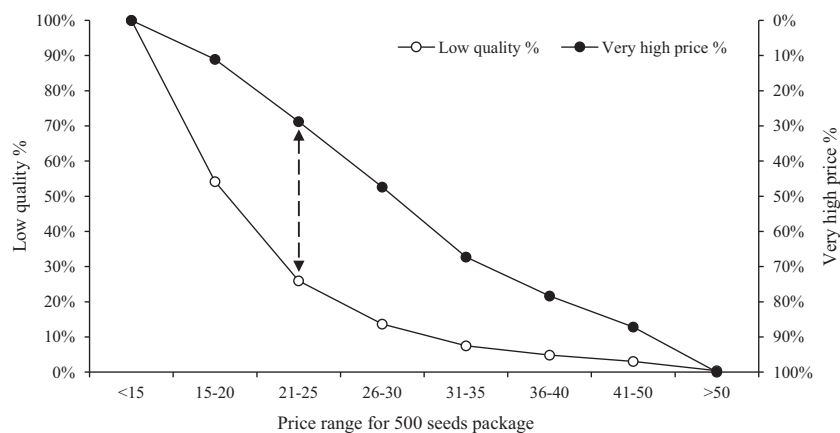
## Discussion

In the recent years, demand on quinoa has been greatly increased following a high interest from countries to introduce quinoa. The number of nations developing the crop has raised quickly from eight in 1980 to 40 in 2010 and to 75 in 2014. Twenty nations have sown quinoa for the first time in 2015 (Bazile et al. 2016a). Currently, it is estimated that more than 105 countries have already introduced and tested quinoa as a new crop.

Rehamna region is one of the driest regions in Morocco with poor soil and water resources. There are about 6000 smallholders' farmers in the region living on a subsistence

farming system. Quinoa has been introduced in the region since 2008 (Benlhabib et al. 2014), but its value chain is still not well developed yet due to many constraints, mainly those related to marketing. The quinoa market in Morocco is increasing, and several farmers have already initiated the cultivation of quinoa in different regions of the country. Nevertheless, yield and production have been highly fluctuating and instable, with only 0.3–0.5 t/ha as average yield, whereas the potential attainable yield can be as low as 0.8–1.0 t/ha under rainfed conditions (Benatti 2017). Pedersen et al. (2013) have found that farmers would envisage to incorporate quinoa into their cropping systems if there was high and stable market demand. This study shows that quinoa production cost is higher than other traditional cereals, which explains the high price of quinoa. According to Angeli et al. (2020), among the causes that increase the cost of manual production of quinoa 2are the cost of the labor force, the consumption of water for washing quinoa, and the use of energy (gas and electricity) for drying the seeds. During agricultural campaigns in Morocco and other Mediterranean countries, farmers will become familiar with the quinoa crop, and production costs will be optimized by obtaining high yields (Yazar et al. 2013).

**Fig. 12** Distribution of low quality vs. very high price percentage for consumer responses



This study revealed that females have more knowledge about quinoa, which can be explained by the role of women in the purchase decision-making of household commodities but also their interest for healthy products. It also revealed that quinoa price in Morocco remains high as perceived by more than 60% of customers. This high price can be explained by the fact that quinoa market in Morocco is still a niche market and depends on the international market where the global average price of quinoa remains relatively high. It rose significantly between 2012 and 2014, from 3 to 6 USD/kg. As of October 2018, the price of a kilogram of quinoa on average worldwide was about 2.3 USD/kg (Shahbandeh 2019). The prices of locally produced quinoa products and imported quinoa products remain similarly high due to high production and processing cost as reported by Benatti (2017) who found that production cost varies from 2.5 to 5 USD/kg.

The finding of the marketing study shows that more than 72% of the interviewed customers stressed on the importance of quinoa seed quality which can be affected negatively by an unacceptable quinoa saponin content due to inappropriate shelling and washing process. The quality of quinoa can be defined by a residual saponin content not exceeding 0.12% and a maximum moisture limit of 13% (Codex 2019). High amounts of saponin are considered a major hindrance of quinoa development (Bhargava et al. 2006) because they can have a negative effect on digestibility and the absorption of nutrients (Maughan et al. 2004). Consequently, the development of sweet varieties with low or no saponin is one of the crucial breeding aims for quinoa (Spehar and da Silva Rocha 2010), in addition to development of mechanized tools for quinoa mechanical abrasion.

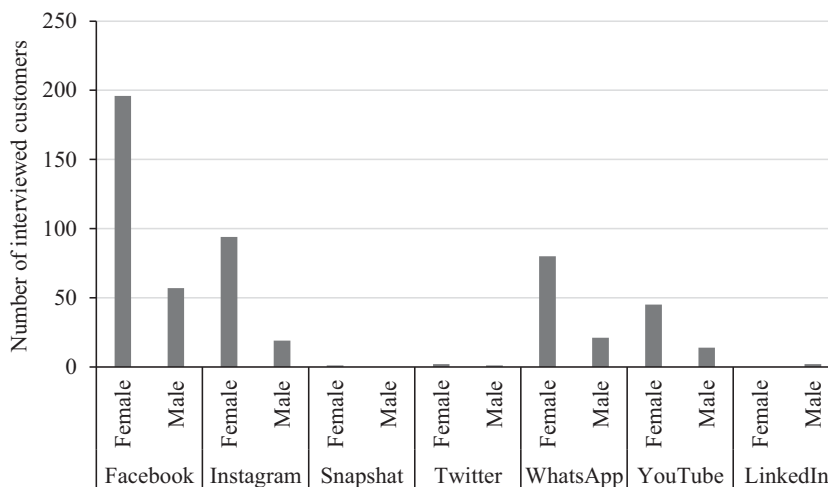
Marketing techniques focused on the client satisfaction, have been developed, and have expanded the number of clients of social systems (Vásquez and Escamilla 2014). Social systems can give profitable data and can be straightforward in genuine time, much appreciated to the meeting of viral communication, which comprises of gigantic and fast diffusion of

a message over the internet that customers transmit (Miller and Lammas 2010). The finding of this study shows that social networks could be an efficient support to be used for quinoa marketing in Morocco in order to raise awareness about its virtues and reach potential consumers. It was shown that Facebook and Instagram should be the focus of any online marketing strategy targeting quinoa in Morocco especially using influencers such as foodists, dieticians, bloggers, and YouTubers with important digital profiles and number of followers who have assumed a decisive role in creating opinion and influencing people (Allué 2013). However, quinoa marketing cannot be adequate and efficient if no effort is deployed to have a very stable product with high quality. Thus, quinoa producers should cultivate first very stable genetic material, adopt best cropping practices, and apply good valorization practices (seed processing, transformation, packaging) to sustain the availability of high-quality product.

Despite the fact that the quinoa market is a niche market, the commercialization of quinoa in Morocco may have new opportunities which are not yet developed. An interview that we conducted with the Moroccan Association of Gluten Intolerants (AMIAG) has revealed several interesting points. The association states that 1% of Moroccans are celiac (350,000 cases). According to a study conducted by Loudghiri and Benelbaghdadi (2010) in Morocco, celiac disease presents a peak frequency between 21 and 40 years of age, with an average age of 32 years at diagnosis. The price of the gluten-free flours varies on average between 4 and 22 USD per kilogram in a grocery store in Rabat (the products are imported from France and Italy). Same for breads, cakes, and sandwiches, which can cost 4 USD for 90 g. They are sold at twice the price compared to their equivalent products with gluten.

The high price of imported gluten-free products can create a market for Moroccan quinoa products if cooperatives and companies sign a contract with the AMIAG. Products derived from quinoa must present a conformity to the requirements of

**Fig. 13** Responses of interviewed customers regarding frequented social network



mandatory labeling according to Decree No. 2-12-389 (28-07 Law) establishing the conditions and modalities of labeling of food products in Morocco. Thus, for these products to be labeled “gluten-free,” they must contain less than 20 mg of gluten per kilogram (20 ppm).

The market assessment clearly indicates that the Moroccan consumer is ready to pay 4 USD/kg of quinoa, which will hardly cover the production cost for smallholder farmers (Benatti 2017). However, production cost could be significantly reduced by using mechanized tools and agricultural inputs to increase yield, which will help quinoa producers to remain competitive vis-à-vis imported products (Thompson and Blank 2000). Despite the various constraints, quinoa is considered to be a potential alternative to cactus trees in Rehamna region, which was completely devastated by the *Opuntia cochineal* scale insect in recent years (Bouharroud et al. 2016).

## Conclusions

The present study shows that quinoa value chain in Morocco is still not well structured yet, and all its actors need to be interlinked. There is a need to develop further all value chain components including seed production processing, valorization, and marketing. It is also necessary to deploy a lot of efforts to raise awareness among farmers, relevant government actors, the private sector, and the general public of the economic benefits of quinoa and its potential as a stress-tolerant alternative crop for marginal environments. In order to meet the consumer expectations in terms of market price, quinoa intensification using irrigation and mechanization is highly recommended. The finding indicates that quinoa is a potential alternative crop to traditional cereals (wheat and barley) and could be a judicious solution to increase farmers’ income, especially because most of farmers are interested to adopt it. Market assessment revealed that social networks could be an efficient tool to accelerate the market development of quinoa in Morocco. In the light of obtained results, we strongly recommend to further upscale quinoa in other regions suffering from water scarcity and salinity (e.g., Draa, Tafilalet, South of Morocco), to explore pathways for further valorization through organic farming and export of quinoa based products to neighboring markets such as Europe and to integrate quinoa in the Moroccan food industry instead of being transformed by local cooperatives. There is also a need to develop incentive policies by the Moroccan government to introduce quinoa in marginal areas where traditional cereals yield is low.

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**Data availability** The data generated within this work are open access and available to be shared with interested persons according to signed agreement with IDRC.

## Compliance with ethical standards

**Competing interests** The authors declare that they have no conflicts of interest.

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**Consent to participate** Not applicable.

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