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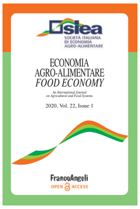

Introducing quinoa in Turkey – farmers perception in the region of Adana

Søren Marcus Pedersen[*,a], **Kim Martin Lind**[a], **Orjon Xhoxhi**[a,c], **Attila Yazar**[b], **Sven-Erik Jacobsen**[a], **Jens Erik Ørum**[a]

[a] University of Copenhagen, Denmark
[b] University of Çukurova, Turkey
[c] Agricultural University of Tirana, Albania

Abstract

In order to look for a more diverse and sustainable cropping system with high value crops in the Mediterranean region of Turkey, the drought and salt tolerant crop quinoa was analysed as an alternative to the current major crops, for instance wheat. This study investigates the conditions for growing quinoa in Adana, and how they are perceived among farmers in the region. A combination of qualitative and quantitative research was employed to group farmers into segments according to their willingness to adopt quinoa. Findings from this study indicate that farmers in Adana perceive quinoa as a crop likely to be adopted in their cropping system if they can gain market access with the new crop. Farmers' previous knowledge regarding the crop, concerns about drought and salt risk and farm characteristics also appear to be determining the farmers' attitude towards new crops.

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* *Corresponding author*: Søren Marcus Pedersen, Associate Professor - Department of Food and Resource Economics - University of Copenhagen, Rolighedsvej 25 - 1958 Frederiksberg C, Denmark - e-mail: marcus@ifro.ku.dk.

Introduction

The Food and Agriculture Organization of the United Nations (FAO) has selected quinoa as a crop among others with the potential to sustain food security and improve the nutritional diets in the next century (Bazile *et al.*, 2016). Quinoa (*Chenopodium quinoa* Willd.) is regarded as the next crop capable of global extension. It is argued that quinoa is a crop that is likely to be cultivated in a sustainable manner worldwide provided that experience about the crop is disseminated effectively in conjunction with the establishment of research projects for testing the crop under a variety of different conditions (Ruiz *et al.*, 2013).

Quinoa is also characterized with underutilized potentials. Crops like quinoa and amaranth are neglected by different users for a variety of reasons such as agronomic, genetic, economic, social and cultural (Andersen, 2012). So far, production has mostly taken place in the Andean region, but a recent increased interest in the crop has led to attempts to introduce quinoa in Europe and North Africa among other regions. Currently, quinoa is tested or cultivated in 95 countries around the world (Bazile *et al.*, 2015). Jacobsen *et al.* (2013; 2015) argue that quinoa might be a crop to be introduced under dry conditions in Africa and Asia, due to its high tolerance to drought and soil salinity (Becker *et al.*, 2017). A study by Lavini et al (2013; 2014) suggest from field experiments in the southern part of Italy that both quinoa cultivars "Titicaca" and "Puno" could be cultivated successfully in Italy and possibly in the Mediterranean area. A study by Yazar *et al.* (2013; 2015) with field experiments from Adana in Turkey supports the characteristic that quinoa is tolerant to saline soils and drought stress.

Field experiments were set up in order to evaluate the yield response of quinoa (*Chenopodium quinoa* Willd. cv. Titicaca) to irrigation with saline and fresh water under Mediterranean climatic conditions in Adana, Turkey. The results indicated that grain yields were slightly reduced by irrigation water salinity up to 30 dS m^{-1} compared with fresh water irrigation. Salinity and drought stress together interfered considerably with crop grain and biomass yields. However, salinity stress alone did not interfere with grain and biomass yield significantly; therefore, quinoa may be defined as a crop tolerant to salinity. Yield parameters such as aboveground biomass, seed yield and harvest index suggested a good adaptation of quinoa cv. Titicaca to Mediterranean environments (Yazar *et al.*, 2015).

To look for a more sustainable and diverse cropping system in the Mediterranean region of Turkey, adapting to predicted climate changes, it is argued that quinoa could be a relevant solution (Benlhabib *et al.*, 2014; Hirich *et al.*, 2014). Our contribution is to cluster farmers into groups of adopters. Any initiative that wants to introduce quinoa should target the group of farmers that have a higher likelihood to adopt this crop.

The objectives of this study are:

1. to describe the potential benefits and barriers from using quinoa as a sustainbale crop among farmers in the semi-arid Mediterranean region (case: Adana in Turkey);
2. to assess farmers' perception of quinoa as a sustainable and high value crop in the Mediterranean region of Adana and to identify specific farmers' segments with corresponding characteristics that could potentially adopt the crop;
3. to describe factors that determine farmers' adoption of a new crop in their local cropping system.

Market trends for quinoa

In recent years, the cultivation of quinoa has shifted from being a crop for local consumption in the Andean countries of Bolivia and Peru to become a cash crop for export to North America and Europe. Quinoa is produced and marketed as an organic crop and sold at high end-user prices. Currently, the average yield of quinoa is less than 1 tons pr. ha (FAO, 2012). There have been increasing prices of quinoa for several years starting 20 years ago but prices have decreased since 2015 (FAO, 2019). International prices of quinoa were on average 3000 USD per tons in 2013, and between 3500-8000 USD per tons for particular varieties. Payments to the farmers (farm-gate prices) were about one-third of these prices, which is regarded as a high price for an arable crop (Small, 2013; FAO, 2013). Bolivia and Peru are the main quinoa producing countries in the World. In 2013, more than 75,000 hectares of land were cultivated with quinoa in Bolivia and more than 45,000 hectares in Peru (Bazile *et al.*, 2016).

United States is the main importer of quinoa from Bolivia and Peru (FAO, 2013) but also EU-27 has imported quinoa from Bolivia and Peru of which the majority originates from Bolivia (CBI, 2012). The most important European importers of quinoa are France, the Netherlands and Germany. So far, there is only a minor domestic production of quinoa in Europe. Currently, Turkey has a minor share of 0,1% of the import to Europe (Koehoek, 2019). According to FAO the export of Quinoa from Turkey was 27 tons in 2017 and turkey imported 252 tons of quinoa in 2017 (FAO, 2019). From a cultivation point of view, quinoa is drought and salt resistant, and it is highly nutritious (Repo-Carrasco *et al.*, 2003; Stikic *et al.*, 2012).

Besides being a stress tolerant crop, it is expected that quinoa can provide higher profits and offer new market potentials due to the gluten free characteristics of the crop.

According to Euromonitor (2011), gluten free products have shown in the last number of years an outstanding performance. Over the period 2004-2009 the category registered a compound annual growth rate (CAGR) of

15%, whereas certain products like gluten free pasta had a 27% growth rate (Euromonitor, 2011). There are several drivers that imply that the gluten free product category will continue to grow in the next ten years. Firstly, the coeliac[1] disease is regarded as one of the most under-diagnosed diseases in the world. It is estimated that 1 out of 100-300 people are affected worldwide (Euromonitor, 2011). Secondly, health as a motive for buying gluten free products is increasing and finally, food companies have large incentives to produce this type of products due to the high added value that they provide. Consequently, a huge market potential for gluten free commodities (including quinoa) exists in Europe and other high income regions. A disadvantage is that quinoa seed, except for sweet varieties, contains saponins, which have to be removed before consumption, and yields are relatively low although compensated by much higher prices. Nevertheless, the fact that quinoa is drought and salt tolerant with an increasing and high market price, organically produced with high protein contents and protein quality, as well as being gluten free, could make quinoa a sustainable crop among farmers in Turkey and the Mediterranean region in the years to come. Moreover, quinoa is a crop with ample amounts of antioxidants, micronutrients and essential amino acids (Jacobsen *et al.*, 2013).

Adoption of new cropping systems

A farm survey conducted by Kusadokoro and Maru (2006) has identified a detailed cropping pattern in the region of Adana. The most important crops in the rain-fed areas are wheat, cotton and barley. In irrigated areas, the main crop is corn (maize), and other crops are wheat, citrus, cotton, vegetables and watermelon. The irrigated area of Adana utilizes intensively the agricultural land by the practice of double cropping, where the first crop is wheat, and the typical second crop is maize. It is argued that the main reason for intensive land use is due to a relatively small field size per family. More than 40% of the farmers cultivate farms with less than 7.5 ha.

To make a succesfull introduction of a new crop it is necessary to understand both the characteristics of that particular crop and farmers' perception as well as to describe specific factors that determine adoption. By identifying potential farm segments that are willing to adopt, the product can be introduced and disseminated among those who appear more willing to adopt the new crop. In turn, the adopters could serve as an example for other farmers, thereby spreading knowledge and use of quinoa.

Studies on farmers' adoption of new cropping systems list some factors that may influence the adoption like farm size, risk exposure, human capital,

1. Coeliac diseases is a genetic disorder requiring a lifelong gluten free diet.

credit constraints and market access (Feder *et al.*, 1985; Zeller *et al.*, 1998). Other studies have also identified other determinants of adoption of new cropping systems such as agro-ecological, labour requirements and seed supply constraints, and specific barriers in relation to traditional values for the specific location (Smale *et al.*, 1994; Bellon & Taylor, 1993; Franzel *et al.*, 2004; Gachango *et al.*, 2014; Pedersen *et al.*, 2013; Phiri *et al.*, 2004; Ajayi *et al.*, 2003, 2007; Arslan & Taylor, 2009; Lawson *et al.*, 2009). Arslan *et al.* (2013) point out that agro-ecological constraint on soils (e.g. drainage capacity) and climate (e.g. semi-arid regions) are also likely to affect adoption. Furthermore, the study finds that extension services and rainfall variability are strong determinants of adoption. Their study highlights the role of agro-ecological and socio-economic constraints in explaining adoption, as well as the potential role and effectiveness of interventions to support it. Knowler and Bradshaw (2007) reviewed 23 studies, and found that farm size tends to be a significant determinant in studies in Africa, whereas education appears to be significant in studies in North America. Several studies have also indicated that education has an impact on farm adoption of new crops. A study from 2003 in Ethiopia shows that educated farmers are less risk averse and more likely to adopt new crops than farmers without education (Knight *et al.*, 2003). Abebe *et al.* (2013) found that farmers' adoption of improved potato varieties is positively related to the frequency of use of technical assistance from NGOs and access to credit, while the use of the main buyer as a source of advice negatively affects improved potato variety adoption. On the other hand, yield, disease resistance, and maturity period appear to be less important (Abebe *et al.*, 2013). The results of Abebe *et al.* (2013) imply improved production-related quality attributes, which may not be enough to encourage farmers to adopt new varieties. They recommend putting more emphasis on market-related quality attributes in new variety introduction. Some variables have only limited variation between farmers making them unsuitable as determining characteristics.

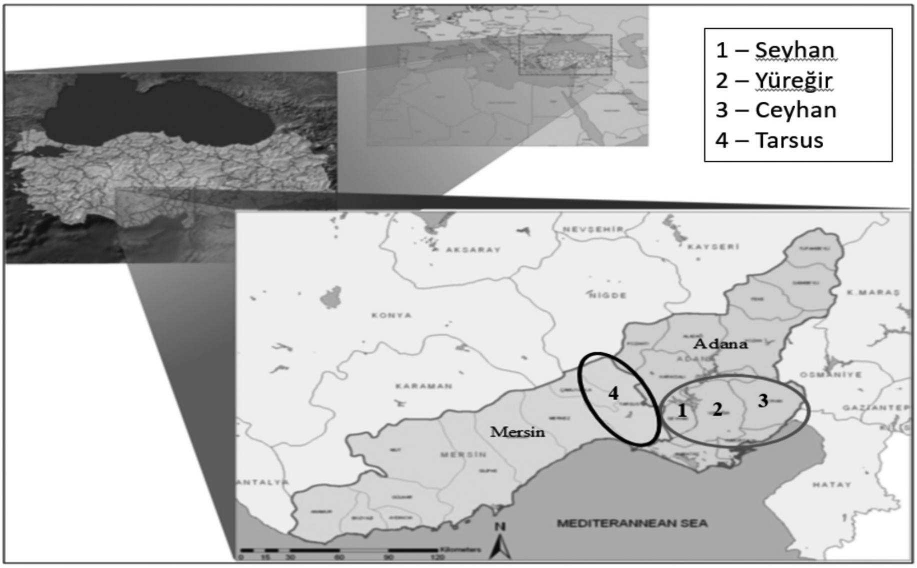
The study is organized as follows, firstly, a background about the study region is provided, followed by a description of the method employed in this study. This is followed by a section with findings and discussion of results. Finally, a conclusion is made, with a list of advantages and barriers to adopt quinoa in Turkey.

1. Materials and methods

In this study, we will apply cluster analysis to identify and reveal specific farm type characteristics or market segments that are willing to adopt a new crop like quinoa. Cluster analysis is a method that uses a minimum of prior assumptions or theories but instead attempts to let data reveal structures and patterns. In general, cluster analysis minimises within-cluster variance while maximising between-cluster variance. Hence, cluster analysis attempts to produce distinct clusters that are internally homogenous. Kotler and Keller (2006) defines distinct groups like this as clustered preferences also known as natural market segments. A market segment consists of a group of customers who share a similar set of needs and wants (Kotler & Keller, 2006). Consequently, farmers are grouped into segments according to variables of interest.

The farm survey was carried out in Adana in the southern part of Turkey, a major agricultural and commercial center with a population of 2 million (Turkstat, 2010). It is the fifth most populous province in Turkey, with an area equal to about 2 % of Turkey's overall area (Çukurova Development Agency, 2007). The study (see figure 1) was conducted in four districts, three of Adana (1. Seyhan 2. Yüreğir and 3. Ceyhan) and one district of Mersin (Tarsus).

Figure 1 - The four districts in the study area



These four districts were selected because they cover most of the Çukurova region, one of the most productive regions in Turkey. Furthermore, the agricultural land areas are substantially located in these districts in the southern part of the region. Agriculture is an important sector in Adana.

Notably field crops and fruit orchards have played important roles in socio-economic terms. Adana produces 4% of Turkey's agricultural products (Çukurova Development Agency, 2007).

This study is based on interviews and a survey of 92 farmers in Adana, Turkey as a part of an EU funded project focusing on sustainable land and water management in the Mediterranean region in 2013. Adana is located in the Mediterranean area close to the European market. It is a semi-arid region with the possibility to irrigate. From interviews and previous experience with farmers' adoption and barriers to adopt new crops, we specifically addressed questions about farmers' current crop production, farm size and their knowledge of quinoa. Moreover, specific questions about salinity and drought resistance, which is a specific crop characteristic of quinoa, are also addressed. In addition, farmers were asked to prioritise among different factors of determining characteristics when deciding to introduce a new crop in relation to: Market access, crop price, ease of production, crop yield and production costs.

Based on survey data described above, the variables chosen for the cluster analysis are: Farmer's age, farm size, use of irrigation, education, farmers' knowledge about quinoa, farmers' experience with salinity, farmers experience with drought and farmers' willingness to adopt a new crop.

In order to analyse farmers' attitudes towards undertaking new crops and their possible interest in quinoa, a cluster analysis employing some basic characteristics of farms and farmers' perceptions was carried out.

Analysis procedure

The analysis begins with a hierarchical cluster analysis with the aim of determining the number of distinct groups or clusters in the dataset. In the hierarchical analysis, Ward's method is employed (Everitt *et al.*, 2011). Ward's method is the most commonly used algorithm for hierarchical cluster analyses and has the property that the number of objects, in this case farmers, in each cluster do not differ too much. Subsequently, to refine the grouping of farmers, a hierarchical cluster analysis is undertaken, which use the number of clusters obtained from the non-hierarchical cluster analysis as given. The hierarchical analysis use a k-means algorithm that minimises Euclidean distance in order to select objects for clusters. The selected variables for the cluster analysis were based on literature review and interviews as described above.

In addition, a logistic regression analysis has been conducted to identify correlation between willingness to adopt and the selected variables from the cluster analysis.

The log-likelihood function for the logistic regression in this case is:

$$lnL(\beta) = y_i log[G(\boldsymbol{x}_i\boldsymbol{\beta})] + (1 - y_i)log[1 - G(\boldsymbol{x}_i\boldsymbol{\beta})],$$

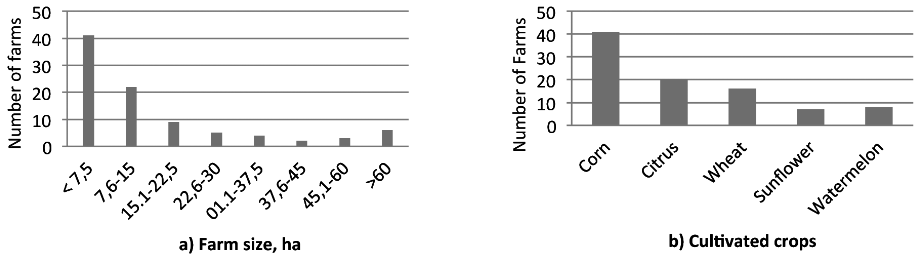
where:
i = 1, 2, …, 92, denotes the farmers;
L(.) is the likelihood function;
G(.) is the logistic function;
…y_i is the dependent variable, which in this case is farmers' willingness to adopt a new crop;
…$\boldsymbol{x}_i$ is a vector consisting of the seven regressor variables plus the intercept and β is the corresponding vector of parameters. The regressor variables are:
$x_{0,1}$ is the intercept;
$x_{1,1}$ is farmer's age;
$x_{2,1}$ is Farm size;
$x_{3,1}$ is use of irrigation;
$x_{4,1}$ is education;
$x_{5,1}$ farmers' knowledge about quinoa;
$x_{6,1}$ farmers' experience with salinity;
$x_{7,1}$ farmers experience with drought.

2. Results

Farmers in Adana had little if any knowledge about quinoa. Most of the farmers said that when they consider the introduction of a new crop in their production system, they make some sort of comparison between the crops that they already produce and the new crop. They look at the market availability, product prices, yield, production cost and ease of production. In Fig. 2a and 2b is seen a description of demographic statistics from the Adana region farm survey. Most farms cover an area of less than 15 hectares with focus on cereals (maize and wheat) and citrus. The main crops in this region are maize, citrus and wheat (Fig. 2b). This cropping pattern is similar to the general cropping pattern for the irrigated land in Adana as identified by the Kusadokoro and Maru (2006) in their survey.

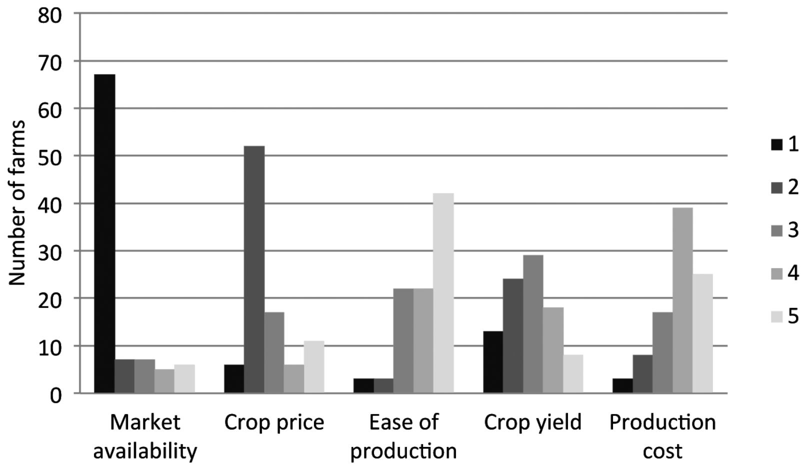
In the survey, we addressed a question to 92 farmers: "have you heard about a crop named quinoa?". About 10 percent of the farmers responded "yes" and about 90% responded that they had never heard about quinoa. However, a majority of the farmers were still open for introducing a new crop that is resistant to drought and salinity on their farms. More than 58 percent of the 92 farmers replied that they would like to include a crop that is resistant to drought and can deal with salinity problems. About 28% of the farmers in Adana said that they have problems with salinity on their land. This problem may be due to a large frequency of irrigation in this region. 19% of the farmers replied that they had problems with drought on their land.

Figure 2 - Farm size distribution (a) and cultivated crops among farmers (b) in the Adana region, N = 92



To introduce a new crop it is however important that the crop can provide a market benefit to the farmers. Farmers' perception of a new crop is highly related to the market conditions. More than 60% of the farmers reply that market availability has the highest priority to them compared with yield, crop price, ease of production and production costs, when deciding what crop to introduce in their production pattern. The second most important factor is crop yield followed by crop price. Ease of production and production costs are not major issues in regard to the adoption of a new crop (Fig. 3).

Figure 3 - Factors of priority that determine farmers inclusion of a new crop, N = 92, 1 is highest priority and 5 is lowest priority



Using these variables as described above, the non-hierarchical clustering procedure produces the results shown in table 1. Cluster analysis does not have a solid statistical foundation in terms of probability distributions due to the number of possibly quite disparate variables used. Therefore, the selection of the number of clusters requires an element of evaluation by the researcher. However, some indicative measures provide some guidance. Table 2 shows the results of the non-hierarchical clustering procedure, which have produced four clusters and in table 1, pseudo-F (PsF) and pseudo-t2 (PsT2) values are displayed. The PsF statistic describes the ratio of between-cluster variance to within cluster variance (Calinski and Harabasz, 1974): Large values of PsF indicate close-knit and separated clusters. In particular, peaks in the PsF statistic are indicators of greater cluster separation. Thus, a large PsF value relative to the preceding value indicates a stopping point. The PsT2 index quantifies the difference between two clusters that are merged at a given step. Thus, if the PsT2-statistic has a distinct jump at step k of the hierarchical clustering, then the clustering in step k+1 is selected as the optimal cluster. Consequently, for the PsT2 statistic, the procedure is to move down the column to stop at a value markedly higher than the preceding one and then move one cluster up. To further aid the selection of the number of clusters, a measure of the proportion of variance in the data accounted for is provided using the squared multiple correlation, R^2.

Both the PF and the PsT2 statistics suggest four clusters with 81% of the variation accounted for. The hierarchical clustering method is an irreversible procedure, which means that once an object has been assigned to a cluster, the object cannot change to another cluster even though cluster characteristics might change significantly as more objects are clustered. Therefore, applying the choice of the number of clusters from the hierarchical procedure, a non-hierarchical procedure is performed with the objective of refining the clustering of farmers. The results of the clustering analysis are presented in the next section.

Table 1 - Hierarchical cluster analysis

Ward's clustering method.

Cluster no.	**R^2**	**PsF**	**PsT^2**
5	0.86	120	42.8
4	0.82	124	12.5
3	0.76	119	39.8
2	0.63	126	54.7
1	0.00	–	126.0

Note: The gray row indicate that 4 clusters are selected.

Cluster analysis results

Cluster 1 "operated by a young farmer" is the largest with 53 of the 92 farmers. It is characterised by young farmers with small farm size. They have less irrigation than farmers in the other clusters and have the lowest level of education. Farmers in cluster 1 have generally not heard about quinoa but are not opposed to undertake a new crop in their crop rotation. This is likely because they have a relatively large proportion of rain fed crops which may give them an interest to adopt crops that are drought tolerant.

Table 2 - Taxonomy of farmers using a non-hierarchical k-means clustering procedure

	Adopters	**Moderate adopters**	**Moderate adopters**	**Non adopters**
	Medium sized farms, educated farmers with some knowledge about quinoa and experience with salinity problems	Small size farms with little knowledge about quinoa but some experience with drought	Large scale farmers with some knowledge about quinoa and moderate salinity problems	Small size farms, relatively high age and little knowledge about quinoa
Cluster no.	3	1	2	4
Number of farmers	8	53	5	26
	Cluster means			
Average farmer's age, years	39.9	39.5	51	57.9
Average farm size, ha	47	6.3	95	16.3
Irrigation 1)	1.00	0.74	1.00	0.92
Educational level, 2)	5.25	4.00	4.40	4.00
Heard about quinoa, 3)	0.25	0.08	0.20	0.08
Salinity problems 5)	0.50	0.23	0.40	0.31
Drought problems 6)	0.00	0.26	0.00	0.15
Farmers who would like to grow a drought and salt resistant crop 4)	0.88	0.62	0.60	0.42

Notes:
1. Use of irrigation, yes = 1, no = 0
2. Educational level, Illiterate = 1, Literate, no school = 2, Primary = 3, Lower secondary = 4, Higher secondary = 5, University = 6
3. Have you heard about a crop named quinoa? yes = 1, no = 0
4. Farmers willingness to adopt a new crop: Would you like to introduce a new crop that is resistant to drought and can deal with salinity problems? yes = 1, no = 0
5. Do you have salinity problems on your land? yes = 1, no = 0
6. Do you have problems with drought on your land? yes = 1, no = 0

Cluster 2 is the smallest cluster and consists of the largest farms operated by older, experienced farmers. They use irrigation and have a fairly long education. Some in cluster two have heard about quinoa and they are not overly opposed to introducing a new crop.

Cluster 3 contains 8 younger farmers. They have medium sized farms and use irrigation. This cluster consists of the highest educated farmers, and a relatively high proportion in cluster 3 have heard about quinoa. Cluster three farmers are the most willing to introduce a new crop. It is however not clear which variable that has an impact on farmers' perception of new crops.

Cluster 4 consists of 26 farmers that are the oldest farmers in the sample. They have relatively small farms and generally they use irrigation. In cluster four, farmers are the lowest educated and they have generally not heard about quinoa. Furthermore, they are the most opposed to introduce a new crop. Relatively few of these farmers have heard about quinoa.

The cluster analysis reveals that education and farmers' previous knowledge about quinoa could have an effect on willingness to undertake a new crop. The more educated and informed the farmer is the more open to new farming techniques he appears to be. Farm size seems also to be a characteristic in determining a farmer's attitude towards new crops. The smaller the farm, the less likely the farmer is to undertake new crops. Age, on the other hand, cannot conclusively be linked to willingness to accept new crops. Salinity problems appears to be an inducement to undertake a new crop, whereas drougt problems cannot be conclusive deemed to impact willingness to undertake a new crop since variation of this variable within the sample is quite small.

In addition to the cluster analysis, a regression analysis has been conducted in order to identify correlations with willingness to adopt a new crop by using the variables from the cluster analysis (see table 3).

Logistic regression results

The cluster analysis produces a taxonomy of farmers based on the chosen characteristics. However, the cluster analysis does not provide a ranking of the importance of each characteristic for being positive towards choosing to undertake quinoa. Estimating the binary choice of being willing to undertake this new crop is carried out by a logistic regression on the same variables used in the cluster analysis.

Maximising the likelihood function produce the results displayed in table 3. Diagnostics support the estimated mode. Thus, Pearson residuals show no sign of remaining systematics and all residuals lie within a reasonable range. Furthermore, the Leverage diagnostic show that almost all observations fall between the range of 0.1-0.9. Parameter estimates suggest that age, farm size and education have little to no effect on the choice of potentially introducing a new crop. However, using irrigation is significantly impacting the choice. Likewise, if the farmer experiences salinity or drought problems affects the choice. Finally, having prior information about quinoa also significantly impacts the choice of undertaking a new crop.

A likelihood ratio test of the validity of the model strongly rejects the null-hypothesis of the model being invalid with a p-value of the χ^2 test less than 0.0001. A goodness-of-fit measure produces an R^2 of 0.37.

Table 3 - Parameter estimates, logistic procedure

Variable	**Parameter estimate**	**Standard error**	**Significance**
Intercept	–1.3484	1.9404	–
Age	0.0349	0,0571	–
Farm size	–0.0132	0.0123	–
Irrigation	2.7422	1.1405	**
Education	–0.4495	0.3327	–
Previous knowledge about quinoa	1.8849	1.1419	*
Farmers that experience salinity problems on their land?	–3.5717	0.8506	***
Farmers that experience problems with drought on their land?	–1.6400	0.7554	**

*** significant at a 1 % level, ** significant at a 5 % level, * significant at a 10 % level.

Findings from the regression analysis shows that age, farm size and education do not appear to have a significant influence on farmers willingness to adopt new salt and drought resistant crops like quinoa. However, it appears that farmers that do not irrigate have an increased interest in new drought and salt resistant crops in their cropping systems. Presumably because drought problems are of a larger concern among these farmers compared to farmers that have access to irrigation systems. In addition, the information level and previous knowledge about quinoa appears to make farmers more positive towards adopting new crops.

Discussion

Quinoa is already imported in large quantities from Bolivia and Peru to the European market. In this respect there is already an established market for quinoa in Europe. Turkeys export revenue is to some extent dependent upon being able to sell food products at the EU-market. Based on the results of this study, a number of advantages and barriers for introducing quinoa as a new crop among farmers in Adana are presented in table 4.

Findings from interviews show that farmers have different experiences with the introduction of new crops in the Adana region.

As argued by Abebe *et al.* (2013) improved production-related quality attributes may not be enough for farmers to adopt new crops. Therefore, farmers' incentive to grow quinoa will depend on the marginal benefit of growing quinoa compared to existing crops. This is also described in a study from Bolivia where farmers demand stable prices and flexible standards (Ofstehage, 2012). On rain fed land quinoa has an advantage due to its high level of drought resistance and lower water demand, which also applies on irrigated lands where less water is needed.

On the consumers' side, quinoa is especially good for people who are intolerant to gluten which could be an important market segment for national markets and for exports to Europe. The introduction of a new crop should start by first considering the market. Several food companies (e.g Unilever, Nestle, Danone etc.) base their new product development process in the market research with the aim to identify new food trends or new market needs. A recent food trend is the health and wellness trend (Vaidya & Mogelonsky, 2007; Bogue & Yu, 2009; Kearney, 2010). Schaafsma and Kok (2005) indicate that most of the managers of the food companies and retail sector expect a strong and further growth of the health food market. Part of this trend is also the food intolerance trend, which has to do with products that are free from certain ingredients, creating intolerance (e.g. gluten). Even in recession (in 2009) the food intolerance category achieved a 11% value sales growth rate compared to the 3% growth rate of the overall health and wellness products. Gluten free foods outperformed the whole category with a 15% CAGR against the 11% of the category (Euromonitor, 2011). In parallel to this we have seen a significant increase in the import of quinoa from South America to North America and Europein the last 5 years (FAO, 2013).

From the discussion so far, there appears to be a significant market potential for quinoa since it is a gluten free product and produced organically with a high protein content. Strategies that aim to introduce this crop in the Mediterranean region should attempt to establish links between food companies or farmers' cooperatives that operate in these regions (e.g. Ulker, ETI etc.) and the farmers. For example, a strategy should aim to increase the awareness of quinoa to these companies. Another strategy could be to introduce quinoa to those farmers segments that are more willing to adopt new crops. If successful, they will serve as an example for others to follow.

Table 4 - Benefits and barriers for implementing quinoa as a new crop among farmers in Adana

Benefits	**Source**	**Barriers**	**Source**
Drought resistant with little need for irrigation. Quinoa can grow under rainfed conditions with low water use	Vacher 1998; Jensen *et al.*, 2014; Sun *et al.*, 2014	In different places around the world yields are from 500 kg ha^{-1} in Bolivia and up to 3 t ha^{-1} under experimental conditions. These yields are low compared with cereals but the nutritional value and price is high for quinoa	Rojas *et al.*, 2011; Jacobsen & Christiansen, 2016
		Mainly produced organically with mechanical weeding	Jacobsen, 2017
		There are no registered herbicides for quinoa and a need to improve non-chemical weed control	
Salt resistant, several varieties can grow in soils with high salt concentrations. Trials have indicated high salinity resistance of quinoa seeds	Koyro & Eisa, 2008; Panuccio *et al.*, 2014; ricardi *et al.*, 2014; Razzaghi *et al.*, 2012; 2015	Difficult to get seed in the short run. It is argued that the geographical increase in distribution of quinoa has implied that it is difficult to access quality seeds. However, there are commercial available European cultivars	Bazile *et al.*, 2016
Good yields even with low precipitation and under rainfed conditions. Field trials in Serbia under rainfed conditions show a seed yield at 1.721 t ha −1 without fertilization	Stikic *et al.*, 2012	Quinoa provided relatively low yield compared with other crops	FAO statistics
High world market prices compared with traditional cereals like wheat and maize. Average export prices from South America in the last decade was about 4 USD kg^{-1}	Gamboa *et al.*, 2017	High content of saponin with a bitter taste and foamy in connection with water – quinoa seeds must be processed and cleaned for saponin before consumption	Vilche *et al.*, 2003

Table 4 - Continued

Benefits	**Source**	**Barriers**	**Source**
Mainly produced organically with mechanical weeding (added value)	Jacobsen, 2017		
Quinoa seeds are gluten free (added value) The protein content of the grain is higher than cereals and is particularly rich in lysine	Galway *et al.*, 1990; Repo-Carrasco *et al.*, 2003		
Relatively high amounts of antioxidants, micronutrients and essential amino acids	Vilche *et al.*, 2003; Amjad *et al.*, 2015		
High durability for a high value crop (similar to other cereals) A study from South eastern part of Europe show that quinoa has a higher contents of essential amino acids, incl. lysine, than wheat flour	Stikic *et al.*, 2012; Repo-Carrasco *et al.*, 2003		
Specific to Adana		**Specific to Adana**	
Adana is a semi arid region relying on irrigation. Water demand for irrigation of wheat at The Çukurova plain will increase due to decreasing precipitation	Yano *et al.*, 2007	Immature market for quinoa in Turkey with little import of quinoa to Turkey	FAO statistics
The long term (1975-2006) mean annual temperature is 19.0 °C, precipitation 650 mm and potential evapotranspiration of 1320 mm in Çukurova	Yano *et al.*, 2007	Quinoa has to compete with several other crops both low value rainfed and high value irrigated crops like cotton, cereals, beans, maize, citrous and watermelons	Kusadokoro and Maru, 2006
The region of Adana and Turkey is close to the European market and other high income countries		Farmers have little if any knowledge about quinoa	(see survey results)

Table 4 - Continued

Specific to Adana	Specific to Adana	
	Relatively small farm sizes may imply that farmers are more risk averse towards new crops. More than 40 percent of the farmers cultivate farms with less than 7.5 ha	Kusadokoro & Maru, 2006

So far, most farmers, when conducting the survey, had little if any knowledge about quinoa in Adana. When farmers consider a new crop in their production system, they make a comparison between the crops that they already produce on their farm and the new crop. First of all they look at the market availability, but also product prices, potential yields, production cost and ease of production. A number of farmers perceive quinoa as a likely crop to be included in their crop rotation if the current prices can be obtained on the market and if it is possible to obtain market access. The creation of a market for quinoa in Turkey has several beneficial effects for the region. One of these benefits is related to crop production on soils with high levels of salinity. A drawback of quinoa is cleaning costs and low physical yields compared to maize and wheat, especially in regard to local consumption where yield are regarded important. However, the nutritional value and financial yield is often high with high international market prices compared to maize and wheat. Therefore, the low yield levels and high labor costs can be off-set by high market prices.

To make a succesfull introduction of quinoa among arable farmers one should consider the local farm type characteristics and segments that are identified locally. A design and market strategy should therefore consider the farmers previous knowledge about quinoa, their education, access to irrigation, farm size, and if the farms are located on marginal rain fed lands with salinity and drought problems.

Conclusion

This study investigates the conditions for growing quinoa in Turkey, and the perception among farmers in the region of Adana. Field experiments from the southern part of Italy and the region of Adana in Turkey indicate that the crop can be cultivated successfully in the Mediteranian region.

However, one issue is the agronomic and climatic conditions another one is related to farmer's perception. A combination of qualitative and quantitative research was employed to group farmers in segments based on their level of willingness to adopt quinoa. Quinoa is a drought and salt tolerant crop with a high market price, glutenfree and high protein content. A clustering procedure was used to group farmers according to specific characteristics with the aim of identifying segments of adopters and features shaping farmers' attitude and perception of new crops to be cultivated in their local region. Findings from this study indicate that farmers in Adana had little prior knowledge about quinoa. Several farmers indicate that they look at the market availability, product prices, yield, production cost as well as ease of production when adopting a new crop.

The cluster and regression analyses revealed that farmers' previous knowledge about the crop influences their willingness to undertake a new crop like quinoa. The more informed the farmer is, the more open to new farming techniques he appears to be. It was also found that respondents with no access to irrigation are more open to introduce a new drought resistant crop. Farm size seems also to be a characteristic in determining a farmer's attitude towards new crops. The smaller the farm, the less likely the farmer is to undertake new crops in their crop rotation. Age, on the other hand, cannot conclusively be linked to willingness to accept new crops. In addition, it is clear that farmers are very concerned about market access for any new crops in their cropping system. They are not likely to start or continue producing any kind of crop without an established market access.

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Søren Marcus Pedersen
Department of Food and Resource Economics, University of Copenhagen, Rolighedsvej 25, 1958 Frderiksberg C, Denmark
Tel: 45 35336882, E-mail: Marcus@ifro.ku.dk
Associate professor and Phd from the Technical University of Denmark, has nearly 20 years of experience in production economics, system analysis and technology assessment. He has participated as a work package leader and senior reseacher in several European research projects on innovative farming systems.

Kim Martin Lind
Department of Food and Resource Economics, University of Copenhagen, Rolighedsvej 25, 1958 Frderiksberg C, Denmark, E-mail: k.m.lind@mail.tele.dk
He holds a Phd from University of Copenhagen and has been a researcher and senior reseacher at University of Copenhagen for 25 years. He is specialized in agricultural trade policy, statistcis and econometrics.

Orjon Xhoxhi
Department of Agribusiness Management, Agricultural University of Tirana
Kodër Kamëz, SH1, Tiranë 1000, Albania
Tel: +355 69 2787 521, E-mail: oxhoxhi@ubt.edu.al
PhD, lecturer at the Agricultural University of Tirana. Current research interests include agri-food value chains governance (e.g. Contract farming) and performance (e.g. Post-harvest losses), farmers' collective actions, rural development, and consumer preferences about agri-food products.

Attila Yazar
Department of Irrigation and Agricultural Structures, Faculty of Agriculture, Çukurova University, Adana, Turkey
Tel: 90 5327742914, E-mail: yazarat@cu.edu.tr
Full professor. Current research interests include evaluation of the effect of abiotic stresses such drought, salinity on yield and yield components of climate proof crops such as quinoa, amaranth. A significant part of interest is also focused on micro-irrigation system and plant-based irrigation scheduling techniques such as canopy temperature, leaf water potential, stomatal conductance etc. on various field and vegetable crops.

Sven-Erik Jacobsen
Sven-Erik Jacobsen (SEJ) is managing director of Quinoa Quality ApS, Teglværksvej 10, 4420 Regstrup, Denmark
Tel.: 45 26859506, E-mail: info@quinoaquality.com
SEJ has a MSc in Agronomy in 1982 from the Royal Veterinary and Agricultural University, and a Phd in Crop Science, 1993, at University of Copenhagen. SEJ has 25 years of employment at the University of Copenhagen, coordinating several EU projects, such as in Horizon2020 PROTEIN2FOOD (www.protein2food.eu), and in FP7 LATINCROP (www.latincrop.org) and SWUP-MED (www.swup-med.dk).

Jens Erik Ørum
Department of Food and Resource Economics, University of Copenhagen, Rolighedsvej 25, 1958 Frderiksberg C, Denmark
Tel: 45 35336879, E-mail: je@ifro.ku.dk
Senior advisor Jens Erik Ørum holds an M.Sc. in Agronomy (1995) from the Royal Veterinary and Agricultural University (KVL) in Denmark. He is specialized in environmental economics and production economics in relation to crop production, crop protection, irrigation, nitrogen application, biodiversity, precision farming, new technologies and farm management.