The Effect of Yield Fluctuations and Production Risk on Pistachio Commercial Cultivars in Kerman Province

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A R T I C L E I N F O	A B S T R A C T
	The required capital and liquidity for agricultural production are always a limiting factor in Iranian agriculture. Since, income is a combination of production and product price, one of the major problems of the country's pistachio industry is the high yield fluctuations and high price fluctuations. In the present study, the mean and yield fluctuations of four pistachio commercial cultivars (Kaleh-Ghoochi, Ahmad-Aghaei, Akbari, and Owhadi) were evaluated in the Anar and Rafsanjan orchards in Kerman province. The information used in this study was collected through a questionnaire from farmers. The orchards were selected by multi-stage random method. From the total number of villages in the two regions, some sites were selected based on random. Then, some farmers were selected randomly. By referring to the selected farmers, an orchard was selected from each cultivar. The number of studied orchards was 100 forms in each cultivar. To measure the yield per hectare, the amount of actual product that had achieved in the last six years. Finally, the mean and yield fluctuations of 4 pistachio commercial cultivars were analyzed. The results showed that the studied cultivars had a significant difference in the yield, profit net and coefficient variation at a probability level of 5%. The results indicated that the Ahmad-Aghaei cultivar was the best in average yield (1758.7 kg ha^{-1}) and net profit per hectare (292530201 Rials ha^{-1}) and then Akbari cultivar. However, performance fluctuations in the Owhadi cultivar (53.06%) was lower than the other three cultivars. Base on the results, the Kaleh-Ghoochi cultivar was minimum in average yield (1073.6 kg ha^{-1}) and production fluctuations (73.14%) than the others. Therefore, if the aim is to minimize the income fluctuations of pistachio farmers, depending on the region, one of Ahmad-Aghaei or Akbari cultivars should be planted. It can be concluded that among commercial cultivars, prioritization and justification for planting and propagation were Ahmad-Aghaei, Akbari, Owhadi and Kaleh-Ghoochi, respectively.

Introduction

Pistachio has a high economic value and occupied a noticeable share of the global market (Bozorgi *et al*. 2013; Tayefeh Aliakbarkhani *et al*., 2017; Norozi etal., 2019; Sharifkhah *et al*., 2020). According to the FAO (2018) statistics, five countries, Iran, the United States of America, Turkey, China, and Syria, are the largest pistachio producers in the world. Iran and the United States of America are the main producers of pistachios in the world, estimating for more than two-thirds of the world's pistachio production. The average pistachio yield in most of the years in Iran was lesser than the world average and showed a decreasing trend mainly due to management limitations and drought crisis in some years. Pistachio (*Pistacia vera* L.), a member of the Anacardiaceae family, is very important in the economic aspect of agricultural production in Iran. Also, the agricultural economy of Kerman province is largely dependent to this product.

According to the published statistics, the area under cultivation of fertile and non-fertile pistachio orchards in the country has exceeded 480 thousand hectares, and Kerman province with 203 thousand hectares of fertile cultivated area and 9 thousand hectares of non-fertile area, are in the first ranks of the country (Agricultural Statistics, 2016, 2017). In recent years, Pistachio cultivation developed in 27 provinces of the country, including Kerman, Khorasan Razavi, Yazd, Fars, South Khorasan, Semnan, Sistan and Baluchestan, Qazvin, Markazi, Isfahan, Qom, Ardabil, East, and West Azarbaijan. The reason for increasing cultivation in most provinces of the country is the high economic value of pistachio and its adaptation to adverse environmental conditions, especially drought and salinity, that not suitable for other crops (Statistics of the Ministry of Jihad Agriculture, 2017). The required capital and liquidity for agricultural production have always been a limiting factor in Iranian agriculture, especially in the pistachio sector. One of the major problems of the pistachio industry is the yield fluctuations and high product price fluctuations that should consider in the management of agricultural production (Osei *et al*., 2003; Arun *et al*., 2006; Ali *et al*., 2008). Abdollahi Ezatabadi and Najafi (2002) studied the income fluctuations of Iranian pistachio producers and the factors that caused it. The results of their study showed that these fluctuations are high, and farmers are not able to predict and deal with them. Examination of the components that cause income fluctuations showed that the fluctuations in the price of pistachios and the yield per hectare are both effective in generating income changes. To eliminate the risk of income fluctuations, it is necessary to use a set of tools to reduce price and yield fluctuations simultaneously. One of the tools to reduce yield fluctuations in pistachio orchards could be a variety of cultivars. Therefore, the study and selection of one or a combination of pistachio cultivars can play an effective role in reducing production fluctuations. As a result, it is very important to know the amount of

variance in the production of different cultivars. Therefore, the present study was conducted to evaluate the difference between the average yield and income of four pistachio commercial cultivars (Akbari, Ahmad-Aghaei, Owhadi, and "Kaleh-Ghoochi"). This research showed that most of the farmers do not use inputs optimally, and if resources are used with the scientific method, yield can be significantly increased. Mousavi *et al*. (2007) investigated the effect of production factors on pistachio yield risk in Fars province. The three-step method of nonlinear squares was used to determine the risk effects of different inputs on production. The results showed that water consumption, chemical fertilizer, and pistachio tree age had an indirect relationship with production risk. On the other hand, they had the greatest direct effect on the production average. However, the age of the pistachio trees has a negative effect on the amount of production. Abdollahi Ezatabadi and Najafi (2004) investigated the yield fluctuations per hectare in pistachios orchards and examined the possibility of using agricultural insurance to reduce the risk of these fluctuations in Iran. In this regard, yield guarantee, expected damages, and premium rates were calculated. Their results showed that due to high and unpredictable fluctuation in pistachio yield, it is necessary to use appropriate tools and policies to reduce the risk of these fluctuations. Thus, insurance can be a proper tool in this regard. Abdollahi Ezatabadi and Javanshah (2005) studied the role of pistachio insurance in reducing the income risk of pistachio gardeners. Their results showed that the expert opinions along with careful management of the Agricultural Insurance Fund play a key role in the success of this project. This cooperation has increased the participation rate of farmers in the insurance plan, in turn, will increase social welfare for a long time. Despite many studies on the risk of pistachio production and the role of insurance in this regard, it is still not clear exactly how much the yield and income from pistachio cultivars are fluctuating.

Sedaghat and Hosseinifard (2011) investigated the role of garden management on the quantitative and qualitative yield of pistachio orchards. Based on their results, improvement of horticultural management, water quality, soil texture, and tree age have positive effects on total profit. Nutrition management, processing management, pest &disease management, and reducing the time interval between the harvests and processing have a positive effect on crop quality. The aim of this study was to examine the difference between the average yield and income of four commercial cultivars (Ahmad-Aghaei, Akbari, Owhadi, and Kaleh-Ghoochi) in the Rafsanjan and Anar regions.

Materials and Methods

This project was carried out in the weather conditions of the Rafsanjan and Anar regions of Kerman province. The average annual temperature is 18.2°C with an average relative humidity 30%. During the growing season, the highest temperature is in July (43 °c) and the lowest temperature is in April (15 °c).

Data collection

The information used in this study obtained from farmers through a questionnaire. For this purpose, the orchards were selected from the Anar and Rafsanjan regions by a multi-stage random method. From the total number of villages in the two regions, sites were selected based on random. In the next step, 100 farmers were selected based on random from the list of sites. Then, by referring to the selected farmers, an orchard was selected from each cultivar, and the required information that was mentioned in the research method section was extracted.

Research method

To estimate the yield per hectare of an orchard, the actual amount of production during the last six years was asked from the farmer. Also, the selling price of the product and the costs were questioned to calculate the profit per hectare. Pistachio cultivar, water, and soil characteristics, irrigation, horticulture, and nutrition management, pests, and disease management were also asked.

The risk analysis for selecting cultivars in orchards is essential. It includes estimating the expected volatility of net income (profitability). With a greater variation in net income, the cultivar becomes riskier. By using past (or expected) annual income data, it estimated how widely net income (profit) changes from year to year. The volatility was compared to the average net income level to get an index of risk. The risk index calculated the standard deviation of net income divided by the average net income for each cultivar. The value of the variation coefficient was calculated by dividing the standard deviation to the average yield. Therefore, the variance, and standard deviation of the average yield of each orchard were determined during six years (2010-2016). The variation coefficient was calculated for four commercial cultivars (Ahmad-Aghaei, Akbari, Owhadi, and Kaleh-Ghoochi).

The amount of income and profit per hectare also calculated for studied cultivars as follow.

Net income (profit) = (Yield × Price) − cost

Net profit = the net profit per hectare for an orchard

Yield= the yield per hectare for an orchard

Price = the price received per kg

Cost = the cost per hectare for an orchard

xi= value of the data

μ=mean of the data

$$\text{Variance} = \partial^2 = \frac{\Sigma(Xi - \mu)2}{N}$$

$$\text{Standard deviation} = \partial$$

$$\text{Coefficient of variation} = \frac{\partial}{\mu} \times 100$$

Analysis of the questionnaire data performed by SPSS software and mean comparison with Duncan's method.

Results

The results of the variance analysis showed that there was a significant difference between pistachio cultivars (Ahmad-Aghaei, Akbari, Owhadi, and Kaleh-Ghoochi) in terms of average yield parameters and coefficient of variation at the level of 5%. The coefficient of variation   calculated as an indicator of fluctuations in the orchards. There was a significant difference in the coefficient of variation ($p<0.05$). The results of the variance analysis showed that there was a significant difference between pistachio commercial cultivars in net profit parameters and coefficient of variation at the level of 5% (Table 1).

Table 1. The mean squares of measured parameters

Means Square				
Source of variance	df	Average yield	Net profit	Coefficient of variation (CV)
cultivar	3	6070527.25[*]	47145263350[*]	5761[*]
Error	265	4846429.38	30100680219	3103

Significant F-test at **P < 0.01, at *P < 0.05 and non-significant (ns)

The results of the mean comparison between the different cultivars showed in Table 2. These results indicated that the Ahmad-Aghaei cultivar had the highest yield and net profit. Therefore, this cultivar introduced as the superior cultivar in terms of production. While the lowest coefficient of variation was related to Owhadi cultivar. Akbari cultivar was in the second cultivar after Ahmad-Aghaei in terms of average yield and profit. Despite the relatively good average yield in Akbari cultivar, yield fluctuations were high (as shown in the coefficient of variation parameter). After the Kaleh-Ghoochi cultivar, which had the most yield fluctuations, the Akbari cultivar is the second place of fluctuations and therefore had a high production risk. Base on the results, the Kaleh-Ghoochi cultivar had the lowest yield and the highest coefficient of variation. Therefore, this cultivar doesn't have a stable and high production and did not recommend for propagation. Based on the evaluated parameters, prioritization and justification for planting and propagation of commercial pistachio cultivars were Ahmad-Aghaei, Akbari, Owhadi and Kaleh - Ghoochi cultivars, respectively.

Table 2. The mean comparison of measured parameters on different cultivars

Parameters			
Treatment	Average yield (kg ha^{-1})	Net profit (Rials ha^{-1})	Coefficient of variation (CV)
Akbari	1205.8 ab	156265909 b	68.21 a
Owhadi	1055.9 b	74313595 b	53.06 b
Ahmad-Aghaei	1758.7 a	292530201 a	62.31 a
Kaleh-Ghoochi	1073.6 b	93302961 b	73.14 a

Means followed by same letter are not significantly different at 5% probability

Discussion

Pistachio is one of the most important agricultural products in Iran (Statistics of the Ministry of Industry, Mines and Trade, 2017). Despite that, the pistachio orchards in Iran have exceeded 480 thousand hectares, but the average production of Iranian pistachio in recent years has decreased from 200,000 tons to 172,000 tons (Statistics and Information Technology Office of the Ministry of Jihad Agriculture, 2013 and 2018). Today, four commercial cultivars of pistachios in Iran are planted, which have different

characteristics include Owhadi, Kaleh-Ghoochi, Akbari and Ahmad-Aghaei (Esmailpour, 2001). This research was conducted to evaluate commercial cultivars (Owhadi, Kaleh-Ghoochi, Akbari and Ahmad-Aghaei) based on yield, net income and coefficient of variation parameters. The results of this research revealed that there was a significant difference in commercial cultivars in average yield, net profit and coefficient of variation. The other researches showed that managing the pistachio orchards needs numerous decisions to be economically efficient (Abdollahi Ezatabadi, 2020). Base on the literature, besides cultivar selection, the profit-determining factor is important in agriculture management. An orchard should have skilled managers in orchards to ensure profitable work (Karimi et al., 2006; Coates et al., 2006; Iniesta et al., 2008; Sedaghat and Hosseinifard, 2011; Ferguson and Haviland, 2016). It means that the management skills could be effective. Thus, that it is important to consider the whole income risk in pistachio orchards. For pistachios, there is some income risk that relates to the kind of cultivar, and yield. In addition, net income is lower in 'off' years than 'on' years, depending on the cultivated cultivar. Esmaeilpour (2005) and Nikoei et al. (2018) reported that the kind of cultivar, vegetative growth and yield effect on product that is consistent with the obtained results from this study. Rosenstock et al. (2010) identified the kind of cultivar that affects quality, price, and market fluctuation, and irregular annual net yields to growers. It means that an important part of the decision risk analysis should be considered in terms of which selected cultivars. These results help pistachio growers in establishing, expanding, or replanting pistachio orchards faced to the selected cultivars. Based on the results, pistachio price fluctuations and yields were effective in causing income changes per hectare. The results of this study indicated that cultivar differences also were significant (P < 0.05, Table 1). Ahmad-Aghaei cultivar was identified as the best cultivar based on the average yield (1758.7 kg ha-

[1]) and profit per hectare (292530201 Rials). The results of this study were consistent with the results of Nikoei et al (2018). They investigated the vegetative and reproductive growth of four commercial cultivars of pistachio and their effects on yield and profit during 2 years. Their results showed that Kaleh-Ghoochi cultivar had the highest non-uniformity in reproductive and vegetative indices in the studied orchards (two regions Anar and Rafsanjan), indicating a direct correlation with the yield. Calculation of correlation coefficients and regression equation showed that non-uniformity at the orchard could reduce the yield and economic efficiency of orchards. Therefore, it can be concluded that the yield, which are the main components of cultivation technology, increase the productivity of agricultural units.

Conclusions

The results of this study showed that prioritization and justification for planting and propagation of pistachio commercial cultivars were Ahmad-Aghaei, Akbari, Owhadi and Kaleh-Ghoochi, respectively. However, the cultivating of a high-yield cultivar in order to maximize its profits, growers might face a sharp decline in income in some years. In addition, it has been consider that the nutrition management, processing management, and pest &disease management have a positive effect on the quantitative and qualitative crops.

Acknowledgements

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