An econometrıc analysıs of table grape in Turkey

Recebimento dos originais: 02/03/2021
Aceitação para publicação: 13/07/2021

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Abstract

Grape is an important fruit crop among the agricultural products exported in Turkey. The demand for agricultural products, which are the feedstocks of vital food is rising in domestic and foreign markets due to the increase in population. The increasing demand for food can be met by increasing the yield per unit area in agricultural lands. Total cost of the product obtained per unit area needs to be calculated by revealing the elements of production cost to determine the factors affecting the yield. In this study, socio-economic characteristics and cost items of table grape producers in Tokat province, known for the vineyards and grape leaves in Turkey, were determined, and the factors affecting the production cost, profitability and productivity were analyzed. The data were obtained by a survey performed with 130 producers, who were determined using simple random sampling method. Cobb-Douglas production model was used to analyze the factors affecting the table grape productivity in Tokat province. The results revealed that net profit of producers with a production cost of 386.04 dollars per unit land (per decare) is 241.24 dollars per decare. Fertilizer and pesticide costs had the highest share in the cost items and positively affected the product obtained from per unit area. The results demonstrated that land size owned by the producers have a positively effect on the productivity, while the fragmentation of lands has a negative effect.

Keywords: Grape. Productivity, Production costs, cost items

1. Introduction

Grape has an important place in agricultural products of Turkey that ranks within the top five grape producers in the world. The highest grape production in the world takes place in Spain with 1.123.644 ha followed by China (797.935 ha), France (752.837 ha), Italy (675.818 ha) and Turkey (417.041 ha), respectively. Annual grape production of Turkey in 2019 was 4.100.000 tons of which 50.00% (2.050.000 ton) is table grape, 39.00% (1.599.000 ton) is dried grape and 11.00% (451.000 ton) is wine grape (TUIK, 2019). The table grape production area in Turkey is 218016 ha with an average yield of 28130 kg/ha. The table grape is mainly exported to Russia, Germany and other European Union countries.

Economic and social conditions of countries rapidly change. The costs for agricultural products in rural areas increase at an increasing rate each year and, the cost determined for previous year losses the validity for the following year. Therefore, the costs should be calculated periodically to evaluate the progress on technologies, measure the outcomes of

agricultural policies implemented and monitor the changes in resource use. Cost analysis in agricultural activities are important to compare various activities in agricultural production and provide information on development and effectiveness of the same activity over time. The calculation of production cost and income of agricultural products by scientific methods is very important in to build Agricultural Policies (Kızıloğlu, 1994; Güngör et al, 2015).

In this study, the socio-economic status of producers in Tokat province, which is known for its vineyards and grape leaves, was determined and the variable and fixed cost items that constitute the production costs of table grape for 2019 were calculated separately. In addition to revealing the production costs and profitability, the Cobb-Douglas function was used as an econometric model in the analysis of factors affecting the yield per unit of land.

An integrated approach on investigating several aspects of table grape production in Turkey has not encountered in the literature. In this study, several economic analyzes and calculations have been carried out to calculate total production costs by determining variable and fixed cost items and to evaluate profitability in table fruit production, in addition to determining the socio-economic characteristics of table grape producers. Therefore, this study aimed to add new information to the literature.

The aim of this study are to determine socio-economic characteristics of table grape producers, to reveal profitability by determining variable and fixed cost items and calculating the production cost, to determine the effects of factors on yield per unit area using Cobb-Douglas production function.

2. Literature Review

Many domestic and international studies have been conducted on grape varieties, viticulture structure and production costs. The studies regarding the production cost of grape are summarized in detail below.

Özkan et al. (2005), who conducted a study to determine the production cost and return of grape vines grown in greenhouses and open fields in Antalya, reported that greenhouse and open field production costs were 9597.4 and 4886.8 million TL/ha, respectively. Net profit was in greenhouse grapes was 7389.4 million TL/ha, while it was 5916.3 million TL/ha in open fields. The profit in greenhouse grape production was higher than the open field grape production.

Özkan et al. (2007) determined the energy use patterns and production costs in greenhouse and open field grape production systems. The production cost for greenhouse and open field grape production was reported as 6391.3 and 3368.6 $/ha, respectively.

Kostadinov et al. (2008) comprehensively evaluated the impact of factors related to production costs in wine grapes, and developed an approach and method for the technological and technical analysis of grape production. The costs associated with plant protection had the largest share of total costs (40%), followed by the costs of grape harvest (17%), fertilization (14.5%) and selective pruning (11%).

The profitability of wine and table grape varieties grown in Kalecik district of Ankara province was carried out by Bayramoğlu et al. (2010). The production costs for table and wine grape varieties were calculated as 356.99 and 419.57 TL/da, respectively. Table grape and wine grape costs were calculated as 0.38 and 0.61 TL/kg, respectively. However, the market price of wine grape (1.17 TL/kg) was 84.3% higher than that of the table grape. Therefore, net profit in the wine grape variety was 376.36 TL/da, while it was 233.24 TL/da in the table grape variety. The results concluded that viticulture has more advantageous than table grape cultivation.

Mårtenssonet et al. (2013) assessed the wine production potential and reported the estimated annual costs for 1800 L/ha wine production as € 15.1 per L wine, and € 41.9 for 525 L/ha wine production.

Uysal and Ateş (2014) calculated the production cost and return of Sultana Grapevine grown in pots. The production cost of potted vine was 1.93 TL/unit and the highest cost (59.31%) was the material cost.

Domingues and Aguila (2016) compared mechanical and manual grape harvesting costs on a farm. The cost of manual harvesting was 133.3% higher than mechanical harvesting. The costs of manual and mechanical harvesting were the same when the farm size was 41.92 ha. Therefore, the researchers concluded that mechanical harvesting will be more economical for the farms over 41.92 ha.

Şirikçi and Gül (2016), who analyzed the production costs and profitability of grape production, calculated gross profit, net and relative profits for grape production. In addition, product cost elements of the total production cost was also determined.

Grape production of farms using good agriculture and traditional practices in the Thrace Region was compared economically (Aydın et al. (2017). The cost of grape production under good agriculture practices was 1.12 TL/kg, while it was calculated as 1.14 TL/kg under traditional grape production. Total production cost, gross production value, gross profit, net

profit and relative profit under good agricultural practices were calculated as 1341.56, 1825, 1034.85, 483.45 TL and 1.36, respectively. Total production cost, gross production value, gross profit, net profit and relative profit under traditional grape production were determined as 1366.45, 1800, 988.94, 433.55 TL and 1.32, respectively. The results revealed that grape production in the region is profitable under both production types, while it is more profitable under good agricultural practices.

Capello et al. (2017) analyze the economic viability of cv. Niagara Rosada, which is the main cultivar of table grapes produced in São Paulo state and is grown under different production systems. Total cost (TC) for the main crop and the second crop in the Campinas area was 0.23 US$/kg and the total net income (TNR) was 0.81 US$/kg. Considering only the main crop, the decrease in grape production increased the production cost, while decreased the profitability. The TC in the main crop was 0.93 US$/kg and TNR was 0.08 US$/kg. Total cost in the Itapetininga region for two cycles per year was calculated as 0.68 US$/kg for main product and TNR was 0.32 US$/kg. The results showed that production of cv. Niagara Rosada in different parts of São Paulo State is profitable and has a positive return for family agriculture.

Uysal et al. (2017) compared economically grape production takes place in lowlands and highlands of Icel province in Turkey. The unit cost in lowlands and highlands grape production was calculated as 0.99 and 0.80 TL, respectively.

Korkutal et al. (2018) reported that 43% of the vineyards produce table grapes, 27% wine grapes and 30% table grapes and wine grapes. Table grape yield was determined as 1500 kg/da, while wine grape yield was 1000 kg/da.

Yılmaz (2018) carried out an economic analysis of the grape producing agricultural farms in the Thrace region and prepared a future production plan. The total variable cost of grape production was calculated as 8,098.78 TL/da and the gross revenue was 7,996.98 TL/da.

Kondi et al. (2019) compared nutrient use efficiency in wine and table grapes. Benefit-cost ratios for wine and table grapes were calculated as 1.44 and 1.57, respectively.

Several domestic studies have been conducted to investigate grape production problems in Turkey (Yener and Seçer, 2017; Safi et al., 2018). In addition, general status of grape production have also been studied by Curtis et al. (2008), Curtis et al. (2010), Guesmi et al. (2012) and Geyikçi (2013).

3. Material and Methods

3.1. Material

The data obtained in face-to-face questionnaires conducted with producers in September 2019 were used to determine socio-economic characteristics and cost items of table grape producers in Tokat province, analyze factors affecting the production cost, profitability and productivity of grape production.

The proportional sampling method was used to determine the sample size representing the population (Newbold, 1995). After the implementation of stratified sampling technique, the equation (Eq.1) proposed by Yamane (2001) was used to determine the final sample size. Similar method has been adopted by Boz (2015), ul Haq and Boz (2019) and ul Haq et al (2020).

$$n = \frac{Np(1-p)}{(N-1)\sigma_p^2 + p(1-p)} \quad \text{Eq 1.}$$

In the equation; n represents sample size, N represents population size, p represents estimation ratio (sample size 0.5 maximum), σ_p^2 represents rate variances (in order to reach maximum sample size, table value should have a confidence interval of 95%, with 1.96 and 10% margin of error). The characteristics of farms that constitute the main population could not be determined at the beginning; therefore, p was considered as 0.5 in order to maximize the sample size. The sample size was calculated as 130 producers.

3.2. Methods

3.2.1. Grape production cost

The alternative cost principle was used to determine the cost in table grape production. Variable and fixed costs that constitute the production cost were calculated separately by considering the production processes.

Daily wages of male and female workers in the study area were used to calculate the family labor wage. Working capital interest, which is a variable cost, reflects the opportunity cost of the capital invested in the production activities. The revolving fund interest rate was calculated assuming that variable costs are spread homogeneously throughout the production period. The credits extended for crop production have been calculated by considering the

interest rate of TC Ziraat Bank. The interest rate a bare land value has been determined as 5% of the current trade value of the bare land in the study area (Kral et al., 1999). The establishment period of a vineyard is 4 years and 5% of the costs incurred each year are added to the total costs of the same year. The facility costs depreciation share was calculated by ratio of the facility cost, which is the sum of the facility costs, to the economic life of a vineyard (45 years). The interest for the vineyard establishment cost was calculated using a real interest rate (5%) above half of the establishment cost of a vineyard (Kral et al. 1999). In the calculation of general administrative expenses, 3% of the variable cost total was taken into calculations.

3.2.2. Cost function

Factors affecting grape yield were assessed using the Cobb-Douglas production function model. The model was adapted from the study of Shahbaz et al (2017) considering various variables. However, grape production in Tokat province is highly dependent on fertilizers; therefore, fertilizer cost was used as an input only in grape production. The labor consisting of family and wage workers were considered as the other inputs in the model. In addition, the fact that farm structure and variability in decision of farmers affect the grape yield, has been taken into considerations. The general form of the model is as follows (Eq. 2);

$$Y=f(X_iD_j)$$

Eq. 2

In the equation; Y is the grape production per unit of land (da), X_i is the vector of the quantitative variable, and D_j is the vector of qualitative variables.

$$\text{Log } Y = \beta_0 + \beta_1 \text{Log}X_1 + \beta_2 \text{Log}X_2 + \beta_3 \text{Log}X_3 + \beta_4 \text{Log}X_4 + \beta_5 \text{Log}X_5 + \beta_6 \text{Log}X_6 + \beta_7 \text{Log}X_7 + \beta_1 D_1 + \beta_2 D_2 \quad \text{Eq. 3}$$

In equation; X_1 is total land area, X_2 is number of parcels, X_3 is age of farmer (years), X_4 is experience in farming, X_5 is fertilizer applied (kg/da), X_6 is pesticide cost (kg/da), X_7 is family labor (number), D_1 is the status of hiring labor (1 for farmer hired the labor, otherwise 0) and D_2 is soil testing status (1 for farmer tested the soil, otherwise 0).

4. Results and Discussion

4.1. General socio-economic characteristics of the producers

The socio-economic structure of the producers is an important indicator of the farm structure. The general socio-economic characteristics of the grape producers in the study area are given in Table 1. The average age of grape producers was 52 with a viticulture experience of 31 years and 46.15% of the producers are secondary school graduates. The ratio of farmers who earn their living only from grape cultivation was 40.77%, while 59.23% of them work in various jobs with insurance besides agricultural production. The average monthly income of producers from agricultural activities was 6430.77 TL and non-agricultural income was 732.69 TL per month. Producers have an average of 4.98 da vineyard and 1.74 vineyard parcels.

Table 1: Some of Socio-Economic Characteristics of Grape Producers

		Frequency	Percent (%)	Mean
Age				52.33
Educational Status	Primary School	22	16.92	
	Secondary School	60	46.15	
	High School	43	33.08	
	University	5	3.85	
Non-agricultural work	Yes	77	59.23	
	No	53	40.77	
Income (Gross) ($/Month)	Income from Agricultural Activities			1118.39$
	Non-Agricultural Income (all salaries and other income in a household)			128.29$
Viticulture experience (years)				30.64
Land Size	Decare			4.98
Number of vineyard parcels	Parcel			1.74

1 $ equals to 5.75 TL in September, 2019 (CBRT, 2019)

4.2. Table grape production cost and profitability

Table grapes production costs are calculated by taking into account the cost items and are shown in Table 2. The total cost of table grapes production per unit area is 386.04 $. Variable costs constitute 73.11% of the table grapes production cost of producers, while fixed costs constitute 26.89 %. Variable costs constitute a large part of the total cost. It is possible to find similar results in the literature. Aydın et al. (2017) revealed that variable costs constitute three-quarters of grape production costs. Bayramoğlu et al. (2010) conducted an economic analysis of table and wine grapes production and found that the share of variable

costs in total production costs was higher than fixed costs in both varieties. In their study, Şirikçi and Gül (2016) analyzed the development of grape production costs and profitability in the province of Kahramanmaraş and determined that variable costs constitute the significant part of the production costs.

Pesticide costs constitute the majority of variable costs of producers. Pesticide costs constituted 24.12% of variable costs, followed by fertilization costs with 15.79%. Similar results on the variable cost of grape production have been reported by others. Aydın et al. (2017) determined that the highest cost item among variable costs in grape production was pesticide costs. Kastadinov et al (2008) indicated that 40% of the variable cost items in table grape production was pesticide, followed by harvest (17%), fertilizers (14.5%) and pruning (11%) costs. Pesticide and fertilizer costs have an important share in grape production costs in Brazil, which is the third largest producer of grapes in the world (Cappello et al. 2017). However, pesticide cost does not constitute the highest share among variable costs in Brazil. Kondi et al (2019) reported that fertilizer costs constitute a large part of variable cost of table grape production in India.

Table 2: Production Costs of Table Grape in the Study Area

Cost Items	Cost per unit area ($ / da)	Share in the production cost (%)
Variable Costs		
Pruning	23.91	8.47
Intermediate Release	16.83	5.96
Fertilization cost	44.57	15.79
Pesticide cost	68.58	24.12
Irrigation cost	13.64	4.83
Other maintenance works (suckering - pinching etc.)	17.57	6.23
Harvest cost	43.69	15.48
Market (certification fee, case-packing material, transportation)	33.05	11.71
The interest of revolving funds	20.91	7.41
Variable Cost Total (A)	**282.25**	**73.11**
Fixed Costs		
General Administrative Costs (A * 3%)	8.47	8.16
Bare Land Value Interest (5%)	74.78	72.05
Facility Cost Depreciation Share	9.67	9.31
Facility Capital Interest	10.87	10.48
Total Fixed Costs (B)	**103.79**	**26.89**
Total Production Costs (A + B)	**386.04**	

1 $ equals to 5.75 TL in September, 2019 (CBRT, 2019)

The mean table grape yield in the study area was 1408.83 kg/da (Table 3). Total production cost to obtain the average yield was $ 386.04, while the amount of variable cost was $ 282.25. The table grape producer made a profit of $ 214.24 with $ 386.04 production cost. In addition, the gross profit earned for the variable cost of $ 282.25 was calculated as $ 318.03. Proportional profit value indicates that a profit of 0.55 $ is obtained for one dollar of production costs.

The revenue and profit generated by unit area of vineyard indicate that the income for total grape production area across the country will be greater. The revenue and profit values obtained per unit area reveal that table grape production is a profitable agricultural production activity for the producers. The results shown in Table 3 reveal that the increase in grape yield will increase profit for the producers. Therefore, the revenue and profitability will increase in grape production with the increase in yield per unit area.

Table 3: Profitability of Table Grape Production

Yield (kg/da)	1408.83
Sale Price ($/kg.)	0.43
Income ($/da)	600.28
Production Cost ($/da)	386.04
Variable Cost Total ($/da)	282.25
Gross Profit ($/da)	318.03
Net Profit ($/da)	214.24
Proportional Profit	1.55
Net profit ($/kg)	0.87

1 $ equals to 5.75 TL in September, 2019 (CBRT, 2019)

4.3. Cobb Douglas function model

The variables affecting grape production in the study area were determined using Cobb Douglas function model. Farm size, number of parcels, age of a farmer, experience in the profession, and fertilizer and pesticide use are the major factor affecting the grape production.

Multiple correlation coefficient (R^2) expresses proportion of the total variance in the dependent variable that can be accounted for by the independent variables. Multiple correlation coefficient (R^2=0.85) shows that 85% of the changes in Y can be significantly explained (P<0.001) by the independent variables.

Sum of the coefficients of the independent variables was 1.42. In the Cobb - Douglas production analysis, the sum of coefficients for the independent variables greater than 1

indicates that an increasing return compared to the scale. The result shows that 1% increase in the independent variables of the model will cause more than 1% increase in grape yield.

The results indicated that farm size, number of parcels, age of farmers, ownership status, fertilizer and pesticide use have significant effects on grape productivity. High grape yield can be obtained with the required maintenance, labor and inputs. The amount of yield is directly related to the revenue and profit per unit area.

Grape productivity and land size had a significant positive relationship at 1% level. The results showed that one percent increase in land size increase grape productivity by 55%. Positive relationship between wine grape productivity and land size have been encountered in the literature (Piesse et al., 2017; Bravo-Ureta et al., 2020; Santas et al., 2020). Similar to the results obtained in this study, the positive relationship between grape productivity and land size was also reported by Bonviller et al. (2016) in Australia and Silvana and Peršurić (2013) in Croatia.

The increase in the number of parcels made land management difficult for the farmers; thus, the number of parcels had a negative effect on the grape yield. Therefore, the increase in land size increases the productivity, in contrast, land fragmentation has a negative impact on productivity. Santos et al. (2020) determined a negative relationship between wine grape productivity and number of parcels in Portuguese.

The age of a farmer significantly affects the grape productivity. The results indicated that 1% increase in the age of a farmer causes a 0.6% increase in grape yield due to the increase in the experience of the producer.

Similar results were reported in a study conducted with wine grape producers in Portuguese (Santos et al., 2020) and cotton producers in Pakistan (Wei et al., 2020). One percent increase in the fertilizer application increased grape productivity by 0.07%. Similarly, 1% increase in the pesticide application increased grape productivity by 0.35%. Piesse et al. (2017), who applied Cobb Douglas model, determined a positive relationship between wine grape production and fertilizer and pesticide costs in South Africa.

A negative relationship was determined between the viticulture experience of the producers and the productivity. This relationship indicates a possible decrease in yield as the increase in the duration of grape production. Long-term producers, who do not update themselves on relevant information and technology may cause a decrease in grape productivity.

Table 4: Factors Affecting the Grape Productivity

	β	Std. Error	t Stat	p-value (Sig.)
Constant	6.65	1.05	6.30	0.00*
Farm Size	0.55	0.13	4.23	0.00*
Number of Parcels	-0.30	0.13	-2.22	0.03*
Age of Farmers	0.60	0.32	1.89	0.06**
Experience in the profession	-0.05	0.11	-0.51	0.01*
Fertilizer	0.07	0.03	2.46	0.02**
Pesticide	0.35	0.09	4.10	0.00*
Family Labor	0.06	0.07	0.82	0.42
Off-Farm Occupation	0.03	0.09	0.30	0.77
Soil Test Performance	0.11	0.12	0.95	0.35

Note: *, **==> Significant at 1%, 5% level

5. Conclusion

The average age of the producers is 52 and 46.15% of the producers are graduates of secondary school. The ratio of farmers who earn their living only from grape cultivation was 40.77%, while 59.23% of them work in various jobs with insurance besides agricultural production. The total cost of table grapes production per unit area is 386.04 $. Variable costs constitute a large part of the total cost.

The grape producers spend more time and labor and use inputs such as fertilizers and pesticides and more in labor-intensive processes such as pruning, intermediate release and maintenance. The results obtained in the study reveal that sufficient yield in grape can be obtained by required maintenance and labor.

The revenue and profit values obtained per unit area reveal that table grape production is a profitable agricultural production activity for the producers. The income obtained in return for the unit cost is 1.56.

The cost in economic terms as well as the productivity are important issues in agricultural production. Economic and social factors have significant impact on the efficient production of a product. This study aimed to reveal the profitability in table grape production, and to determine factors affecting the productivity by using the Cobb Douglas model. Fertilizer and pesticide costs, which have the largest share in variable cost items, have a positive effect on table grape production. The size of a land owned by the producers has positive effect on the productivity, while fragmentation of a land has a negative effect on productivity.

This contribution to the existing literature could help policy makers in the country develop new policies to increase the productivity of grape producers. Another important contribution is the addition of the land use factor (own, shareholder) in determining current

grape productivity methodology. In addition to the contribution to the literature, this study opens up a path for further studies in this area using other productivity measures such as crop yield. These studies will help policymakers to assess the success and productivity of grape farm groups who are using agricultural resources.

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