ECONOMIC ANALYSIS OF GRAIN MAIZE PRODUCTION: A CASE STUDY IN TÜRKİYE

Aysegül TANIN, Sait ENGINDENIZ

Ege University, Faculty of Agriculture, Department of Agricultural Economics, Izmir-Türkiye,
E-mails: taninaysegul@gmail.com, sait.engindeniz@ege.edu.tr

Corresponding author: sait.engindeniz@ege.edu.tr

Abstract

The main purpose of this study is to determine the level of input use, cost and profitability for farmers and entrepreneurs by making an economic analysis of grain maize production in Izmir province of Türkiye. The data of the study was collected by survey method from 93 farmers with proportional sampling. First, the socio-economic characteristics of the farmers were examined. Then, the activity results of the farmers regarding maize production were analyzed. Variable cost items in maize production were labour and machine costs, material (seed, fertilizer, pesticide, water, etc.) costs and interest on the total costs. Fixed cost items were land rent and management costs. To calculate the net return obtained from maize, production costs were subtracted from the gross production value. The average age of the farmers and average education period were determined as 46.47 and 7.81 years, respectively. The average maize land in the farms was 9.90 hectares. The average total production cost per hectare for maize was 27,953.30 TL. Farmers obtained an average of 15,885.16 TL/ha gross return and 11,406.71 TL/ha net return from maize production in the relevant period. The study results show that maize production in the region can be done economically.

Key words: *maize growing, maize costs, maize marketing, profitability analysis*

INTRODUCTION

Different purposes can be considered when determining the crop pattern in the farms. Farmers are looking for ways to obtain the highest income when determining the crop pattern. One of the most important alternatives for farmers in irrigable lands is maize [14]. The origin of maize (*Zea mays L.*) is the Andean Region of Central America. It is one of the most important grains for human and animal nutrition. In terms of global production, maize was the third most important food crop after rice and wheat. Demand for maize is increasing both as a fresh and processed food [20]. Maize is currently also grown for the biodiesel market by many ethanol plants. Maize, which has a very important place in the market with its agricultural products, production and trade, is an important food source due to the valuable nutrients it contains [1, 5].
According to FAO's 2022 data, 1,163 million tons of maize were produced in 203.5 million hectares of land in the world. Maize ranks second in the world after wheat in terms of growing area and first in terms of production. The most important countries in world maize production are USA (30%), China (24%), Brazil (9%), Argentina (5%) and India (3%) [19]. Many studies have been conducted on the economic aspects of maize production in different countries of the world [24, 27, 34, 36, 2, 3, 23, 37, 29, 17, 33]. These studies have shown that maize production can be done profitably in different climate and soil conditions.
According to TURKSTAT data, 8.5 million tons of grain maize were produced in 911,885 hectares of land in Türkiye in 2022. 74% of the total maize production was obtained from main crop maize. 30% of the maize produced in 2022 was provided from Western Anatolia Region, 22% from the Mediterranean Region, 21% from Southeastern Anatolia Region, 11% from Eastern Marmara Region and 7% from the Aegean Region. Maize yield in Türkiye may vary from region to region. The average maize yield per hectare in Türkiye in 2022 is 9,321 kg [39]. In the same year, the world average maize yield was 5,718 kg and Türkiye were well above this yield level [19].

The increasing trend in maize production in recent years is a positive development in terms of meeting domestic demand with domestic supply and reducing the increase in imports. However, in the future, it is necessary to preserve and further develop the current production structure and ensure continuity in production. From this perspective, the premium application and the purchases of the Turkish Grain Board are important. On the other hand, the most important factor in increasing maize production is increasing the yield level [38].

Many studies have been conducted on the cost and profitability analysis of maize in Türkiye [9, 12, 16, 13, 6, 32, 11, 26, 22, 15, 7, 40]. These studies have shown that maize is an important alternative for irrigated lands in terms of increasing farmer income. However, these studies need to be repeated over time and in different regions. Because changes in economic and ecological conditions can affect production costs and income levels.

One of the provinces of Türkiye with significant agricultural potential is Izmir province. In this province, farmers mostly grow potatoes, cotton, tomato (paste), pepper, cucumber, watermelon, green beans, maize, wheat and some forage crops on irrigated lands. In recent years, declines and fluctuations in cotton, tomato and wheat income have led farmers in Izmir to turn to maize production. Ecological and economic conditions may have an impact on the income provided by maize farmers. Therefore, farmer practices, input selection and usage levels, cost and income items in maize production need to be determined over time and through local research. The research results can be a guide for farmers in determining the crop pattern, as well as contribute to the control of production costs, preparation of production plans, and the creation and implementation of appropriate agricultural policies.

The main purpose of this study is to determine the level of input use, cost and profitability for farmers and entrepreneurs by making an economic analysis of grain maize production in Izmir province of Türkiye.

MATERIALS AND METHODS

Study data was obtained by face-to-face survey method from maize farmers in Menderes district of Izmir province (Map 1). In addition, the results of previous studies and statistical data published by relevant institutions were also used.

Map 1. Menderes districts in Izmir province
Source: [4].

Approximately 2% of grain maize production in Türkiye is provided by Izmir province. Menderes district is one of the important districts in maize production in Izmir province. This district provides approximately 20% of the maize production in the province. For this reason, it was planned to include Menderes district. According to the information received from the Menderes District Directorate of the Ministry of Agriculture and Forestry, Cileme, Tekeli, Cakaltepe, Karakuyu, Gölcükler and Develi neighbourhoods, which produce approximately 90% of maize production in the district, were included in the scope of the study. The total number of farmers registered in the Farmer Registration System in these neighbourhoods was determined as 742. Some of these farmers were included with proportional sampling. At this stage, the following formula was used [30]. It is seen that this formula has been used in many similar studies [18, 21, 11].

$$n = \frac{Np(1-p)}{(N-1)\sigma^2{}_{px} + p(1-p)}$$

....(1)

In the formula:
n = Sample size
N = Total number of farmers

p = Proportion of farmers producing maize (0.5 was taken for maximum sample size)
$\sigma^2 px$ = Variance.

In the study, calculations were made based on a 90% confidence interval and an 8% margin of error, and the sample size was determined as 93. In determining the number of farmers to be interviewed in each neighbourhood, the shares of the neighbourhoods in the total number of farmers were taken as basis. The farmers to be interviewed in the neighbourhoods were determined using the random numbers table. Study surveys were conducted in March-April 2022.The study was found ethically appropriate with the decision of Ege University Scientific Research and Publication Ethics Committee numbered E.668908/2022.

In the analysis of data, farmers are divided into 3 groups according to the size of their maize land. The first group is farmers with maize land of less than 5.0 hectares (36 farmers), the second group is farmers with maize land of 5.0-9.9 hectares (27 farmers), and the third group is farmers with maize land of 10.0 hectares and more (30 farmers) were formed.

First, the socio-economic characteristics of the farmers were examined. At this stage, the age, education period, household size, land size, family labour potential, capital availability and organizational characteristics of the farmers were determined.

In the study, the activity results of the farmers regarding maize production were analyzed. Variable cost items in maize production; labour and machine costs, material (seed, fertilizer, pesticide, water, etc.) costs and interest on the total costs.

Fixed cost items are land rent and management costs. Half (5%) of the interest rate applied by Ziraat Bank (State Agriculture Bank) for subsidized crop production loans in 2021 was used in interest calculations. In calculating the management costs, 3% of variable costs was taken.

The following formulas were used to calculate the gross and net return obtained from maize production [25].

Gross Return = Gross Production Value – Variable Costs..(2)

Net Return = Gross Production Value – Production Costs...(3)

Farmers' opinions about the economic aspects of maize growing and their tendencies to sustain it in the future are revealed. At this stage, a five-point Likert scale was used [8].

In the study, it was also tested statistically whether there was a difference between the farm groups. For continuous variables, first the Kolmogorov-Smirnov test and the normal distribution test were applied, and variables with or without normal distribution were determined. Analysis of variance (ANOVA) was performed for normally distributed variables. For variables that do not show normal distribution; the Kruskal-Walli's test was used [31].

RESULTS AND DISCUSSIONS

Information on the socio-economic characteristics of farmers is presented in Table 1.

The average age of the farmers and average education period were determined as 46.47 and 7.81 years, respectively. The education period of the farmers in the third group is longer. However, the difference between groups is not statistically significant (p>0.05).

The average experience period of farmers in maize production was determined as 15.90 years. In a study conducted in Kahramanmaras province, Türkiye, the average maize production experience of farmers was found to be 11 years [32].

The average household size in farms was found to be 3.49. 49.23% of the total population in farms is women, and 47.12% is the population in the 15-49 age group.

Family labour potential was calculated as male labour unit (MLU) and it was determined as average 2.46 MLU.

Table 1. Socio-economic characteristics of farmers

Characteristics	Farm groups			
	Group 1 (<5.0 ha)	Group 2 (5.0-9.9 ha)	Group 3 (≥10.0 ha)	General
Age of farmers	46.31	48.48	44.87	46.47
Education period of farmers (year)	7.42	7.15	8.87	7.81
Maize experience of farmers (year)	15.33	16.74	16.00	15.90
Household size	3.08	3.89	3.63	3.49
Family labour potential (MLU)	2.22	2.75	2.48	2.46
Land size (ha)	93.39	112.00	343.67	179.53
Equity rate (%)	90.99	93.72	95.52	93.02
Cooperative partnership rate (%)	75.00	55.56	73.33	68.82

Source: Results of this study.

The average agricultural land cultivated by farms is 179.53 decares. 64.27% of the total land consists of self-owned lands. 97.27% of the active capital owned by farms is land assets. Soil assets constitute 82.24% of the land assets. In liabilities, the most important element is equity capital with 93.92%. 68.82% of the farmers stated that they were partners in any cooperative. In a study conducted in Konya province, Türkiye, it was found that 87.77% of maize farmers were partners in an agricultural cooperative [11].

The average maize land in the farms was determined as 9.90 hectares. 67.07% of the land where maize is produced in farms consists of self-owned lands. When the farm groups are examined, it is seen that the highest proportion of self-owned land is in the third group (68.95%) (Table 2). In a study conducted in Kahramanmaras, Türkiye, the average maize production land was found to be 8.15 hectares [32]. In a study conducted in Konya, Türkiye, it was determined as 10.40 hectares [11].

Table 2. Ownership characteristics of maize lands

Farm groups	Land ownership			
	Self-owned land (ha)	Jointly operated land (ha)	Rented land (ha)	Total land (ha)
Group 1 (<5.0 ha)	1.69	0.51	0.79	2.99
Group 2 (5.0-9.9 ha)	4.67	1.09	1.22	6.98
Group3 (≥10.0 ha)	14.37	4.07	2.40	20.84
General	6.64	1.83	1.43	9.90
%	67.07	18.49	14.44	100.00

Source: Results of this study.

The average maize production amount in the farms was determined as 143,787.47 kg. Maize yield based on the average production area is calculated as 14,523.99 kg/ha. It is seen that the yield is higher in the first group of farms (Table 3).

The varieties used and timely irrigation and maintenance play an important role in yield level.
The difference between groups is not statistically significant ($p > 0.05$).

Table 3. Yield obtained from maize production

Farm groups	Maize production land (ha) (1)	Total production quantity (kg) (2)	Yield (kg/ha) (2/1)
Group 1 (<5.0 ha)	2.99	43,958.33	14,701.78
Group 2 (5.0-9.9 ha)	6.98	99,990.74	14,325.32
Group3 (≥10.0 ha)	20.84	302,999.50	14,539.32
General	9.90	143,787.47	14,523.99

Source: Results of this study.

In studies conducted in different provinces of Türkiye, it has been determined that the average maize yield varies between 7,000 and 15,032 kg/ha [35, 13, 10, 32, 11, 26, 41, 22, 15].
76.13% of the maize produced in the farms was marketed (Table 4).
It is seen that some of the maize is reused in the farms, and some is given to the workers. The marketing rate of maize in the third group of farms is higher than the others (76.89%).

Table 4. Marketed quantity of maize

Farm groups	Total production quantity (kg)	Total quantity of marketed (kg)	Total quantity used in the farms (kg)	Total quantity given to workers (kg)
Group 1 (<5.0 ha)	43,958.33	32,777.78	10,972.22	208.33
Group 2 (5.0-9.9 ha)	99,990.74	74,472.22	25,185.19	333.33
Group3 (≥10.0 ha)	302,999.50	232,976.17	69,500.00	523.33
General	143,787.47	109,462.74	33,978.49	346.24
%	100.00	76.13	23.63	0.24

Source: Results of this study.

72.06% of the maize marketed in farms was sold to merchants-brokers. It is seen that farmers also market to maize processing companies and livestock enterprises (Table 5).
The rate of marketing maize to merchants-brokers is higher in the third group of farms than in others (73.26%).

Table 5. Maize marketed channels

Farm groups	Marketing channels			
	Merchants-brokers (kg)	Maize processing companies (kg)	Livestock enterprises (kg)	Total (kg)
Group 1 (<5.0 ha)	23,194.44	4,166.67	5,416.67	32,777.78
Group 2 (5.0-9.9 ha)	51,137.04	14,444.44	8,890.74	74,472.22
Group3 (≥10.0 ha)	170,680.00	48,666.67	13,629.50	232,976.17
General	78,882.80	21,505.37	9,074.57	109,462.74
%	72.06	19.65	8.29	100.00

Source: Results of this study.

The average maize price received by farmers in the examined farms was calculated as 2.71 TL/kg. It is seen that farmers in the third group obtain higher maize prices. However, the difference between groups is not statistically significant ($p > 0.05$). Considering the yield per hectare and the average price received by the farmers, the average gross production value obtained from maize is calculated as 39,603.01 TL/ha (Table 6).

Table 6 . Gross production value obtained from maize production

Farm groups	Yield (kg/ha) (1)	Average maize price (TL/kg) (2) (*)	Gross production value (TL/ha) (1x2) (*)
Group 1 (<5.0 ha)	14,701.78	2.67	39,253.75
Group 2 (5.0-9.9 ha)	14,325.32	2.70	38,678.36
Group3 (≥10.0 ha)	14,539.32	2.77	40,273.92
General	14,523.99	2.71	39,360.01

*1 US$ = 8.88 TL in 2021
Source: Results of this study.

The inputs used by farmers for maize production and their average usage amounts are shown in Table 7. Seed usage per hectare was determined as 30.10 kg, labour usage was 60.00 hours, and machine power usage was 38.70 hours. The most used corn varieties were DEKALB DKC 6761, DEKALB DKC 6980, Syngenta (SY Prosperic, Gladius,

Fuerza) and May 7575. Farmers use pesticides for weeds, leafworms, earworms and spider mites. It was determined that farmers used 12 kg of herbicide and 2.8 kg of insecticide per hectare.

Table 7. Inputs used in maize production

Inputs	Farm groups			
	Group1 (<5.0 ha)	Group 2 (5.0-9.9 ha)	Group 3 (≥10.0 ha)	General
Materials				
Seed (kg/ha)	29.70	30.40	30.30	30.10
Fertilizer (kg/ha)				
N	444.40	429.60	481.70	452.10
P2O5	177.80	161.10	191.70	177.40
K2O	70.80	63.00	81.70	72.00
Pesticides (kg/ha)				
Herbicide	9.20	13.30	14.30	12.00
Insecticide	2.40	3.03	2.80	2.80
Labor (h/ha)	57.40	61.40	62.00	60.00
Soil preparation	11.40	12.20	12.00	11.80
Planting	2.50	3.00	3.00	2.80
Fertilization	3.30	3.30	3.30	3.30
Pesticide application	3.10	3.70	3.70	3.40
Irrigation	23.60	24.10	24.30	24.00
Hoeing	7.20	8.10	8.00	7.70
Harvest	4.40	4.80	4.70	4.60
Transportation	1.90	2.20	3.00	2.40
Machine power (h/ha)	35.30	39.30	42.30	38.70

Source: Results of this study.

Table 8. Maize production costs (TL/ha)

Cost items		Farm groups			
		Group 1 (<5.0 ha)	Group 2 (5.0-9.9 ha)	Group 3 (≥10.0 ha)	General
1. Labor and machine costs	Soil preparation	2,736.10	2,685.20	2,783.30	2,736.60
	Planting	944.40	925.90	966.70	936.20
	Fertilization	888.90	851.80	933.30	882.50
	Hoeing	1,097.20	1,074.10	1,133.30	1,092.10
	Irrigation	1,527.80	1,463.00	1,616.70	1,527.60
	Pesticide application	1,166.70	1,185.20	1,233.30	1,183.50
	Harvest	3,263.90	3,037.00	3,266.70	3,188.90
	Transportation	1,194.40	1,092.60	1,266.70	1,188.20
	Total	12,819.40	12,314.80	13,200.00	12,735.60
2.Material costs	Seed	2,083.30	2,018.50	2,166.70	2,081.40
	Fertilizer	3,138.90	2,963.00	3,166.70	3,086.80
	Pesticide	1,263.90	1,333.30	1,366.70	1,317.20
	Electric diesel	2,361.10	2,351.80	2,433.30	2,381.70
	Others	694.40	777.80	816.70	754.30
	Total	9,541.60	9,444.40	9,950.10	9,621.40
3.Interest on variable costs (5%)		1,118.05	1,087.96	1,157.50	1117.85
4.Total variable costs (1+2+3)		23,479.05	22,847.16	24,307.60	23,474.85
5.Fixed costs	Management cost (3%)	704.37	685.41	729.23	704.25
	Land rent	3791.70	3,759.20	3,766.70	3,774.20
	Total	4,496.07	4,444.61	4,495.93	4,478.45
Total production costs (4+5)		**27,975.12**	**27,291.77**	**28,803.53**	**27,953.30**

Source: Results of this study.

Farmers use compound fertilizers (15-15-15, 18-18-18, 20-20-20), Ammonium Nitrate (26%), DAP (18-46), Ammonium Sulphate, Urea, Potassium Sulphate and uses leaf fertilizer.

The average total cost per hectare for maize production in farms was calculated as 27,953.30 TL (Table 8). Variable costs constitute 83.98% of total production costs. Total production costs are higher in the third group of farms. 54.25% of variable costs consist of labour and machine costs. The cost items that have the highest share in total production costs are land rent (13.50%), harvest costs (11.30%), fertilizer costs (11.04%) and electric-diesel costs (8.52%). Studies conducted in different provinces of Türkiye have found that the share of variable costs in production costs varies between 65.45% and %83.72 [35, 13, 10, 32, 41, 26, 15].

When the total production cost per hectare for maize in farms was divided to the yield, the unit maize cost was calculated as 1.92 TL/kg. In the third group of farms, unit costs are higher. However, the difference between groups is not statistically significant (p>0.05). Average gross return and net return obtained from maize in farms were calculated as 15,885.16 and 11,406.71, respectively. The gross and net return in the third group of farms is higher (Table 9). The difference between groups is not statistically significant (p>0.05).

Table 9. Profitability level of maize production in farms

Economic results	Farm groups			
	Group 1 (<5.0 ha)	Group 2 (5.0-9.9 ha)	Group 3 (≥10.0 ha)	General
Yield (kg/ha) (1)	14,701.78	14,325.32	14,539.32	14,523.99
Average maize price (TL/kg) (2)	2.67	2.70	2.77	2.71
Gross production value (TL/ha) (3=1x2)	39,253.75	38,678.36	40,273.92	39,360.01
Variable costs (TL/da) (4)	23,479.05	22,847.16	24,307.60	23,474.85
Production costs (TL/ha) (5)	27,975.12	27,291.77	28,803.53	27,953.30
Unit maize cost (TL/kg) (6=5/1)	1.90	1.91	1.98	1.92
Gross return (TL/ha) (7=3-4)	15,774.70	15,831.20	15,966.32	15,885.16
Net return (TL/ha) (8=3-5)	11,278.63	11,386.59	11,470.39	11,406.71

Source: Results of this study.

According to the study results, when the proportional return is calculated, that is, when the gross production value is divided by production costs, it is determined as 1.41. In other words, 1.41 TL production value is obtained for 1 TL cost in maize production in farms. In studies conducted in different provinces of Türkiye, it was determined that the relative return obtained from maize varied between 1.16 and 1.74 [35, 10, 32, 26; 15].

The government also provides support for grain maize production.

Table 10. Farmers' opinions on the economic aspects of maize growing

Opinions	Participation level*
Maize production provides a good income level	4.10
High yield is obtained from maize production	3.83
Maize has a high price advantage	3.84
Maize has a cost advantage	4.13
Maize has ease of marketing	4.04
Maize production is storable	4.12
Maize is suitable for contract production	4.07
Supports for maize production is sufficient	2.39
I would like to continue maize production in the future	4.04

*1: Strongly disagree, 2: Disagree, 3: Undecided, 4: Agree, 5: Strongly agree
Source: Results of this study.

In 2021, maize farmers were provided with 270 TL diesel fuel and 80 TL fertilizer support per hectare. In addition, 0.03 TL/kg was paid to maize farmers as a difference payment (premium) [28].

When fertilizer and diesel support (350 TL/ha) and premium support (435.72 TL/ha) are added, the average net return obtained from maize in the farms reaches 12,192.43 TL/ha.

In the study, farmers were asked about their opinions on the economic aspects of maize growing. According to the answers, it is possible to say that the farmers are satisfied with the yield and income level of maize and do not experience marketing problems. However, it is understood that they do not find government support sufficient (Table 10).

CONCLUSIONS

In this study, the economic aspects of grain maize production were analyzed with data collected from 93 farmers in Menderes district of Izmir province. According to the study results, farmers achieved an average maize yield of 14,523.99 kg/ha. Maize was marketed at an average price of 2.71 TL/kg and an average gross production value of 39,360.01 TL/ha was obtained. The average total production cost per hectare for maize was 27,953.30 TL. Farmers obtained an average of 15,885.16 TL/ha gross return and 11,406.71 TL/ha net return from maize production in the relevant period.

The study results show that grain maize production in the region can be done economically. As a matter of fact, farmers think that the yield is at the desired level, marketing of maize is easy, and the net return obtained from maize is sufficient. While the high-water demand of maize is a disadvantage, the low labour demand and the use of machine power at all stages may be a reason for preference for farmers. Farmers have a positive approach to contract maize production. Farmers do not find government support sufficient. However, farmers tend to sustain mostly maize production.

It would be beneficial to take some measures to increase grain maize production and ensure sustainability both in the region and throughout Türkiye. Maize has a high price in the domestic market. This is due to high input costs. Local and cheap input supply can be ensured through policies regarding input costs, price policies and credit opportunities for farmers can increase the attractiveness of maize production and reduce costs. Increases in input prices increase production costs. For this, field-based input support should be increased. Additionally, taxes paid on inputs should continue to be reduced. Most farmers find government support insufficient. Increasing the difference payment for maize production is one of the most important expectations of farmers. Support in this direction should be increased and support payments should be planned on time. Maize is a crop that requires a lot of irrigation. Farmers are having difficulty covering water costs. Therefore, farmers should be informed about the use of alternative irrigation techniques and encouraged through financial methods. Turkish Grain Board should announce the guaranteed crop price early to support farmers, and the necessary financial means should be created to make the necessary payments on time. For farmers to obtain input at lower prices, cooperative and union activities should be increased, and the organization of farmers should be encouraged.

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