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Economic Analysis of Oilseed Sunflower Production in Türkiye

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ABSTRACT

The aim of this study is to conduct an economic analysis of oilseed sunflower production in farms engaged in oilseed sunflower cultivation in Türkiye. Primary data were collected through face-to-face surveys with 222 farmers located in the provinces of Tekirdağ, Edirne, Kırklareli, and Konya, which together account for more than half of Türkiye's oilseed sunflower production. The Neyman allocation method was employed to distribute the sampled farms according to the size of their oilseed sunflower fields. According to the research findings, the average production cost of oilseed sunflower is $874.83 per hectare, of which 64.93% consists of variable costs and 35.07% consists of fixed costs. Fuel and lubricant expenses constitute the largest variable cost component (14.90%), while land rent represents the most significant fixed cost component (19.91%). The average area for cultivating oilseed sunflowers was found to be 12.32 hectares, with an average yield of 1952.70 kg ha^{-1} and an average selling price of $0.59 per kg. The gross production value was calculated as $1304.08 per hectare, gross profit as $736.06, and net profit as $429.25. The relative profit was determined to be 1.49. Agricultural subsidies were determined to increase gross profit by 25.74%, net profit by 54.08%, and relative profit by 12.88% on farms engaged in oilseed sunflower production. Given that agricultural subsidies play a crucial role in the profitability and thus the income of oilseed sunflower producers, increasing these subsidies, ensuring their timely payment, and systematically assessing their effectiveness are essential for sustaining farmers' engagement in sunflower production. Targeted subsidy mechanisms should be developed to reduce major cost burdens on farmers, especially fuel expenses and land rents. Specifically, policymakers may consider additional fuel support based on production quantity or cultivated area, along with land rent subsidies for tenant farmers, as concrete policy options.

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Türkiye'de Yağlık Ayçiçeği Üretiminin Ekonomik Analizi

ÖZET

Bu çalışmanın amacı, Türkiye'de yağlık ayçiçeği üretimi yapan işletmelerde yağlık ayçiçeği üretiminin ekonomik analizini yapmaktır. Çalışma, işletme büyüklük gruplarına göre maliyet ve kârlılık göstergelerini analiz ederek yağlık ayçiçeği üretimi yapan işletmelerin ekonomik performansını Türkiye ölçeğinde ele almaktadır. Birincil veriler, Türkiye yağlık ayçiçeği üretiminin yarısından fazlasını oluşturan Tekirdağ, Edirne, Kırklareli, ve Konya illerindeki 222 çiftlikle yüz yüze anket yoluyla toplanmıştır. Yağlık ayçiçeği üretim alanlarının büyüklüğüne göre örnekteki işletmeleri dağıtmak için Neyman yöntemi kullanılmıştır. Araştırma bulgularına göre, yağlık ayçiçeğinin ortalama üretim masrafı hektar başına 874.83$ olup, bunun %64.93'ünü değişken masraflar, %35.07'sini ise sabit masraflar oluşturmaktadır. Yakıt ve yağ masrafının en büyük değişken masraf bileşenini (%14.90) ve arazi kirasının ise en önemli sabit masraf bileşenini (%19.91) oluşturduğu tespit edilmiştir. Ortalama yağlık ayçiçeği ekim alanı 12.32 hektar, ortalama verim 1952.70 kg ha^{-1} ve ortalama satış fiyatı kg başına $0.59 olarak belirlenmiştir. Gayrisafi üretim değeri hektar başına $1304.08,

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brüt kâr $736.06, net kâr $429.25 olarak hesaplanmıştır. Nispi kâr ise 1.49 olarak tespit edilmiştir. Yağlık ayçiçeği üreten işletmelerin kârlılıkları, dolayısıyla gelirleri için önemli olan tarımsal desteklerin artması, zamanında ödenmesi ve bu desteklerin etkisinin ölçülmesi çiftçilerin yağlık ayçiçeği üretimlerine devamlılıkları için önemlidir. Çiftçilerin üzerindeki önemli maliyet yüklerini, özellikle de yakıt giderlerini ve arazi kiralarını azaltmak için hedef odaklı destek mekanizmaları geliştirilmelidir. Somut politika seçenekleri olarak, üretim miktarına veya ekili alana dayalı ek yakıt desteği ile birlikte, kiracı çiftçilere yönelik arazi kira destekleri değerlendirilebilir.

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INTRODUCTION

Oilseed crops (sunflower, soybean, cottonseed, safflower, sesame, poppy, and canola) are strategic commodities for countries, as they are used not only in human and animal nutrition but also in skincare products, perfumes, the paint industry, biodiesel production, and the energy sector, and they are extensively subject to international trade (Kadakoğlu et al., 2023b). According to data from the Food and Agriculture Organization of the United Nations (FAO) for 2023, approximately 30.15 million hectares of land worldwide were dedicated to oilseed sunflower cultivation, producing a total of 58.575 million tons. Russia ranks first in global oilseed sunflower production, with 18.1 million tons accounting for 30.90%. Russia is followed by Ukraine with a share of 21.78%, Argentina with 8.57%, China with 5.12%, and Türkiye with 3.75% (Anonymous, 2025a).

Türkiye ranks eighth in the world in oilseed sunflower cultivated area and fifth in oilseed sunflower production. Although Türkiye's share of the global oilseed sunflower cultivation area has declined over the years, it increased in 2021 and 2022. However, the share declined again in 2023. The share, which was 4.19% in 1990, decreased to 2.63% in 2020, rose to 3.35% in 2022, and then fell to 3.16% in 2023. In terms of production quantity, Türkiye's global share has fluctuated over time. The share, which was 3.79% in 1990, increased to 4.70% in 2022 and was recorded as 3.75% in 2023 (Figure 1).

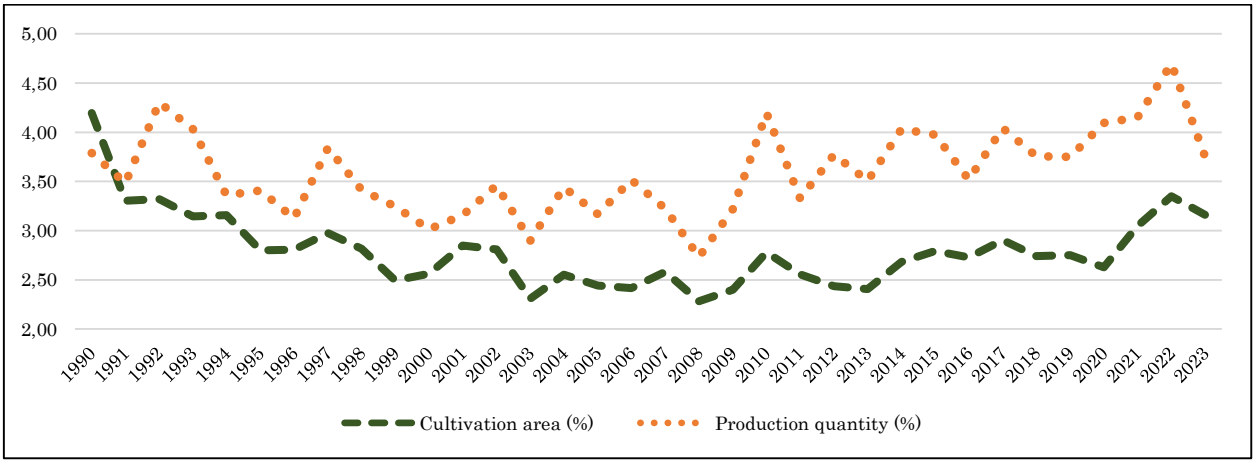

Figure 1. Türkiye's share in the world's oilseed sunflower cultivated area and production quantity (%) (Anonymous, 2025a and authors' calculations).

Şekil 1. Türkiye'nin dünya yağlık ayçiçeği ekim alanı ve üretim miktarı içerisindeki payları (%) (Anonymous, 2025a ve yazarların hesaplamaları).

Although Türkiye has a high level of self-sufficiency in the production of many agricultural commodities, it is not self-sufficient in oilseed crops and vegetable oil production (Kadakoğlu & Karlı, 2019). The self-sufficiency ratio in sunflower production has fluctuated during the period 2000–2023, yet it has remained below the desired level. In 2023, the self-sufficiency ratio of sunflower was calculated as 71.9%, indicating that domestic production is insufficient to meet national consumption (Figure 2).

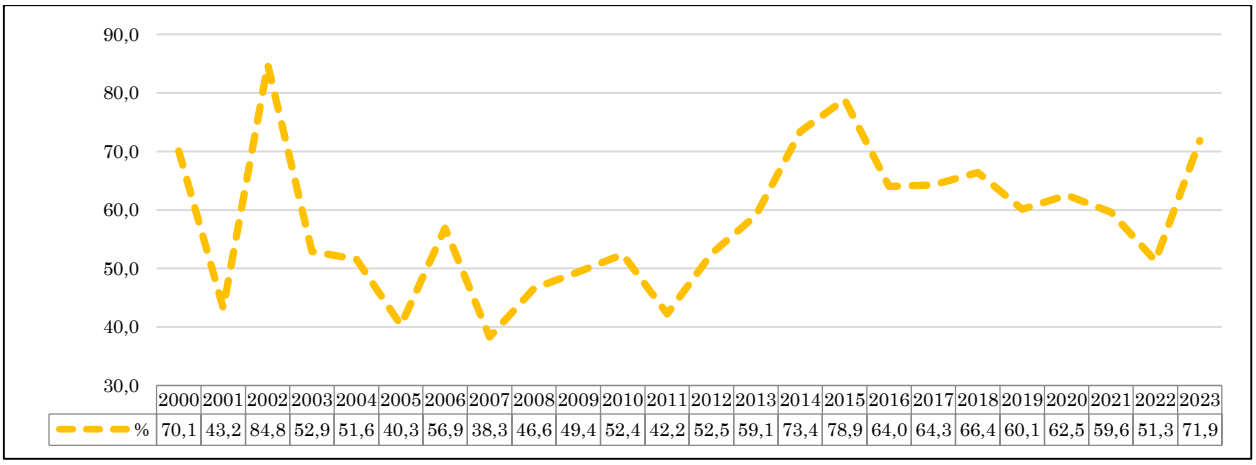

Figure 2. Türkiye's oilseed sunflower sufficiency level (%) (Anonymous, 2025c).
Şekil 2. Türkiye'nin yağlık ayçiçeğinde yeterlilik derecesi (%) (Anonymous, 2025c).

Türkiye pays an average of 2.75 billion USD annually for the import of oilseeds and their derivatives (crude oil and meal) (Kadakoğlu & Karlı, 2019). Türkiye's trade deficit in oilseed sunflower (imports - exports) was recorded as 2 224 tons and 2 million USD in 1990, whereas in 2023 it increased to 653 033 tons and 205 million USD. Based on the average of the last five years, Türkiye has an annual sunflower trade deficit of 840 338 tons and 354.3 million USD (Figure 3).

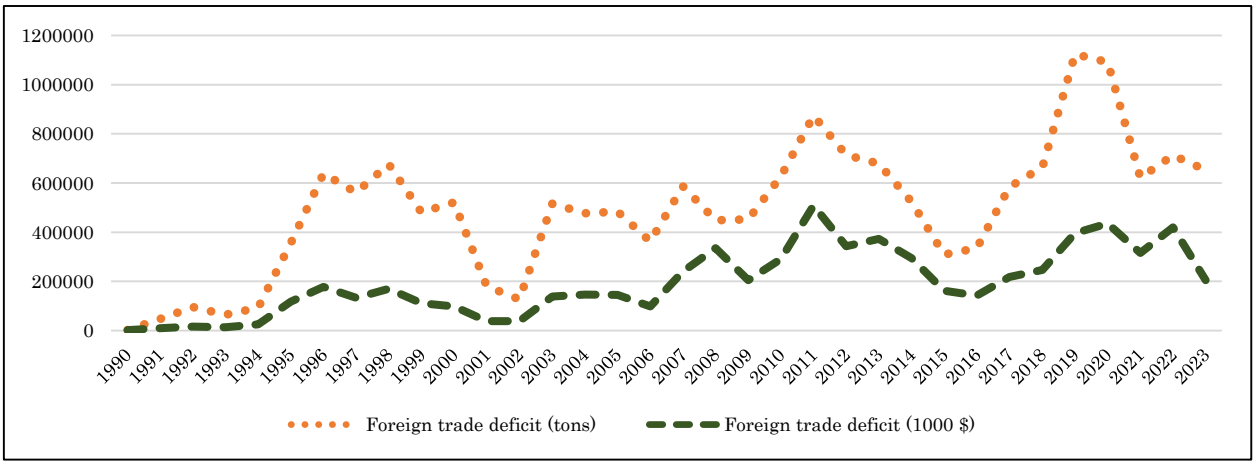

Figure 3. Türkiye's foreign trade deficit in oilseed sunflower (Anonymous, 2025b and authors' calculations).
Şekil 3. Türkiye'nin yağlık ayçiçeği dış ticaret açığı (Anonymous, 2025b ve yazarların hesaplamaları).

According to data from the Turkish Statistical Institute (TURKSTAT), the average oilseed sunflower cultivation area in Türkiye for the period 2020-2022 is 787 566 hectares, while the production volume is 2 155 000 tons. Among the provinces where oilseed sunflower production is concentrated—Tekirdağ, Edirne, Kırklareli, and Konya—the total cultivation area amounts to 429 812 hectares, with a production volume of 1 159 596 tons. These provinces account for 54.57% of Türkiye's total oilseed sunflower cultivation area, and 53.81% of the country's total oilseed sunflower production takes place in these provinces (Anonymous, 2025d).

The low self-sufficiency level and high import dependency in Türkiye's oilseed sunflower sector make it essential to secure the supply of domestically produced raw materials for the biodiesel, vegetable oil, and feed industries. Determining production costs in the agricultural sector is a critical decision-making criterion not only for producers but also for policymakers, traders, and industrial stakeholders (Bayramoğlu et al., 2021; Kadakoğlu and Karlı, 2022). Therefore, the calculation of production costs for agricultural commodities is of significant importance to all actors in the sector (Kadakoğlu et al., 2023a).

The aim of this study is to conduct an economic analysis of oilseed sunflower production on farms that produce oilseed sunflowers in Türkiye. By analyzing cost and profitability indicators across different farm size groups, the study assesses whether cost components vary among these groups. Additionally, the effects of agricultural subsidies utilized by farms on cost and profitability indicators in oilseed sunflower production were examined. This study represents the first comprehensive economic analysis covering Türkiye's major sunflower-producing regions,

statistically examining cost and profitability differences across farm size groups and providing a detailed assessment of the impacts of subsidy schemes.

The hypotheses of this study are the following: (1) unit production costs decrease as farm size increases; (2) agricultural subsidies have a greater impact on the profitability of smaller farms.

MATERIAL and METHOD

As the research area, the provinces of Tekirdağ, Edirne, Kırklareli, and Konya, which together account for more than half of Türkiye's area for oilseed sunflower cultivation and production, were selected. The main material of the study (primary data) consists of surveys conducted with 222 farms engaged in oilseed sunflower production in these provinces. The data obtained from oilseed sunflower producers pertain to the 2023 production season, and the face-to-face survey was conducted in October, November, and December of 2023. As secondary data, statistical information from various institutions and organizations was utilized.

Sampling Method

Data pertaining to the main population were sourced from the records of the Republic of Türkiye Ministry of Agriculture and Forestry, General Directorate of Plant Production. The number of sample farms to be surveyed was determined using the Neyman allocation method, a form of stratified sampling (Yamane, 2001). This method was chosen because group variances within the population differed. The sample size required to represent the main population was calculated using Equation 1.

$$n = \frac{(\sum NhSh)^2}{N^2D^2 + \sum NhSh^2} \quad (1)$$

In the equation: n: sample size, N: total number of units in the main population, Nh: number of units in the hth group, Sh: standard deviation of the hth group, Sh^2: variance of the hth group, D^2: d^2/z^2, d^2: allowed error amount from the main population mean, (5%), z^2: represents the table value of the allowed security limit (90%).

Farms were randomly selected from the population and subsequently stratified into three groups based on the size of their oilseed sunflower cultivation area. The distribution of farms into these groups was determined using Equation 2 (Çiçek and Erkan, 1996).

$$n_h = \frac{N_h S_h}{\sum N_h S_h} * n \quad (2)$$

In the equation: Nh: number of samples selected for each group; n: total number of samples.

The total sample size required to represent the population at a 90% confidence level with a 5% margin of error was calculated to be 222 farms. Accordingly, the group was defined as follows: Group I consisted of farms with a sunflower production area of 5.00 hectares and under (52 farms); Group II included farms with areas between 5.01 and 10.00 hectares (26 farms); and Group III comprised farms with 10.01 hectares and above (144 farms).

Table 1. Sample size
Çizelge 1. Örneklem büyüklüğü

Group	Cultivation area width groups (hectares)	Nh	Average cultivation area (hectares)	Sh	Sh2	n
I	0.1-5.00	34 455	2.54	1.232	1.5186	52
II	5.01-10.00	14 872	7.06	1.406	1.9781	26
III	10.01 +	10 909	18.64	10.684	114.1513	144
Total/Average		60 236	6.57	7.599	57.7459	222

Methods Used in Calculation

The study's hypotheses were tested to determine whether there were statistically significant differences between cost and profitability indicators and across farm size groups. Prior to the analysis, the normality of the data distribution was examined using normality tests. The Kolmogorov–Smirnov test, which is frequently used in the literature, was applied to the data (McKillup, 2012). It was determined that some variables followed a normal distribution while others did not. For variables with a normal distribution, the parametric one-way analysis of variance (ANOVA) was used, whereas for variables that did not meet the normality assumption, the nonparametric Kruskal–Wallis test was used.

The cost items related to oilseed sunflower production were examined under two categories: fixed costs and variable costs. Fixed costs include family labor, land rent, depreciation (buildings, machinery and equipment, facilities, and land improvements), building repair and maintenance expenses, interest on loans, and general administrative

expenses. Variable costs consist of temporary labor, seed, fertilizer, pesticides, machinery rental, electricity, water, fuel and oil, harvesting, marketing, other variable expenses, and working capital interest.

In calculating the imputed value of family labor, the daily wages paid to hired labor in the region were taken as the basis. Working capital interest was calculated as half of the annual agricultural loan interest rate (20%) applied by T.C. Ziraat Bankası, based on the assumption that variable capital remains tied up for an average period of six months. General administrative expenses were assumed to be 3% of the total variable costs incurred by the farm (Kıral et al., 1999).

The calculations of Gross Production Value (GPV) and profitability indicators for oilseed sunflower production are presented in Equation 3 (Erkuş, 1979; Açıl & Demirci, 1984; Rehber, 1993; Erkuş et al., 1995; Kıral et al., 1999).

GPV = Production Quantity (kg) × Selling Price (USD kg^{-1}), Gross Profit = GPV – Variable Costs, Net Profit = GPV – Total Production Costs, Relative Profitability = GPV / Total Production Costs, Cost of 1 kg of Sunflower = Total Production Costs (USD ha^{-1}) / Yield (kg ha^{-1}), Profit Margin = Selling Price (USD kg^{-1}) – Production Cost (USD kg^{-1}) (3)

RESULTS and DISCUSSION

An examination of the production pattern on the farms revealed that a total of 12.32 hectares of land was allocated to oilseed sunflower production. Specifically, the oilseed sunflower production area was 2.62 hectares in Group I, 6.71 hectares in Group II, and 16.84 hectares in Group III. In addition to oilseed sunflower, other crops such as wheat, canola, paddy, walnut, and various other plants were also cultivated on the farms. Following oilseed sunflower, the largest areas were allocated to wheat (3.39 hectares) and canola (1.18 hectares). Overall, oilseed sunflower accounted for 68.41% of the total production area, followed by wheat (18.80%) and canola (6.54%). The share of oilseed sunflower production in the total cultivated area by group was 61.94% in Group I, 63.00% in Group II, and 69.24% in Group III (Table 2).

Özkaya (1982) reported that in the provinces of Çorum, Afyonkarahisar, Konya, and Kayseri, the average cropping pattern of the surveyed farms consisted of 6.90 hectares of wheat (31.94%), 3.79 hectares of barley (17.50%), and 2.70 hectares of oilseed sunflower (12.50%). In a study conducted by Seçer (2005) in Adana province, the average cropping pattern of the farms was determined as 12.56 hectares of wheat (60.73%), 5.81 hectares of sunflower (28.06%), 1.03 hectares of maize (4.99%), and 0.54 hectares of cotton (2.62%). Oğuz et al. (2019) found that in the Karatay district of Konya province, the average cropping pattern consisted of 9.68 hectares of sunflower (41.17%), 7.25 hectares of wheat (30.72%), 3.02 hectares of barley (12.86%), and 1.42 hectares of grain maize (6.05%). Semerci (2019) determined that in Kırklareli province, the cropping pattern was composed of 50.38% wheat, 45.17% sunflower, and 2.16% barley. According to the findings of Düğmeci (2020) in the Çumra district of Konya province, the average cropping pattern included 12.55 hectares of grain maize (36.37%), 8.91 hectares of sunflower (32.82%), 4.78 hectares of wheat (11.79%), and 3.13 hectares of barley (10.19%). Yurt (2022) reported that in Çanakkale province, the cropping pattern consisted of 38.60% wheat, 30.66% sunflower, 10.96% barley, 9.32% canola, and 4.20% paddy rice.

Table 2. Crops grown on farms
Çizelge 2. İşletmelerdeki üretim deseni

Crops	I	II	III	Farms average
		ha		
Oilseed sunflower	2.62	6.71	16.84	12.32
Wheat	0.39	2.40	4.65	3.39
Canola	0.15	0.48	1.67	1.18
Paddy	0.15	0.35	0.37	0.32
Walnut	0.31	0.00	0.23	0.22
Other crops	0.61	0.71	0.57	0.59
Total	**4.23**	**10.65**	**24.33**	**18.02**
		%		
Oilseed sunflower	61.94	63.00	69.24	68.41
Wheat	9.12	22.56	19.11	18.80
Canola	3.65	4.51	6.88	6.54
Paddy	3.65	3.25	1.51	1.75
Walnut	7.30	0.00	0.93	1.21
Other crops	14.35	6.67	2.33	3.29
Total	**100.00**	**100.00**	**100.00**	**100.00**

The GPVs (Gross Production Values) of the farms were examined under three categories: the GPV obtained from oilseed sunflower production activities, the GPV obtained from other crop production activities, and the GPV

obtained from livestock production activities. The total GPV of the farms ranged from $14 070.32 to $42 943.73 across the groups, with an average of $33 973.29 for all farms (Table 3).

The GPV obtained from oilseed sunflower production activities ranged between $3 644.55 and $21 739.78 across the groups, with an average of $16 066.03 for all farms. The GPV obtained from other crop production activities ranged between $9 017.55 and $20 487.32 across the groups, and the farm average was calculated as $16 960.47 (Table 3).

The GPV obtained from livestock production activities ranged between $716.62 and $1 408.22 across the groups, with an average value of $946.78. When the proportional distribution of the GPV components in the farms was examined, the share of the GPV obtained from oilseed sunflower production within the total GPV was determined as 25.90% in Group I, 39.36% in Group II, 50.62% in Group III, and 47.29% on average for all farms (Table 3).

In a study conducted by Oğuz et al. (2019), it was reported that in the farms located in the Karatay district of Konya province, 47.48% of the total GPV was obtained from sunflower, while 52.52% came from other crop products.

Table 3. Distribution of gross production value on farms
Çizelge 3. İşletmelerde gayrisafi üretim değerinin dağılımı

GPV	I	II	III	Farms average
		USD farm^{-1}		
Oilseed sunflower	3 644.55	9 485.13	21 739.78	16 066.03
Other crop products	9 017.55	13 313.01	20 487.32	16 960.47
Animal production	1 408.22	1 298.65	716.62	946.78
Total	**14 070.32**	**24 096.79**	**42 943.73**	**33 973.29**
		%		
Oilseed sunflower	25.90	39.36	50.62	47.29
Other crop products	64.09	55.25	47.71	49.92
Animal production	10.01	5.39	1.67	2.79
Total	**100.00**	**100.00**	**100.00**	**100.00**

In the production of oilseed sunflower, farm expenses were calculated as fixed and variable costs. Variable cost items included temporary labor, seed, fertilizer, pesticides, water and electricity, fuel and oil, machinery rental, harvesting, marketing, interest in working capital, and other variable costs. Other variable costs consisted of items such as agricultural insurance premiums, hardware store expenditures, and similar expenses.

The total variable cost per hectare was calculated as $568.01. Across groups, this amount was determined as $522.83 in Group I, $575.23 in Group II, and $570.03 in Group III. Fuel and oil expenses were identified as the most significant variable cost items in all groups. The fuel and oil cost per hectare was calculated as $130.34 on average, with $116.25 in Group I, $138.13 in Group II, and $130.57 in Group III (Table 4).

The share of variable costs in total production expenses was determined to be 64.93%. Among variable cost items, fuel and oil constituted the most important expenditure, accounting for 14.90% of total production costs. Fuel and oil expenses were followed by fertilizer (14.15%), seed (9.76%), harvesting (7.25%), interest in working capital (5.90%), water and electricity (5.37%), pesticides (4.23%), other variable costs (1.88%), marketing (0.94%), temporary labor (0.48%), and machinery rent (0.06%) (Table 4).

Fixed cost items in oilseed sunflower production included family labor, land rent, building maintenance and repair costs, depreciation, interest on debt, and general administrative expenses. The total fixed cost per hectare was calculated as $306.82. Across groups, this amount was determined as $468.80 in Group I, $435.22 in Group II, and $288.49 in Group III. In all groups, land rent was found to be the most important fixed cost. The land rent per hectare was calculated as $174.19 on average, with $176.95 in Group I, $251.94 in Group II, and $168.44 in Group III. The share of fixed costs in total production expenses was found to be 35.07%. Among fixed cost items, land rent was the most important, accounting for 19.91% of total production costs. Land rent was followed by family labor (5.44%), depreciation (5.26%), general administrative expenses (1.95%), interest on debt (1.71%), and building maintenance and repair (0.81%) (Table 4).

The total sunflower production cost per hectare was calculated as $874.83. Across groups, this amount was determined as $991.63 in Group I, $1,010.45 in Group II, and $858.52 in Group III (Table 4).

It was determined that the differences observed between farm size groups and the variables representing production expenses—seed, fertilizer, pesticides, fuel and oil, machinery rental, harvesting, marketing, operating capital interest, other variable costs, total variable costs, family labor, land rent, depreciation, interest on loans, general administrative expenses, total fixed costs, and total production costs—were statistically significant ($p<.01$). Elevated fuel costs are largely attributable to fluctuations in energy prices, while high land rents reflect constraints

in land supply combined with strong regional demand for agricultural land.

Several studies have analyzed the cost structure of oilseed sunflower production across different regions of Türkiye. Oğuz and Altıntaş (2002) reported that in Kırıkkale in 2001, variable costs accounted for 32.52% of total production expenses, while fixed costs represented 67.48%. Among these costs, family labor wages were the largest component (41.72%), followed by land rent (22.04%), machinery rental (17.05%), and fertilizer (6.36%).

In the Thrace region, Erdem (2012) found that in 2010, land rent was the most significant expenditure in sunflower production, representing 22.60% of total costs. Similarly, Unakıtan and Aydın (2018) reported that in 2016, variable costs constituted 43.73% of total expenses, while fixed costs accounted for 56.27%. Machinery rental (18.56%) and land rent (18.33%) were identified as the leading cost items.

Oğuz et al. (2019), in a study conducted in the Karatay district of Konya province, indicated that variable costs made up 69.10% of total expenses, whereas fixed costs accounted for 30.90%. Fertilizer (24.09%), fuel (15.71%), seed (14.78%), and land rent (14.55%) were reported as the most significant cost components. Semerci (2019) analyzed sunflower production in Kırklareli for the 2009–2010 period and found that variable costs accounted for 62.11% of total expenditures, with land rent being the largest single cost item at 26.24%.

Düğmeci (2020), in a study conducted in Çumra, Konya province, reported that variable costs accounted for 53.59% of total sunflower production expenses, while fixed costs accounted for 46.41%. The leading cost items included land rent (27.91%), irrigation (11.98%), fertilization (11.09%), and pesticide application (9.57%).

Overall, these regional studies consistently highlight land rent as the most critical cost item in sunflower production, with fuel and fertilizer also representing significant expenditures. These findings emphasize the necessity to manage input costs to improve the economic efficiency of oilseed sunflower farming in Türkiye.

Table 4. Oilseed sunflower production costs in farms
Çizelge 4. İşletmelerde yağlık ayçiçeğinin üretim masrafları

Cost items	I		II		III		Farms average	
	USD ha^{-1}	%	USD ha^{-1}	%	USD ha^{-1}	%	USD ha^{-1}	%
Fuel and oil*	116.25	11.72	138.13	13.67	130.57	15.21	130.34	14.90
Fertilizer*	97.68	9.85	133.46	13.21	124.58	14.51	123.81	14.15
Seed*	82.75	8.34	87.90	8.70	85.37	9.94	85.40	9.76
Harvesting*	62.18	6.27	63.05	6.24	63.55	7.40	63.45	7.25
The interest in working capital*	47.53	4.79	52.29	5.18	51.82	6.04	51.64	5.90
Water and electricity	65.59	6.61	51.30	5.08	45.65	5.32	47.00	5.37
Pesticides*	17.43	1.76	28.26	2.80	38.72	4.51	36.99	4.23
Other variable costs*	7.23	0.73	11.97	1.19	17.27	2.01	16.43	1.88
Marketing*	8.90	0.90	8.86	0.88	8.13	0.95	8.22	0.94
Temporary labor	6.07	0.61	0.00	0.00	4.37	0.51	4.17	0.48
Machinery rental*	11.22	1.13	0.00	0.00	0.00	0.00	0.56	0.06
Variable costs*	**522.83**	**52.72**	**575.23**	**56.93**	**570.03**	**66.40**	**568.01**	**64.93**
Land rent*	176.95	17.84	251.94	24.93	168.44	19.62	174.19	19.91
Family labor*	96.08	9.69	70.65	6.99	43.17	5.03	47.55	5.44
Depreciation*	137.40	13.86	68.13	6.74	39.26	4.57	45.98	5.26
General administrative expenses*	15.68	1.58	17.26	1.71	17.10	1.99	17.04	1.95
Interest on debt*	11.60	1.17	16.00	1.58	15.04	1.75	14.93	1.71
Building maintenance and repair cost	31.08	3.13	11.24	1.11	5.48	0.64	7.12	0.81
Fixed costs*	**468.80**	**47.28**	**435.22**	**43.07**	**288.49**	**33.60**	**306.82**	**35.07**
Production costs*	**991.63**	**100.00**	**1010.45**	**100.00**	**858.52**	**100.00**	**874.83**	**100.00**

*; Statistically significant (p<.01)

To evaluate the effect of agricultural subsidies on the profitability of oilseed sunflower production, the gross production value (GPV) of sunflower farming activities was calculated under two scenarios: including and excluding agricultural subsidies. Subsequently, key profitability indicators—gross profit, net profit, and relative profit—were assessed for each farm under both scenarios. This approach allows for a clear comparison of the contribution of subsidies to overall farm profitability and reveals the economic significance of government subsidies in sunflower production.

In the farms, the gross production value (GPV) obtained from oilseed sunflower production was divided by the total oilseed sunflower output to calculate the unit selling price. The unit selling price of oilseed sunflower was determined to be \$0.59 for farms in Group I, \$0.60 in Group II, \$0.59 in Group III, and \$0.59 on average across all farms. The unit cost of oilseed sunflower was calculated by dividing total farm expenses by the quantity of oilseed sunflowers produced. The unit cost was \$0.47 for Group I, \$0.48 for Group II, \$0.44 for Group III, and \$0.45 on average. The unit amount of agricultural subsidies was calculated by dividing total subsidies by oilseed sunflower production. Farms received \$0.07 per kilogram in Group I, \$0.08 in Group II, \$0.08 in Group III, and \$0.08 on

average, indicating that each kilogram of oilseed sunflower produced receives $0.08 in government subsidies (Table 5).

Gross profit was calculated by subtracting variable costs from the GPV of oilseed sunflower production. When agricultural subsidies were included in the GPV, gross profit per hectare was $870.67 for Group I, $838.03 for Group II, $721.18 for Group III, and $736.06 on average. When agricultural subsidies were excluded, gross profit per hectare was $724.66 for Group I, $668.13 for Group II, $571.64 for Group III, and $585.41 on average (Table 5).

Net profit was calculated by subtracting total farm costs from the GPV. When including agricultural subsidies, net profit per hectare was $401.88 in Group I, $402.81 in Group II, $432.69 in Group III, and $429.25 on average. Excluding agricultural subsidies, net profit per hectare was $255.87 in Group I, $232.92 in Group II, $283.16 in Group III, and $278.59 on average (Table 5).

Relative profit was determined by dividing the GPV by total farm costs. With agricultural subsidies included, relative profit was 1.41 for Group I, 1.40 for Group II, 1.50 for Group III, and 1.49 on average. Without agricultural subsidies, relative profit was 1.26 for Group I, 1.23 for Group II, 1.33 for Group III, and 1.32 on average (Table 5). Thus, for every 100 units of cost incurred in oilseed sunflower production, farms generate 149 units of revenue, yielding a profit of 49 units.

In a study conducted by Seçer (2005) in Adana province, she reported a relative profit of 1.04. Unakıtan and Aydın (2018) found a relative profit of 1.02 in the Thrace region. Oğuz et al. (2019) reported a relative profit of 2.96 for farms in the Karatay district of Konya province. Semerci (2019) determined a relative profit of 1.12 in Kırklareli province. In another study in Adana, Yüksek (2019) calculated relative profit as 0.84 without subsidies and 1.03 with subsidies. Düğmeci (2020) reported a relative profit of 1.40 in the Çumra district of Konya. Semerci (2022) found relative profits of 1.37 in Edirne and 1.18 in Tekirdağ. Finally, Yurt (2022) reported a relative profit of 1.12 in the Çanakkale province.

When the findings of this study are compared with previous research in the literature, they are generally consistent; however, notable regional and temporal differences in profitability levels are evident. For example, the studies by Seçer (2005), Unakıtan and Aydın (2018), and Yüksek (2019) reported relative profit values considerably lower than those obtained in the present study, whereas Oğuz et al. (2019) documented a substantially higher relative profit (2.96). These discrepancies may be associated with regional variations in production costs, differences in input use levels, yield differentials, and diverse implementations of support mechanisms. Indeed, the results indicate that production expenses, particularly fixed cost components, can vary markedly from one region to another.

Table 5. Indicators of profitability of oilseed sunflower production on farms
Çizelge 5. İşletmelerde yağlık ayçiçeğinin üretiminin kârlılık göstergeleri

Profitability indicators	Unit	Equality	I	II	III	Farms average
Production	Kg ha^{-1}	A	2108.80	2087.30	1934.20	1952.70
Sales price	USD kg^{-1}	C/A=B	0.59	0.60	0.59	0.59
GPV	USD ha^{-1}	C	1247.50	1243.36	1141.67	1153.42
Agricultural subsidies	USD ha^{-1}	D	146.01	169.90	149.54	150.66
Total GPV	USD ha^{-1}	C+D=E	1393.50	1413.26	1291.20	1304.08
Variable costs	USD ha^{-1}	F	522.83	575.23	570.03	568.01
Fixed costs	USD ha^{-1}	G	468.80	435.22	288.49	306.82
Production costs	USD ha^{-1}	F+G=H	991.63	1010.45	858.52	874.83
Unit cost	USD kg^{-1}	H/A=I	0.47	0.48	0.44	0.45
Unit subsidies amount	USD kg^{-1}	D/A=J	0.07	0.08	0.08	0.08
			Profitability calculated with GPV + agricultural subsidies			
Unit profit margin	USD kg^{-1}	(B-I)+J	0.19	0.20	0.22	0.22
Gross profit	USD ha^{-1}	E-F	870.67	838.03	721.18	736.06
Net profit	USD ha^{-1}	E-H	401.88	402.81	432.69	429.25
Relative profit		E/H	1.41	1.40	1.50	1.49
			Profitability calculated with GPV			
Unit profit margin	USD kg^{-1}	B-I	0.12	0.11	0.15	0.14
Gross profit	USD ha^{-1}	C-F	724.66	668.13	571.64	585.41
Net profit	USD ha^{-1}	C-H	255.87	232.92	283.16	278.59
Relative profit		C/H	1.26	1.23	1.33	1.32

The impact of agricultural subsidies on oilseed sunflower production was analyzed across farm groups. The results indicate that subsidies significantly enhanced profitability: gross profit increased by 20.15% in Group I, 25.43% in Group II, and 26.16% in Group III, with an average increase of 25.73% across all farms. Similarly, net profit grew substantially, rising by 57.06% in Group I, 72.94% in Group II, and 52.81% in Group III, with an overall average increase of 54.08%. Relative profit also improved, with increases of 11.90%, 13.82%, and 12.78% for Groups I, II, and III, respectively, and a corresponding average increase across all farms (Table 6). These findings point out the importance of agricultural subsidies in enhancing the economic performance of oilseed sunflower production.

Table 6. The impact of agricultural subsidies on profitability indicators in farms
Çizelge 6. Tarımsal desteklerin işletmelerdeki kârlılık göstergelerine etkisi

Profitability indicators	I	II	III	Farms average
		%		
Gross profit	20.15	25.43	26.16	25.73
Net profit	57.06	72.94	52.81	54.08
Relative profit	11.90	13.82	12.78	12.88

CONCLUSION

In this study, which conducted an economic analysis of farms engaged in oilseed sunflower production, the cost and profitability indicators of oilseed sunflower cultivation were identified. It was also determined whether these cost and profitability indicators differed across farm size groups.

On average, oilseed sunflower production costs were calculated as $874.83 per hectare. Among the variable cost components in sunflower production, fuel and oil expenses were the most significant, accounting for 14.90% of total production costs. Among the fixed cost components, land rent was identified as the most important item, representing 19.91% of total production costs. The unit production cost of oilseed sunflower was determined as $0.45 kg^{-1}, while the average selling price was $0.59 kg^{-1}. On a per-hectare basis, the gross production value obtained from sunflower cultivation was calculated as $1 304.08, gross profit as $736.06, and net profit as $429.25. Relative profit was determined as 1.49.

In oilseed sunflower production—where the foreign trade deficit has been increasing each year, the supply deficit has widened, and the self-sufficiency ratio remains low—it was found that agricultural subsidies have a significant impact on profitability indicators. Agricultural subsidies were determined to increase gross profit by 25.74%, net profit by 54.08%, and relative profit by 12.88% on farms engaged in oilseed sunflower production.

The findings of this study demonstrate that oilseed sunflower production is economically viable across all farm groups, with agricultural subsidies exerting a considerable positive influence on profitability. The relative profit ratios, calculated by dividing the gross production value (GPV) by total farm costs, underscore this profitability. These results indicate that farms generate a 49% return above production costs under subsidized conditions, highlighting the important role subsidies play in strengthening farm incomes.

Based on the research findings, the following recommendations are proposed for oilseed sunflower production:

- Increase agricultural subsidies to improve profitability and income for oilseed sunflower-producing farms and to support the continuity of production.
- Ensure timely payment of subsidies and regularly evaluate their impact on farm profitability and production sustainability.
- Develop additional support schemes targeting fuel and oil costs, given their significant share in total production costs.
- Encourage long-term lease arrangements in regions with high land rents to reduce producers' cost burden and production uncertainty.
- Consider land rent subsidies for farmers operating on rented agricultural land.
- Shift support payments to the pre-planting period to enhance farmers' liquidity and the efficiency of input use.

For future research, the impacts of climate change and input price volatility on the production costs of oilseed sunflowers could be modeled to better understand cost dynamics and support the development of adaptive agricultural policies.

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Ethic Statement

Ethics committee approval for conducting the study was obtained from the Scientific Research and Publication Ethics Committee of Isparta University of Applied Sciences with the letter dated 10.05.2023 and numbered 150/1.

Contribution Rate Statement Summary of Researchers

The authors declare that they have contributed equally to the article.

Conflict of Interest

The authors of the article declare that they have no conflict of interest.

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