



Walnut Production Cost and Profitability Analysis: Niksar District of Tokat Province, Türkiye

Hayriye Sibel Gülse Bal¹

Received: 10 March 2025 / Accepted: 10 June 2025 / Published online: 9 September 2025
© The author(s), exclusively licensed to Springer-Verlag GmbH Germany, a part of Springer Nature 2025

Abstract

In this research, 59 enterprises engaged in walnut cultivation in Niksar district of Tokat province, Türkiye, were surveyed. The data obtained belong to 2021. ‘Chandler’ walnut is grown in 93.22% of the enterprises and the local walnut variety is grown in 35.59% of the enterprises. Walnut production, cost and profitability were analyzed according to the walnut variety grown. The amount of walnut land per enterprise is 1.89 ha for the ‘Chandler’ variety and 0.89 ha for the local (domestic) variety. The yield per tree is 8.79 kg for the ‘Chandler’ variety and 22.30 kg for the local variety. A large portion of the walnuts produced are sold. Walnut production cost per ha is \$4653.94 for the ‘Chandler’ variety and \$3918.04 for the local variety. ‘Chandler’ variety walnuts are sold at a higher price. However, the local walnut variety has very high values in terms of both yield and profitability. There is no marketing problem for walnuts produced in the region. With the solution of the problems encountered in production, profitability will increase even more.

Keywords Local Niksar Walnut · Chandler · Walnut production · Walnut profitability · Variety competition

Introduction

The genetic center of walnut (*Juglans regia* L.) is the Ghilan region of Iran located at 35–40 north latitude on the Caspian Sea coast (Haskınacı 2003). Walnut, which is resistant to cold and drought, is a fruit species that can grow in various ecological conditions. It is cultivated in a wide geography including the southern region of the Carpathian Mountains in Eastern Europe, Iran, the Himalayan Mountains and Türkiye. Walnut production has been carried out for many years in Türkiye, which is one of the gene centers of walnut (Kadakoğlu et al. 2022). It is stated that there is information that walnut cultivation existed in Anatolia in the 15th century (Güvenç and Purlu 2022).

The most important walnut producing countries in the world are the People’s Republic of China, USA, Iran, Türkiye, Mexico, Ukraine and Chile (Aksoy and Kaymak 2021). As of 2020, the world walnut production area is 1.02 million ha, the production amount is 3.3 million tons

and the yield is 3.3 ton/ha⁻¹. The People’s Republic of China ranks first in terms of both walnut production area and production amount worldwide, followed by the USA, Iran, Türkiye and Mexico. Türkiye ranks fourth in terms of walnut production in the world. World walnut trade is carried out in shelled and unshelled form. In 2021, the most important countries in world walnut exports are the USA (37.3%), Chile (13.7%), China (13.3%) and Mexico (10.3%), while the most important walnut importing countries are Türkiye (11.3%), Germany (10.0%), Italy (9.0%), Mexico (8.7%) and the United Arab Emirates (7.6%).

Walnut production areas in Türkiye are increasing every year. While the walnut production area in the country was 868 ha in the 2016/17 production season, this value was realized as 1418 ha in the 2020/21 season (Özcan 2022). As of 2022, the number of bearing walnut numbers of trees in Türkiye was 15,327 and the number of non-bearing walnut trees was 12,246. Walnut production was 335,000 tons in the same year (Anonymous 2023a) and this value is estimated to be 398,000 tons in 2023 with an increase of 18.81% (Anonymous 2023b). The yield per tree was 23 kg in the 2020/21 production period (Özcan 2022).

Türkiye is both a walnut exporting and walnut importing country. As a matter of fact, as of 2021, Türkiye’s largest walnut exporters were Iraq (34.1%), Azerbaijan (18.2%), Syria (9.1%), Egypt (4.5%) and Morocco (3.7%),

✉ Hayriye Sibel Gülse Bal
hayriyesibel.gulsebal@gop.edu.tr

¹ Faculty of Agriculture, Department of Agricultural Economics, Tokat Gaziosmanpaşa University, Taşlıçiftlik, 60240 Tokat, Turkey

while its largest walnut importers were the USA (40.2%), Chile (20.6%), China (19.1%), Uzbekistan (9.7%) and Iran (4.0%) (Özcan 2022).

In the past years, walnut cultivation in Türkiye was mostly carried out in home gardens or as border trees. Today, it is stated that the interest in walnut has increased and conscious walnut cultivation has started to be carried out in the form of establishing closed gardens (Ketenci and Bayramoğlu 2018).

Walnuts are grown in almost every region in Türkiye. Tokat province, where the research area is located, is also one of the important walnut production areas. The share of Tokat province in Türkiye's total walnut production is 2.10% with 6833 tons. The share of Niksar district, which was selected as the research region, is 0.77% with 2512 tons.

Fruit lands constitute 3.86% of the total amount of cultivated agricultural land in the district (37,935 ha). Walnut has a very important place in the district economy. Walnut has been cultivated in Niksar district for many years on an amateur basis in the form of scattered plantings on the edges of fields in the villages. In recent years, with the increase in the income provided by walnut, new varieties have been transferred and covered gardens have started to be established. There are four modern walnut crushing and packaging facilities in the district that have received food production permits. Walnut cracking in the district is generally done by women. Most of the crushed and packaged walnuts are sold in the Turkish market and some are exported abroad (Anonymous 2023c).

In order to ensure the continuity of the existence of agricultural farms, it is necessary to examine the changing market conditions, and technological developments and make appropriate adjustments in production techniques. In this context, for these changes to be beneficial, farms should determine production costs and know the share of the cost elements that make up the production cost. These data are also important for producers in planning which products to produce and how to produce them in the long term (Gül and Kart 2024). In this study, walnut production status, cost and profitability of walnut production in Niksar district of Tokat province located in the Black Sea Region of Türkiye were revealed.

Materials and Methods

Primary and secondary data constitute the main material of the research. As primary data, data obtained from 59 producers engaged in walnut cultivation in Niksar district of Tokat province through face-to-face questionnaires were used.

In the selection of the population to be sampled, villages with 20 or more walnut enterprises were selected by the researcher with the purposive sampling method. A total of 426 walnut enterprises registered in the Farmer Registration System (FRS) of Tokat Niksar District Directorate of Agriculture and Forestry were taken as basis. The data obtained belong to 2021. In the selection of the enterprises to be surveyed from the sample population, the walnut land holdings of the enterprises registered in the FRS were taken into consideration and the simple random sampling method was used (Karadaş 2016).

Considering the number of walnut enterprises, the number of enterprises to represent the population was calculated by the following formula:

$$n = \frac{N * S^2 * t^2}{(N - 1) d^2 + S^2 * t^2}$$

In the formula, n : number of enterprises to represent the population (59), N : total number of enterprises in the population (426), S : standard deviation of the population (16.50), t : ruler value at 90% confidence limits (1.65), d : acceptable margin of error (10% of the population mean: 3.28).

The enterprises were analyzed in three groups in terms of socio-economic characteristics. Based on the amount of walnut land owned, 26 enterprises with 1.5 ha and below formed the 1st group, 18 enterprises with 1.6–2.5 ha formed the 2nd group and, finally, 15 enterprises with 2.6 ha and above formed the 3rd group.

'Chandler' and "local or domestic" walnut varieties are grown in the surveyed enterprises. Therefore, the production amount, yield, cost and profitability of the walnut plant and production period were analyzed in terms of these two varieties.

In the surveys, data on the physical production inputs and costs required for walnut production were determined over the total walnut production area and then calculations were made on ha (Kıral et al. 1999).

While calculating the production cost of walnut cultivation, firstly, the costs related to the walnut establishment period (fruitless period) were determined (each year and total), and then the costs related to the production period of the product at the yielding age (fruiting period) were determined.

Research Findings

Socio-economic Characteristics of Enterprises

The characteristics of the respondents in the study area are given in Table 1. The majority of the respondents (98.1%) were male.

Table 1 Demographic characteristics and agricultural experience of the surveyed businesses

	Business groups						Business average (59)		
	Group 1 (26)		Group 2 (18)		Group 3 (15)				
	Frequency	%	Frequency	%	Frequency	%			
Gender									
	Male	26	100.00	17	94.44	15	100.00	58	98.31
	Woman	0	0.00	1	5.56	0	0.00	1	1.69
	Total	26	100.00	18	100.00	15	100.00	59	100.00
Age (years)									
	≤40	2	7.69	1	5.56	2	13.33	5	8.47
	41–50	1	3.85	1	5.56	2	13.33	4	6.78
	51–60	8	30.77	7	38.89	3	20.00	18	30.51
	61–70	8	30.77	6	33.33	7	46.67	21	35.59
	71 ≥	7	26.92	3	16.66	1	6.67	11	18.65
	Total	26	100.00	18	100.00	15	100.00	59	100.00
	Average	63.35		61.28		58.27		61.42	
Education Status									
	Literate	2	7.69	0	0.00	0	0.00	2	3.39
	Primary School	11	42.31	9	50.00	6	40.00	26	44.07
	Middle School	1	3.85	4	22.22	1	6.67	6	10.17
	High School	5	19.23	3	16.67	4	26.66	12	20.34
	Associate Degree	2	7.69	0	0.00	1	6.67	3	5.08
	License	5	19.23	2	11.11	3	20.00	10	16.95
	Total	26	100.00	18	100.00	15	100.00	59	100.00
Agricultural experience (years)									
	≤20	14	53.85	4	22.22	6	40.00	24	40.68
	21–40	4	15.38	10	55.56	7	46.67	21	35.59
	41 ≥	8	30.77	4	22.22	2	13.33	14	23.73
	Total	26	100.00	18	100.00	15	100.00	59	100.00
	Average	29.85		34.17		29.40		31.05	
Walnut production experience (years)									
	≤7	13	50.00	8	44.44	6	40.00	27	45.76
	8–14	7	26.92	2	11.11	6	40.00	15	25.42
	15 ≥	6	23.08	8	44.45	3	20.00	17	28.82
	Total	26	100.00	18	100.00	15	100.00	59	100.00
	Average	10.69		15.06		13.07		12.63	

Table 2 Land status of the surveyed farms

	Business groups			Business average (59) ha			
	1st Group (26)		2nd Group (18)		3rd Group (15)		
	ha	%	ha	%	ha	%	
Land ownership status	Property land	2.99	92.86	4.11	84.57	5.71	96.13
	Rent + partner	0.23	7.14	0.75	15.43	0.23	3.87
	Total	3.22	100.00	4.86	100.00	5.94	100.00
Land irrigation status	Irrigated land	1.44	44.72	2.63	54.12	4.33	72.90
	Dry land	1.78	55.28	2.23	45.88	1.61	27.10
	Total	3.22	100.00	4.86	100.00	5.94	100.00
Walnut land asset	'Chandler'	0.91	87.50	1.78	86.83	3.21	82.10
	Domestic	0.13	12.50	0.27	13.17	0.70	17.90
	Total	1.04	100.00	2.05	100.00	3.91	100.00
Total ratio of walnut land in enterprise land (%)		32.30		42.18		65.82	
Number of walnut trees		227.50		480.72		902.67	
Piece ha ⁻¹		218.75		234.50		230.86	
Business average (59) ha						4.02	91.17
						0.39	8.83
						4.41	100.00
						2.54	57.60
						1.87	42.40
						4.41	100.00
						1.76	84.62
						0.32	15.38
						2.08	100.00
						47.17	
						476.41	
						229.04	

The average age of the interviewees was 61.42 years and the highest age group was between 61–70 years. These data show that mostly the elderly population is engaged in walnut production in the study area. There is an inverse relationship between the area of walnut production and the age of the producers.

It was determined that about half of the walnut producers surveyed had primary school education. However, it is pleasing to note that some of the farmers have associate and bachelor's degrees (usually retired). Thus, with the acceptance of agricultural innovations, it will be possible to implement many issues such as establishing a walnut orchard, benefiting from incentives and supports, and trying new varieties.

On the average of all holdings, it was found that they had approximately 31 years of agricultural experience and 13 years of walnut production experience. Especially with the projects implemented in the region in recent years, walnut seedlings are distributed, technical information on cultivation is provided and the establishment of closed walnut gardens is encouraged. This shows that walnut cultivation will become more widespread in the region and therefore the experience of farmers will increase.

Land Assets of Enterprises

On average, the amount of land was 4.41 ha farm⁻¹ (Table 2). More than 90% of the total land holdings in the analyzed farms are in the form of property land. The amount of land rented and held in partnership is at low levels. On the other hand, more than half of the enterprise land is irrigated land.

Two different walnut varieties, 'Chandler' and local varieties, are grown in the surveyed enterprises. Approximately 85% of the walnut production area in the surveyed enterprises consists of 'Chandler' variety. 'Chandler' variety has a fruiting rate of 80–90% on the side branches. It is stated that 'Chandler', which is accepted as a very suitable variety for walnut cultivation, has a 49% kernel rate, a kernel weight of 6.5 g and a light-colored kernel rate of 90–100% (Haskınacı 2003).

It was determined that the total walnut production area per enterprise was 1.4 ha in group 1 enterprises, 2.05 ha in group 2 enterprises, 3.91 ha in group 3 enterprises and 2.08 ha in the average of enterprises. In the study conducted by Çiftçi and Gökçe (2006) in İzmir and Manisa provinces, the share of walnut production area in the total enterprise land was determined as 8.11%.

The number of walnut trees was calculated as 476.41 trees per enterprise and 229.04 trees perha on the average of all enterprises regardless of variety.

Walnut Production and Marketing Status in Enterprises

In some of the examined enterprises, both local and ‘Chandler’ walnut varieties are grown together (Table 3). As an average of all enterprises, it was determined that 93.22% of the enterprises grow ‘Chandler’ (55 enterprises) and 35.59% grow the local walnut variety (21 enterprises). But rates vary according to business groups. In the research previously conducted by Kilci (2015) in the same region, it was stated that 73.8% of the producers grew domestic and 26.2% foreign walnut varieties.

With regard to the amount of walnut land per enterprise for all enterprises, this was determined as 1.89 ha in ‘Chandler’ variety and 0.89 ha in local variety. It is seen that approximately 75% of the ‘Chandler’ variety walnut area consists of fruit-bearing trees. This shows that new closed gardens consisting of this variety have been established.

In businesses that grow local walnut varieties, all walnut trees bear fruit. In the ‘Chandler’ variety, the average number of walnut trees per farm is 464.42, and 74.98% of them were determined to be of fruit-bearing age. The average age of fruit bearing walnut trees is calculated to be 6.20 years for the ‘Chandler’ variety and 26.05 years for the local variety.

When the walnut yield per ha and per tree is examined, it is seen that the local variety has higher values. Yield of ‘Chandler’ walnut variety was calculated as 8.79 kg per tree and 2171.57 kg per ha. These values were 22.30 kg and 3060.46 kg, respectively, in local walnut growing enterprises. Many factors such as the age and size of the tree, the soil characteristics of the environment in which it is grown, and the climate may be effective in this. It is stated that the walnut yield in Türkiye in the 2020/21 production period is 23 kg per tree (Özcan 2022).

It has been stated that the selling price of walnuts is slightly higher for the ‘Chandler’ variety ($\$3.70 \text{ kg}^{-1}$). All of the walnuts produced in the surveyed enterprises were sold in cash.

Information on walnut production and marketing situations in the examined enterprises, without distinguishing between varieties, is given in Table 4.

Walnut production has been carried out in the research area for many years, especially in terms of local varieties. In recent years, the production of the ‘Chandler’ walnut variety suitable for the land and climatic conditions has become widespread.

The product produced in the region is very famous under the name ‘Niksar Walnut’ and is a sought-after product in the market. In other words, the most important reasons that make ‘Niksar Walnut’ different from other walnuts are that it is stated to have characteristics unique to the region as well as superior features sought in the consumption

and food industry. Additionally, the factors that make this walnut valuable are described as the high quality of irrigation water in the ecological conditions specific to the region, the soil being unpolluted and suitable for organic agriculture, and the genetically high fruit quality of the walnuts produced in the region. However, it is stated that ‘Niksar Walnut’, which is different from other walnuts in the region in terms of taste and quality, has a fat content of 65% (Anonymous 2023d). ‘Niksar Walnut’: As a result of the application made to the Turkish Patent Institute on 17.05.2011, the geographical indication was obtained and registered on 17.12.2013 (Registration No: 177) (Anonymous 2023e). All these features and factors cause walnut cultivation to become widespread in this region and to be seen as a profitable production.

According to the surveyed enterprises, there is more than one factor in walnut cultivation. The most important reason is its good economic return, followed by factors such as the land being suitable for walnut cultivation, the product being easy to market, being a traditional product of the region, and being easy to produce.

As with many agricultural products, there are some agricultural supports for walnut cultivation. As of 2021, the supports applied for walnuts include: soil analysis ($\$0.09 \text{ decare}^{-1}$), fertilizer support ($\0.90 decare^{-1}) and fuel support ($\$1.92 \text{ decare}^{-1}$) (Özcan 2022). All of the producers surveyed stated that they benefited from the supports provided for walnuts and that the supports they benefited from were more than one. The supports benefited from are as follows: diesel fuel-fertilizer support, certified sapling support, benefiting from projects implemented in the region for walnut cultivation and using low-interest loans.

Many projects have been implemented by different institutions to popularize walnut cultivation in the research region and continue to be implemented. Since 1997, a total of 141,792 walnut saplings have been planted within the scope of village-based clustering projects (Anonymous 2023c).

Walnut Cost and Profitability Status in Enterprises

The walnut cost and profitability of the analyzed enterprises were calculated per unit area (ha) in terms of the walnut varieties grown. As mentioned before, some enterprises grow both ‘Chandler’ and local walnut varieties.

Since walnut is a perennial plant, the plant period and production period were evaluated separately in the cost calculation.

Cost elements related to the establishment period in walnut cultivation by cultivars are given in Table 5.

During the establishment period of a walnut orchard, there are varying costs including soil preparation costs in the first year, seedling planting costs, materials used in

Table 3 Presence of walnuts and the way the product is used in the businesses surveyed

	Business groups												Business average (59)
	Group 1 (26)				Group 2 (18)				Group 3 (15)				
	Walnut type grown		Domestic		'Chandler'		Domestic		'Chandler'		Domestic		
Number of breeding enterprises (number)	Frequency	25	9	16	5	14	7	55	21	35.59			
Walnut land (ha farm ⁻¹)**	%*	96.15	34.62	88.89	27.78	93.33	46.67	93.22	35.59				
	Bearing fruit	0.54	0.37	1.51	0.96	2.83	1.50	1.41	0.89				
	Not bearing fruit	0.41	0.00	0.49	0.00	0.61	0.00	0.48	0.00				
	Total	0.95	0.37	2.00	0.96	3.44	1.50	1.89	0.89				
Number of walnut trees (number farm ⁻¹)**	Bearing fruit	117.80	46.67	386.12	125.00	716.43	217.14	348.24	122.14				
	Not bearing fruit	102.00	0.00	115.63	0.00	142.14	0.00	116.18	0.00				
	Total	219.80	46.67	501.75	125.00	858.57	217.14	464.42	122.14				
Number of walnut trees (numberha ⁻¹)**	Bearing fruit	216.50	127.20	255.90	130.20	252.60	144.80	247.30	137.90				
	Not bearing fruit	252.50	0.00	235.50	0.00	234.20	0.00	241.50	0.00				
	Average	231.90	127.20	250.90	130.20	249.40	144.80	245.90	137.90				
Fruit-bearing walnut tree age (years)**	kg tree ⁻¹	5.52	20.56	6.75	35.00	6.79	26.71	6.20	26.05				
Walnut yield**	kg ha ⁻¹	9.03	22.97	8.89	25.52	8.66	20.79	8.79	22.30				
Total walnut production (kg farm ⁻¹)**	kg ha ⁻¹	1968.89	2897.89	2273.80	3322.92	2193.08	3009.53	2171.57	3060.46				
Walnut sales price (\$ kg ⁻¹)**	Total walnut production (kg farm ⁻¹)**	1063.20	1072.22	3433.44	3190.00	6206.43	4514.29	3061.91	2723.81				
	Walnut sales price (\$ kg ⁻¹)**	3.35	3.38	3.90	3.31	4.09	3.87	3.70	3.24				
How walnuts are used (kg farm ⁻¹)**	Family consumption	24.60	72.22	51.26	180.00	67.21	118.57	43.20	113.33				
	Given to workers	0.00	0.00	0.00	0.00	7.14	0.00	1.82	0.00				
	Tenant/shareholder share	0.00	0.00	3.12	0.00	0.00	0.00	0.91	0.00				
	Sold	1038.60	1000.00	3379.06	3010.00	6132.07	4395.71	3015.98	2610.48				
	Total	1063.20	1072.22	3433.44	3190.00	6206.43	4514.29	3061.91	2723.81				

*Total exceeds 100.00% because more than one answer was given

**Shows the share of walnut growing enterprises

Table 4 Walnut production problems and support in the surveyed enterprises

Problems encountered in walnut production*	Business groups											
	Group 1 (26)			Group 2 (18)			Group 3 (15)			Business average (59)		
	Frequency	%		Frequency	%		Frequency	%		Frequency	%	
Not being able to find workers during harvest	8	30.77		5	27.78		6	40.00		19		32.20
Wild animal damage	16	61.54		9	50.00		12	80.00		37		62.71
Diseases and pests	22	84.62		16	88.89		10	66.67		48		81.36
Sapling quality	13	50.00		8	44.44		9	60.00		30		50.85
Low selling price	2	7.69		1	5.56		0	0.00		3		5.08
Climate (frost)	22	84.62		9	50.00		10	66.67		41		69.49
Water deficiency	15	57.69		10	55.56		11	73.33		36		61.02
Lack of organization	1	3.85		4	22.22		2	13.33		7		11.86
Benefiting from support for walnuts	26	100.00		18	100.00		15	100.00		59		100.00
No	0	0.00		0	0.00		0	0.00		0		0.00
Total	26	100.00		18	100.00		15	100.00		59		100.00
Supports used for walnuts*	1	3.85		2	11.11		2	13.33		5		8.47
Diesel-fertilizer	22	84.62		18	100.00		14	93.33		53		89.83
Certified sapling	13	50.00		11	61.11		11	73.33		35		66.04
<i>Project**</i>	8	30.77		8	44.44		8	53.33		24		40.68

*Total exceeds 100.00% because more than one answer was given

**Tokat Develops with Walnuts” Project

maintenance works, labor and traction power costs. In the establishment period of walnut orchards, the maintenance period starts after the first year (Ketenci and Bayramoğlu 2020).

Variable costs are defined as costs that arise depending on production and vary according to the production level (Rehber and Çetin 1998). Variable costs in walnut production in the research area include the costs incurred for soil preparation (deep plowing, doubling, marking the planting place and opening the sapling hole), inputs (fertilizer, pesticide, water, lath, wire, etc.) and maintenance works (labor for input use, pruning, etc.).

During the establishment period, the highest costs are incurred in the first year, while the costs decrease in the following years. When the cost elements are analyzed, it is seen that input and maintenance costs constitute the highest item. Approximately half of the costs incurred during the establishment period were realized in the first year and the rest in the last 4 years. As a result of the calculations made, it is seen that the total of the establishment costs incurred in

‘Chandler’ variety (\$ 15,522.85 ha⁻¹) is higher than the local variety walnut (\$ 11,470.95 ha⁻¹). This is due to the fact that the number of seedlings used in the cultivation of ‘Chandler’ variety is higher, and therefore the input and labor costs used are higher than the other variety. As a result, the share of amortization of facility costs was also calculated to be higher in ‘Chandler’ variety walnut production.

During the production period of walnut orchards, variable costs consist of maintenance and harvesting operations. Maintenance operations include intermediate plowing, fertilization, spraying, hoeing, irrigation and pruning (Ketenci and Bayramoğlu 2020).

Cost elements related to the walnut production period in the analyzed enterprises are given in Table 6.

In walnut cultivation at the productive stage, a number of costs are incurred for soil preparation, input and maintenance works, harvesting and marketing activities. As in the establishment period, the total variable costs incurred for ‘Chandler’ walnut variety (\$ 1387.19 ha⁻¹) is higher than the costs incurred for local walnut variety (\$ 918.60 ha⁻¹) in

Table 5 Walnut planting period cost (\$ ha⁻¹)

Cost elements		Walnut type grown					
		‘Chandler’ (55)			Domestic (21)		
		Value	%*	**	Value	%*	**
Soil preparation	Deep version	108.35	0.89	0.70	50.75	0.60	0.44
	Doubling	80.38	0.66	0.52	53.19	0.63	0.46
	Planting location marking	56.37	0.46	0.36	84.56	1.00	0.74
	Pitting	67.65	0.56	0.44	101.47	1.20	0.88
	Total (1)	312.75	2.57	2.01	289.98	3.43	2.53
Input and maintenance	Sapling + planting	882.25	7.25	5.68	544.01	6.43	4.74
	Fertilizer + fertilization	315.78	2.59	2.03	184.08	2.18	1.60
	Water + irrigation	314.81	2.59	2.03	127.08	1.50	1.11
	Medicine + disinfestation	65.62	0.54	0.42	47.26	0.56	0.41
	Pruning	174.62	1.43	1.12	31.49	0.37	0.27
	Support bar	1082.38	8.89	6.97	631.39	7.47	5.50
	Wire fence	2931.44	24.08	18.8	2367.70	2.00	20.64
	Total (2)	5766.91	47.38	37.15	3933.01	46.52	34.29
3—Facility period 1st year cost total (3 = 1 + 2)		6079.66	49.95	3917	4222.99	49.95	36.81
4—Total facility period 2nd year cost		725.33	5.96	4.67	503.81	5.96	4.39
5—Total facility period 3rd year cost		1160.51	9.53	7.48	806.10	9.53	7.03
6—Facility period 4th year cost total		1885.84	15.49	12.15	1309.93	15.49	11.42
7—Total facility period 5th year cost		2321.04	19.07	14.95	1612.21	19.07	14.05
8—Total variable cost (8 = 3 + 4 + 5 + 6 + 7)		12,172.38	100.00	78.42	8455.04	100.00	73.71
9—General administration expense (9 = 8 × 0.03)		365.17	10.90	2.35	253.65	8.41	2.21
10—Bare land value interest (5%)		2254.95	67.30	14.53	2254.95	74.77	19.6
11—Current year interest on investment (6%) (11 = 8 × 0.06)		730.34	21.80	4.70	507.30	16.82	4.42
12—Total fixed cost (12 = 9 + 10 + 11)		3350.47	100.00	21.58	3015.91	100.00	26.29
13—Total facility cost (13 = 8 + 12)		15,522.85	—	100.00	11,470.95	—	100.00
14—Economic life (years)		80			80		
15—Facility expenses depreciation share (15 = 13/14)		194.04			143.39		

*Shows the rate within its own group

**Shows the rate within Total

the production period. Fertilizer+ fertilization and water+ irrigation expenses have the highest share in total variable costs in both walnut cultivars.

Total walnut production cost per ha was calculated as \$4653.94 for ‘Chandler’ variety and \$3918.04 for local variety. The share of fixed costs in total production cost is 70.19% for ‘Chandler’ variety and 76.55% for local variety. The rest consists of total variable costs. In the study conducted by Ketenci and Bayramoğlu (2020), it was calculated that the share of fixed costs in the production period cost of a walnut orchard in Kaman district of Kırşehir province was 52.82%. In the study conducted by Uzun (2006), the share of fixed costs in total production cost was calculated as 21.48%.

Data on the profitability of walnut cultivation in the research region are given in Table 7. The gross production value obtained per ha in the enterprises was calculated as \$8034.81 for ‘Chandler’ walnut variety and \$9915.89 for local walnut variety. Although ‘Chandler’ walnuts are sold at a higher price (\$3.70 kg⁻¹) compared to the other, they have a lower gross production value due to their higher production costs.

The cost of 1 kg of walnut was calculated as \$2.14 for the ‘Chandler’ variety and \$1.28 for the local variety. The most important factor in this is the high production costs and low yield level in ‘Chandler’ walnut cultivation.

As the years progress, product costs will decrease as a result of the increase in yield levels in ‘Chandler’ walnut cultivation and the proportional decrease in production costs. Gross and net profits per unit area (ha) were \$6647.62 and \$3381.37 for the ‘Chandler’ variety and \$8997.29 and \$5997.85 for the local variety, respectively.

The proportional profit was \$1.73 for ‘Chandler’ walnut and \$2.53 for the local variety. This means that for an investment of \$1 per kg in walnut cultivation, \$1.73 is earned in ‘Chandler’ walnut cultivation and \$2.53 in local walnut cultivation.

In full cost analysis; along with the actual cost elements, there are many external cost elements such as depreciation, interest on investments and expenses, rent provisions and farmer family labor provisions. In reality, producers do not incur most of these cost elements (fixed costs and some of the variable costs), but they appear on paper (Altıntaş and Karkacier 2002). From this point of view, producers’ earn-

Table 6 Walnut production period cost (\$ha⁻¹)

Cost elements		Walnut type grown					
		‘Chandler’ (55)			Domestic (21)		
		Value	%*	%**	Value	%*	%**
Soil preparation	Bottom anchor	118.3	8.53	2.54	67.66	7.37	1.73
	Intermediate version	37.00	2.67	0.80	70.93	7.72	1.81
	Total (1)	155.33	11.20	3.34	138.59	15.09	3.54
Input and maintenance works	Fertilizer+ fertilization	510.92	36.83	10.98	245.44	26.72	6.26
	Pruning	71.00	5.12	1.53	41.99	4.57	1.07
	Water+ irrigation	258.94	18.67	5.56	169.44	18.45	4.32
	Medicine+ disinfestation	91.68	6.61	1.97	32.94	3.59	0.84
	Total (2)	932.53	67.22	20.04	489.81	53.32	1.50
Harvest and marketing	Harvest+ whisk	126.27	9.10	2.71	191.07	20.80	4.88
	Dehulling	34.13	2.46	0.73	2.16	0.24	0.06
	Drying	27.84	2.01	0.60	18.07	1.97	0.46
	Transport	18.42	1.33	0.40	18.16	1.98	0.46
	Rope, sack, etc.	14.21	1.02	0.31	8.73	0.95	0.22
	Total (3)	220.86	15.92	4.75	238.20	25.93	6.08
4—General total (4= 1+ 2+ 3)		1308.72	94.34	2.12	866.60	94.34	22.12
5—Revolving fund interest (5= 4×0.06)		78.52	5.66	1.69	52.00	5.66	1.33
6—Total variable cost (6= 4+ 5)		1387.19	100.00	29.81	918.60	100.00	23.45
7—General administration expense (7= 15×0.03)		41.62	1.27	0.89	2.56	0.92	0.70
8—Bare land value interest (5%)		2254.95	69.03	48.45	2254.95	75.18	57.55
9—Facility expenses depreciation share		194.04	5.94	4.17	143.38	4.78	3.66
10—Facility capital interest (5%)		776.14	2376	16.68	573.55	19.12	14.64
11—Total fixed cost (11= 7+ 8+ 9+ 10)		3266.75	100.00	70.19	2999.44	100.00	76.55
12—Total production cost (12= 6+ 11)		4653.94	–	100.00	3918.04	–	100.00

*Shows the rate within its own group

**Shows the rate within ‘Total’

Table 7 Profitability of walnut production

	Cultivated variety of walnut	
	'Chandler' (55)	Domestic (21)
1—Total variable cost (\$ ha ⁻¹)	1387.19	918.60
2—Total fixed cost (\$ ha ⁻¹)	3266.75	2999.44
3—Total production cost (\$ ha ⁻¹) (3 = 1 + 2)	4653.44	3918.04
4—Product yield (kg ha ⁻¹)	2171.57	3060.46
5—Product sale price (\$ kg ⁻¹)	3.70	3.24
6—Gross value of production (\$ ha ⁻¹) (6 = 4 × 5)	8034.81	9915.89
7—Product cost (\$ kg ⁻¹) (7 = 3/4)	2.14	1.28
8—Gross profit (\$ ha ⁻¹) (8 = 6–1)	6647.62	8997.29
9—Net profit (\$ ha ⁻¹) (9 = 6–3)	3381.37	5997.85
10—Proportional profit (\$ kg ⁻¹) (10 = 5/7)	1.73	2.53

ings are higher in reality. As a result, both walnut varieties are profitable production activities.

Conclusions and Recommendations

In this study, which examined the enterprises producing 'Niksar Walnut' which has a geographical indication certificate and has a nationwide reputation, it was revealed that production is profitable. Walnut cultivation is becoming widespread every year in the research region. In addition to the fact that production is profitable and the region is very suitable for walnut cultivation, the projects implemented for the expansion of cultivation have a great contribution to this. Although there are some problems in walnut cultivation, there is no problem in the marketing of the product.

In order for walnut cultivation to become more widespread and its economic contribution to be higher in the research region, some studies are needed.

First of all, the most suitable areas for walnut cultivation should be determined by examining the land use capabilities of the region. These areas should be evaluated in the best way in terms of geographical and climatic advantages, variety advantages and marketing advantages. In this context, the flavor advantages of local varieties and the demand for local varieties especially in big cities should not be ignored.

Efficiency increasing studies should be emphasized in terms of varieties. Low-yielding walnut trees or those that have completed their economic life should be replaced with high-yielding varieties. All kinds of support should be provided to producers for this. Especially, the new closed gardens to be established should be created by selecting high-yielding varieties suitable for the region's conditions.

More work and effort is required to utilize the opportunities for organic walnut cultivation in the region. In this way,

the products to be obtained can be sold at higher prices in new markets.

Walnut cultivation in the region should be encouraged to take a professional and specialized form through various support mechanisms. Young farmers should be prioritized in these support mechanisms for the sustainability of agriculture.

The walnut produced has no marketing problems and is a highly profitable production line. However, with new promotion or advertising activities to be carried out in print and visual media for the product, 'Niksar Walnut' should become a local brand and its market demand should be further increased. For this, a variety of activities should be utilized.

It is a fact that walnut farmers in the research region are generally elderly and the number of individuals in the family is low. In this context, training activities on walnut cultivation (new garden establishment, production techniques, organization, marketing, etc.) should be organized for producers. Information sources such as universities, provincial/district directorates of agriculture, development agencies, cooperatives, private consultants, etc., should be utilized in the region. National and international projects should be realized in this regard.

Conflict of interest H.S. Gülse Bal declares that she has no competing interests.

References

- Aksoy A, Kaymak HÇ (2021) Competitiveness analysis of walnut sector: seven leading countries example. *Atatürk Univ J Agric Fac* 52(2):139–147. <https://doi.org/10.17097/ataunizfd.773270>
- Altıntaş A and Karkacier O (2002) Physical Production Inputs and Costs of Peach (Tokat-Kazova Region). *Gaziosmanpaşa University Journal of Agriculture Faculty*, 19(1):9–21. <https://dergipark.org.tr/tr/pub/gopzfd/issue/7348/9613>
- Anonymous (2023a) Nut Fruits. <https://data.tuik.gov.tr/Kategori/GetKategori?p=tarim-111&dil=1>. Accessed 28 Nov 2023
- Anonymous (2023b) Turkish Statistical Institute. <https://data.tuik.gov.tr/Bulten/Index?p=Bitkisel-Uretim-2.Tahmini-2023-49533>. Accessed 28 Nov 2023
- Anonymous (2023c) Fruits, nuts and beverage plants balance tables. <https://data.tuik.gov.tr/Kategori/GetKategori?p=tarim-111&dil=1>. Accessed 28 Nov 2023
- Anonymous (2023d) Niksar district agriculture and forestry directorate briefing file. Niksar Tokat
- Anonymous (2023e) Tokat chamber of commerce and industry. <https://niksartso.org.tr/icerik.php?id=64>. Accessed 28 Nov 2023
- Anonymous (2023f) Turkish Patent Institute. <https://ci.turkpatent.gov.tr/cografi-isaretler/detay/38047>. Accessed 28 Nov 2023
- Çiftçi K, Gökçe O (2006) A study on the socio-economic aspects and problems of walnut cultivation in İzmir and Manisa provinces. *Yüzyüncü Yıl Univ Fac Agric J Agric Sci* 16(1):7–17 (<https://dergipark.org.tr/tr/download/article-file/204849> (Access date: 24.03.2025))

- Gül M, Kart FM (2024) Cost and profitability of pear farms in Türkiye: the case of Korkuteli district of Antalya province. *Appl Fruit Sci* 66:2169–2177. <https://doi.org/10.1007/s10341-024-01186-6>
- Güvenç İ, Purlu G (2022) Walnut production and requirement projection in Turkey for the period of 2020–2045. *Kahramanmaraş Sütçü İmam Univ J Agric Nat* 25(1):57–65. <https://doi.org/10.18016/ksutarimdogu.vi.848460>
- Haskınacı Ş (2003) Walnut sector research. Istanbul Chamber of Commerce Publications <https://doi.org/10.30910/turkjans.448387>
- İnan İH (1998) Agricultural economics and management, 4th edn. Tekirdağ
- Kadakoğlu B, Bayav A, Karlı B (2022) Walnut production projection and competitiveness analysis in Turkey. *Fruit Sci* 9(1):8–15. <https://doi.org/10.51532/meyve.1125552>
- Karadaş K (2016) Calculation of wheat production costs in agricultural enterprises in Ağrı province. *Alinteri* 31:33–41 (<https://dergipark.org.tr/tr/download/article-file/267329> (Access date: 24.03.2025))
- Ketenci CK, Bayramoğlu Z (2018) Competition analysis of walnut production in Turkey. *Turkish J Agric Nat Sci* 5(3):339–347. <https://doi.org/10.30910/turkjans.448387>
- Ketenci CK, Bayramoğlu Z (2020) A research on investment analysis and determination of profitability of walnut cultivation in Kaman district of Kırşehir province. *Ordu Univ J Sci Technol* 10(1):11–22 (<https://dergipark.org.tr/tr/pub/ordubtd/issue/55660/702661> (Access date: 24.03.2025))
- Kilci M (2015) Walnut production and marketing structure of Niksar district of Tokat province. Gaziosmanpaşa University, Institute of Science, Tokat (Unpublished Master's Thesis)
- Kıral T, Kasnakoğlu H, Tathdil FF, Fidan H and Gündoğmuş E (1999) Cost Calculation Methodology and Database Guide for Agricultural Products. Agricultural Economics Research Institute, Publication No: 37, Ankara. <https://arastirma.tarimorman.gov.tr/tepge/Belgeler/Yay%C4%B1n%20Ar%C5%9Fivi/1997-2005%20Yay%C4%B1n%20Ar%C5%9Fivi/Yay%C4%B1nNo37.pdf>
- Özcan M (2022) Agricultural Products Markets. Agricultural Economics and Policy Development Institute, Ankara. <https://arastirma.tarimorman.gov.tr/tepge/Belgeler/PDF%20Tar%C4%B1m%20%C3%9Cr%C3%BCnleri%20Piyasalar%C4%B1/Birle%C5%9Ftirilmi%C5%9F%20T%C3%9CP%20Raporlar%C4%B1/Tar%C4%B1m%20%C3%9Cr%C3%BCnleri%20Piyasa%20Raporu%202022-Temmuz%20snp.pdf>. Accessed 24 Mar 2025
- Özçelik A, Sayılı M (1998) A research on the determination of peach production cost in Tokat central district. *J Coop* 121:5–21
- Rehber E, Çetin B (1998) Agricultural economics. Uludağ University Strengthening Foundation Publications No:134, VİPAŞ A.Ş. Publications No:10. Bursa
- Uzun ÖH (2006) Economic analysis of market oriented walnut farms in Kaman district of Kırşehir province. Ankara University, Institute of Science (Unpublished Master's Thesis, Ankara. <https://dergipark.org.tr/en/download/article-file/1178929> (Access date: 24.03.2025))

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.