RESEARCH ARTICLE

International Journal of Agriculture, Environment and Food Sciences 2023; 7(1): 49-61
DOI: https://doi.org/10.31015/jaefs.2023.1.6

The agricultural mechanization situation of agricultural enterprises involved in organic and conventional hazelnut cultivation in Türkiye

Onur Kahraman[1] • **Ebubekir Altuntaş**[2] • **Osman Gökdoğan**[3]

[1] Tokat Gaziosmanpaşa University, Institute of Science, Biosystem Engineering Department, Tokat, Türkiye
[2] Tokat Gaziosmanpaşa University, Agriculture Faculty, Biosystem Engineering Department, Tokat, Türkiye
[3] Isparta University of Applied Sciences, Agriculture Faculty, Agricultural Machinery and Technologies Engineering Department, Isparta, Türkiye

Citation: Kahraman, O., Altuntas, E., Gokdogan, O. (2023). The agricultural mechanization situation of agricultural enterprises involved in organic and conventional hazelnut cultivation in Turkiye. International Journal of Agriculture, Environment and Food Sciences, 7 (1), 49-61

Received: 28 October 2022
Revised: 01 December 2022
Accepted: 06 December 2022
Published Online: 12 February 2023

Correspondence: Ebubekir Altuntaş
E-mail: ebubekir.altuntas@gop.edu.tr

Abstract

The aim of the research is to examine and evaluate the agricultural mechanization status of organic and traditional hazelnut farming enterprises in Alaplı and Karadeniz Ereğli districts of Zonguldak province in Turkey. A survey was conducted with a total of 209 enterprises from 34 villages in 2 districts where hazelnut production is intense in the research. The survey study includes information about the land assets of the enterprises, tractor, agricultural-tool and machinery assets, and hazelnut production stages. In addition, mechanization applications in all agricultural processes from tillage to harvest in hazelnut production were examined and evaluated. It has been determined that 24 of the organic hazelnut production enterprises and 30 of the traditional hazelnut production enterprises have tractors and it has been determined that the tractor brand preferences of the enterprises vary independently from each other. Massey Ferguson and New Holland brands are mostly preferred. It has been determined that the vast majority of businesses prefer to use motorized hoeing machines. As a result, when organic hazelnut enterprises used traditional hazelnut production in previous years and gave up this production system, they reduced the use of tools and machinery. For this reason, it has been determined that there are fewer tools and machines in organic hazelnut producer enterprises compared to traditional hazelnut producer enterprises. While the tractor power (kW/ha) value per unit area processed in organic hazelnut producer enterprises was 1.344, this value was found as 6.320 kW/ha in traditional hazelnut producer enterprises. It is seen that traditional hazelnut producer enterprises are in a better situation in terms of mechanization level than organic hazelnut producer enterprises

Keywords: Hazelnut, Production, Organic hazelnut, Tractor, Mechanization Level

INTRODUCTION

Hazelnut (*Corylus avellana*) is a hard-shelled fruit belonging to the Betulaceae (Birch) family of the Fagales (Beechaceae) family and has over 25 species (Polat, 2014). Being the most cultivated product in the world following almond, the cultural varieties of hazelnut are being widely produced in Turkey, Italy, Georgia, Azerbaijan, USA and Spain (TMO, 2021). Hazelnut is a long-lived culture plant that grows in 36°41' northern latitudes around the world, has a unique climate need, in the form of a bush and can be grown up to 6-7 m (Sobutay, 2006; Doğanay, 2012).). In order to obtain efficient results in hazelnut production, the annual

average temperature should be between 13-16°C, and the temperature should not be less than -8°C or -10°C in winter months and should not exceed 36°C or 37°C in summer months (Ünsal, 2020).

A total of 18 hazelnut varieties are grown in Turkey. Among these, Tombul, Çakıldak, Foşa, Kara Hazelnut, Mincane, Palaz and Sivri are commercially important hazelnut varieties (Pelvan et al., 2012). The regions where hazelnut cultivation is carried out in Turkey are examined in two groups as old and new regions. The Eastern Black Sea Region, which is considered to be the more important region and includes the provinces of Artvin, Rize, Giresun, Ordu and Trabzon, is the first region. The hazelnut production area of this region was 7.3 million hectares in 2020. The second region is the provinces of Düzce, Sakarya, Zonguldak, Bartın, Kocaeli, Kastamonu and Sinop, known as the Central and Western Black Sea region. According to TUIK 2021 data, Ordu, Samsun, Düzce, Trabzon, Zonguldak, Kocaeli, Artvin, Giresun, Bartın, Rize provinces meet 82% of Turkey's hazelnut production (Öztürk and İslam, 2019; Anonymous, 2021a).

Hazelnut consumption has reached significant levels in the world and in Turkey, and every year people prefer cleaner, chemical-free, and pesticide-free products. For this reason, organic production has gained importance in hazelnut production and this type of cultivation is becoming increasingly common. There are important differences between organic and traditional (conventional) hazelnut cultivation. In the traditional (conventional) production method, enterprises can apply their preferred chemical fertilizers or pesticides to the soil and the plant. In organic hazelnut cultivation, animal manures, compost, and green manures are applied. In organic hazelnut cultivation, labour costs are less when compared to traditional hazelnut cultivation. The main purpose of organic hazelnut cultivation is to provide quality, low-cost and healthy production without harming nature and preserving the ecological balance.

Hazelnut cultivation includes agricultural practices such as soil preparation, planting, fertilization, spraying, harvesting and threshing. In hazelnut cultivation, about 50% of total production cost consists of collection costs of the harvested product. Hazelnut cultivation is generally carried out in very inclined areas in the Black Sea Region and mechanic harvesting is very difficult in the region. Despite ranking first in the world hazelnut production, pre-harvest and harvest mechanization applications are almost non-existent in Turkey. Such applications require labour-intensive human labour and this significantly increases production costs in Turkey. However, post-harvest mechanization applications are continuously improving (Yıldız, 2020).

In the literature, there are some studies on mechanization in hazelnut cultivation on a regional basis in Turkey. Alkan and Kılıç (2007) interviewed 151 enterprises in Samsun province and concluded that hazelnut cultivation is mostly carried out in the high-altitude regions of the province, but the desired yield cannot be obtained due to the training status of the enterprises and farmers and the structure of the land. They have further reported that organic hazelnut cultivation is the popular choice in the area. According to Beyhan and Sauk (2018), Turkey is at the forefront of hazelnut production in the world, but due to the slope of the hazelnut growing areas, Turkey is not suitable for machine harvesting. In the study conducted by Güney and Güner (2018), especially based on Ordu, Trabzon and Giresun provinces, it was stated that hand harvesting is common due to the sloping land structure of these provinces. Öztürk and İslam (2019) conducted a survey with hazelnut farms in 183 old (Eastern Black Sea) production areas and 93 new (Central and Western Black Sea) production areas in hazelnut agricultural lands in Turkey. In this study, they also explained that the mechanization situation in the old production areas was lower than the new production areas in terms of differences in agricultural mechanization, irrigation and similar issues between these two regions. Taylan and Durul (2019) concluded that Kocaeli province is unsuitable for mechanization in hazelnut farming. Yıldız (2020) drew attention to the difficulty of mechanization in hazelnut farming in Turkey. In addition, he concluded that the mechanization status of hazelnut in Turkey is lower than in other developed countries, especially in the Black Sea Region, due to the high slope of the soil and the scattered planting areas.

There is no comparative study in terms of mechanization between organic system and traditional cultivation in hazelnut cultivation in Turkey. For this purpose, considering its contribution to the literature, it is planned to examine the mechanization status in organic and traditional hazelnut cultivation. For this purpose, Zonguldak province, which is one of the provinces where organic hazelnut cultivation is important, has been considered as a research subject in this study. In the study, the mechanization levels of producers in traditional and organic hazelnut cultivation were compared.

MATERIALS AND METHODS

The data obtained through face-to-face interviews with the farmers formed the main material of the study. Black Sea Ereğli and Alaplı districts, where hazelnut production is intense in Zonguldak province, were determined as research areas. The sampling study of the research was carried out in two stages. The Black Sea Ereğli and Alaplı districts of Zonguldak province were determined as the districts with the highest hazelnut production and the mostly sloping rural settlements in these districts were taken into account in the study. Afterwards, the villages where the survey will be conducted were determined among these villages by *Purposeful Sampling Method*. The information obtained from the Provincial Directorate of Agriculture and Forestry, TUIK data, Chambers of Agriculture and Headmans were used to determine the

enterprises in the villages included in the sampling area.

Karadeniz Ereğli and Alaplı districts of Zonguldak province have been determined as the most intense hazelnut producers, and then the rural settlement areas of these districts have been defined. Organic hazelnut is being produced in 59 villages of Karadeniz Ereğli district and 47 villages of Alaplı district. Traditional hazelnut, on the other hand, is produced in 126 villages of Karadeniz Ereğli district and in 55 villages of Alaplı district. Villages with 4 or less producers have been removed from the long list leaving behind 22 villages producing organic hazelnut in Karadeniz Ereğli and 20 in Alaplı, and 91 villages producing traditional hazelnut in Karadeniz Ereğli district and 42 villages in Alaplı district. These villages have then been ranked with regards to number of producers and land size. Based on *Purposeful Sampling Method*, it has been decided to study 20% of these villages and the villages with the highest number of producers and area size have been determined. Hazelnut producers from 34 villages comprised the main mass of the study. 8 of these villages (Karadeniz Ereğli 4, Alaplı 4) did organic production and 26 villages (Karadeniz Ereğli 18, Alaplı 8) did traditional production. Based on hazelnut production area and using *Simple Random Sampling Method* (Altunışık et al., 2012), the sample volume has been determined as 209 with 95% confidence interval and 10% deviation from average. Based on districts and product method (organic-traditional), sample volume has been shared by Karadeniz Ereğli organic hazelnut cultivation (43), Karadeniz Ereğli traditional hazelnut cultivation (53), Alaplı organic hazelnut cultivation (63) and Alaplı traditional hazelnut cultivation (50).

The sample numbers to be studied were distributed proportionally to the villages and interviews were made with the enterprises determined through the random numbers table. Questionnaire forms were prepared for the purpose of the research and for businesses producing organic and traditional hazelnuts, and a survey was conducted considering the sample volume determined. For the study, an ethical committee report was received from Tokat Gaziosmanpasa University University Social and Human Sciences Ethics Committee. The data compiled by the survey study were transferred to digital media, evaluated and interpreted in Microsoft Excel program through frequency tables, average, minimum-maximum values and percentage distributions. In the study, the agricultural mechanization level was determined by taking into account the existing agricultural land and tractor numbers in Zonguldak province, Karadeniz Ereğli, Alaplı and other districts throughout Turkey. In addition, the mechanization levels of organic and traditional hazelnut producer enterprises were also tried to be determined.

The condition of the tractor park of a commercial enterprise by years and its relationship with agricultural machinery is the most important indicator to reveal the agricultural mechanization level of the region. Tractors, which have an important place in agricultural mechanization, constitute an important part of mechanization investments. In order to have a good idea about the agricultural mechanization level, the tractor power per unit area (kW/ha), the number of tractors per hectare (tractor /1000 ha), the worked area per one tractor (ha/tractor) values should be determined as the fundamental criteria. Tractor power per hectare (kW/ha) is one of the tractor-related criteria and is the most widely used indicator in the world to explain the current situation and to obtain comparative results (Sümer et al. 2003; Özgüven et al. 2010). As the tractor power grouping, generally 1-5 HP, >5 HP power ranges for single axle tractors, tractors with 1-10 HP, 11-24 HP, 25-34 HP, 35-50 HP, 51-70 HP and >70 HP are taken into account for double-axle tractors, respectively. In determining the tractor power per unit area on the basis of districts for both Zonguldak province and traditional and organic hazelnut producer businesses, the average power value of each tractor power group is multiplied by the number of tractors for the desired year and the unit is proportioned to the processed area (Aybek et al., 2021).

RESULTS AND DISCUSSION

Socio-economic characteristics of the enterprises

Table 1 lists the age distributions and education levels of traditional and organic hazelnut cultivation enterprise owners. The gender distribution of the 209 operators included in the survey was examined and it was determined that 88.68% of the organic production enterpris-

Table 1. Age distributions and education levels of traditional and organic hazelnut cultivation enterprise owners

	Traditional enterprises		Organic enterprises		Traditional enterprises			Organic enterprises	
Age distribution	**Freq.**	**Rate %)**	**Freq.**	**Rate (%)**	**Education level**	**Freq.**	**Rate (%)**	**Freq.**	**Rate (%)**
20-30	1	0.97	-	0.00	Literate	11	10.68	17	16.04
31-40	5	4.85	2	1.89	Primary	34	33.01	59	55.66
41-50	20	19.42	9	8.49	Secondary	36	34.95	23	21.70
51-60	36	34.95	35	33.02	High School	22	21.36	7	6.60
>61	41	39.81	60	56.60	University-Postgrad.	-	0.00	-	0.00
Total	103	100	106	100	Total	103	100	106	100

es were male and 11.32% were female. In the survey of traditional businesses, it was determined that 87.38% of them were male and 12.62% were female.

As Table 1 indicates, average age of traditional-production enterprises is 56 and average age of organic-production enterprises is 58. It was noted that the youngest operator among the traditional production enterprises participating in the survey was 33 years old and the oldest operator was 81 years old. The rate of literate enterprises in organic production enterprises is 16.04%. This rate was recorded as 10.68% in traditional production operators in terms of educational status. The educational status of the operators was examined. According to this analysis, while the rate of operators who state that they are primary school graduates and engage in organic production is 55.66%, this rate is 33.01% for those who make traditional production. The rate of those who state that they are secondary school graduates in traditional production enterprises is 34.95%. The distribution of secondary school graduates in organic production enterprises is 21.70%.

and are engaged in farming. It is seen from the survey results that 16.07% of the operators work in various factories. Most of the surveyed enterprises are retired and have been producing hazelnut for many years.

Land assets of enterprises

The area where hazelnut is grown belonging to the enterprises producing traditional and organic hazelnut is given in Table 2 in terms of 'da'. Accordingly, most of the enterprises engaged in traditional and organic production stated that the lands belonged to them (90.56% and 97.22%, respectively). It was determined that the remaining 2.56% of the land in 6 731 da area was rented and 0.22% of the land was common use. It has been determined that some of the enterprises, where the cultivated lands are rented and shared, produce hazelnuts in rental lands in addition to their own lands.

In Table 3, the sizes of the hazelnut production lands included in the survey are given. In the survey analysis conducted with 209 enterprises in the Black Sea Ereğli and Alaplı districts, a survey was conducted with the enterprises with a land of 15 da or more, according to the total

Table 2. Hazelnut cultivation areas (da) of enterprises engaged in traditional and organic hazelnut production

	Traditional enterprises		Organic enterprises	
Enterprise area	**Processed area (da)**	**Rate (%)**	**Processed area (da)**	**Rate (%)**
Self-owned	1889.771	90.56	6544	97.22
Rented	174.875	8.38	172	2.56
Co-owned	15	0.72	15	0.22
Other	7.21	0.34	-	-
Total	2086.856	100	6731	100

Table 3. Land sizes of hazelnut producers that participated in the survey

Enterprise size (da)	**Frequency**	**Rate (%)**
15-20 da	132	63.16
21-30 da	49	23.44
31-40 da	16	7.66
41-50 da	4	1.91
^{3} 51 da	8	3.83
Total	209	100

Each one of the 209 business owners participating in the survey was asked "*Do you always reside in the village*?". According to the answers received from the enterprises, 196 (93.78%) of the 209 enterprises were permanently residing in the village, and 13 (6.22%) were not residing in the village. 37.73% of the businesses producing organic and traditional hazelnuts are operated by people retired from different fields of business. Although there is no various job distributions in the enterprises, it has been observed that 16% of the enterprises work in the private sector. 19% of the enterprises surveyed stated that they do not work in any job, 11.20% of the enterprises stated that they are coffee shop operators, bakery operators

land assets of the enterprises. There are 132 enterprises with land in the range of 15-20 da. The size of the land of the enterprises varies. Among the enterprises participating in the survey, the land size of the enterprise with the most land is 70 da. Looking at the other product patterns of organic hazelnut producers, in the Black Sea Ereğli and Alaplı districts, the walnut production as a by-product of the enterprises engaged in organic farming is 85.30%, and 56.50% in traditional producers.

Hazelnut production experiences of enterprises

Enterprises producing organic hazelnuts were asked how many years they had been producing this type of

production. The results are given in Table 4. Accordingly, it has been determined that 42% of the organic producer enterprises have between 16 and 20 years of experience. Again, enterprises producing organic hazelnuts were asked the question "*For how many years did you produce traditional hazelnut*?" According to the answers received, 41% of the enterprises answered that they produce traditional hazelnut in the range of 21-30 years.

Table 5 provides the experience durations of traditional hazelnut production enterprises. As the Table 5 indicates, 33.98% of the enterprises have been engaged in traditional production for 21 to 30 years.

The enterprises engaged in traditional production have been asked about the reasons for preferring traditional production. Enterprise owners stated that traditional production is more effective in combating diseases and pests and they prefer traditional production because it is a method they know better. The same enterprises were asked, "*Do you think there is a difference between organic and traditional production systems in terms of tool-machine use?*". Traditional production enterprises stated that the labour costs increased due to the limitation of the use of agricultural tools and machinery in organic production, and therefore they did not switch to organic production. In addition, the fact that organic production requires less labour and the tool-machine costs of traditional production are increasing is an important difference between the organic and traditional production systems. Although some of the traditional production enterprises are aware that chemicals can harm the soil and beings, they do not prefer organic production because there is no limitation in the use of tools and machinery. At the same time, they do not give up on traditional production because they have adopted an understanding of agriculture that has been going on for years.

Pesticides and fertilizers used by enterprises

In order to determine whether the fertilizers and pesticides they use are used consciously, the question "*how often do they have an analysis done on the soil where they grow hazelnut*" was posed to the enterprises. It has been observed that 67.92% of the enterprises producing organic hazelnuts have their soils analysed, although not at regular intervals, and 26.42% of them have their soil analysed at regular intervals. However, a significant proportion of the enterprises producing traditional hazelnut have never had a soil analysis and this rate corresponds to 51 enterprises out of 103 enterprises, that is, almost half of the enterprises. Table 6 shows the fertilizers and pesticides are used by organic and traditional hazelnut cultivation enterprises.

The pesticides and fertilizers used by traditional hazelnut producers were examined. It was taken into account that more than one answer was given to the questions asked.

Table 4. Hazelnut production experiences of organic production enterprises

Traditional production experience	Frequency	Rate (%)	Organic hazelnut production experience	Frequency	Rate (%)
1-10 years	3	2.83	1-5 years	2	1.89
11-20 years	31	29.25	6-10 years	41	38.68
21-30 years	43	40.57	11-15 years	19	17.92
31-40 years	22	20.75	16-20 years	44	41.51
41-50 years	5	4.72	-	-	-
51- + years	2	1.89	-	-	-
Total	106	100	Total	106	100

Table 5. Hazelnut production experiences of traditional production enterprises

Traditional production length	Frequency	Rate (%)
1-10 years	2	1.94
11-20 years	10	9.71
21-30 years	35	33.98
31-40 years	26	25.24
41-50 years	21	20.39
51-60 years	8	7.77
61- > years	1	0.97
Total	103	100

Accordingly, 58 enterprises among 103 traditional production enterprises used insecticides to combat pests in hazelnut production. Enterprises were asked how often they use insecticide. According to the answers received, it was determined that the ratio of the insecticide used varied between 50 cc/100 litres of water and 100 cc/100 litres of water. The enterprises also stated that they increased the amount of pesticides according to the size of the land. Apart from this, it has been determined that the rate of fungicide used in pest control varies between 250 cc/100 litres of water and 600 cc/100 litres of water.

Soils in the Black Sea region are generally poor in terms of nitrogen and phosphorus. Therefore, enterprises engaged in organic production frequently use farmyard manure, which is one of the organic fertilizers, in order to meet this need of soils (Doğanay, 2012). The enterprises participating in the survey gave more than one answer to the questions asked about the fertilizer and pesticide types. According to the information obtained from the survey data, all of the enterprises use organic solid fertilizer and organic foliar fertilizer. The amount of fertilizer used by enterprises using organic solid fertilizers varies between 3 kg/pit and 5 kg/pit. Enterprises using organic foliar fertilizer are using it in a ratio of 200 cc/100 litres water and 250 cc/100 litres water. 7 out of

Table 6. Distribution of the fertilizers and pesticides are used by organic and traditional hazelnut cultivation enterprises

	Traditional enterprises			Organic enterprises	
Fertilizer	**Frequency**	**Rate (%)**	**Fertilizer**	**Frequency**	**Rate (%)**
Farm manure	32	17.68	Organic solid fertilizer	98	46.23
Base fertilizer (artificial)	67	37.02	Organic foliar fertilizer	90	42.45
Top fertilizer (artificial)	63	34.81	Farm manure (cattle manure)	24	11.32
Lime	19	10.50	-	-	-
Total	181	100	Total	212	100
Pesticide	Frequency	Rate (%)	Pesticide	Frequency	Rate (%)
Insecticide	58	31.02	Burgundy slurry	27	60
Fungicide	22	11.76	Sulphur	11	24.44
Herbicide	79	42.25	Lime	7	15.56
Burgundy slurry	18	9.63	-	-	-
Sulphur	10	5.35	-	-	-
Total	187	100	Total	45	100

Table 7. Reasons for enterprises to prefer either organic or traditional production

What are the reasons for your organic production preference?	**Frequency**	**Rate**	**What are the reasons for your traditional production preference?**	**Frequency**	**Rate**
Marketed at a higher price	40	22.10	Marketed at a higher price	18	8.91
Easier to find buyers	25	13.81	Easier to find buyers	13	6.44
Not harmful to the environment	33	18.23	Not harmful to the environment	9	4.46
Input costs are lower	11	6.08	Input costs are lower	20	9.90
Requires less labour	5	2.76	Requires less labour	43	21.29
More effective control of diseases and pests	21	11.60	More effective control of diseases and pests	29	14.63
Higher yield	27	14.92	Higher yield	17	8.42
A method I know better	13	7.18	A method I know better	49	24.26
Other	6	3.31	Other	4	1.98
Total	181	100	Total	202	100

Table 8. Differences between organic and traditional hazelnut production

What are the differences between organic and traditional production?	Frequency	Rate (%)
Organic production is a more labour-intensive (labour-based) system	45	13.76
In organic production, I produce with fewer tools and machines	30	9.17
Since I produce organically, my tool-machine cost decreases	23	7.03
Since there is a limitation on the use of tools and machinery in organic production, my labour costs increase	36	11.01
Traditional production is a more labour-intensive (labour-based) system	20	6.12
The use of tools and machines in traditional production can harm the soil and beings	41	12.54
The fact that there is no limitation in the use of tools and machines in traditional production makes my production easier	63	19.27
Being able to use tools and machines as I want in traditional production is one of the reasons why I did not switch to organic agriculture	56	17.13
Other	13	3.98
Total	327	100

Table 9. The number and brands of tractors belonging to enterprises engaged in traditional and organic production

Tractor brand	Traditional enterprises		Organic enterprises		
	Number (pcs)	Rate (%)	Tractor brand	Number (pcs)	Rate (%)
Massey Ferguson	8	26.67	New Holland	8	33.33
New Holland	6	20.00	Erkunt	2	8.33
Tümosan	1	3.33	Massey Ferguson	5	20.83
John Deere	4	13.33	Fiat	3	12.50
Başak	2	6.67	Ford	2	8.33
Erkunt	3	10.00	International	2	8.33
Deutz	2	6.67	Tümosan	1	4.17
Case IH	3	10.00	John Deere	1	4.17
Fiat	1	3.33	-	-	-
Total	30	100	Total	24	100

Table 10. Tractor powers of enterprises engaged in traditional and organic production

Power groups of tractors	Traditional enterprises		Organic enterprises	
	Number of tractors	Rate (%)	Number of tractors	Rate (%)
1-10 HP	-	-	-	-
11-24 HP	-	-	-	-
25-34 HP	2	6.67	2	8.33
35-50 HP	6	20.00	13	54.17
51-70 HP	16	53.33	6	25.00
71-100 HP	6	20.00	3	12.50
Total	30	100	24	100

106 organic hazelnut production enterprises stated that they use lime for pest control in hazelnut production, 27 enterprises use burgundy slurry and 11 enterprises use sulphur. It has been determined that 24 enterprises engaged in organic production use farm manure and this is generally cattle manure.

The enterprises that participated in the survey and preferred organic (106) and traditional (103) production methods were asked the question *'which method of control they use against weeds in hazelnut orchards'*. It was noted that 62.20% of the enterprises scythe weeds and 37.80% of them use weed control in the fight against weeds instead of scythes. The results obtained show that all of the organic production enterprises apply scythe. It was determined that 27 of 130 enterprises preferred the traditional production method, but they used scythe in-

Table 11. Tractor age distributions of enterprises engaged in traditional and organic production

Age distribution of tractors	Traditional enterprises		Organic enterprises	
	Number of tractors (pcs)	Ratio among all tractors (%)	Number of tractors (pcs)	Ratio among all tractors (%)
5-10 years	3	10	8	33.33
11-15 years	8	26.67	2	8.33
16-20 years	2	6.67	5	20.83
21-25 years	4	13.33	1	4.17
> 25 years	13	43.33	8	33.33
Total	30	100	24	100

Table 12. Agricultural tools and machines used in enterprises engaged in traditional and organic production

	Traditional enterprises		Organic enterprises	
Tools and machines	Number (pcs)	Rate (%)	Number (pcs)	Rate (%)
Motorized hoeing machine	61	19.00	82	32.03
Handsaw	109	33.96	112	43.75
Motorized garden sprayer	96	29.91	36	14.06
Motorized back sprayer	27	8.41	10	3.91
Trailer	14	4.36	9	3.52
Portable chain-saw	10	3.12	7	2.73
Pull-type hazelnut harvester	2	0.62	-	-
Disc plough	1	0.31	-	-
Harrow	1	0.31	-	-
Total	321	100	256	100

stead of herbicide in weed control. The majority of the enterprises stated that they use motor scythes in the fight against weeds. On the other hand, 79 enterprises use herbicides to dry and destroy weeds. Although the use of this pesticide varies according to the size of the land, it has been determined that they are used in the range of 200 cc/100 litres of water and 500 cc/100 litres of water. Enterprises also use burgundy slurry. They stated that they preferred 1% and 2% levels in the selection of burgundy slurry. As another pesticide, sulphur is also used in hazelnut to prevent disease. The enterprises stated that the sulphur usage rate varies between 150 cc and 200 cc/100 litres of water.

According to the results obtained from the surveys, some enterprises use only chemical fertilizers and some only apply chemical pesticides. According to the survey data, 17.68% of the enterprises use farm manure. The usage rates of fertilizers vary between 1 kg/pit and 8 kg/pit. In enterprises using base fertilizer, this rate varies between 2 kg/pit – 6 kg/pit. Since the soil of the Black Sea Region is not very sufficient in terms of nitrogen, enterprises use nitrogen fertilizers a lot. 63 of the enterprises participating in the survey stated that they use top fertilizer. It was determined that the fertilizer was applied in varying amounts between 2 kg/pit - 5 kg/pit. According to the answers given by the enterprises to the questionnaires, it has been revealed that they add lime to the hazelnuts in certain years, if not every year, for fertilization purposes. The amount of lime used in hazelnut production varies between 1.5 kg/pit - 7 kg/pit.

In the survey study, 8 enterprises out of 106 organic production enterprises stated that they do not use organic fertilizers and 36 enterprises stated that they do not apply pesticides. Likewise, it was determined that 11 enterprises among the enterprises producing traditional hazelnut do not fertilize and 6 enterprises do not apply pesticides. According to the answers received from the enterprises, it is also known that the reasons why the enterprises do not spray and fertilize are due to economic reasons.

It is known that there are certain differences between the two production patterns known as organic and traditional. In order to identify these differences, businesses were asked "*why they prefer organic or traditional production*" and "*what are the differences between the two production patterns*". The answers obtained from the enterprises are given in Table 7 and Table 8. According to Table 7, the first reason why 22.10% of organic production enterprises prefer this type of production is that the product is marketed at a higher price. Another reason that is effective in the preference of businesses is that it is not harmful to the environment (18.23%). On the other hand, 24.26% of the enterprises engaged in traditional production, that is, the majority, argued that their preference for traditional production is due to the fact that it is a method they know better. 14.63% of businesses think that traditional production is more effective in combating diseases and pests. At the same time, according to the survey results, considering the use of machinery and tools, enterprises stated that less labour is required (21.29%) due to the

lack of limitations in the use of tools and machinery and the use of pesticides and fertilizers in the fight against pests.

Enterprises engaged in organic and traditional production were asked "What are the differences between organic production and traditional production?" In the answers given, the idea that there is more intensive labour in production in organic production enterprises is noteworthy, while the other important difference is the thought that traditional production harms the soil and soil creatures with a ratio of 12.54% compared to organic enterprises. Traditional production enterprises, on the other hand, think that the most important one among the two production methods is the lack of tool-machine limitation (19.27%). At the same time, enterprises stated that they did not switch to organic agriculture because they used tools and machines as they wished (17.13%).

Mechanization status of hazelnut-producing enterprises

In order to determine the mechanization status of all 209 enterprises included in the study, the number of tractors belonging to the enterprises and the tools-machines they use were determined (Table 9). There are a total of 30 enterprises that have tractors in traditional production enterprises. It is striking that the tractor preferences of the enterprises are very different from each other. Majority of the enterprises prefer Massey Ferguson and New Holland brands. In the brand analysis, it was determined that the enterprises producing organic hazelnuts preferred the New Holland brand at a significant rate (33.33%), the tractors used by the enterprises were garden type tractors, and the tractor preferences of the enterprises were very different from each other. It has been determined that a total of 24 enterprises have tractors. On the basis of enterprises, the rate of ownership of tractors in enterprises engaged in traditional production was 29.13%, while the rate of ownership of tractors in enterprises engaged in organic production was determined as 22.64%.

Horsepower of tractors belonging to enterprises engaged in traditional and organic production is given in Table 10. From the information given, it is seen that tractors with power distribution in the range of 51-70 HP are mostly preferred among the tractor preferences of traditional production companies (53.33%). It is known that enterprises engaged in traditional production prefer high-powered tractors for spraying, fertilizing and transporting. These tractors are generally garden tractors. Enterprises participating in the research stated that they prefer vehicles that can manoeuvre easily in the garden due to the terrain structure. It has been noted that 54.17% of the tractors used by organic production enterprises are in the 35-50 HP power range. 25% of the enterprises have tractors with 51-70 HP, 12.50% with 71-100 HP and 8.33% with 25-34 HP power ranges. Garden type tractors are mostly used in Alaplı and Karadeniz Ereğli districts due to the slope of the hazelnut fields and the frequent planting of the quarries. There are a total of 6 tractors in the range of 71-100 HP in traditional production enterprises

It has been observed that the enterprises make their tractor selections according to the size of the land. It has been determined that enterprises with 31 da of land or more prefer higher powered tractors. Considering the land assets of the enterprises, it is known that the number of enterprises with a production area of 31 da or more is 28. Among these enterprises, 6 of them prefer high power tractors. At the same time, it is known that the enterprises use tractors according to the size of the land, and the tools and machines also vary. Data relating to age distributions of tractors used in traditional and organic production facilities are provided in Table 11. According to this, when the age distribution of tractors of the enterprises engaged in traditional production is reviewed, it is observed that 13 of the 30 enterprises have tractors older than 25 years (43.33%). 3 of the enterprises have tractors between 5-10 years of age. The average tractor age of the enterprises is 25. The average age of the tractors used by the organic production enterprises is 22 years. There are 8 tractors older than 25 years, and 8 tractors between 5 to 10 years.

Tractor assets and tractor power data are not sufficient on their own to determine the mechanization level of the enterprises, therefore the existence of agricultural tools and machines belonging to the enterprises have also been examined (Table 12).

According to the data given in Table 12, 19% of traditional production enterprises have motorized hoeing machines. Majority of these enterprises use these machines for transportation purposes. Due to the land structures of the enterprises and the spraying machines used, many enterprises prefer the use of tractors instead of motorized hoeing machines. 29.91% of the enterprises prefer motorized garden sprayers with 200 litres and 400 litres tank capacity when spraying. In traditional production, the proportion of motorized garden sprayers is higher than those that make organic production, due to the greater number and amount of spraying and fertilization. Among 103 traditional production enterprises, 2 enterprises have hazelnut harvesting machines. These enterprises own large plots and therefore they prefer hazelnut harvester to reduce labour costs. However, due to the slope of the lands, most of the enterprises producing traditional and organic hazelnuts prefer to collect manually.

32.03% of organic production enterprises use motorized hoeing machines. Significant portions of these enterprises use hoeing machines for transportation and some enterprises have two motorized hoeing machines for both hoeing and transportation. 14.06% of organic production enterprises use garden sprayers. These sprayers have two different tank capacities, 200 litres and 400 litres. It was determined that motorized garden sprayers

Table 13. To what extent do the existing tools-machines and tractors meet the needs of enterprises engaged in traditional and organic production enterprises

Do your existing tractors and tools-machines meet your needs?	Traditional enterprises		Organic enterprises	
	Frequency	Rate (%)	Frequency	Rate (%)
Not at all	13	12.62	8	7.55
To some extent	48	46.60	39	36.79
They meet all my needs	45	43.69	59	55.66
Total	103	100	106	100

Table 14. Number of tractors and power values in Zonguldak province, its districts and Turkey in general (Anonymous, 2021b)

Tracto Dist. (BG) Axle	Power		Alaplı	Karadeniz Ereğli	Other Districts	Zonguldak	Turkey
Single-axle	1-5		75	-	102	177	19 416
	>5		215	3400	586	4201	73 782
Tractors with single axle			290	3400	688	4378	93 198
Two-axle		1-10	105	-	3	108	6969
		11-24	102	-	75	177	20 944
		25-34	4	-	105	109	68 157
		35-50	42	360	665	1067	517 899
		51-70	150	-	1319	1469	544 909
		>70	83	-	657	740	190 677
Total number of two-axle tractors			486	360	2824	3670	1 349 555
Total number of tractors			776	3760	3512	8048	1 442 753

(14.06%) were used more than back sprayers (3.91%) in spraying and fertilization. Due to the large number of hazelnut orchards, enterprises tend to prefer garden-type sprayers. It is also noted from the study data that most of the garden sprayers are common property. It is determined that the enterprises use hand saw and tree motor for cleaning and pruning hazelnut trees. It is determined that there are 112 hand saws in total in the 106 enterprises included in the survey that make organic production. It is also noted that some businesses have more than one hand saw. In the same way, it is seen that tree engine is used in 7 enterprises. 9 enterprises stated that they have agricultural carts.

Enterprises engaged in organic and traditional (209) production were asked, "*What do you use to harvest hazelnuts*?" It was concluded that almost all of the enterprises (99.04%) harvested hazelnut by hand, and only 2 enterprises harvested hazelnut with machinery (0.96%). Another question asked to enterprises was "*Do you dry after harvesting*". According to the answers obtained from this question, all of the enterprises dry after the hazelnut harvest.

In addition to the characteristics of the mechanization status of the hazelnut producer enterprises such as tractors, tools-machines, tractor powers and ages, it is also important to know how much mechanization tools benefit the enterprises. For this reason, businesses were asked to what extent their existing tools-machines and tractors can meet their needs (Table 13).

It has been observed that the existing tools and machines do not meet the needs of 12.62% of the traditional production enterprises, they moderately meet the needs of 46.60% of them, and they completely meet the needs of 43.69% of them. It has been determined that the existing tractors and tools-machines fully meet the needs of 55.66% of the organic production enterprises, do not meet any of the needs of 7.55%, and moderately meet the needs of 36.79%. Since organic production enterprises do not need too many tools-machines, enterprises think that the existing tools-machines are sufficient for them.

Comparing the mechanization levels of Zonguldak province, its districts and Turkey in general

Zonguldak province has an important position in hazelnut production. In terms of measuring the level of mechanization in Zonguldak, the number of tractors and their power were evaluated by taking into account the TUIK

Table 15. Mechanization level comparison between Zonguldak province, and Turkey in general

	Agricultural land (ha)*	Number of tractors (pcs)*	Tractor power per unit area (kW/ha)	Number of tractors per 1000 ha (tractor/1000 ha)	Processed area per tractor (ha/tractor)
Alaplı	10 716.1	776	1.527	72.414	13.809
Karadeniz Ereğli	16 621.3	3760	1.807	226.216	4.421
Other districts	21 306.8	3512	5.977	164.830	6.067
Zonguldak	48 644.2	8048	3.572	165.446	6.044
Turkey	23 145 133.7	1 442 753	2.360	62.323	16.045

*: Anonymous, 2021c.

2020 data (Table 14). Accordingly, there are a total of 1 349 555 two-axle tractors used for agricultural mechanization in Turkey. 3670 of those tractors are found in Zonguldak province. Considering the ratio of single-axle tractors, which are generally used in small areas, there are 4378 tractors in total in Zonguldak. 290 of those tractors are found in Alaplı and 3400 of them are found in Karadeniz Ereğli district. About 5% of all single-axle tractors in Turkey are found in Zonguldak. Due to the sloping lands of Zonguldak province, 77.66% of the use of these vehicles belongs to the Black Sea Ereğli district. It is seen that the use of tractors is higher in the Black Sea Ereğli district, where hazelnut production is higher than other districts.

The average power values used to calculate the tractor powers were determined according to the average power values of each tractor power group determined by Aybek et al (2021). While determining the mechanization level, single and double axle tractors were evaluated together as tractor power groups and accordingly, the average tractor power value was determined as 31.70 kW for organic enterprises and 43.96 kW for conventional enterprises according to tractor power groups. In this study, for the fundamental criteria agricultural mechanization level, the tractor power per unit area (kW/ha), the number of tractors per hectare (tractor /1000 ha), and the worked area per tractor (ha/tractor) values were determined. A comparison of the agricultural mechanization level of Zonguldak province, its districts and Turkey is given in Table 15.

According to the 2020 data given in Table 15, the tractor power (kW/ha) per unit area worked in Zonguldak province and Turkey is 3.572 kW/ha for Zonguldak province and 2.360 kW/ha for Turkey. It has been revealed that the value of Zonguldak province is lower than that of Turkey. On the basis of districts, the sum of 1.527 kW/ha in Alaplı and 1.807 kW/ha in Karadeniz Ereğli is close to the value of Zonguldak province. While the number of tractors per 1000 ha in the province of Zonguldak is 165.446, approximately 3.63 times the average of Turkey, the district of Alaplı is above the average of Turkey. On a district basis, the number of tractors per 1000 ha in Karadeniz Ereğli is 226.216, which is nearly 4 times the average of Turkey. The processed land value of 16.045 per tractor in Turkey is 2.65 times higher than the value of 6.044 ha/tractor in Zonguldak.

Table 16. Hazelnut production areas and number of tractors per enterprise on the basis of traditional and organic producers

	Hazelnut production area (ha)	Number of tractors (pcs)	kW/ha	tractor/1000 ha	ha/tractor
Traditional enterprises	208.686	30	6.320	143.757	6.956
Organic enterprises	673.1	24	1.344	35.656	28.046

Mechanization levels of enterprises engaged in traditional and organic production

Calculations were made to determine the mechanization levels of traditional and organic production enterprises and the values obtained are given in Table 16.

Enterprises engaged in organic production have a production area of 6731 da, while enterprises engaged in traditional production have a production area of 2 086.856 da. The difference is 3.23 times. However, in terms of the number of tractors, traditional manufacturing enterprises have 1.25 times less tractors. According to 2020 data, the tractor power (kW/ha) per unit area processed in organic hazelnut producing enterprises is 1.344, while the tractor power per unit area in traditional hazelnut

producing enterprises is 6.320 kW/ha. This criterion was found to be 4.70 times higher in traditional enterprises compared to organic enterprises. This is because the hazelnut production areas of traditional enterprises are less, but the number of tractors is higher.

While the number of tractors per 1000 ha in traditional hazelnut producer enterprises was 143.757 in total, this value was found to be 35.656 in organic producer enterprises, which is 4.03% times higher. On the other hand, while the processed area value of traditional hazelnut producer enterprises was 6.956 per tractor, this value was 4.03 times higher with 28.046 in organic enterprises. Accordingly, traditional hazelnut producer enterprises are seen to be in a better position in terms of mechanization level compared to organic hazelnut producer enterprises, this situation is related to the current situation of agricultural land and tractor numbers.

CONCLUSION

In the present study, a survey was conducted with enterprises producing organic and traditional hazelnuts in Karadeniz Ereğli and Alaplı districts of Zonguldak province, and the number of agricultural tools and machinery and tractor numbers were evaluated within the scope of the enterprises' socioeconomic structures, land assets, agricultural structures, mechanization status of the producers and a comparison of the agricultural mechanization level of producer enterprises was made.

The age distribution of the owners of enterprises producing hazelnuts was analysed and it was determined that the average age of enterprises producing with organic and traditional methods was over fifty years old. Educational status of enterprise owners was also examined and it was determined that many enterprises owners were secondary and primary school graduates. In the study, the total processed area is 8817.856 da in two production patterns separated as organic and traditional, and 76.33% (6731 da) of this is organic production area. Enterprises argued that traditional production is harmful to human health and that organic production is a more profitable method. Enterprises that perform traditional production use too many chemical inputs and they continue traditional production because they know this method better. It has been observed that enterprises engaged in organic farming have 24 tractors and traditional producers have 30 tractors, and there are differences in terms of tractor brand and power preferences. It has been determined that both manufacturers prefer Massey Ferguson and New Holland brands the most. As a result of the study, it has been observed that 14.06% of the enterprises engaged in organic production have garden sprayers and the sprayers are mostly 200 litres car/roller type garden sprayers. It has been determined that the tractor power group preferences of traditional production enterprises are mostly medium power tractors (35-70 HP). The age of the tractors used by the enterprises was determined as 25 in traditional producers and 22 in organic enterprises.

Within the scope of the study, the mechanization levels of the enterprises in Zonguldak and its districts and Turkey in general were examined and according to the results obtained, it was determined that the tractor power per unit area in Zonguldak was above the Turkey average of 2.360 kW/ha. When a comparison is made with the whole of Turkey on the basis of districts, it has been determined that the tractor power per unit area of Alaplı and Karadeniz Ereğli districts is below the Turkey average. It has been observed that the tractor power (kW/ha) value per unit area processed in traditional hazelnut producer enterprises is 4.70 times higher than the organic production enterprises, and the number of tractors per 1000 ha is also 4.03% higher.

The production amount of organic hazelnut producer enterprises is increasing, but the use of tractors, tools and machinery remains limited. Therefore, in order to improve the current level of agricultural mechanization and to increase the number of tractors and tools and machinery they use in agricultural production, providing incentives and supports for the purchase of tractors and tools-machines to the enterprises that will abandon the traditional production approach and adopt the organic production approach will contribute to the more profitable production of organic enterprises.

COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interest

Authors do not declare any conflict of interest.

Author contribution

The contribution of the authors to the present study is equal. All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are
original and that they have not been published before.

Ethical approval

Ethics Committee Report was received from Tokat Gaziosmanpasa University Social and Human Sciences Ethics Committee (30.06.2021, session 14, 1-16 issues).

Funding

No financial support was received for this study.

Data availability

Not applicable.

Consent for publication

Not applicable.

Acknowledgements

This study was summarised from Onur Kahraman's master's thesis. This study was submitted as poster abstract in 34th National Agricultural Mechanization and Energy Congress 7-9 Sep 2022, Bilecik, Turkey.

REFERENCES

Altunışık, R., Coşkun, R., Bayraktaroğlu, S., Yıldırım, E. (2012). Sosyal Bilimlerde Araştırma Yöntemleri SPSS Uygulamalı, Sakarya, Sakarya Yayıncılık (in Turkish).

Alkan, I., Kılıç, O. (2007). Samsun ili Terme ilçesinin ova ve yüksek kesimindeki fındık işletmelerinin karşılaştırmalı ekonomik analizi, OMÜ Ziraat Fakültesi Dergisi, 22(2): 171-178 (in Turkish).

Anonymous. (2021a). Fındık, Tarım Ürünleri Piyasaları, Strateji Geliştirme Başkanlığı, 1-4 (in Turkish).

Anonymous. (2021b). Türkiye İstatistik Kurumu, https://biruni.tuik.gov.tr/medas/ (Access date: 24 July 2021).

Anonymous, (2021c). Türkiye İstatistik Kurumu, https://biruni.tuik.gov.tr/medas/?locale=tr, (Access date: 10.12.2021).

Aybek, A., Kuzu, H., Karadöl, H. (2021). Türkiye'nin ve tarım bölgelerinin tarımsal mekanizasyon düzeyindeki değişimlerin son on yıl (2010-2019) ve gelecek yıllar (2020-2030) için değerlendirilmesi, KSÜ Tarım ve Doğa Dergisi, 24(2): 319-336 (in Turkish). https://doi.org/10.18016/ksutarimdoga.vi.747163

Beyhan, M., Sauk, H. (2018). Türkiye'de fındık tarımında mekanizasyon durumu, Türktob Dergisi, 27: 22-27 (in Turkish).

Doğanay, H. (2012). Türkiye fındık meyvacılığındaki yeni gelişmeler, Doğu Coğrafya Dergisi, 17(27), 1-22 (in Turkish).

Güney, M., Güner, F., (2018). Fındık tarımında durum analizi, makineli hasat gerekliliği ve hasat makinelerinin sınıflandırılması, Türk Tarım-Gıda Bilim ve Teknoloji Dergisi, 6(9): 1141-1147 (in Turkish).

Özgüven, M.M., Türker, U., Beyaz, A. (2010). Agricultural Structure and Mechanization Level of Turkey, Journal of Agricultural Faculty of Gaziosmanpaşa University, 27(2): 89-100 (in Turkish).

Öztürk, D., İslam, A. (2019). Türkiye'de eski ve yeni üretim bölgelerinde fındık yetiştiriciliği yapan işletmelerin tarımsal üretim açısından karşılaştırmalı analizi, Akademik Ziraat Dergisi, 8 (özel sayı): 99-106 (in Turkish).

Pelvan, E., Alasalvar, C., Uzman, S. (2012). Effects of roasting on the antioxidant status and phenolic profiles of commercial Turkish hazelnut varieties (*Corylus avellana* L.), Journal of Agricultural and Food Chemistry, 60: 1218-1223. https://doi.org/10.1021/jf204893x

Polat, S. (2014). Türk fındığının Türkiye'deki yeni yayılış alanı, Marmara Coğrafya Dergisi, 29 (Ocak): 136-149 (in Turkish).

Sobutay, T. (2006). Fındık Sektör Araştırması, İstanbul Ticaret Odası Dış Ticaret Şubesi Uygulama Servisi, 26 (in Turkish).

Sümer, S.K., Say, S.M., Has, M., Sabancı, A. (2003). Türkiye'de ekonomik traktör parkı ve gelişimi, Ç.Ü. Ziraat Fakültesi Dergisi, 18(4): 45-52 (in Turkish).

Taylan, E., Durul, M. (2019). Kocaeli'nde fındık tarımı ve Kandıra'da fındık, Uluslararası Marmara Fen ve Sosyal Bilimler Kongresi, (Bahar) 2019, Bildiriler Kitabı (2): 2294-2301 (in Turkish).

TUIK. (2021). Türkiye İstatistik Kurumu, https://data.tuik.gov.tr/Kategori/GetKategori?p=tarim-111&dil=1 (Access date: 9 Dec 2021).

TMO. (2021). 2020 Yılı Fındık Sektör Raporu, Toprak Mahsulleri Ofisi Genel Müdürlüğü, Ankara (in Turkish).

Ünsal, S. (2020). 1970'ten itibaren Türkiye'nin fındık üretimi ve ihracatı, (Proje Finali) Bilkent Üniversitesi, İstanbul (in Turkish).

Yıldız, T. (2020). Türkiye'de fındık tarımında hasat-harman mekanizasyonu, Tarım Makinaları Bilimi Dergisi, 16(1): 12-22 (in Turkish).