Economic Analysis of Lettuce Growing in Greenhouse: A Case Study from Türkiye

ABSTRACT

The main purpose of this study is to analyze the economic aspects of greenhouse lettuce production in the Menderes district of Izmir province, Türkiye and to determine the criteria that growers attach importance to in lettuce growing. Data were collected from 66 growers using a proportional sampling method using a survey. In the study, first of all, the socio-economic characteristics of the growers were determined. Then, economic aspects of lettuce production of the growers were analyzed and the criteria that growers attach importance to in their decisions to grow lettuce were determined. Average lettuce production area was 3.76 decares. Average lettuce yield per decare was calculated as 4,516.17 kg. The average gross return of lettuce per decare was determined as US$ 1,474.19, and average net return per decare US$ 542.25. the most important criterion that growers consider for growing lettuce was determined to be soil and water structure. The study results show that lettuce production can be done economically in the region. But, in order to make production profitable and ensure economic sustainability in greenhouse vegetable growing, it is necessary to reduce production costs. In addition, vegetables should be marketed at a high price.

Keywords: growing under cover, greenhouse vegetable, lettuce, profitability analysis, grower decisions.

1. INTRODUCTION

Lettuce (*Lactuca sativa L.)* is an annual cool-season plant belonging to the Compositeae family. Lettuce, one of the most produced and consumed leafy vegetable species in the world and Türkiye, is the most popular salad plant (Kandemir and Balkaya, 2022). Lettuce varieties belonging to different product segment groups are consumed not only as salads, but also as wraps, pickles, meals and processed forms (Nicholson et al., 2020; Eaton et al., 2023). It is accepted that its origin is Anatolia, the Caucasus, Iran and Turkestan (Balkaya and Özgen, 2019). It has spread to Europe via Greece and Türkiye and from there to the American continent (De Vries, 1997; Karaagac and Balkaya, 2019). In 2023, 28.1 million tons of lettuce were produced in 1.3 million hectares of land in the world. China ranks first in lettuce production worldwide, followed by the United States and India. India is followed by Spain, Italy, Iran, Japan, Türkiye, Mexico and Germany (FAOSTAT, 2024).

Accordıng to TURKSTAT 2023 data, a total of 106,166 tons of lettuce were produced in 27,497 decares of plastic and glass greenhouses in Türkiye. Adana, Antalya and Mersin provinces are the most important provinces in the production of cos lettuce; Sakarya, Antalya and Tokat provinces are the most important provinces in the production of curly lettuce, and Ankara, Mersin and Adana provinces are the most important provinces in the production of iceberg lettuce. One of the important provinces in Türkiye in terms of greenhouse vegetable growing is Izmir. In Izmir province, 11,228 tons of lettuce were produced in 3,557 decares of glass and plastic greenhouses in 2023. In the same year, in Menderes district, which is the most important region in Izmir province, 10,611 tons of lettuce were produced in 3,418 decares of land. 85% of the lettuce produced in this district was loose leaf lettuce (TURKSTAT, 2024).

In order to make production profitable and ensure economic sustainability in greenhouse vegetable growing, it is necessary to reduce production costs. In addition, vegetables should be marketed at a high price (Karkacier et al., 2020). If yield and price increases can be achieved, profitability will also increase. Input support should be provided to growers to reduce costs. In order to increase the yield obtained from unit area, it is necessary to use quality seeds, ensure efficiency in input use and apply the most appropriate growing techniques. For this reason, greenhouse vegetables in different regions should be analyzed technically and economically and growers should be guided in this direction.

It is seen that many studies have been conducted in Türkiye to analyze the economic aspects of greenhouse vegetable growing (Engindeniz and Yücel Engindeniz, 2006; Engindeniz and Gül, 2009; Onaran and Yanar, 2012; Sipahioglu and Tipi, 2016; Yücel Engindeniz, 2017; Örük and Engindeniz, 2019; Cebi et al., 2019; Karkacier et al., 2020; Oruc and Gözener, 2020; Ölmez et al., 2021; Bayramoglu et al., 2021; Gül et al., 2021). However, the number of studies analyzing the economic aspects of greenhouse lettuce growing is quite limited (Engindeniz, 2004; Engindeniz and Tüzel, 2004; 2006).

With the study to be conducted on this subject, the economic problems of the growerss can be determined and important data that can be used in the creation of effective policies to ensure sustainability can be obtained. The main purpose of this study is to analyze the economic aspects of greenhouse lettuce production in the Menderes district of Izmir province, Türkiye and to determine the criteria that growers attach importance to in lettuce growing.

2. MATERIAL AND METHODS

The data for the study were obtained from growers producing lettuce in greenhouses in the Menderes district of Izmir province through a face-to-face survey method. Menderes district is in Izmir Province and is located in western Türkiye (Figure 1). According to the data of the Izmir Provincial Directorate of the Ministry of Agriculture and Forestry, 70% (906 ha) of greenhouse areas in Izmir province are located in the Menderes district. Therefore, the Menderes district was determined as the study area.

Figure 1. Menderes district in Izmir Province and Türkiye

According to the information received from the Menderes District Directorate of the Ministry of Agriculture and Forestry, the total number of growers registered in the Farmer Registration System in the district is 2,488. Some of these growers were included in the study by sampling. For this purpose, the following Proportional Sample Size Formula was used (Newbold, 1995).

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

In the formula:
n = Sample size
N = Total number of growers
p = Proportion of growers producing lettuce in greenhouse (0.5 was taken for the maximum sample size)
σ^2px = Variance

In the study, calculation was made based on 90% confidence interval and 10% margin of error and the sample size was determined as 66. Growers to be interviewed in the district were determined by using the random numbers table. During the survey phase, growers were informed and their voluntary participation was ensured. In the study, the production period of 2023/2024 was taken as a basis, and the survey studies were carried out in July and August of 2024. The study was carried out and completed in accordance with scientific ethical rules.

In the analysis of the data; growers were divided into three groups according to the size of the greenhouse production area. At this stage, decare (1,000 m^2=0.1 hectare) was used. The first group was growers with greenhouse production area of 2 decares or less (23 growers), the second group was growers with greenhouse production area between 2-4 decares (26 growers) and the third group was growers with greenhouse production area of 4 decares or more (17 growers). In the study, firstly the socio-economic characteristics of the growers were determined. Then the economic aspects of the growers' lettuce production were analyzed and the criteria that the growers gave importance to in their decisions to grow lettuce were determined.

Total production costs were subtracted from total gross return to calculate the net return from lettuce. Total production costs of lettuce include fixed and variable cost. Variable costs include costs for labor, fertilizer, seed, electricity, marketing, transportation and interest on total variable costs. Fixed costs include land rent, interest on total initial investment, annual initial investment costs and administrative costs (Engindeniz and Tüzel, 2004; 2006). Interest on total initial investment costs and total variable costs was calculated by charging a simple interest rate of 2.41% (saving deposits interest rates, monetary values on US $ in December 2023). Administrative costs were estimated to be 3% of total variable costs (Kiral et al., 1999).

Fuzzy Paired Comparison method was used in the analysis of the factors affecting the growers' decision to produce lettuce in the greenhouse. In this method, growers compare the two purposes. Method steps may be summarized as follows (Ross, 1995; Tanaka, 1997; Pedrycz and Gomide, 1998).

First, pairwise comparisons are presented to indicate individual preferences. For example, the degree of preference of objectives K and H, G_{KH}, is measured according to the distance between them. The change in the value was between 0 and 1 for each element. The total distance is equal to the following.

If G_{KH}=0.5 then K≈H; if G_{KH}>0.5 then K>H and if G_{KH}<0.5 then K<H. (2)

The number of paired comparisons of the objectives (C) were determined as C= [(Z.(Z-1))/2]. Z refers to the preferred number of objectives in the formula.

In the study, each grower was presented with 15 comparisons of six different criteria. Influencing factors are listed according to their weights, from largest to smallest. For each pairwise comparison, g_{cr} preference was obtained. Measurement of the preference degree of r according to c can be expressed as g_{cr}=1-g_{rc}. Then, fuzzy preference matrix was as follow generated as follow.

$$\text{Gcr} = \begin{cases} 0 & if\ \ c = r\ \ \forall\, c, r = 1, \ldots . n \\ g_{cr} & if\ c \neq r\ \forall\, c, r = 1, \ldots . . n \end{cases} \quad (3)$$

In this study, 6x6 fuzzy preference matrix was created for everyone as follow (G):

$$\text{G} = \begin{bmatrix} g_{11}g_{12}g_{13}g_{14}g_{15}g_{16} \\ g_{21}g_{22}g_{23}g_{24}g_{25}g_{26} \\ g_{31}g_{32}g_{33}g_{34}g_{35}g_{36} \\ g_{41}g_{42}g_{43}g_{44}g_{45}g_{46} \\ g_{51}g_{52}g_{53}g_{54}g_{55}g_{56} \\ g_{61}g_{62}g_{63}g_{64}g_{65}g_{66} \end{bmatrix} \quad (4)$$

Separately preferred density of each objective (μj) was obtained using the following equation.

$$\mu\text{j} = 1 - \left(\sum_{c=1}^{n} G_{cr}^{2} / (n-1) \right)^{1/2} \quad (5)$$

The value of μj ranges between 0 and 1. Whether the purpose of comparison was equally important was determined by the Friedman Test. In addition, Kendall's coefficient of agreement was used for the rows.

3. RESULTS AND DISCUSSION

In the socio-economic characteristics of the growers are presented in Table 1. 6.06% of growers are women and 93.94% are men. The ages of the growers range from 32 to 71, with the average being 48.12. Education periods vary between 5-15 years, with an average of 9.17 years.

Table 1. Socio-economic characteristics of growers

Characteristics	Farm groups			
	Group 1 (≤2 da)	Group 2 (2-4 da)	Group 3 (4 da≤)	General
Age of growers	47.26	48.61	48.53	48.12
Education level of growers (years)	7.22	9.54	11.23	9.17
Household size	3.61	4.15	3.23	3.73
Land size (da)	22.65	37.46	63.71	39.06
Greenhouse land size (da)	1.48	3.23	7.65	3.76
Cooperative partnership rate (%)	30.82	32.54	71.47	41.97
Equity ratio (%)	91.48	84.35	85.65	87.17

The total population in the farms examined is 246 people and the average household size is calculated as 3.73 people. Women constitute 49.18% of the total population in farms. The rate of the population aged 15-49 in the total population is 39.84%.

The land size in farms varies between 8-110 decares. The average land size was determined as

39.06 decares. Greenhouse lands constitute 9.63% of the lands in farms. Growers generally cultivate their own land. Land assets constitute 97.25% of the total active capital in farms. It was determined that equity ratio is 87.17%. 41.97% of the growers are partners in any agricultural cooperative.

All greenhouse areas in the farms are made up of plastic greenhouses. Iron and galvanized construction is generally used in greenhouses. The economic life of greenhouses is based on 25 years. It was determined that growers grow autumn lettuce after spring cucumber. Loose leaf lettuce (*lactuca sativa var. crispa)*) is generally grown in greenhouses.

The results for the economic analysis of lettuce production are presented in Table 2. Average lettuce production area is 3.76 decares. Lettuce yield per decare varies between 4,300 and 4,600 kg. Average lettuce yield per decare was calculated as 4,516.17 kg. In a study conducted in Canakkale province, Türkiye, it was determined that the yield of loose leaf lettuce grown in greenhouses varied between 2,239-3,742 kg/da (Yildirim et al., 2015). In a study conducted in Isparta province, it was determined that the yield of curly lettuce was 4,323 kg/da (Demirel and Aktas, 2023). 77.12% of the lettuce were marketed to merchants, 14.42% to brokers and 8.46% to local markets. The average lettuce price received by the growers was calculated as 0.74 US$/kg.

Table 2. Profitability level of lettuce production

Economic results	Farm groups			
	Group 1 (≤2 da)	Group 2 (2-4 da)	Group 3 (4 da≤)	General
Production area (da)	1.48	3.23	7.65	3.76
Yield (kg/da) (1)	4,518.22	4,565.23	4,438.35	4516.17
Average lettuce price (US$/kg) (2) *	0.74	0.73	0.76	0.74
Gross production value (US$/da) (3=1x2)	3,343.48	3,332.62	3,373.15	3,341.97
Variable costs (US$/da) (4)	1,898.96	1,834.57	1,876.41	1,867.78
Production costs (US$/da) (5)	2,832.18	2,763.22	2,811.64	2,799.72
Unit lettuce cost (US$/kg) (6=5/1)	0.63	0.60	0.63	0.62
Gross return (US$/da) (7=3-4)	1,444.52	1,498.05	1,496.74	1,474.19
Net return (US$/da) (8=3-5)	511.30	569.40	561.51	542.25

*1 US$ = 23.75 TL in 2023

The average production cost per decare for lettuce was calculated as US$ 2,799.72. Material costs account for 42.24% of production costs, labor and machine costs 31.72%, and other costs account for 26.04%. As can be seen, 73.96% of production costs are variable costs. The average kg cost of lettuce was determined as US$ 0.62. The average gross return of lettuce per decare was determined as US$ 1,474.19, and average net return per decare US$ 542.25 in the examined farms.

In a previous study conducted in the Menderes district of Izmir, Türkiye, it was determined that the net return obtained from organic greenhouse lettuce varied between US$ 376 and 901 per decare depending on the organic fertilizer used (Engindeniz and Tüzel, 2006). In another study conducted in the same region, it was calculated that the net return obtained from conventional lettuce production varied between US$ 155 and 650 per decare, and the net return obtained from soilless lettuce was US$ 188 per decare (Engindeniz, 2004). A study conducted in Brazil found that net return from greenhouse lettuce ranged between US$ 618 and 784 per decare (Vendruscolo et al., 2019).

In the study, Fuzzy Paired Comparison analysis was performed to determine the criteria that growers will give importance to when growing lettuce. Growers were presented with six criteria to determine their decision preferences. These criteria: climate conditions, soil and water structure, yield, production cost, government supports and lettuce price. In the study, 15 comparisons of six different criteria were presented to each farmer. Results were evaluated using the Friedman Test and Kendall's coefficient of concordance.

For optimum production in greenhouses, suitable soil and water resources must be found. In addition, climate conditions are of great importance in terms of greenhouse location and appropriate air conditioning. Thus, according to the analysis results, the most important criterion that growers consider for growing lettuce was determined to be soil and water structure. This is followed by climate conditions, price, production costs, yield and government supports, respectively (Table 3). The Friedman test shows that there is a statistical difference between preferences. Considering the values of Kendall's W test, it can be said that the fit is very weak (0.1), weak (0.3), moderate (0.5), strong (0.7), and strongly strong (0.9). Kendall's W value was found to be 0.457 in the study.

Table 3. Results of Fuzzy Paired Comparison analysis

Criteria	Min.	Max.	Mean	Standard error	Order of importance
Soil and water structure	0.410	0.690	0.584	0.410	1
Climate conditions	0.390	0.710	0.558	0.400	2
Price	0.380	0.680	0.551	0.390	3
Production costs	0.350	0.660	0.529	0.350	4
Yield	0.310	0.630	0.455	0.310	5
Government supports	0.290	0.600	0.416	0.270	6
Friedman test is significant at $p<0.01$. Kendall's W: 0.457					

4. CONCLUSIONS

Lettuce is one of the important alternatives for greenhouse vegetable growers. The study results show that lettuce production can be done economically in the region. Lettuce is easier to grow and its profitability is also higher, as has been shown in many previous studies (Engindeniz, 2004; Engindeniz and Tüzel, 2004; 2006; Cebi et al., 2019). If growers can use some inputs more effectively, it will be possible to reduce production costs a little more. As expected, it was determined that soil, water and climate conditions are important in growers' lettuce growing preferences. These factors become more important for autumn production. According to growers, there is no marketing problem. However, they recommend increasing input supports. The main point emphasized is that vegetable growers in Türkiye are not given direct support. Growers are willing to sustain lettuce production in greenhouses, but they think that their children do not want to be involved in agriculture in the future. This shows that projects should be produced that will attract young people to greenhouse vegetable growing, especially in rural areas.

ACKNOWLEDGMENTS

The author would like to thank the regional growers who shared their data and neighborhood headmen.

COMPETING INTERESTS

Author has declared that no competing interests exist

AUTHORS' CONTRIBUTIONS

Author DYE collected data, analyzed them, performed econometric evaluations, wrote and checked the article.

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