Cost and profitability analysis of greenhouse eggplant production: a case study of Antalya Province, Turkey

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Abstract

This study aimed to analyse the technical and economic structure of the enterprises engaged in greenhouse eggplant cultivation in the sample of Gazipaşa district of Antalya province. Based on the data obtained from the Farmer Registration System in the Gazipaşa district, it was determined that 65 farmers producing eggplant in a greenhouse should be interviewed. The data obtained from the eggplant growers were obtained by face-to-face interviews with the farmers of the producer questionnaire developed by these researchers. As a result, it was determined that greenhouse eggplant cultivation is a substantial income-generating activity in the region, and fertiliser, marketing, seedling and pesticide elements take the first place in variable costs. To reduce the unit costs of eggplant, it is necessary to produce products suitable for domestic and foreign demand and present them to the market at the appropriate time. We determined that large-scale enterprises operated more profitably.

Keywords*:* Eggplant. Greenhouse. Technical structure. Production cost. Profitability.

1. Introduction

Turkey is among the few countries globally in terms of vegetable production area, production amount and export. While world vegetable production was 684 million in 2000, it increased by 68% to 1148 million tons in 2020. In Turkey, it increased by 38%, from 18.8 million to approximately 26 million tons (FAOSTAT, 2022) in the same period. Turkey ranks fifth in the world in vegetable production volume and meets 2.3% of the world's vegetable production.

Tomatoes, onion dry, cucumber, cabbage, eggplant, mushroom, carrot, and peppers are the most grown vegetables in the world. Eggplant ranks fifth in world vegetable production with a rate of 4.9%. It ranks sixth in Turkey's vegetable production. Eggplant constitutes 3.2% of the total vegetable production.

World eggplant production increased 2.1 times from 27.4 million in 2000 to 56.6 million tons in 2020. In Turkey, it decreased by 10% from 0.924 million tons to 0.835 million tons (FAOSTAT, 2022) in the same period. Turkey ranked fourth in the world in eggplant production volume and accounted for 1.5% of the world's eggplant production.

Greenhouse production activity depends on high essential production obtained from the unit area, getting product outside the production season, using more inputs, and a high value-added production method (Gül et al., 2021).

Mainly varieties such as tomatoes, peppers, eggplant, cucumbers, zucchini and beans are grown in greenhouse vegetable production in Turkey. Greenhouse vegetable production has approached 8 million tons today and constituted approximately 30% of the general vegetable production.

Greenhouse eggplant production in Turkey also accounted for approximately 40% of the overall eggplant production. While the greenhouse eggplant production in Antalya in 2004 met 73.09% of the production of Turkey, its share decreased to 55.20% in 2020. While Antalya's greenhouse eggplant area was approximately 62.17% of the greenhouse eggplant area in Turkey in 2004, its share fell to 48.08% in 2020 (Figure 1).
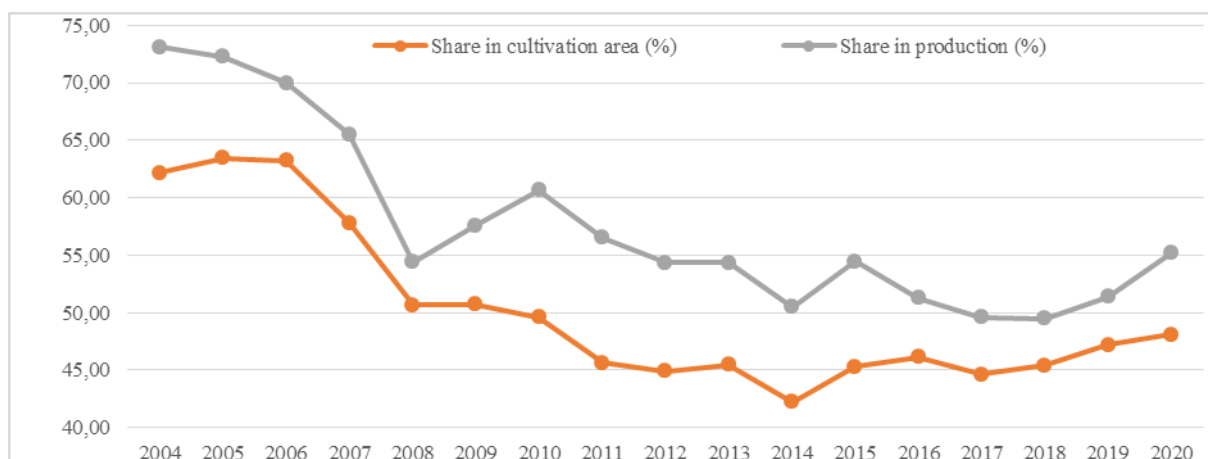
Figure 1: The share of Antalya province eggplant cultivation area and production in a greenhouse in Turkey (%)

Antalya's greenhouse eggplant area decreased by 30% in this period, but its production remained the same. The contribution of Adana and Mersin provinces to Turkey's greenhouse eggplant production has increased. The 36.33% of greenhouse eggplant production in Turkey is in plastic tunnel greenhouse, 35.83% in a glass greenhouse, 26.43% in high tunnel greenhouse and 1.41% in low tunnel greenhouse. In Antalya, 50.78% of its production is in a glass greenhouse, 42.19% in a plastic tunnel greenhouse, 5.57% in a high tunnel greenhouse and 1.46% in a low tunnel greenhouse.

In 2004, the greenhouse eggplant production of the Gazipaşa district met approximately 0.86% of Antalya's production. This value increased to 23.64% in 2020 (Figure 2). In the period under consideration, the greenhouse eggplant area of the Gazipaşa district increased 7.3 times, and its production increased 27.2 times. The increase in yield per unit area had a more significant impact on the rise in production; as a matter of fact, the yield increased fourfold, from 4 tons to 15 tons.. 50.32% of greenhouse eggplant production of Gazipaşa district is in a glass greenhouse, 44.06% in plastic tunnel greenhouse and 5.62% in high tunnel greenhouse.
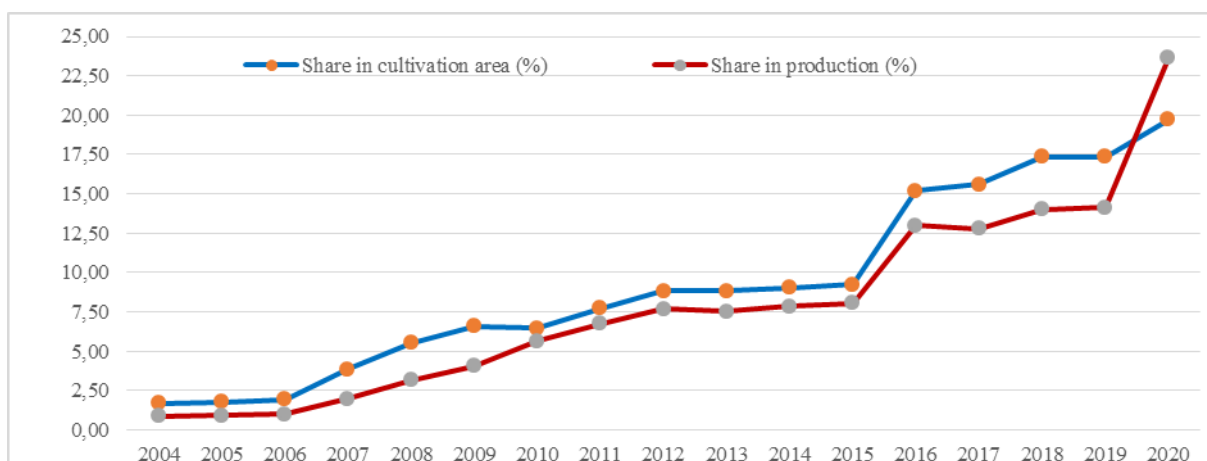
Figure 2: The share of Gazipaşa district in Antalya province eggplant greenhouse cultivation area and production (%)

This study aimed to analyse the technical applications, cost, and profitability of farms that grow eggplant in greenhouses.

2. Literature Review

Özkan et al. (2002), based on the information obtained from 83 farms producing vegetables in greenhouses in Serik and Manavgat districts in Antalya province, compared the amount of pesticides used in one-year tomato, pepper, eggplant and cucumber cultivation with the amount of pesticides required to be used, and calculated their economic loss. The author determined that the additional cost from overuse of pesticides accounted for 26% of the pesticide consumption cost per decare in eggplant cultivation.

Gül et al. (2009) reported that agricultural product prices fluctuate over time due to various factors, and especially the change in product supply affects these fluctuations more. The authors calculated the seasonal fluctuations and developments in the prices of 16 vegetables using Antalya Fruit and Vegetable Wholesale Market data between 1997-2006. The authors determined that the real prices of the vegetables they examined had a decreasing trend. This decreasing trend was even more severe in the real prices of tomato, pepper, eggplant, cucumber, onion (dry), red cabbage, spinach, carrot, leek and cauliflower.

Engindeniz et al. (2010) analysed the input (fertiliser, pesticide, hormone, labour, seed-seedling, etc.) use of producers engaged in greenhouse vegetable growing in Antalya Mersin, Muğla and İzmir. They calculated that about 2740 seedlings per decare were used in eggplant cultivation, and a labour force of 615 to 652 hours was used.

Chupungco et al. (2011) identified the seed system, production and marketing of eggplant in the Philippines. They obtained the data from focus group discussions in major eggplant producing provinces of Pangasinan, Batangas and Quezon. They found that the seed system was generally organised, involving public and private sectors in eggplant. They determined that commercial eggplant growers adopt hybrid seeds and found profitable eggplant production. Still, significant problems include fruit and shoot borer infestation, bacterial wilt, irrigation supply and climate-related issues.

Bărbuță et al. (2014) determined the economic efficiency of eggplants cultivated in plastic tunnels under the influence of culture method, fertilisation and plant directing method in an experiment conducted at the USAMV Cluj-Napoca in 2012. They found that when using the PE bags filled with peat as a growing medium, the highest production was 92.8 tons per hectares, and the profit rate was 73.10%.

Başbuğ and Gül (2016a) calculated the gross profit, absolute profit and relative profitability of vegetable producers in greenhouses in Antalya. They calculated the relative profit as 1.34.

Ukav (2018) calculated the production costs of eggplant, pepper, tomato and cucumber in Kahta district of Adıyaman province. The data belonged to the production period of 2016. He found the kg cost of eggplant to be 0.68 TRY. He reported that about half of the production cost is labour and fertiliser costs. He calculated the gross profit per decare of eggplant as 2249.50 TRY and net profit as 2079.74 TRY. He determined that the relative profit of eggplant was 2.95.

Hayran and Gül (2020) calculated the cost and profitability indicators of tomato, pepper, eggplant, cucumber, zucchini and bean production grown under greenhouse in Mersin. Research data belonged to 2019. As a result of their calculation, the cost of 1 kg of eggplant was 1.79 TRY. The authors stated that tomatoes, peppers, eggplants, cucumbers, zucchini and beans produced in Mersin are preferable products in net income and other profitability indicators they provide to the farmer.

Rashid et al. (2018) determined the farm level performance of Bt eggplant in reducing pesticide use cultivation cost and increasing farm income. They selected purposively 505 Bt eggplant farmers and 350 non-Bt eggplant farmers randomly for their study. They calculated that net returns per hectare for Bt eggplant was higher than non-Bt eggplant. According to the authors, the Bt eggplant farmers saved 61% of the pesticide cost compared to non-Bt eggplant

farmers. The authors' suggested that good production practices must be emphasised for getting higher yield and economic benefits.

Bayramoğlu et al. (2021) calculated the production costs and financial results of tomatoes, peppers, eggplants, zucchini and cucumbers grown in Antalya. They also determined the factors affecting the production cost. They calculated the production cost of 1 kg of eggplant is 3.07 TRY, and determined the gross profit of 1 kg eggplant production as 0.44 TRY and the net profit as -0.41 TRY. The authors estimated the factors affecting the cost of products by linear regression analysis. Accordingly, seedling, fertiliser, and pesticide costs positively affected vegetable production, while material and seasonal labour costs were negatively affected. According to the authors, greenhouse farms claimed that the cost and profit advantage provided by the economies of scale did not occur, and therefore the net profit against the growth of farms scales was negative.

3. Materials and Methods
3.1. Materials

Data was obtained via face-to-face survey method from 65 greenhouse eggplant production farms in the Gazipaşa district of Antalya province. Gazipaşa district has a 19.74% eggplant cultivated area in greenhouses and 23.64% of greenhouses eggplant production quantity of Antalya province. It was influential in the selection of Gazipaşa district as the research area, (i) doubling the eggplant cultivation area and production in a greenhouse in the last five years, and (ii) rising to the second rank in greenhouse eggplant cultivation area and production of Antalya province. Data belongs to the 2019 production season. The research area is given in Figure 3.
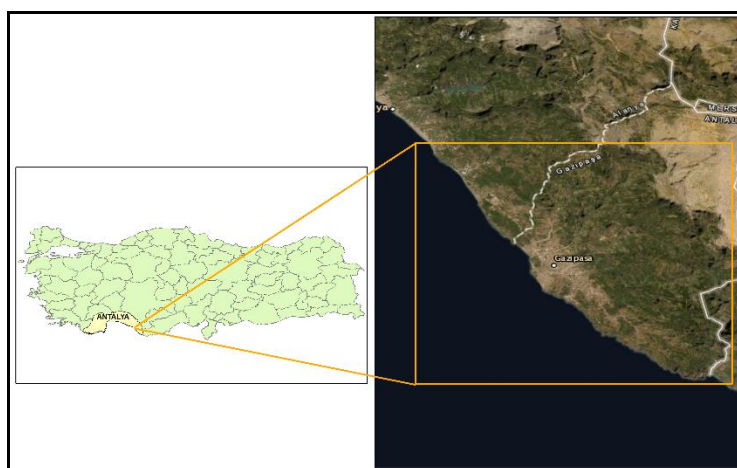
Figure 3: Research area

3.2. Methods

The list of greenhouse eggplant growers was obtained from the Farmer Registration System of the Gazipaşa district to serve the research purpose. Stratified Sampling Neyman method (Yamane, 2001) was applied to this population, and the sample size was calculated as 65 farmers, with a 5% deviation from the mean and a 95% confidence interval.

The eggplant producers in the research were divided into groups according to their greenhouse area. According to this, the farms were divided into three groups "I group (less than 2.00 decares; 35 farms), II group (2.00-3.99 decares; 16 farms) and III groups (more than 3.99 decares; 14 farms)". The average eggplant greenhouse area of the farms was calculated as 1.34 decares for I group farms, 2.97 decares for II group farms, 6.93 decares for III group farms and 2.95 decares for all farms in the groups (Table 1). Data were provided with face-to-face surveys with eggplant producers. Data entries were made electronically and evaluated in tables by making calculations.

Table 1: Sample size

Groups	Greenhouse area (decare)*	Number of farms	Percent	Average size (decare)
I	<2.00	35	53.85	1.34
II	2.00-3.99	16	24.61	2.97
III	3.99<	14	21.54	6.93
Total		65	100.00	2.95

*1 decares = 0.1 hectares

In calculating the cost and profitability of the farms, the calculations were made after the answers were received through face-to-face surveys with the farmers. Single product budget analysis was used in eggplant cost analysis. The variable cost consisted of fertiliser, marketing, seedlings, pesticide, temporary labour, irrigation, machine rental, other variable costs, and working capital interest. Establishment depreciation value, establishment capital interest, permanent-family labour, land rent and general administration expenses made up the fixed cost.

The gross production value was calculated by multiplying the eggplant production of the enterprise with the sales price. The daily wage paid to the wage labourer in the region was taken as a precedent in calculating the farms daily wages of the business owner and his family

members. 3% of the total variable cost was the general administrative expenses (Kıral et al., 1999). The gross profit was calculated by subtracting the variable costs from the gross production value, and the net (absolute) profit was calculated by subtracting the production costs (Açıl, 1977; Aras, 1988; Oktay, 1989). The relative profit was calculated by dividing the gross production value by the production cost (Kıral et al., 1999).

4. Results and Discussion

The average age of the interviewed breeders was 48.43 years. Age of breeders 47.49 years and the lowest group I farms. On the other hand, III. group farms had a higher age of 51.29 years (Table 2).

The experience of the eggplant growers in the region in greenhouse production was calculated as 24.78 years on the farms average. III. group farms was the highest experience with 29.79 years, and the least experience was the group I farms with 22.86 years. Their experience increased as the scale of farms increased (Table 2).

The education level of the eggplant growers was 7.62 years (Table 2). According to the UNDP (2015) report, the average education level in Turkey is reported to be 7.6 years. According to these findings, the education level of eggplant growers is at the level of Turkey's average. Family size was 3.95 people in the enterprises studied (Table 2). Therefore, it can be stated that the large family dominates the enterprises interviewed.

The rate of having a non-agricultural job among the interviewed eggplant producers was 10.77%. 78.46% of the producers had computers, 72.31% had internet, 41.54% had tractors, and 72.31% had credit cards. The indebtedness of 24.62% of the interviewed enterprises had increased in the last five years. The increase in debt was higher in small-scale enterprises (Table 2).

It was determined that 55.38% of the eggplant growers in the region kept records. The highest record-keeping was in group II farms with 68.75%, and the least record-keeping was in the group I farms with 48.57% (Table 2).

It was determined that the level of satisfaction of the farmers interviewed in the region from eggplant cultivation was high (3.52, using a 5-point Likert scale), and their satisfaction levels increased with the scale of the enterprise. It was determined that the level of knowledge of the farmers in eggplant cultivation was high (3.52 points, using a 5-point Likert scale), and the level of farm-scale and eggplants knowledge also increased. Producers tend to continue

growing eggplants (4.26 points, using a 5-point Likert scale) as the farm-scale increased, the tendency to continue farming increased (Table 2). Producers' tendency and satisfaction to continue greenhouse eggplant cultivation were also statistically related to their relative profit from eggplant production.

The 44.62% of eggplant growers used loans. 51.88% of the eggplant growers in the region were members of agricultural organisations. As the enterprise-scale increased, the rate of being a member of agricultural organisations increased (Table 2).

Soil analysis status of the enterprises within the scope of the research was examined, and 36.92% of the enterprises had soil analysis. As the scale of farms increased, the rate of having soil analysis increased (Table 2).

The 58.46% of the eggplant growers were doing solarisation. The most solarisation was group III, with a rate of 64.28% (Table 2).

While the seedling spacing (over row) used in eggplant cultivation was 75.62 cm, the spacing between the rows was 97.85 cm. In greenhouse eggplant cultivation, 93.85% of the producers applied foliar fertilisation, 95.38% applied fungicide, 78.46% applied animal manure, and 20% applied herbicide (Table 2).

The 30.77% of the farmers benefited from a paid consultation in eggplant cultivation. As the scale production increased, the rate of benefiting from a paid consultation also increased (Table 2).

Table 2: Some characteristics of the farms

Some characteristics of the farms and farmers	Farm groups (da)			Average
	I	II	III	
Age (year)	47.49	48.00	51.29	48.43
Education level (year)	7.57	8.50	6.71	7.62
Experience in greenhouse production (year)	22.86	24.63	29.79	24.78
Keeping records in his enterprise (%)	48.57	68.75	57.14	55.38
Increased indebtedness in the last five years (%)	25.71	31.25	14.29	24.62
Having a credit card (%)	68.57	75.00	78.57	72.31
Owns a tractor (%)	5.71	75.00	92.86	41.54
Computer owner (%)	74.29	81.25	85.71	78.46
Internet owner (%)	62.86	87.50	78.57	72.31
Member of the agricultural organisation (%)	48.57	50.00	57.14	50.77
Having a non-agricultural job (%)	14.29	12.50	0.00	10.77
Household size (person)	3.74	3.81	4.64	3.95
Using credit (%)	48.57	37.50	42.86	44.62
Having had soil analysis (%)	22.86	50.00	57.14	36.92
Benefited from a paid consultation in eggplant cultivation (%)	25.71	31.25	42.86	30.77
Performing solarisation (%)	60.00	50.00	64.29	58.46
Foliar fertilisation (%)	97.14	87.50	92.86	93.85
Applying animal manure (%)	68.57	87.50	92.86	78.46
Herbicide application (%)	20.00	18.75	21.43	20.00

Applying fungicide (%)	94.29	93.75	100.00	95.38
Using grafted seedling with a single stem (%)	31.43	37.50	35.71	33.85
Using grafted seedling with a double stem (%)	62.86	68.75	64.29	64.62
Using ungrafted seedling (%)	5.71	0.00	0.00	3.08
Seedling spacing (over row) (cm)**	76.14	73.75	76.43	75.62
Row spacing (cm)**	98.29	97.50	97.14	97.85
Satisfaction level with eggplant production*	3.34	3.63	3.86	3.52
Knowledge level in eggplant production*	3.29	3.75	3.86	3.52
Tendency to continue eggplant farming*	4.14	4.44	4.36	4.26

*5-point likert scale (1 Very low….5 Very high)

**1 centimeter = 0.01 meters

The most crucial factor in deciding the type of production of the enterprises (with 4.82 points) was their ideas. Then, broker suggestions (with 2.97 points), buyer requests (with 2.89 points), consultant suggestions (2.42 points), and firm suggestions (with 2.15 points) were effective (Table 3).

Table 3: Factors that are effective in determining the type of vegetable to be grown in the greenhouse

Factors*	Farm groups (da)			Average
	I	II	III	
Themself	4.74	4.94	4.86	4.82
Broker's Suggestions	2.83	3.31	2.93	2.97
Buyer's Request	2.66	3.13	3.21	2.89
Consultant Suggestions	2.34	2.81	2.14	2.42
Company Suggestions	1.94	2.56	2.21	2.15
Agriculture province/district technical staff's suggestions	1.60	1.44	1.50	1.54

*5-point Likert scale (1 Not at all important….5 Very important)

Gül et al. (2008) reported in their study that consumers' concerns about chemical drug residues reveal the necessity of new initiatives in the fresh fruit and vegetable production process and marketing process. Greenhouse eggplant farms direct their production with different production methods such as GAP and IPM in their input use. The farm activity methods for diseases and pests in greenhouse eggplant production were investigated using a 5-point Likert scale. Among the cultural struggle methods, farms were applying resistant varieties at a very high level with a score of 4.77. In addition, they were also using pruning, which is one of the cultural struggle methods, at a high level with a score of 4.28. In terms of physical and mechanical control methods, eggplant farms used mulching at a high level (4.78 points). They preferred mulching because it saves water, prevents erosion, and encourages biological activity. Today, we can say that greenhouse eggplant farms produce more consciously. The most important factors considered by the eggplant growers in the region to

be important in selecting seedlings was the ease of the sale (4.97 points) and with 4.97 points of resistance to diseases and pests. Yield ability (4.94 points) and physical characteristics of the product (4.92 points) were reported as very important in seedling selection. Production period (4.72 points), ease of payment (4.63 points) and price (4.62 points) were also reported as factors that farmers consider very important in choosing eggplant seedlings. In addition, farmers also stated that the seedling producer (3.77 points) is an important factor in selecting seedlings (Table 4). Hızal and Karlı (2020) identified the reasons why producers prefer greenhouse vegetable cultivation as traditional production habits (78.13%), suitable land and climatic conditions (70.83%). They also determined that 90.65% of the producers decided on the type of vegetable themselves.

Table 4: Importance level of factors in eggplant seedling selection

Factors*	Farm groups (da)			Average
	I	II	III	
Disease and pest resistance	4.97	5.00	4.93	4.97
Ease of sale	4.97	4.94	5.00	4.97
Yield level	4.91	5.00	4.93	4.94
Physical characteristics of the product (size, shape, colour, etc.)	4.91	4.94	4.93	4.92
Production period	4.77	4.69	4.64	4.72
Ease of payment	4.80	4.56	4.29	4.63
Price	4.74	4.50	4.43	4.62
Manufacturer	4.00	3.31	3.71	3.77

*5-point Likert scale (1 Not at all important….5 Very important)

At the beginning of the criteria for the eggplant growers to decide on the spraying time, the disease was detected as soon as it was seen, with a score of 4.60 using a 5-point Likert scale (1 Not at all important….5 Very important). Application of pesticides at regular intervals (4.05 points), when the disease/pest reaches a specific density (3.95 points), were important decision criteria.

Production cost in eggplant cultivation was calculated as 24610.45 TRY per decare in farms average. The most important cost factor in the greenhouse eggplant production process in the enterprises interviewed was the variable cost. The variable cost was 61.76% of the total production cost. The share of fixed costs was 38.24%. As for cost items, the most important elements were establishment depreciation value, fertiliser, marketing, establishment capital interest, seedlings, labour, pesticide and land rent. Establishment depreciation value had the most important share with 17.65% among the factors that constituted the production costs (Table 5). The establishment depreciation value was calculated as 4344.13 TRY per decare in

the average of enterprises. Establishment depreciation value was followed by fertiliser cost with 14.14% share and 3479.08 TRY per decare. Marketing cost was calculated as 3440.70 TRY per decare in the average of enterprises. The percentage of marketing costs in production costs was 13.98%. Marketing cost was followed by 11.27% share and establishment capital interest cost with 2772.15 TRY. Labour costs with 9.32% followed seedling costs, pesticide cost with 6.18%, interest in working capital with 4.31%, other variable costs with 3.73%, irrigation cost with 3.07%, machine rental with 2.09%, land rent with 1.88%, general administration expenses with 1.85%, respectively (Table 5).

The use of family labour is higher in small-scale enterprises. On the other hand, fixed cost decreases per unit area as the scale of the enterprise increases.

Table 5: Production costs per unit area in farms

Cost items	Farm groups (da)			Average
	I	II	III	
	Cost (TRY per decare)			
Fertiliser	3395.85	3543.16	3488.02	3479.08
Marketing	3005.64	3630.69	3558.60	3440.77
Seedlings	2284.64	2738.00	2663.07	2588.78
Pesticide	1540.64	1305.05	1619.45	1522.13
Temporary labour	138.79	761.45	1375.06	919.44
Irrigation	705.32	745.89	785.67	756.08
Machine rental	570.64	556.74	467.63	515.01
Other variables	877.13	950.78	922.33	918.29
The interest in working capital	938.90	1067.38	1115.99	1060.47
Total variable cost	*13457.54*	*15299.15*	*15995.82*	*15200.05*
Establishment depreciation value	5065.85	4061.90	4132.63	4344.13
Establishment capital interest	3232.71	2592.05	2637.19	2772.15
Permanent-family labour	3944.47	1494.95	70.62	1374.67
Land rent	441.49	426.32	492.27	463.45
General administration expenses	403.73	458.97	479.87	456.00
Total fixed cost	*13088.25*	*9034.19*	*7812.58*	*9410.40*
Total production costs	**26545.78**	**24333.34**	**23808.41**	**24610.45**
	The share in the production costs (%)			
Fertiliser	12.79	14.56	14.65	14.14
Marketing	11.33	14.91	14.95	13.98
Seedlings	8.61	11.25	11.19	10.52
Pesticide	5.80	5.36	6.80	6.18
Temporary labour	0.52	3.13	5.78	3.74
Irrigation	2.66	3.07	3.30	3.07
Machine rental	2.15	2.29	1.96	2.09
Other variables	3.30	3.91	3.87	3.73
The interest in working capital	3.54	4.39	4.69	4.31
Total variable cost	*50.70*	*62.87*	*67.19*	*61.76*
Establishment depreciation value	19.08	16.69	17.35	17.65
Establishment capital interest	12.18	10.66	11.07	11.27
Permanent-family labour	14.86	6.14	0.30	5.59

Land rent	1.66	1.75	2.07	1.88
General administration expenses	1.52	1.89	2.02	1.85
Total fixed cost	*49.30*	*37.13*	*32.81*	*38.24*
Total production costs	**100.00**	**100.00**	**100.00**	**100.00**

*1 USD = 5.67 TRY for 2019 year

In greenhouse eggplant production, the gross production value per decare was found to be 30868.93 TRY in the average of the enterprises. This value is the lowest in I. group farms with 28151.06 TRY per decare. II group farms had the highest value with 32637.89 TRY. This value was calculated as 31319.59 TRY in III group farms (Table 7). Gross profit was found by subtracting the variable cost from the gross production value (Kıral et al., 1999). The gross profit per decare in greenhouse eggplant production was calculated as 15668.88 TRY in the average of enterprises. It was the lowest value with 14693.53 TRY per decare in small scale enterprises (Table 6).

The absolute (net) profit was determined by subtracting the production cost for greenhouse eggplant production from the gross production value (Kıral et al., 1999). It is known that the primary purpose of the business is to make a profit, and it must seek ways to maximise this profit. The average absolute profit of the enterprises was calculated as 6258.48 TRY per decare. Net profit per decare in small-scale enterprises was at the lowest level with 1605.28 TRY. Net profit was increasing as the scale of the farms increased. It was calculated that this value varies between 1605.28 TRY and 8304.55 TRY in farms groups (Table 6). Absolute profit from greenhouse eggplant production was negative in 17% of the enterprises.

The relative profit was found as the ratio of the gross value of production to the cost of production. Relative profit better measures the return of production activities (Kıral et al., 1999). The relative profit in greenhouse eggplant cultivation was calculated as 1.25 (Table 6). The relative profit value calculated for the 2019 production season indicated the profitable greenhouse eggplant activity. A gross production value of 125 TRY was obtained for each 100 TRY production cost in greenhouse eggplant production. Therefore, a profit of 25 TRY was obtained for every 100 TRY production costs. However, approximately 24.62% of the farms in the region made a loss. In addition, there were also high-profit enterprises.

The cost of 1 kg of eggplant was 2.59 TRY in the farm width group I, 2.01 TRY in the farms' width group II. It was calculated as 2.13 TRY in the III. farms group and 2.20 TRY in the average of the enterprises. As the greenhouse area increased in the enterprises, the unit product cost also decreased (Table 6).

The selling price of 1 kg of eggplant changed between 2.69 TRY and 2.81 TRY in farms width groups. It was calculated as 2.76 TRY in the average of the enterprises (Table 6).

The yield of eggplants per decare ranged between 10255.32 kg and 12126.32 kg in the farms' groups. The greenhouse eggplant yield was 11174.93 kg per decare in the average of the enterprises (Table 6). Therefore, an increase in the scale of the enterprise in the region will increase profitability.

In a study conducted in Antalya in 2019, they calculated the cost of 1 kg of a product as 3.07 TL, the price received by the farmer as 2.65 TL, and the gross profit as 0.44 TL in greenhouse eggplant cultivation. Researchers found the net profit negative (Bayramoğlu et al., 2020). In a study conducted in Adıyaman in 2018, the cost of eggplant per kg was determined as 0.68 TL and the sales price as 2 TL (Ukav, 2018). In a study conducted in Mersin in 2019, they calculated the cost of 1 kg of a product as 1.79 TL and the sales price as 2.52 TL in greenhouse eggplant cultivation. In the same study, the authors found the relative profit to be 1.41 (Hayran and Gül, 2020).

Table 6: Cost and profitability of eggplant production in greenhouse

Costs and profit	Farm groups (da)			Average
	I	II	III	
1. Gross production value (TRY/da)	28151.06	32637.89	31319.59	30868.93
2. Variable cost (TRY/da)	13457.54	15299.15	15995.82	15200.05
3. Gross profit (TRY/da) (1-2)	14693.53	17338.74	15323.76	15668.88
4. Total production costs (TRY/da)	26545.78	24333.34	23808.41	24610.45
5. Net profit (TRY/da) (1-4)	1605.28	8304.55	7511.18	6258.48
6. Relative profit (1/4)	1.06	1.34	1.32	1.25
7. Per kg production cost (TRY/kg)	2.59	2.01	2.13	2.20
8. Per kg sale price (TRY/kg)	2.75	2.69	2.81	2.76
9. Yield (kg/da)	10255.32	12126.32	11154.64	11174.93

In Figure 4, 1 kg cost and relative profit of 65 greenhouse eggplant producers were interviewed, and the relationship between these two variables was given. The model, in which the cost of 1 kg of greenhouse eggplants was taken as the dependent variable and the relative profit as the independent variable, was calculated linearly. Accordingly, the relative profit will reduce the cost of 1 kg of greenhouse eggplants.

Greenhouse eggplant farms' main marketing channels in the sale of products were commissioners. Because there is a fresh fruit and vegetable market in the district. Başbuğ and Gül (2016b) also found in their study that the leading role players in the fresh vegetable marketing channel were local commissioners.
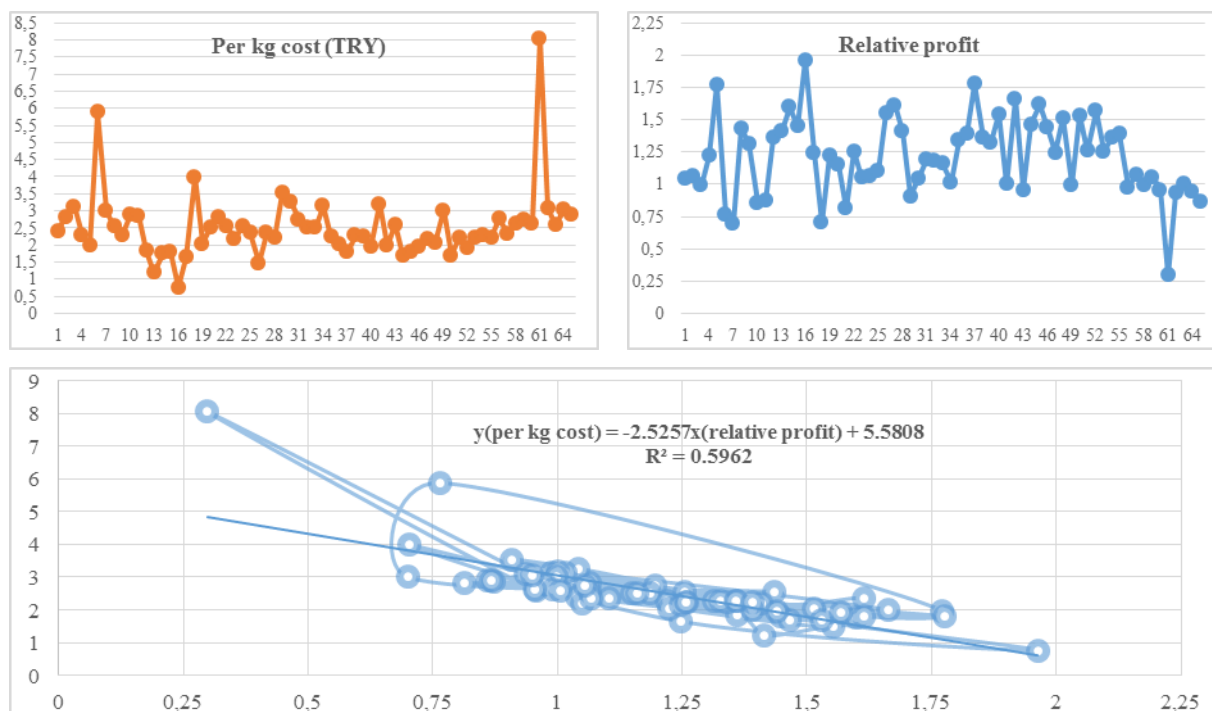
Figure 4: Relationship per kg cost and relative profit

5. Conclusions and Recommendations

As a result of this study, in which the technical structure, cost and profitability analysis of greenhouse eggplant cultivation in Gazipaşa district of Antalya province, it can be stated that the economic performance of large-scale farms is better. It was determined that the farms, divided into three groups, were generally economically profitable, and the profit rates of large-scale farms were higher than medium-small-sized farms.

The precautions to be taken to maintain and develop greenhouse eggplant cultivation in the Gazipaşa region can be expressed as follows:

In terms of greenhouse eggplant cultivation in the region, the production of Yakut, Sicilian, Doyuran black eggplant varieties demanded by export should be preferred.

Considering the environmental conditions, various control methods should be expanded for biological control and residue-free production.

Ensuring cooperatives in the operators engaged in greenhouse cultivation of eggplant in the region will enable them to be more effective in the market.

Measures should be taken to increase the scale of especially small-scale production enterprises in the region.

6. References

ACIL, A.F. Calculation of agricultural product costs and developments in agricultural product cost in our Country (in Turkish). Ankara University Faculty of Agriculture Publications, p. 76, 1977.

ARAS, A. Agricultural accounting (in Turkish). Ege University Faculty of Agriculture Publications No: 486, p. 86, 1988.

BĂRBUȚĂ, I; MĂNIUȚIU, D; BALCĂU, S. Economic efficiency of eggplant culture under the influence of some technological factors. Bulletin UASVM Horticulture, v. 71, n. 1, p. 130-134, 2014.

BASBUG, T; GUL, M. Analysis of cost and profitability for enterprises engaged in greenhouse cultivation in highland conditions: The case of Elmali, Antalya. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, v. 16, n. 2, p. 19-26, 2016a.

BASBUG, T; GUL, M. Problems regarding input use and marketing structure of farms involved in greenhouse cultivating in highland conditions: The sample of Antalya city's Elmali District. Scientific Papers: Management, Economic Engineering in Agriculture & Rural Development, v. 16, n. 2, p. 27-35. 2016b.

BAYRAMOĞLU, Z; KARAKAYACI, Z; AĞIZAN, K; AĞIZAN, S; BOZDEMİR, M. Determination of factors affecting production costs in major vegetable products (in Turkish). Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi, v. 24, n. 3, p. 603-613, 2021.

CHUPUNGCO, A; ELAZEGUI, D; NGUYEN, M. R. Seed system, production and marketing of eggplant in three major producing provinces in the Philippines. The Philippine Journal of Crop Science, v. 36, n. 2, p. 37-47, 2011.

ENGINDENIZ, S; YILMAZ, İ; DURMUŞOĞLU, E; YAĞMUR, B; ELTEZ, R. Z; DEMIRTAŞ, B; ENGINDENIZ, D; TATARHAN, A. H. Comparative input analysis of greenhouse vegetables (in Turkish). Ekoloji, v. 19, n. 74, p. 122-130, 2010.

FAOSTAT. Food and Agriculture Organization of the United Nations. Date of access: 30.01.2022, website: https://www.fao.org/faostat/en/#data/QCL, 2022.

GÜL, M; DAĞISTAN, E; DEMİRTAŞ, B; YILMAZ, H; KARATAŞ, A; YILMAZ, Y. Developments and seasonal fluctuations in some vegetable prices in Antalya province (in Turkish). Mustafa Kemal Üniversitesi Ziraat Fakültesi Dergisi, v. 14, n. 2, p. 57-68, 2009.

GÜL, M; TOPÇU, F; KADAKOĞLU, B; ŞİRİKÇİ, B.S. (2021). Cost and profitability analysis of tomato production in the greenhouse in highland conditions: a case study of Burdur Province, Turkey. Custos e @gronegócio online, v. 17, p. n. 3, 160-175, 2021.

GÜL, M; YILMAZ, H; AKPINAR, M. Fresh fruit and vegetable consumption and expenditure structure: A case of Adana province (in Turkish). VIII. National Agricultural Economics Congress, Proceedings of Food Marketing, June 25-27, Bursa, p. 133-144, 2008.

HAYRAN, S; GÜL, A. The profitability analysis of the main vegetables in Mersin province (in Turkish). Ziraat Mühendisliği, n. 370, p. 45-53, 2020.

HIZAL, T; KARLI, B. Determination of factors affecting of producers' seed preferences in greenhouse vegetable growing: The case of Antalya province (in Turkish). Mustafa Kemal Üniversitesi Tarım Bilimleri Dergisi, v. 25, n. 3, p. 383-393, 2020.

KIRAL, T; KASNAKOGLU, H; TATLIDIL, F.F; FIDAN, H; GUNDOGMUS, E. Cost Calculation Methodology and Database Guide for Agricultural Products (in Turkish). Agricultural Economics and Research Institute, TEPGE Report No: 1999-13, p. 143, 1999.

OKTAY, E. Analysis and planning of agricultural enterprises (in Turkish). Ege University Faculty of Agriculture Agricultural Economics Lecture Notes, Publications No: 64-1, p. 114, 1989.

ÖZKAN, B; AKÇAÖZ, H. V; KARAMAN, S; TAŞCIOĞLU, Y. An economic assessment of pesticide use in greenhouse vegetable production in Antalya province (in Turkish). Bahçe, v. 31, n. 1, p. 9-16, 2002.

RASHID, M; HASAN, M; MATIN, M. Socio-economic performance of Bt eggplant cultivation in Bangladesh. Bangladesh Journal of Agricultural Research, v. 43, n. 2, p. 187-203, 2018.

UKAV, İ. A research on the production costs and profitability of some vegetables produced in Adıyaman province (in Turkish). Turkish Journal of Agriculture-Food Science and Technology, v. 6, n. 9, p. 1285-1289, 2018.

UNDP (2015). United Nations Development Programme, Human Development Report 2015, Work for Human Development.

YAMANE, T. Basic Sampling Methods. Translated by A. Esin; M.A. Bakir; C. Aydin; E. Gurbuzsel. Literature Publishing No:53, p. 118, 2001.