Economic analysis of tomato cultivation in plastic greenhouses of Antalya Province in Turkey

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Abstract

Crop production in a greenhouse has the disadvantages such as high establishment and operational costs compared to the other agricultural production areas. Therefore, determining the production costs of the products grown in a greenhouse which has advantages such as more products per unit area and higher selling price due to the time advantage in marketing, and the economic outcome of the operational activities are important. In this study, 66 producers, who were determined by purposive sampling method and engage in greenhouse tomato cultivation in Serik district of Antalya province consisted the sample size. The data for the 2016-2017 production season were collected via the face to face questionnaires. The socio-economic characteristics of the producers primarily were examined in the analysis of the data, and then the production cost of 1 kg tomatoes was calculated. The results indicated that the total cost of tomato production in the plastic greenhouses per decare was US$ 621.34, and the ratio of variable costs to the total production costs was 80.48%. The cost of tomato production was determined as 0.061 US$/kg and the yield was 10151 kg/da. The relative profit of tomato production was calculated as US$ 4.08.

Keywords: Antalya province. Tomatoes. Cost. Greenhouse.

1. Introduction

Greenhouses are the transparent buildings that enable the cultivation of plants economically under climatic conditions that are not suitable for plant growth, and provide necessary growing conditions for vegetative production (Sevgican et al., 2000). The greenhouses, where necessary environmental conditions are created by removing the effects of external climate factors, can be high or low and covered with plastic or glass.

Ecological conditions are the primary causes in expansion of the greenhouse farming; thus most of greenhouses have been concentrated on the southern coast of Turkey. Antalya is one of the well-known regions in greenhouse cultivation, and tomato, cucumber, eggplant and pepper are the intensely grown vegetables in the greenhouses of Antalya province (TÜİK 2019a).

Total coverage area of plastic greenhouses in Turkey is 352.044 da and tomato is grown in 59.72% of the plastic greenhouses. The share of plastic greenhouses in Antalya where tomatoes grown is 63.20%. Serik where greenhouse farming is important, is one of the important districts of Antalya. The coverage of greenhouse cultivation in Serik district as of 2018 was 45.980 da (TSI, 2019).

Greenhouse cultivation requires high establishment and operational costs compared to the other agricultural branches and also requires more technical information, however, increases the profit of a farm by obtaining a high price since the products are placed in market before the products produced in the open fields. More products obtained from per unit area compared to open fields and higher market prices due to time advantage in marketing makes greenhouse production attractive. In addition, Pezikoğlu (1999) stated that greenhouse cultivation also reduces hidden unemployment in the agriculture.

Successful management in a farm requires production management towards the goal of profit maximization. In this respect, information gathered from the real data on the costs and profitability of these products will help producers decide among the product alternatives. Therefore, calculating the production costs of products grown in the greenhouses and determining the economic outcome of the operating activities are important. In this study, the cost of tomato production in the plastic greenhouses located in Serik district of Antalya province was calculated.

2. Literature Review

Many studies have been carried out to determine the costs of agricultural products, except the cost and profitability of grown in the greenhouses. Bayramoğlu et al. (2005), Rad and Yarşı (2005), Taşcı and Oğuz (2014), Topçu et al. (2015), Gözener (2016) and Gözener (2018) can be listed among such studies. The examples of studies on the cost and profitability of other products can be increased. The previous researches on the production cost and profitability of tomato were summarized below.

Karkacıer and Altuntaş (1998) who conducted a comparative cost analysis in cucumber and tomato cultivation in Tokat province found that the net profitability of greenhouse tomato cultivation was higher.

The calculations of Popescu (2003), who evaluated a three-year data of a greenhouse farm growing tomatoes in Romania, revealed that the cost of tomato production increased every year due to the influence of the inflation. The results indicated that the revenues generated were high enough to cover production costs and provided an average profit of 13%. The researcher commented that tomato production in the greenhouse which guarantees high income and profit can be a good option for a producer.

Rad and Yarşı (2005), who carried out a study with the enterprises located in Silifke district of Mersin province growing single and double period tomatoes in the greenhouses, determined that the enterprises producing double periods are more profitable. The researchers stated that greenhouse production in the region is a profitable alternative for the agricultural enterprises that want to use their family labor, capital and land, and suggested to be supported.

Polat et al (2013) conducted a study in Eskişehir province to determine the production input costs of barley, wheat, sugar beet, corn, green lentils, chickpeas, tomatoes, red beans, poppy, canola, nectarine, sunflower and aspirin. The results showed that tomato is one of the three products with the lowest average production cost per kilogram product among the 13 products investigated. However, tomato, nectarine and sugar beet have been identified as the highest cost products based on the total cost per unit area.

Testa (2014) focused on economic sustainability in the greenhouse cherry tomato cultivation in the province of Ragusa and calculated the production cost and profitability of cherry tomatoes in Sicily. The researcher who carried out an economic analysis on thirty representative farms, stated that a small decrease in tomato yield or price will cause negative profits, therefore indicated that the cherry tomato cultivation may hardly cover the production costs if sales prices remain at the current level. The results concluded that the tomato supply chain should be restructured since tomato producers operate in a competitive market.

Başbuğ (2016) analyzed the economic structure of the enterprises dealing with greenhouse production in Elmalı district of Antalya province. The cost of 1 kg of tomatoes was determined as 0.69 TL and the researcher stated that greenhouse vegetable cultivation is an important source of income for Antalya province.

Demirtaş et al. (2016) compared the production costs and net profits of tomatoes produced in organic, traditional and soilless cultures in the greenhouses located in Mersin

province, where greenhouse farming is extensive. The results showed that the organic cultivation system provided the highest net profit in greenhouse cultivation.

Timofte (2017) analyzed the cost and profitability of the greenhouse enterprises located in the Moldovan region of Romania in 2014-2015 and 2015-2016 growing seasons, and compared the hydroponic, conventional and organic tomato growing systems. The result of cost and profitability of greenhouse cultivation study indicated that economic indicators of larger farms were better. The total profitability ratio of the enterprises was quite high which led to the expansion of greenhouse farming in the region. The greenhouse practice was considered vital for the region because it promotes the effective use of regional resources, increases the income of people and creates employment, thereby reduces the migration from rural areas.

The researchers who carried out a study in Punjab on off-season tomato cultivation, stated that the fruits and vegetables demanded in all seasons of a year can be produced outside the season under polyethylene and plastic tunnels (Ali et al., 2017). Cost analysis of tomato production was carried out with 70 farmers and the enterprises classified as small, medium and large-scale, and the factors affecting the income were determined by a regression analysis. The researchers concluded that off-season tomato cultivation is a profitable production activity and the return is more than double the cost. The profits of small-scale farms was found to be higher in this type of production compared to the medium and large size enterprises.

Vanitha et al. (2018) conducted a study in Karnataka with 150 farmers who grew tomatoes in three seasons using different tomato varieties in three rural settlements. Costs, returns and profits of tomato farming in different seasons, market prices for hybrid varieties and hybrids were analyzed separately. The researchers revealed that the production is profitable in Malur for all three seasons, in spring and summer in Mulbagal, and only in summer in Srinivaspura.

Örük and Engindeniz (2019) studied the economic analysis of greenhouse tomato production in Muğla Province. The farms producing tomatoes in glass and plastic greenhouses were included in the scope of the study. Tomato cultivation alternatives for double season (fall-spring) and single crop cultivation per year have been investigated in the study. The results indicated that the highest profit was obtained in fall season tomato cultivation for the glass greenhouse, while the cultivation in plastic greenhouse during the spring season caused to lose money. The findings revealed that the net profit gained in the glass greenhouse was mostly higher than that of the plastic greenhouse.

Kocaköse and Aktürk (2019) evaluated the production preferences of the enterprises located in Kumkale Plain, Çanakkale Province with their product costs. Tomato was one of the six products investigated in the study. Analytical Hierarchy Process (AHS) method was used in determining the preferences of producers and simple cost calculations method was used in calculating the product costs. Eight criteria were used to determine the producer preferences among six products and tomato was ranked second only for the product price criterion. The net profit of tomato was determined as negative.

The aforementioned studies indicated that the cost and profitability level of tomato production in greenhouses varies depending on the regions, growing system and production seasons. There are some studies demonstrating that tomato cultivation is a profitable production area in a greenhouse, while others reporting small profit margins, profit rates that may risk the producers due to high input costs or low product prices and even negative profitability.

Determining the actual costs and profitability of tomatoes is a vital issue for the agriculture in Turkey. The actual costs may be learned by conducting micro scale studies. Studies in different regions of the country may enable general assessment about the cost and profitability status of tomatoes production in the country. In addition, studies on the product costs and profitability conducted in any region enable comparisons at international level. In this study, the production cost and profitability of greenhouse tomato production in Serik district, which is a very important region for greenhouse tomato production, of Antalya province in Turkey was determined.

3. Material and Methods

Antalya province was chosen as the study area due to the intensive greenhouse vegetable production areas in Turkey. Three villages (Türkler, Toslak and Payallar) from Serik District, which constitute more than 10% of the total plastic greenhouse areas in Antalya province, have been determined purposefully. The records of Serik District Agriculture and Forestry Directorate indicated that there were 219 producers growing tomatoes in the greenhouse in the villages determined. The sample volume consisted 30% of the 219 producers (66 producers) and the data obtained from the surveys conducted with 66 producers constituted the main material of the study. The surveys were conducted in March 2017.

The labor force of the farmer family was converted to the male labor force unit (MLU) to use a common unit to express the labor force of the enterprises. The calculations were

performed assuming that a male worked an average of 10 hours a day, 300 days a year or 10 months. Family labor force wages were determined as alternative wages on foreign labor force wages.

The production costs were calculated for a production season. In the interest calculations, vegetable production interest rate (8%) of TC Ziraat Bank was used and the value was calculated over the half of the interest rate, assuming that the variable costs spread throughout the production period (Kıral et al., 1999). Bare land value was calculated by 5% of the land purchase and sale value (Fidan, 2001). General administrative expenses were calculated by 3% of the variable expenses.

The Straight Line Method was used to calculate the depreciations, considering the economic life of the fixtures, and the economic life of the greenhouses (iron construction) was considered as 20 years (Eraktan, 1995).

The production cost of 1 kg tomatoes was calculated using the data obtained. The dollar exchange rate of the Central Bank of the Republic of Turkey (US$1 = 3.52 TL) was used in the production cost and profitability analysis. The currencies have been converted to US$ to include the other studies carried out in different countries to the discussion and to make healthier comparisons. Two different sources have been used during the conversion process (Anonymous 2020a, Anonymous 2020b).

4. Results and Discussion

Some demographic characteristics of the producers were determined and the data related to demography were given in Table 1. The age was the first characteristic determined for the producers and the average age of the producers was 32.68. The age distribution of the producers revealed that the ratio of producers who can be defined as young between the ages of 20-30 was quite low (10.61%). The most crowded age group was 31-45 years old.

Table 1: Some demographic characteristics of the producers participated in the survey

		Frequency	Percent
Distribution of producers by age	20-30	7	10.61
	31-45	32	48.49
	46-+	27	40.90
	Total	**66**	**100**
Distribution of producers by gender	Man	64	96.97
	Women	2	3.03
	Total	**66**	**100**

Distribution of producers by level of education	Primary	53	80.30
	Secondary	7	10.61
	High	6	9.09
	Total	**66**	**100**

Almost all the tomatoes producers in the study area were men (Table 1). The patriarchal structure is still maintained in agricultural families throughout the country. Although women work as much as men in the greenhouses, though the owner of the enterprises are generally the men. The data obtained in this study also concur with this information.

The statistical data of Turkey in 2017 on education revealed that 17.62% of the population over the age of 15 composed of undergraduate, graduate and postgraduate levels of education (TSI, 2018). The results on educational status of the producers participating in the survey pointed that none of the producers had an undergraduate or higher education and a large part (80.30%) was composed of primary school graduates. The results showed that the education level of the people engaged in agriculture in the region is low. Education level in rural areas of Turkey has been often reported as low. The field surveys conducted in different rural areas of Turkey indicated that the ratio of individuals who had undergraduate or higher education was quite low and revealed that the majority was the primary school graduates (Akalin 2018, Bozok et al., 2016, Oruç et al., 2016, Kutlar et al 2014, Torun, 2011). The education level of producers in the region of interest is similar to the education level of other rural areas in Turkey.

Some information on tomato production was given in Table 2. All enterprises interviewed grow tomatoes in the greenhouse. Therefore, the producers used in the study will mean the farmers who grow tomatoes in the greenhouse.

Significant share of the producers had their own greenhouses (90.91%), while some producers (12.12%) hired the greenhouses. More than half of the producers use the seedlings that they grow, however, significant rate (38.36%) of the producers buy seedlings from input dealers.

Table 2: Some information on the tomato production of the producers

		Frequency	Percent
Tomato production area ownership status*	Own	60	90.91
	Hired	8	12.12
Tomato seedlings supply locations*	Input dealer	28	38.36
	Own farm	45	61.64
Length of tomato farming experience	0-5	4	6.06

time (year)	6-10	16	24.24
	11-+	46	69.70
	Total	**66**	**100**

* Multiple options should be marked

Approximately three quarters of the producers had at least 11 years of experience in tomato cultivation. The duration of experience was parallel to the ages of the producers.

The opinions of the producers about the preference for tomato cultivation, the problems they encountered during the production process and the adequacy of the state supports provided for tomato cultivation were gathered (Table 3).

Table 3: Some evaluations of the producers on the tomato production process

		Frequency	Percent
Tomato growing reason *	High return	52	78.79
	Low labor	50	75.76
	Low cost	7	10.61
Problems encountered in tomato production *	Difficulty in disease-pest management	59	89.39
	High cost of inputs	35	53.03
	Low price of the product	16	24.24
	Lack of technical information	3	4.55
	Insufficient labor	2	3.03
Thoughts on the adequacy of state subsidies	Sufficient	9	13.64
	Insufficient	57	86.36

* Multiple options should be marked

The two main reasons for tomato production were the high yield of the product and low labor requirement. Small rate of the producers also indicated the low cost as a reason.

The main problem in tomato production is the disease and pest management. The difficulty of control was the most common problem (90%) raised by the producers. Other researches also reported that the disease and pest problems cause great concern in tomato production. The study conducted in Ankara province revealed that despite the plant protection against pests and diseases during the tomato production process, there was 25.92% crop loss in Ayaş district and 27.51% in Nallıhan district (Demirci et al., 2005). High cost of the inputs in the tomato production is ranked in the second place among the tomato production problems and the ratio of producers who stated this problem was 53.03%. In addition, lack of labor force and technical knowledge, low prices were among the problems specified by the producers. A significant rate of the producers (86.36%) stated that the supports provided by the state are insufficient.

Calculation of the tomato production cost in the plastic greenhouses for the research area was one of the main purposes of the study. The information on the calculations of production costs were given in Table 4. Total cost of tomato production per decare in plastic greenhouses was USD 621.34. The ratios of fixed and variable costs in total costs differ depending on regions, production systems or production periods.

Table 4: Production costs (USD da[1]) of tomato growing farms surveyed and relative distribution (%)

COST ELEMENTS	Value	%	%
Greenhouse maintenance, preparation	43.95	7.07	8.79
Plastic cover and labor costs	39.55	6.37	7.91
Seedling + Planting	93.67	15.08	18.73
Fertilizer + Fertilization	119.92	19.30	23.98
Water + Irrigation	69.41	11.17	13.88
Pesticide + Disinfection	32.35	5.21	6.47
Heating cost	12.80	2.06	2.56
Harvest	27.27	4.39	5.45
Transport	5.46	0.88	1.09
Maintenance	36.42	5.86	7.28
Circulating Capital Interest (0.04)	19.23	3.09	3.86
TOTAL of VARIABLE COSTS (A)	500.03	80.48	100.00
General Administration Expenses (A*%3)	15.00	2.41	12.37
Provision of bare land value interest	23.63	3.80	19.48
Depreciation of greenhouse facility costs	57.88	9.32	47.71
Provision of greenhouse investment interest	20.67	3.33	17.04
Depreciation of machinery	2.95	0.47	2.43
Provision of machine capital interest	1.18	0.19	0,97
TOTAL of FIXED COSTS(B)	121.31	19.52	100,00
TOTAL of PRODUCTION COSTS (A + B)	621.34	100.00	-

The results compiled from previous studies on the costs in greenhouse tomato cultivation were given below.

The results related to the production costs in studies conducted in different countries and regions were presented with different criteria (m^2, decares, acres, hectares, kilograms) and with various currencies. The differences in the date that the researchers conducted make the comparison of the results difficult. In this study, the results of previous studies on the cost of tomato production in the greenhouses and the results obtained in this study were compared by using the similar results.

The lowest cost (in US$) of 1 kg tomatoes in the greenhouse production was reported in Romania with US$ 0.402 (Popescu, 2003). The researchers stated that the costs of tomato

production in 2000 and 2001 increased from year to year due to the influence of the inflation. Popescu, who conducted the study, reached this conclusion based on the values he found for 2000 and 2001. Popescu (2003) reported that the cost of 1 kg tomatoes in 2000 and 2001 was US$ 0.302 and 0.352, respectively. Demirtaş et al. (2016) determined the production costs per kg tomatoes for traditional, organic and soilless farming systems as US$ 0.58 0.70 and 0.57. The cost of cherry tomatoes grown in a greenhouse located in Italy for 2014 was as € 1.26 (Testa, 2014). The comparison of the costs reported in previous studies in terms of year and currency showed that the costs in Italy is higher than the others. Testa (2014) reported that the profit margin of tomato production in greenhouse is low, therefore, the producers tend to give up tomato production in the greenhouse. Timofte (2017) determined the production costs of greenhouse tomato production for three separate systems in Romania. The 1 kg of tomato production costs given in the Rumen Leu converted to US$ at the exchange rate of 2016 was US$ 0.428 for the conventional system (1.69 RON), US$ 0.370 (1.46 RON) for hydroponic greenhouse growing system and the 2.460 US$ (9,71RON) for organic system. The researcher stated a special case in the 2016 related to the organic system, and the cost calculated for the previous year (2015) corresponded to US$ 0.801 (3.16 RON). Vanitha et al. (2018) determined 9 different production costs during three different production seasons for tomato production in the greenhouses located in three different rural settlements in Karnataka. Two values, the lowest and the highest values, were quoted from the study. The units were given as acre and Kental and as Indian Rupee (INR) and the currency was converted to the US$. The highest and the lowest costs of 1 kg tomato production in 2016 were US$ 1,930 and 1,219, respectively. Ali et al. (2017) determined the tomato production cost for three groups of enterprise size in Punjab province of Pakistan. The results showed that the production costs of 1 kg of tomatoes for small through large size enterprises in 2014 were ranked as S$ 0.193 (Rs 19.87), 0.118 (Rs 18.67) and 0.197 (Rs 20.23).

The cost of tomato production per kg in Serik, Antalya was determined as US$ 0.061 which is lower than the tomato production costs reported in other studies that given as US $ and € currency.

Rad and Yarşi (2005) reported the 1 kg tomato production cost as TL currency of the year in which the study was conducted. These values in the current TL are 0.776 TL (US$ 0.58), 0.594 TL (US$ 0.45) and 0.431 TL (US$ 0.32), respectively. The cost of 1 kg tomato production in 2008 was reported as 0.234 YTL (US$ 0.20) by Peker and Oğuz, in 2016 as 0.73 TL (US$ 0.24) by Başbuğ, and in 2017 as 0.90 YTL (US$ 0.24) by Topkara.

The production cost (US$ 0.061) determined in Serik district of Antalya province was 0.2231 TL/kg based on the US$ exchange rate of 2017. This value is the lowest cost among the costs reported in TL/kg. The comparison of the cost obtained for Serik in 2017 with the previous years suggested that the production cost of 1 kg of tomatoes was reduced or the cost in general was low for the study area.

Engindeniz and Tüzel (2002), who presented the production cost in m^2, calculated the production cost as € 3.3 for 2002, while Testa reported this value as € 20.87 for 2014. The value of the production cost determined in this study was US$ 0.621 per m^2 unit. Time difference between 2002 and 2017 is high enough that that the monetary value change for the Dollar and Euro, which are known as stable currencies, may partially be reflected in the production costs. However, the production cost of tomato determined for Romania is considerably higher than the others.

In addition, total cost values have been determined over per decare land. The total production cost per decare for glass greenhouse was reported as 8405.13 TL (US$ 1548.93) and for plastic greenhouses as 7 711.51 TL (US$ 1421.11) (Örük and Engindeniz 2019), while total production cost per decare for open field tomato production was determined as 3.819,93 TL (US$ 703.95) (Kocaköse and Aktürk 2019). Total production cost per decare in Serik, Antalya was calculated as 2 348.2 TL (US$ 621.34) based on the exchange rate of 2017.

The distribution of production costs, which will provide a more reliable comparison of production costs, is also important to understand the decisions of producers and the cost structure of the product. Therefore, the issue was also discussed in this respect based on quotations from previous studies.

The variable costs are generally higher in the distribution of the cost elements of tomato production in the greenhouse and can reach up to 90%. The distribution of variable-fixed costs varies depending on the production system. The results of this study indicated that variable costs are generally higher in traditional greenhouse tomato production system compared to the fixed costs. Engindeniz (2007) determined variable expense rates for contracted and non-contracted farming as 70.80 and 67.27%, respectively. The results show that the contract farming system also affects the cost distribution. Engindeniz (2007) stated that the seedling and seed cost of the producers engaged in contract farming are quite high and the most important costs compared to those non-contracted producers, and this element increased the variable cost ratio. The variable cost rate was reported as 78.1% by Testa (2014), 71.95% by Topkara (2017), and between 89.13 and 91.72% for different regions by

Vanitha et al. (2018). The most important cost elements in these studies were labor (Testa, 2014; Vanitha et al., 2018) and fertilizers (Topkara, 2017). The variable cost ratio for greenhouse tomato production in traditional, organic and soilless system was reported as 80.87, 80.84 and 78.99%, respectively (Demirtaş et al., 2016). Seedling costs are prominent for all three systems, while labor cost come to the fore for organic production in addition to the seedling cost. The rate of variable cost reported for tomato production in open fields was between 60.84% (Peker and Oğuz, 2008) and 85.06% (Kocaköse and Aktürk, 2019). The highest cost for the open field tomato production in Konya was recorded for irrigation (Peker and Oğuz, 2008), and material costs (Kocaköse and Aktürk, 2019) in Çanakkale. Rad and Yarşi (2005), who determined the variable cost rates for three periods based on the cultivation of single and double crops, reported that the variable-fixed costs were almost equal compared to other studies. The variable cost rate for three periods was ranged from 49.15 to 57.67% (fall season). Family labor allowance has become a prominent cost element in this study.

Studies conducted by Engindeniz and Tüzel (2002) and Timofte (2017) showed that the distribution of costs has changed in organic and hydroponic growing systems. Higher fixed cost rate (58.8%) was reported by Engindeniz (2002) for organic production compared to soilless system. Timofte (2017) indicated that the rate of variable costs (61.79%) was the highest for the traditional system, while the fixed costs was the highest for the organic and hydroponic systems. The fixed cost rate for the hydroponic system was 76.30%, while quite higher rate (97.97%) was determined especially for organic production system. The researcher stated that the depreciation of permanent labor, greenhouse facility and auxiliary elements were the prominent fixed costs in hydroponic and organic production systems, whereas certification costs were added to these costs in the organic production system. The fixed cost element that stands out in the study of Engindeniz (2002) was the first investment depreciation.

Considering all cost elements, the studies revealed that variable costs have an important share in greenhouse tomato cultivation. The seedling, seed, fertilizer-fertilization and greenhouse facility and the investment in services supporting the greenhouse are the prominent costs of the depreciation.

The rate of variable costs to total costs in in this study was determined as 80.48%. Fertilizer, fertilization, seedling and planting the seedling costs were the prominent costs among the variable costs. These costs had the highest share in total production costs. Fertilizer and fertilizing costs consist of about one fifth (19.30%) of the total cost. Seedlings and planting the seedlings had a share of 15.08% and ranked in the second place. Water and

irrigation costs (11.17%) were in the first place. Depreciation of greenhouse facility costs had the most important share in fixed costs.

Tomato yield varies significantly depending on region, climate and production systems. The tomato yield in this study was 10151 kg/da. Engindeniz and Tüzel (2002) determined organic tomato yield in the greenhouse as 7.29 kg/m^2 (7290 kg/da). The average yield of farms in Silifke district of Mersin province was 7500 kg/da for tomato growing in plastic greenhouse once a year, and for the two cultivations in a year, the yield was 9000 and 7500 kg/da in spring and in autumn seasons, respectively (Rad and Yarşı, 2005). Topkara (2017) reported the average tomato yield in Erdemli district of Mersin province as 9038.69 kg/da. The average tomato yield in open field of Çumra plain, Konya province was determined as 5830 kg/da (Peker and Oğuz 2008). Popescu (2003) who evaluated the three-year data stated that the tomato yield was 60 tons/ha in 2001 and increased to 92 tons/ha in 2002.

Demirtaş et al. (2016) indicated that the highest yield was obtained in the soilless agriculture system as 22.37 ton/da, followed by organic tomato cultivation with 19.23 ton/da and the traditional method with 18.55 ton/da. Kocaköse and Aktürk (2019) determined the average tomato yield in the open fields of Kumkale plain in Çanakkale province as 7 350 kg/da. Testa (2014) reported the average tomato yield in the Ragusa region of Sicily as 16.6 kg/m^2 (16600 kg/da). The tomato yield in glass greenhouses located in Central and Serik districts of Antalya province, where bumble bees were used for pollination was reported as 22 564 kg/da, while the yield in glass greenhouses without bumble bees was 20 589 kg/da (Karaman and Yılmaz, 2006). Engindeniz (2007) determined the tomato yield in contracted tomato production in Torbalı district of Izmir province as 75 915 kg/ha, while the tomato yield in uncontracted production was 71 971 kg/ha. The yield for open field tomato production in Punjab, Pakistan was reported in kg per acre. The acre is an area measurement unit of approximately four times greater the size of decare (1 decare = 0.247 acre). The tomato yield was 27524.17 kg, 29065.65 kg and 29563.20 kg/acre, for small, medium and large farms, respectively. The yield values calculated on a decare basis were 6 798.47 kg, 7 179.21 kg and 7 302.11 kg respectively (Ali et al., 2017). Small farmers had lower yields, however, they earned better revenue and price for their products. Vanitha et al. (2018) reported the yield values for three regions in Punjap as 188.5 q/acre, 157.5 q/acre and 188.7 q/acre, which correspond to 4 655.95 kg/da, 3 890.25 kg/da and 4660.89 kg/da.

Tomato yield varies between 4000 and 23 000 kg/da depending on the regions and the production systems. This is a determining factor for the profitability of tomato production.

The yield determined in this study (10151 kg/da) was close to the lower level of the tomato yield range.

The cost is an important factor in determining the production of a product, while profitability is expected to be decisive in final decision. Therefore, the yield and market price of a product also emerge as the important factors. The producers decide based on many rational and non-rational criteria in choosing the products to be grown, however, the profitability is the most important determinant for a product to be chosen.

The data on the profitability status of the tomato cultivated in the plastic greenhouse in Serik district of Antalya Province were given in Table 5. Tomato price for the relevant year was US $ 0.25 per kg. The price determined was calculated using the data for the amount of product and the cost of production per decare. Net profit for tomato production in the plastic greenhouses of the study area was determined as US $ 1916.41 per da and net profit per kilogram was US $ 0.1888. The relative profit of tomato production was calculated as US$ 4.08; thus, each unit cost for tomato production in the plastic greenhouses of the study area yields a profit of US$ 4.08.

Table 5: Profitability status in tomatoes cultivation

		Value
Yield (kg/da)	A	10 151
Sale price (US$/kg)	B	0.25
Production cost (US$/decare)	C	621.34
Gross production value (US$/decare)	A*B=G	2 537.75
Unit cost (US$/kg)	C/A=D	0.06121
Production Cost (US$ tonnes-1)	D*1000	61.21
Net profit per unit (US$/kg)	B-D	0.1888
Net profit per decare (US$/decare)	G-C	1 916.41
Proportional profit	B/D	4.08

The results obtained in this study were discussed by taking the results reported in other studies related to net profit and similar criteria into account. Similar units have been evaluated to provide opportunity for reliable comparison.

Rad and Yarşi (2005) calculated the profitability for single and double period tomato cultivation in the greenhouse, and reported that double-period tomato growing was 226.6% more profitable than the single period tomato growing. Net profit in the autumn production period was reported negative. The conversion of data to US$ indicated that net profit per decare corresponds to US$ 1065.79 and 3 480.91 in single period tomato cultivation.

Demirtaş et al. (2016) comparatively analyzed the costs and profitability of traditional, organic and soilless greenhouse tomato cultivation. The results of Demirtaş et al. (2016) showed that organic system provided the highest net profit, while the traditional system the lowest. Net profits per unit area (1000 m^2) in traditional, organic and soilless systems were US$ 2608.98, 7314.31 and 3278.87, respectively.

Popescu (2003) also investigated the effect of inflation on cost and profitability, which were calculated using three-year data. The researcher stated that the net profit in 2000 was 2 644 US $ per hectare and increased to 4815 US $ in 2002.

Topkara (2017) calculated the net profit per decare in Erdemli district of Mersin province as 2856.63 TL that corresponds to US $ 923.31 when calculated with the rate in 2017. Engindeniz (2007) determined the net profit as 1804 US $/ha for contracted tomato growers and 2513 US $/ha for non-contracted growers.

Testa et al. (2014) calculated the net profit per square meter as (US$ 0.29) € 0.21 for the cherry tomatoes cultivation in the greenhouses located in the Ragusa region of Sicily. The results of the study revealed that the cherry tomatoes growers in the region should settle for a modest income. In this regard, the researchers emphasized that the farmer unions should be effective in providing an increase in profit margin.

Ali et al (2017) calculated the net profits for three different farm groups in Punjap, and showed that net income of small farms were higher than the medium and large size farms. Small size farms focus more on quality and get better prices for their products in the market. Net profit for small-scale enterprises was reported as 828 679.19 Rs/acre, for medium-sized enterprises 795296.05 Rs/acre and for large-scale enterprises 727842.99 Rs/acre. The net profits were converted to US$ per decare, and the values were US$ 1.988,18, 1.908,10 and 1.746,27 for small, medium and large size farms.

Timofte (2018) determined six different net profit levels for tomato production in the greenhouses with traditional, hydroponic and organic systems in two production periods (2014-2015 and 2015-2016). The results of the study showed that although the tomato production without soil requires extra cost for labor, it is more advantageous than the other two systems in terms of net profit. The highest net profit in the first production period was obtained in organic production, while in the second production period, net profit in the hydroponic system was higher than the traditional and organic systems. The net profit per square meter in the second production period was determined as 10.73 Lei in the traditional system, 51.47 Lei in the hydroponic system and 8.04 Lei in the organic system. The net profit

values for the relevant production period calculated in dollars were 3.062, 14.689 and 2.303 US $/m^2, respectively.

The highest profit in Muğla province was in greenhouses as 9152.14 TL/da which corresponded to 2958.1 US $/da (Örük and Engindeniz, 2019). In addition, the results revealed that tomato cultivation in the plastic greenhouse during spring period caused to lose money.

The net profit (1916.41 US$/da) in Serik district of Antalya province was close to the average compared to the net profit values reported in other studies. The results of previous studies indicated that the profit level per decare increased from US$ 180.4 (1804 US$/ha in the study) (Popescu, 2003) to US$ 14689 (14,689 US$/m2 in the study) (Timofte, 2018). The profits obtained in soilless system were significantly higher than others (Demirtaş et al., 2016; Timofte, 2018). The net profit level per decare was mostly concentrated around US$ 2000 to 3000.

The values given in kilogram eliminate the difference in yield in tomato cultivation and reveal the effect of cost-price clearer.

Demirtaş et al. (2016) reported the net profits in traditional, organic and soilless systems as 0.14, 0.38 and 0.15 US$/kg, respectively.

The net profit obtained in a tomato growing greenhouse in Romania was 0.052 US$/kg in 2002 (Popescu, 2003).

Testa et al. (2014), who conducted a study in the Ragusa region of Sicily, found that net profit for cherry tomatoes in the greenhouse was 0.01 €/kg.

Vanitha et al. (2018) determined nine different net profit values for three seasons (single, spring and autumn) in three rural settlements in Karnataka. The highest net profit was 547 Rs/q and the lowest one was -51 Rs/q. Two out of nine net profits were negative and the other seven were positive net profit. The highest profit in USD bases was calculated as 0.082 US$/kg.

Kocaköse and Aktürk (2019) determined the relative profit for 1 kg of tomatoes as 1 TL open field tomato production. According to the dollar currency of 2018, the net profit per kilogram tomato in Çanakkale province was equal to 0,183 US $.

In this study, the net profit value was calculated as 0.0612 US$/kg, which was similar to net profit values given in some of the other studies. Demirtaş et al. (2016) indicated that the net profit values per kilogram tomato in Çanakkale province for open field tomato production in three different systems were higher than the previous studies. The results of Demirtaş et al

(2016) indicated that the highest net profit for one kilogram of tomatoes was recorded in the soilless system with US$ 0.38.

The profit obtained in return for the 1 unit cost reveals the relative profitability of a product. In this study, the relative profit value for the tomatoes production in the plastic greenhouses was calculated as 4.08. Demirtaş et al. (2016) determined the relative profitability of traditional, organic and soilless systems as 1.24, 1.54 and 1.26, respectively. Ali et al. (2017) reported the relative profitability values for small, medium and large enterprises in Punjab, Pakistan as 0.52, 2.47 and 2.22, respectively. The proportional profit of tomato was calculated as 1.70 in a study in which the costs and profitability of eggplant, pepper, tomato and cucumber in Adıyaman province of Turkey.

The relative profit determined in this study was a high value. Similarly, other studies indicated that the return in tomato cultivation is higher than the cost of each unit. Although negative values have been reported for some production systems, regions or production periods, the positive profit was much more common. The relative profit values given in different studies indicate that the return may increase depending on different periods, regions and systems.

5. Conclusion

Tomato cultivation in the greenhouse is a profitable production area for the study area. The results of different studies revealed the differences in tomato production cost, distribution of cost by elements and profitability. Determining the causes of differences is important. Because, the differences may be related to incompetence or difficulties in the production systems, irregularities in the input and product markets. Thus, the avoidable negativities, between the input supply and consumer stages, reflected in the income from production can be eliminated.

Producers in the study area can be suggested to use better systems and technologies such as glass greenhouse, organic production, hydroponic and soilless production system in greenhouse tomato production. High investment requirement of these systems compared to the plastic greenhouse system may cause producers to be reluctant. Therefore, the producers should be informed about the quick return or the high revenue of the investments in aforementioned systems.

The findings of the study indicated that fertilizer and fertilization have an important share in the production costs. Therefore, a study can be conduct to investigate if the farmers

use the proper fertilizers at the right amount and at the right time, and precautions can be taken to prevent unnecessary use.

The disease-pest control is a severe problem in greenhouse tomato production for the majority of producers. This problem increases the costs and negatively affects the profitability due to significant reductions in the production and management costs. In the research level, the focus should be concentrated on developing versatile management strategies against tomato diseases and pests, while on the producer level, qualified information and application support should be provided to the producers in the field on agricultural control practices in greenhouse tomato production. Farmers should be supported on sustainable use of fertilizer and pesticide.

The findings of this study as well as previous studies reveal that tomato production, especially in the greenhouse system, generally provides a return above the expenses. However, the level of profitability varies significantly; thus, the producers may sustain the tomato production with a stable decent income rather than high income provided from time to time. Therefore, the factors leading to irregular functioning in the tomato production and marketing should be determined, and the effects of these factors if possible should be eliminated, or at least their effects should be controlled.

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