Production costs in safe vegetable production in greenhouse growing: the case study of Konya Province, Türkiye

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Abstract

Konya, one of the Turkish provinces where greenhouse production has increased the most recently, was selected as the research area. The primary goal of the study is to analyze the production costs of safe vegetable production in greenhouse cultivation. The study employed the full count method to determine the sample size. a survey was conducted with 96 operating enterprises. The enterprises are categorized as the following: 500-1000 m2, 1001-2000 m2, 2001-6000 m2, and 6001 m2 and above greenhouse enterprise size. 42.73 decares is the average total area of the enterprises in the research area, of which 2.43 decares are greenhouse areas and 40.30 decares are open areas. The average number of people per enterprise was found to be 4.86, with men making up 51.85% of the population and women, 48.15%. In greenhouse production, family labor makes up 35.90% of the labor force on average, while foreign labor makes up 64.10 percent. Tomatoes are the most widely grown vegetable, with a 99.67% share of the greenhouse production area dedicated to vegetable production. It was found that parsley generated the highest income per decare ($5,784.55), while lettuce generated the lowest income per decare ($1,379.61). In a greenhouse area of 352,199 m², tomatoes, cucumbers, and parsley have the highest production costs. The total cost of production per decare for growing tomatoes was determined to be 4,432.90 $/da, for cucumbers it was 4,251.00 $/da, and for parsley, 4,035 $/da. The research region's safe vegetable production index was found to be 56.60%, and the factors influencing safe vegetable production in the analyzed enterprises were examined using multiple linear regression analysis. Though at a moderate level, it can be said that producers' tendency to produce safe vegetables in the region is significant.

Keywords: Greenhouse cultivation. Safe Vegetable Production Index. Production cost. Konya.

1. Introduction

All nations in the world depend heavily on the agricultural sector, particularly when it comes to the supply of food. Globally, the number of people living in agricultural areas is declining annually. It is estimated that the world population, now approximately 7.8 billion, will exceed 9 billion in the 2050s (Oğuz and Bayramoğlu, 2018). With 84,680,273 people in 2021, Turkey is home to 1.06% of the world's population, placing it 19th out of 235 nations in terms of population size (TSI- Turkish Statistical Institute, - 2022). The importance of agriculture is once again demonstrated by the discussion of healthy and secure food, which has gained a lot of attention in recent years to feed both our nation's and the world's population. Solutions are pursued to increase the productivity obtained from the unit area by using new techniques and technologies in agricultural production to meet the growing demand for food resulting from population growth and to ensure food security against climate change. For this reason, greenhouse production—which enables the use of small and marginal areas—is an important issue that should be emphasized in addition to the use of high-yield and quality production varieties in open areas. Using more inputs per unit area in greenhouse production results in higher efficiency, which is advantageous as a profitable production system in small areas (Pezikoğlu, 1999; Wachira, 2012; Hedau et al., 2014). For this very reason, greenhouse farming is becoming more and more important, with a growing range of applications. Greenhouse agriculture, according to Sevgican (2003), includes low plastic tunnels and production under greenhouses. In the 12th Development Plan, it is among the priority sectors of agriculture (TSI, 2022).

Konya Province greenhouses can yield for at least ten months out of the year. Greenhouses are only abandoned for a maximum of two months during the winter in extremely cold years. Crops can be harvested in greenhouses in 2/3 periods in a year. Greenhouse farming is a source of income for small family enterprises, particularly those located in rural areas. These enterprises grow scallion, parsley, arugula, cress, dill, and other similar greens. Because the yield meets the producers' expectations, the number of enterprises in the region producing greenhouse goods is rising. The province of Konya contains 672 decares (0.08%) of Turkey's total greenhouse area of 854,600 decares. Thanks to ongoing projects and support, the greenhouse area in Konya is growing daily (TSI, 2022). According to estimates, greenhouse cultivation will accelerate in tandem with our region's average winter temperatures as a result of global warming. The fact that products like parsley, arugula, cress, scallion, and others grown in the area's greenhouses are continuously in

demand on the market is advantageous to the producer. Determining the production costs for safe vegetable production in greenhouse cultivation is the primary goal of the study.

2. Literature Review

The following is a summary of earlier pertinent research on estimating the costs of agricultural products in greenhouses.

In their work, Comparative Economic Analysis of Growing Tomato and Cucumber in Greenhouse and Open Area, Karkacıer and Altuntaş (1998) compared the cultivation of vegetables (cucumber and tomato) under greenhouse and open conditions. The study's 109 agricultural enterprises provided data, and based on that data, they concluded that greenhouse cultivation yielded a higher net profit than open-field farming. It has been found that the yield in open cucumber cultivation is lower than that of tomatoes, even though the yield in greenhouse tomato cultivation is higher than that in greenhouse cucumber cultivation.

Using information gathered from the enterprises where greenhouse vegetable cultivation is practiced extensively, Yilmaz et al. (2000) examined the attitudes and practices of producers regarding the use of pesticides and fertilizers in their study titled "Analysis of Pesticide and Fertilizer Use in Greenhouse Vegetable Growing in Antalya Province". It was found that 76% of the producers got their information about fertilizer and fertilization from pharmaceutical and fertilizer dealers, and 42% of them said they had no issues using fertilizer. They discovered that the production of tomatoes, peppers, and cucumbers involved the overuse of fertilizers and pesticides.

In their study "Possibilities for the Development of Greenhouse Vegetable Cultivation in Konya Region," Oğuz and Arısoy (2002) studied the enterprises growing greenhouse vegetables in the districts of Sarayönü, Konya, Merkez, Çumra, Seydişehir, Derebucak, Kadınhanı, and Merkez. The enterprises' economic activity results were also presented. 394.65 m2 is the average greenhouse area of the region's enterprises. It has been found that tomatoes are the most profitable product type; they are grown in 71.67% of this production area, while cucumbers are grown in 22.72%. The researchers claim that maintaining the region's greenhouse vegetable production could benefit enterprises financially.

By comparing the amounts of effective substances and the amounts that should be used, Özkan et al. (2002) aimed to reveal the economic losses of pesticides used by producers in growing annual tomatoes, peppers, eggplants, and cucumbers in greenhouses. The study's findings showed that the extra

expenses associated with overusing pesticides accounted for 27.3% of the cost of pesticide consumption per decare in tomato cultivation, 55.7% in pepper, 26% in eggplant, and 51% in cucumber. While 68.3% of the producers stated that they sprayed pesticides by observing their gardens, 20.2% did so based on the recommendations of pharmaceutical dealers. While 9.8% of the producers applied pesticides according to the recommendations of the technical staff of the provincial/district directorate of Agriculture and consultancy agricultural engineers, 1.7% stated that they applied pesticides when diseases and pests were observed in the fields and gardens of neighboring producers. They determined that the reasons why producers use more pesticides than the recommended dose are that the recommended dose is not effective enough (51.7%), that the recommended pesticides are not effective (42.7%) and that some pests are immune to the pesticides (5.6%).

In their study, Comparative Input Analysis of Greenhouse Vegetables, Engindeniz et al. (2010) analyzed the input usage levels of 204 producers in Antalya, Mersin, Muğla and İzmir. Ecological conditions are a determining factor in greenhouse production, and it has been found that this dependence leads to losses in productivity and quality. It has also been found that to lower these product losses, extensive synthetic chemicals are used in greenhouses, which are intensive agricultural areas. These substances were described as commercial (chemical) fertilizers, hormones that regulate plant growth, and substances that pollute the environment, upset the natural balance, and endanger human health. According to the study, producers went overboard with pesticides when growing vegetables in greenhouses.

In the province of Muğla, Öztürk and Engindeniz (2018) carried out a technical efficiency analysis on input use in greenhouse tomato production. In the study, survey data from 93 enterprises were assessed. The socioeconomic characteristics of the enterprises were first disclosed, and Data Envelopment Analysis (DEA) was then used to ascertain the input use efficiency of the enterprises' greenhouse tomato production. The average efficiency values in the CCR model, according to the DEA results, varied from 63% to 81% in glass greenhouses and from 55% to 76% in plastic greenhouses.

Örük and Engindeniz (2019) conducted a study titled "Analysis of input use decisions of producers growing greenhouse tomatoes with the analytical hierarchy process" to look at how producers in Muğla province make decisions about what inputs to use. Among the multi-criteria decision-making techniques, the Analytical Hierarchy Process (AHP) method was applied. It has been found that price, followed by marketing and yield, is the most influential factor when it comes to producers' decisions to use input in greenhouse tomato production.

They found that seedlings are the most crucial input for producers to consider when choosing which inputs to use, and that chemical inputs are the most preferred ones.

Eylem and Semerci (2023), in their study, Input Usage and Cost Analysis in Table Tomato Production: Çanakkale Province Turkey Example, made an economic analysis of open field table tomato production in agricultural enterprises in the Central District of Çanakkale province. The research's data came from 99 companies that produced table tomatoes in 2020, as determined by the Stratified Sampling Method. The cultivation area of 18.17 decares was used in the investigated enterprises to produce table tomatoes, and the yield per unit area was 7109.18 kg/da. Furthermore, the analysis revealed that the production of table tomatoes requires 1016.67 saplings per unit area, 48.92 kg/da of pure fertilizer, 0.62 lt of pesticides, 38.28 lt of diesel fuel, 207.82 hours of machine pulling, and 41.85 hours of human labor. The research area's enterprises yielded an average production value of 985.52 $/da for table-tomatoes, while the production cost per unit area was found to be 856.12 $/da.

In their 2020 study, "Economic Analysis of Tomato Cultivation in Plastic Greenhouses of Antalya Province in Turkey," Esen and Gözener analyzed data from 66 growers in the Serik district of Antalya province who grow tomatoes under greenhouse conditions using a purposeful sampling method they found that the production cost of a kilogram of tomatoes in plastic greenhouses is 621.34 USD per decare, with a unit cost of 0.061 USD/kg and a yield of 10151 kg/da.

Testa (2014) focused on the production cost and profitability of cherry tomatoes in Sicily with an emphasis on economic sustainability in greenhouse tomato cultivation in the province of Ragusa. After conducting an economic analysis on thirty representative farms, the researcher concluded that because tomato producers compete in a market where profits are at risk, even a slight drop in tomato yield or price would result in negative earnings and that the tomato supply chain needs to be reorganized.

In their study, A Comparison of Profitability and Cost Analyses of Tomato Cropping Systems in Greenhouses, Demirtaş et al. (2016) conducted an economic comparison of soilless, conventional, and organic cultivation systems in greenhouses. The study covers the years 2012-2014. The organic growing system outperformed the other two production systems in terms of net profit and production costs. In soilless culture, the average yield per unit area (ton 1000 m-2) was 22.37; in organic agriculture, it was 19.28; and in conventional cultivation, 18.55. The total production cost per unit area is $13,508.09 in organic cultivation,

$12,694.34 in soilless culture, and $10,744.62 in conventional cultivation systems. Net profit per unit area was $7,314.31 in organic production, $3,278.87 in soilless culture, and $2,608.98 in conventional cultivation system. The findings demonstrated that growing vegetables using alternative production methods is feasible financially.

3. Materials and Methods

3.1. Materials

The primary source of data for the study is a face-to-face survey conducted among Konya province producers who grow vegetables in greenhouses in an area of at least 500 m2. Furthermore, data gathered from pertinent institutions and organizations as well as earlier studies on the topic were employed. The data for the study spans the production period of January 1 through December 31, 2019, with a basis in 2019. The sample size was established using the full count method, which involved counting all 116 producers who were registered in the province's current greenhouse registration system (GRS). The surveys took place in October and September of 2020. Twenty of the 96 enterprises that participated in the survey were unable to meet with the producers due to the global pandemic. Dollars ($) are used to calculate operating income and expenses. For dollar exchange rate products, the average sales period is calculated as 1$=5.68 TL.

3.2. Method

3.2.1. Determining sample volume

A face-to-face survey was conducted with 96 enterprises under the Ministry of Agriculture and Forestry that operate greenhouse production in an area of 500 m2 or more in 44 neighborhoods across 13 districts in the province of Konya during the study's sampling phase. Table 1 and Figure 1 show the sample volume distribution by districts and villages.

Table 1: Distribution of sample volume by districts

Nr	District	Village	Nr. of Producers
1	Akşehir	13	33

2	Beyşehir	4	9
3	Bozkır	2	2
4	Çumra	1	2
5	Derebucak	3	4
6	Doğanhisar	3	7
7	Güneysınır	1	4
8	Hadim	1	1
9	Hüyük	1	1
10	Ilgın	2	3
11	Karatay	1	5
12	Meram	10	16
13	Seydişehir	2	9
Total	13	44	96

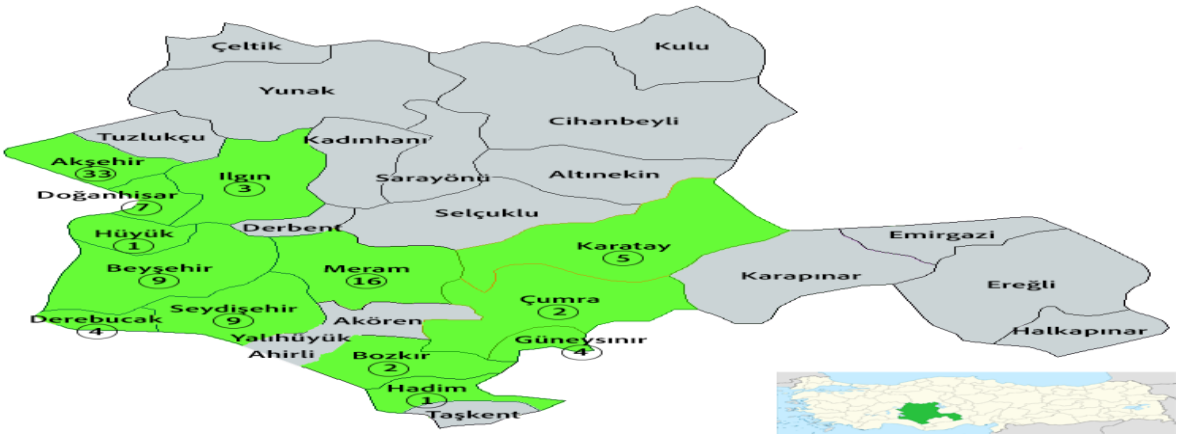

Figure 1: Districts and survey numbers included in the sample volume

Taking into consideration the coefficients of variation, the enterprises that were part of the study were categorized into four layers. As a result, they are categorized as enterprises having greenhouse operating sizes of at least 500-1000 m2, 1001-2000 m2, 2001-6000 m2 and 6001 m2 and above (Table 2).

Table 2: Distribution of enterprises by size groups (sample volume)

Enterprise size groups (m^2)	**Number of enterprises (n)**
500-1000	41
1001-2000	28
2001-6000	16
6001- +	11
Total number of enterprises	**96**

Based on producer declarations, the current land use status, vegetable production areas, and enterprise productivity levels were determined. After the survey data were

imported into Excel, the relevant charts were made and can be seen as straightforward graphs, analyses, and percentage rates.

3.2.2. Determination of cost elements and unit costs in greenhouse vegetable production

Producers grow tomatoes, cucumbers, peppers, beans, lettuce, scallion, cress, arugula, and parsley as their principal products for greenhouse cultivation. The data obtained about vegetables grown in greenhouses are compared using average values expressed as 1000 m² (1 decare). The cost of the product is determined per kilogram. Each product was

evaluated by filling out a different form. Every product's unit cost is computed using the producer's declared values. Drip irrigation systems are used as irrigation

equipment. By dividing the total costs by the amount of production attained, the unit product cost was computed.

$$Unit\ product\ cost = \frac{Production\ expenses\ total\ (TL)}{Production\ amount\ (kg)}$$

Based on the product, the values of absolute profit, relative profit, and gross profit were calculated. Relative profit is computed by dividing GPV (Gross Production Value) by production costs, gross profit is computed by deducting variable costs from GPV, and absolute profit is determined by subtracting production costs from GPV. Costs were analyzed as fixed and variable in greenhouse production. Labor, traction costs, material expenses (seedlings, seeds, fertilizer, pesticide, water, crate, rope, etc.), interest on the total expenses, harvest, marketing costs, etc. were calculated as cost elements in the analysis of variable costs. Calculated among the fixed costs were 3% for general administrative costs, 5% for the value of the bare land, depreciation on the greenhouse, interest on the capital of the greenhouse, depreciation on tool equipment, interest on tool equipment capital, and insurance costs. Based on the producers' declaration, material costs are calculated. The formula to calculate greenhouse capital interest is (Greenhouse value/2) x 5%. Following the calculation, this value was proportioned using GPV on a product basis.

Marketing expenses: All expenses incurred to take the product to the place where it will be sold (bazaar, market, etc.) after it is harvested, loading-unloading, transportation, packaging materials (crates, sacks, ropes and similar) and other related expenses (withholding

tax, commission and similar) costs were calculated (Erkuş et al., 1995; Kıral et al., 1999). Interest on variable expenses (revolving capital interest): Revolving capital interest is calculated by taking half of the total variable expenses and multiplying it by the operating interest rate applied by Ziraat Bank in the relevant period (Kıral et al., 1999). Half of the 12% interest rate for the working year has been taken as 6%. Greenhouse capital depreciation was calculated by subtracting its present value from the new establishment cost and dividing it by its economic life. The economic life of the greenhouse is taken as 15 years, and the plastic life is taken as 3 years (Özkan et al., 2005). Interest on fixed capital elements: Interest is calculated based on the half value of fixed capital elements subject to depreciation. While calculating the interest provision for machinery and building capital, end-of-period values were taken into account and interest requests were made at 5% (Kıral et al., 1999). Irrigation facility expenses: Irrigation facility expenses consist of depreciation, investment interest, repair and maintenance expenses. In this calculation, the technical characteristics and economic life of the facility were taken into account. These values are taken as an economic life of 4 years for drip irrigation and an average of 20 years for sprinkler irrigation systems. Tax: Real estate taxes of buildings, land and field, and taxes on agricultural machinery are taken into account as expense items, excluding income and corporate taxes (Kıral et al., 1999). General administrative expenses: In the study, general expenses were calculated by taking 3% of the total expenses incurred for a production period. (Kıral et al., 1999).

In calculating the Safe Vegetable Production Index (SVPI), the following data were determined to calculate the safe vegetable production levels of the producers in the research area and each of them was given a score between "0 and 1". After this scoring was turned into an index, all producers were named "Those who produce safe vegetables" according to the points they received." and "Those who do not produce safe vegetables" (Özkaya, 1996). The safe vegetable production index was calculated as follows:

Safe Vegetable Production Index (SVPI) = (TPRP / MSPR) *100

TPRP: Total Points Received by the Producer

MSPR: Maximum Score a Producer can Receive.

The group that includes producers with a safe vegetable production index of less than 50% is considered as "not producing safe vegetables", and the group of producers with an index of 50% and above is considered as "producing safe vegetables". The data used in the Safe Vegetable Production Index is given below:

SVPI =[(a+b+c+d+e+f+g+h+ı)/9] * 100

a: Organic Agriculture and good farming status (0: not doing, 1: doing)

b: Producer's experience period (less than 5 years: 0; more than 5 years: 1)

c: Insured production status (Not insured: 0; insured: 1)

d: The status of the pesticides leaving residue on the product (Leaves a little, a lot: 0; leaves no, very little, moderate residue: 1)

e: The producer's opinion about the harm to human health of the pesticides (leaves a little, a lot of residues: 0; leaves no, very little, moderate residue: 1)

f: The producer's opinion about the pesticides causing environmental pollution (somewhat, very much: 0; not at all, very little, moderately causing: 1)

g: Status of having soil analysis (Not having analysis: 0, having analysis: 1)

h: Status of being registered in the greenhouse registration system (GRS) (unregistered: 0, registered: 1)

ı: The average of the answers given by the producer to the attitudes towards the use of chemical inputs according to a five-point Likert scale (If the answers are less than 3; point: 0, if they are greater than 3; point: 1)

An analysis of multiple linear regression was used to identify the variables influencing the production of safe vegetables. A multiple linear regression model was employed to ascertain the variables influencing greenhouse growers' safe vegetable production. Depending on the correlation coefficient, the t-test value and coefficient of determination are used to assess the appropriateness and significance of the variables found through regression analysis. The interaction between the dependent and independent variables is displayed by the "t" test while its strength is indicated by the coefficient of determination. Squaring the correlation coefficient (R2) yields the coefficient of determination (Gujarati, 2009). The established model's dependent and independent variables are listed below.

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \varepsilon_i$$

Y= Safe Vegetable Production Index (SVPI) (above 50%, producing safe vegetables; below 50%, not producing safe vegetables)

β0= Fixed value

X1= Age of Producer (Year),

X2= Education level (primary level 1, high school level 2, and university level 3),

X3= Good farming status (0 for not doing good farming, 1 for doing good farming),

X4= Experience period (years),

X5= Cooperative membership (those who are members of the cooperative are 1, those who are not are 0),

X6= Gross profit ($/da),

X7= Insurance status (Insured 1, uninsured 2)

X8= Young farmer (young farmer 1, non-young farmer 0).

ε_i: Represents error.

4. Research Findings

4.1. Land use status of the enterprises

Land is the most crucial requirement for production in agricultural enterprises. Global food supply must be met through adequate production. Table 3 lists land assets categorized by enterprise groups.

Table 3: Land use status by enterprise groups

Enterprise size groups (m^2)	Open land (da)			Greenhouse land (da)			Total (da)		
	Owned	Lease	Total	Owned	Lease	Total	Owned	Lease	Total
500-1000	26.56	12.95	39.51	0.68	-	0.68	27.24	12.95	40.19
1001-2000	36.79	7.61	44.39	1.35	-	1.35	38.14	7.61	45.74
2001-6000	33.38	2.50	35.88	3.44	0.34	3.78	36.82	2.84	39.66
6000-+	37.09	2.18	39.27	6.10	3.61	9.71	43.19	5.79	48.98
Enterprise ave.	31.89	8.42	40.30	1.96	0.47	2.43	33.84	8.89	42.73
Ratio (%)	74.62	19.70	94.32	4.58	1.10	5.68	79.20	20.80	100.00

Since the amount of land used for production worldwide cannot be increased—instead, it is decreasing—more efforts have been made to produce more goods per unit area and to produce goods from the same land at different times. Greenhouse production is becoming

more significant in this regard. The land use status in enterprises, including both leased and owned lands, was investigated in the research area. Open land makes up 94.32% of the examined enterprises, while greenhouse areas comprise 5.68%. Farmers typically grow their crops in greenhouses in addition to open fields. The average total area of the enterprises is 42.73 decares, of which 2.43 decares is used as a greenhouse and 40.30 decares as open field. Table 4 shows the state of fragmentation in the greenhouse lands of the enterprises under research.

Table 4: Number and size of parcels in average greenhouse area according to enterprise groups

Enterprise size groups (m^2)	Greenhouse area (da)	Parcel number (pcs)	Parcel size (da)
500-1000	0.68	1.12	0.61
1001-2000	1.35	1.36	0.99
2001-6000	3.78	3.81	0.99
6001-+	9.71	1.45	0.78
Enterprises average	2.43	2.94	0.83

Depending on the enterprise group, the average greenhouse area ranges from 0.68 decares to 9.71 decares. All greenhouse structures are plastic. In a similar study conducted in Antalya, the total greenhouse area was determined as 9.40 decares, including 18.39 decares of open-field land, 3.04 decares of glass, and 6.36 decares of plastic (Yiğit, 2019). The average size of the greenhouse area in the enterprises was found to be 0.61 decares in the first group, 0.99 decares in the 2nd group of enterprises, 0.99 decares in the 3rd group, and 0.78 decares in the 4th group. In the research, the average greenhouse area of the enterprises was found to be 2.43 decares, the number of greenhouses was 2.94 and the greenhouse size was 0.83 decares. In the discussed enterprises, some enterprises grow crops in one, two and three seasons on the same land in greenhouses. Considering the second and third crop cultivation situation, the total production area in the examined enterprises increases by 51.06% and the cultivation area reaches 352,199 m2. 69.79% of the examined enterprises grow products in one season, 20.83% in two seasons and 9.38% in three seasons (Table 5). The products grown in the greenhouses of the enterprises vary depending on the growing season, such as tomatoes, cucumber, lettuce, pepper, beans, parsley, cress, arugula, scallion, and strawberry.

Table 5: Periods of growing crops in greenhouses in enterprises

Crop growing period	Number of enterprises (nr)	Ratio (%)
One season	67	69.79
Two seasons	20	20.83
Three seasons	9	9.38
Total number of enterprises	96	100.00

Table 6 lists the goods produced in greenhouses along with the number of enterprises and their ratios. According to the table, 35.37% of the total greenhouse area of 352,199 m2 is tomato, 25.60% is cucumber, 19.17% is lettuce, 6.69% is arugula, 1.64% is pepper, 6.13% is cress, 4.17% is parsley, 0.45% is scallion, 0.44% is green beans and 0.33% is strawberries. Enterprises that use a variety of products in greenhouse production are diversifying to appeal to a wider market, lower the rate of loss if diseases and pests increase in the products, and boost revenue.

Table 6: Products grown in greenhouses, number of enterprises, areas (m2) and ratios (%)

Product	Number of Enterprises	Greenhouse size (m^2)	Ratio (%)
Tomatoes	71	124,100	35.37
Cucumber	51	89,825	25.60
Lettuce	19	68,554	19.17
Arugula	7	23,479	6.69
Pepper	6	5,760	1.64
Cress	5	21,525	6.13
Parsley	3	14,650	4.17
Scallion	3	1,596	0.45
Green beans	2	1,560	0.44
Strawberry	2	1,150	0.33
10 types of products		352,199	100.00

4.2. Demographic structure and educational status of the enterprises

Human beings, who constitute the labor force among the production factors, and therefore the population, are the most basic factor of life and economy. For this reason, the population and workforce structure of the enterprises were determined. Each family was considered as an enterprise and was examined according to age groups and gender. Table 7

shows the age-based population distribution within the enterprises. The average number of people per enterprise was found to be 4.86, with men making up 51.85% of the population and women making up 48.15%. When it comes to the workforce in enterprises, the majority of workers are in the 15–49 age range.

Table 7: Distribution of population by age groups in enterprise groups

Enterprise size groups (m^2)	Age groups								Total		
	0-6		7-14		15-49		50-+				
	M	F	M	F	M	F	M	F	M	F	M+F
500-1000	0.12	0.32	0.56	0.51	1.39	1.27	0.32	0.36	2.39	2.46	4.85
1001-2000	0.18	0.18	0.50	0.39	1.53	1.28	0.36	0.36	2.57	2.21	4.78
2001-6000	-	-	0.37	0.37	1.94	1.44	0.44	0.44	2.75	2.25	5.00
6001-+	0.18	0.45	0.73	0.36	1.55	1.37	0.09	0.18	2.55	2.36	4.91
Ave.	0.12	0.24	0.53	0.44	1.54	1.31	0.33	0.35	2.52	2.34	4.86
Ratio to total population (%)	2.47	4.94	10.91	9.05	31.69	26.95	6.79	7.20	51.85	48.15	100.00
Ratio of age groups to total population (%)	7.41		19.96		58.64		13.99		-	-	100.00

This ratio holds significance for enterprises. The educational attainment of the population aged 6 and older was assessed in the examined enterprises based on enterprise groupings (Table 8). In the enterprises, it seems that 22.89% of the population is a primary school graduate (5 years), 48.67% is either continuing to or graduate of primary education (8 years of education), 24.22% is a high school student or graduate, 4.22% is a university student or graduate.

Table 8: Educational status (person) and rates (%) of the population in the enterprises

Enterprise size groups (m^2)	Primary school (5 years)	Primary education (8 years)	High school	University	Total
500-1000	1.12	2.07	1.07	0.15	4.41
1001-2000	1.07	2.32	0.89	0.15	4.43
2001-6000	0.94	2.13	1.56	0.37	5.00
6001-+	0.73	2.36	1.00	0.18	4.27
Average	1.03	2.19	1.09	0.19	4.50
Ratio (%)	22.89	48.67	24.22	4.22	100.00

4.3. Family labor force presence

One of the most crucial resources needed to maintain agricultural production is the labor force. Erkuş (1979) determined the annual potential workforce to be 1029 Male Power Unit (MPU), taking into account the ability of the population to work in terms of age groups and gender, as well as the periods during which they cannot participate in enterprise activities due to reasons such as constant illness, education, and military service. The average working day per year is accepted as 300 days. As a result, an enterprise's labor force has been calculated using the male labor unit (MPU). The gender distribution of family workforces in enterprises is displayed in Table 9. The average family labor force in the enterprises is 3.43 MPU. The average family labor force owned by the enterprises is 3.43 MPU. 2.05 MPU (59.84%) of this workforce are men, and 1.38 MPU (40.16%) are women. When age groups are considered, the active population, or those in the 15–49 age range, makes up 73.54% of the workforce. Table 10 lists the labor force utilized during working days in the production of greenhouses. On average, 35.90% of the workforce used in greenhouse production is family labor and 64.10% is foreign labor.

Table 9: Family labor force presence (MPU)

Enterprise size groups (m^2)	Age groups								Total
	7-14		15-49		50-+		Total		
	M	F	M	F	M	F	M	F	M+F
500-1000	0.28	0.26	1.39	0.95	0.24	0.18	1.91	1.39	3.30
1001-2000	0.25	0.20	1.53	0.96	0.27	0.18	2.05	1.34	3.39
2001-6000	0.19	0.19	1.94	1.08	0.33	0.22	2.46	1.49	3.94
6001-+	0.37	0.18	1.55	1.03	0.07	0.09	1.98	1.30	3.28
Enterprises average	0.27	0.22	1.54	0.98	0.25	0.18	2.05	1.38	3.43
Ratio to total workforce (%)	7.73	6.41	44.90	28.64	7.22	5.10	59.84	40.16	100.00
Ratio of age groups to total workforce (%)	14.14		73.54		12.32		100.00		

As enterprise sizes increase, the number of products produced for the market increases, and the foreign labor force also increases.

Table 10: Labor force used in greenhouse production in the enterprises (MPD)

Enterprise size groups (m^2)	Family workforce				Foreign workforce						Total
	M	F	M+F	Oran (%)	M- Temporary	M Permanent	F Temporary	F Permanent	M+F	Ratio (%)	
500-1000	19.60	30.80	50.41	73.66	0.64	-	17.39	-	18.02	26.34	68.43
1001-2000	51.96	42.83	94.79	74.17	2.95	-	30.06	-	33.01	25.83	127.80
2001-6000	37.30	39.86	77.16	37.36	12.90	5.56	100.28	10,64	129.38	62.64	206.54
6001-+	52.89	26.97	79.86	9.40	12.93	263.51	159.95	333.50	769.94	90.60	849.81
Enterprise Average	35.80	35.38	71.19	35.90	4.76	31.12	51.23	39.99	127.11	64.10	198.30

The experience of the producers is an important factor in greenhouse production, and it is seen that 51.04% of the producers have 1-3 years of experience (Table 11). The table shows that young farmers with one to three years of experience make up more than half of the producers. This is because the projects carried out in the region prioritize greenhouse production and provide assistance to young farmers. The majority of these young producers who have just started are young ones, and it has been determined that they constantly work together with the Provincial-District Directorate staff. The average experience period of the enterprises is 6.17 years, and the enterprises with the highest experience are the ones that carry out greenhouse production in an area of 6001 m2 and above.

Table 11: Experience period of producers in greenhouse production (years)

Enterprise size groups (m^2)	**1-3**	**4-6**	**7-9**	**10-12**	**13-15**	**16-18**	**19-21**	**>21**	**Average**
500-1000	30	3	1	1	1	-	-	5	5,54
1001-2000	15	8	3	-	1	-	1	-	4.64
2001-6000	3	7	1	2	1	1	1	-	7.50
6001-	1	-	5	2	1	1	1	-	10.45
Total	49	18	10	5	4	2	3	5	6.17
Ratio (%)	51.04	18.75	10.42	5.21	4.17	2.08	3.12	5.21	100.00

4.4. Economic Activity Results of Enterprises Engaging in Greenhouse Cultivation

4.4.1. Gross production value (GPV)

GPV is the amount that is calculated by multiplying the quantity of goods produced in an enterprise by their market prices. Table 12 provides information on the products grown in the greenhouse, including yield and income data.

Table 12: Total gross production income, yield and average sales price of the products grown in greenhouses

Products	Total gross production value ($)	Total production (kg)	Gross production value per decare ($/da)	Yield (kg/da)	Average selling price ($/kg)
Tomatoes	596,130	1,923,000.00	4,803.63	15,495.57	0.31
Cucumber	434,652	1,498,800.00	4,838.87	16,685.78	0.29
Lettuce	94,578	429,900.00	1,379.61	6,270.97	0.22
Pepper	16,346	32,050.00	2,837.76	5,564.24	0.51
Scallion	5,208	1,866.67	3,263.16	1,169.59	2.79
Green beans	4,620	5,250.00	4,620.00	5,250.00	0.88
Parsley	84,744	130,375.00	5,784.55	8,899.31	0.65
Cress	41,250	75,000.00	1,916.38	3,484.32	0.55
Arugula	48,953	80,250.00	2,084.95	3,417.95	0.61
Strawberry	5,282	3,800.00	4,593.05	3,304.35	1.39

Tomatoes are the most widely grown vegetable, with a 99.67% share of the greenhouse production area dedicated to vegetable production. In similar studies on greenhouse production, Rad and Yarşı (2005) reported the average tomato yield per decare as 7,500 kg in autumn production and 9,000 kg in spring production, and Purchaser et al. (2007) reported an average yield of 14,139 kg in single-crop tomato cultivation, while Gale et al. (2014) determined it as 12,000-13,000 kg, Sipahioğlu (2014) 19,844 kg/da, Öztürk and Engindeniz (2018) determined it as 12,376.86 kg in the fall period, 15,166.52 kg in the spring period and 20,027.78 kg in single product.

Table 13: Cost elements in products grown in greenhouses

Products	Variable costs ($/da)	Fixed costs ($/da)	Total production expenses ($/da)
Tomatoes	2,433.26	1,999.64	4,432.90
Cucumber	2,462.82	1,788.18	4,251.00
Lettuce	744.59	351.61	1,096.20
Pepper	1,229.95	1,322.83	2,552.78
Green beans	1,140.29	1,574.51	2,714.80
Scallion	598.80	782.49	1,381.29
Parsley	2,560.96	1,474.25	4,035.21
Cress	330.89	449.22	780.11
Arugula	342.69	509.68	852.38
Strawberry	2,222.88	1,109.66	3,332.54

These findings suggest that, in comparison to other studies of a similar nature, the yield of one decare of tomatoes in the research area is good. In the area, the production of products like arugula, parsley, and cress in greenhouses is steadily rising, particularly in enterprises that employ small family labor. These products are also widely produced in the interim between major product batches. Cucumber is the second crop planted on the farms under research. Table 13 lists the costs associated with greenhouse production in the study area.

Accordingly, the products with the highest total production costs per decare are tomatoes, cucumber, parsley, green beans and pepper, respectively. The highest production costs in a total greenhouse area of 352,199 m2 belong to tomatoes, cucumber and parsley. Variable and fixed costs are calculated separately for each product. Total production costs per decare in tomato production were calculated as $4,432.90, and total production costs per decare in cucumber production were calculated as $4,251.00. GPV, cost, absolute profit, gross and relative profit rates for the products grown in greenhouses in the region are given in Table 14. The highest GPV belongs to parsley, followed by tomato, cucumber. The product with the highest relative profit rate is arugula. In other words, arugula gives the highest profit per unit cost. Cress and scallion follow the arugula. Although parsley, scallion, tomato and cucumber seem to be profitable in terms of absolute profit, when the relative profitability obtained against unit cost is taken into account, arugula, cress and scallion give the highest income against unit cost. In tomato production, absolute profit per decare was determined as 448.76 $, gross profit was 2,458.97 $ and relative profit was 1.10.

Table 14: GPV, cost, absolute profit, gross profit and relative profit rates of products grown in the greenhouse

Products	Gross Production Value ($/da)	Cost ($/Kg)	Absolute profit ($)	Gross profit ($)	Relative profit
Tomatoes	4,803.63	0.29	448.76	2,458.97	1.10
Cucumber	4,838.87	0.26	556.92	2,345.10	1.13
Lettuce	1,379.61	0.17	295.03	646.64	1.27
Pepper	2,837.76	0.46	291.32	1,614.16	1.11
Scallion	3,263.16	1.18	1883,92	2,666.31	1.20
Green beans	4,620.00	0.52	247.68	1,822.19	1.09
Parsley	5,784.55	0.45	1,768.04	3,242.30	1.43
Cress	1,916.38	0.22	1,136.26	1,562.58	2.43
Arugula	2,084.95	0.25	1,240.23	1,749.38	2.45
Strawberry	4,593.05	1.00	1,260.23	2,369.89	1.39

In a similar study, Koçak (2014) determined the relative profit in tomatoes as 1.28, and Hayran and Gül (2020) found it to be 3.49. The yield per decare in the research area is 15,495.57 kg/da, and Öztürk and Engindeniz (2018) calculated the tomato production amount as 20,0027 kg/da for a single product in the plastic greenhouse. In cucumber production, absolute profit per decare was determined as 556.92$, gross profit was 2,345.10$ and relative profit was 1.13. In the studies of Hayran and Gül (2020), the relative profit was calculated as 2.01 and has a higher profitability. The average yield of arugula farms with the highest profitability is 3,417.95 kg/da. The average selling price is $0.61/kg. Absolute profit per decare was determined as $1,240.23, gross profit was $1,749.38 and relative profit was determined as 2.45. In terms of profitability, cress is followed by arugula. In cress production, absolute profit per decare was determined as 1,136.26 $, gross profit was 1,562.58 $ and relative profit was 2.43.

4.4.2. Calculation of the Safe Vegetable Production Index (SVPI) in greenhouse production in the research region

For the analysis, the factors that are considered to affect safe vegetable production in the research area were determined as 9 variables, and a safe vegetable production index was created in enterprises that grow vegetables under greenhouses. The safe vegetable production index is important in terms of showing the issues that enterprises should pay attention to in the use of inputs and production stages and the extent to which enterprises produce safe

vegetables. To calculate the safe vegetable production levels of producers in the research area, the group containing producers with a safe vegetable production index of less than 50% was accepted as "not producing safe vegetables", and the group containing producers with an index of 50% and above was accepted as "producing safe vegetables".

Safe Vegetable Production Index (SVPI) = (TPRP / MSPR) *100

The average safe vegetable production index in the research region SVPI=5,433.33/96=56.60 was calculated as 56.60%. Multiple linear regression analysis was performed to analyze the factors affecting safe vegetable production in the enterprises. Multiple linear regression results are given in table 15. 4 of the 8 factors examined in the model were found to be statistically significant.

Table 15: Analysis of factors affecting safe vegetable production in the enterprises

Variables	B	Standard error	B	t	Sig.
(Constant)	81,816	11,639		7,029	,000
Age	-,244	,238	-,134	-1,023	,309
Educational background	-,296	2,841	-,009	-,104	,917
Good farming status	21,653	4,668	,386	4,639	**,000***
Experience period	20,462	3,418	,544	5,986	**,000***
Cooperative Membership	-6,502	4,823	-,111	-1,348	,181
Gross profit	,000	,000	,271	3,254	**,002***
Insurance	-12,093	3,252	-,319	-3,719	**,000***
Young farmer	-2,714	4,424	-,076	-,613	,541

F:8.673 df:5 R^2: 0.444 *P< 0.05

As a result of the multiple regression analysis, P values were specified to be significant as they were less than 0.05 according to the producer's good farming status, experience period, gross profit per decare, and crop insurance status. There is a positive relationship between the producer's good agricultural practices and the preference for safe vegetable production (sig: 0.000), and the experience period positively affects safe vegetable production. Put another way, the tendency to produce safe vegetables increases with the producer's experience. It is also observed that producers who insure their products and those who make large gross profits from the goods in question are shifting to safe vegetable production. The tendency of farmers with crop insurance to produce safe vegetables is negatively correlated with other producers in the research area. In other words, people with insurance have a 31.9% lower tendency to grow safe vegetables than people without

insurance. It is observed that there was a 27.10% increase in the tendency for producers with higher gross profit per decare to produce safe vegetables. Therefore, it is a factor that favors safe vegetable production and increases the use of safe inputs in the research field among producers.

5. Conclusion and Recommendations

In this study, enterprises growing vegetables in greenhouses in an area of 500 m2 or more in Konya province were analyzed. The average land size in the enterprises is 42.73 decares. 5.68% of this land consists of greenhouse areas. The study is based on the 2019 production year and the data covers the period 1 January - 31 December. In the last 10 years in Turkey, the average greenhouse farm size has increased from 2 decares to 4 decares. In the enterprises, the average greenhouse land holdings were determined as 2.43 decares, and the greenhouse production area is increasing throughout the province of Konya. As is the case throughout Turkey, greenhouse producers are small family-run enterprises that serve as agriculture's insurance. In comparison to other production sectors, greenhouse production has greater facility costs and calls for a higher level of expertise. Producers who are familiar with the culture of growing vegetables are particularly successful in this area of production. One further benefit in addressing unemployment is the labor-intensive nature of greenhouse production. In light of these elements, it is a matter that ought to be prioritized to boost agricultural output. Furthermore, it is imperative to calculate the expenses associated with Konya's greenhouse production to enhance its profitability. Tomatoes are the most grown vegetable in the greenhouse production area, which has a 99.67% vegetable production area. It was found that the production of parsley yielded the highest income per decare, while lettuce yielded the lowest. In the greenhouse, lettuce is planted either prior to or following the main crop. Greens group (arugula, cress, and scallion) products had the highest relative profit rate in the research area, while green beans had the lowest. Parsley yields the highest gross profit margin. Parsley is preferred as a second crop or as the only crop. In the region, sowing/planting is done 3 or 4 times a year while mowing, 8-9 times. Parsley is sold in bundle form, and producers have started to focus on parsley production in recent years as it can find buyers in the market at any time and does not have many diseases and pest problems.

Greenhouse production is a profitable branch of production for farmers in the region, and it would be beneficial to continue government incentives and greenhouse training.

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