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Socioeconomics study of Tomato production in Egypt: A case study

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ABSTRACT

The primary aim of this article was to investigate the socioeconomic variables of tomato production in Sharqia Governorate by using a random sample of 123 growers. According to the results, the characteristics of the respondents concentrated in the medium and low rating categories. Furthermore, it was discovered that 86.2 % of respondents referred to their cultivated tomato decision to profitability, while 80.4 % referred to production cost, and 57.7% referred to marketing efficiency. It is evident that the second layer was better for productivity indicators than others. In addition, the marketing efficiency for tomato crops has been estimated at 30.36%, whereas the producers' share was estimated to be 47.62%, which illustrates the predominance of competitive market characteristics in the tomato market. Finally, it becomes clear that increasing price with a lagged year increased current tomato cultivated area, production, and the number of farmers.

Keywords: Social variables, Economic variables, Tomato, Production, Efficiency

1. Introduction

The state is working to increase tomato production, whether through horizontal expansion by increasing area or vertical expansion by increasing productivity, to encourage producers to reach maximum productivity by achieving the best use of available resources. The study investigated the tomato crop for several reasons; first, it is one of the essential daily nutritional needs for all members of society due to its high nutritional value, a wide range of uses, and vast cultivated area, where tomato cultivated area was 413.67 thousand feddans (MALR, 2020, 2019, 2018), representing 22% of the total vegetable cultivated area which amounting 1.9 million feddans during 2018-2020. In addition, tomatoes are products that exhibit severe price fluctuations. Moreover, the Egyptian Agricultural Policy Strategy 2030 aimed to develop a tomato crop distinguished by broad export potential and high competitiveness. Sharqiya Governorate was chosen for its wide-scale tomatoes cultivate area, as it ranked first in the area at the level of within the valley governorates, and in second place at the level of the Republic after the Nubaria region, by 57% of the total cultivated area in Egypt. Therefore, it is crucial to assess the agricultural decision by conducting an opinion survey to optimize the farmers' benefits and face problems. Even though several studies have addressed the variables associated with tomato production, tomato growers in Egypt continue to face price fluctuations. This study aims to answer the following questions in this context: What are the social factors influencing tomato production? What technical, marketing, financial, and social issues do tomato growers face? What are the main reasons that tomato growers are compelled to cultivate tomatoes? What are the economic factors influencing tomato production? The following is how this paper is structured: There will be a literature review of several tomato production variables in the following section. The material and method approach is described in section two. The third section focuses on the findings of an empirical study to gain access to

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socioeconomic relationship variables and tomato production. The concluding remarks are provided in the final section of this article.

Tomato production has spawned a plethora of literature over the last two decades. Many of these empirical studies have investigated the variables associated with tomato production. According to (MALR, 2018), Egypt is the fifth largest producer of tomatoes globally, and tomatoes are a significant crop in Egypt in terms of consumption and income for smallholder farmers. In 2015, the area cultivated with tomato was estimated at 469 000 feddans1, representing 32 percent of Egypt's total area cultivated with vegetables. Small-scale growers using traditional growing methods on highly fragmented land plots dominate the tomato value chain in Egypt. Up to 80% of tomato land is cultivated on plots of 5 feddans or less, with the remaining 20% of land classified as medium to large-scale farms. Only a small portion of tomatoes are processed or exported, leaving the vast majority in the domestic distribution system, which is is largely informal, dominated by traders and intermediaries, and traditional in terms of technology, handling practices, and marketing methods. The weaknesses in the tomato value chain are directly related to high levels of quantitative and qualitative food loss. However, in the absence of quality standards or customer awareness about quality, the damaged tomatoes that standard definitions would be considered losses tend to be sold. Sampling revealed that quantitative loss was 40 percent and qualitative loss at wholesale level 19 percent. According to wholesalers surveyed, the loss was perceived to be about 5.7 percent and increased to 16 percent if the tomatoes stayed in the wholesale market for three days without selling. The losses found at the wholesale markets can mainly be attributed to the accumulated damage caused by improper packaging, such as palm crates whose rough edges cause abrasions to the fresh tomatoes. These crates are also over-packed, which causes compression injuries to the fresh produce. During transportation, unpaved roads and poorly equipped transportation vehicles cause major injuries due to vibration. Furthermore, overloading the trucks to decrease transportation costs contributes to compression injuries. The product reaches the market without any sorting or grading. Wholesales also have no storage facilities adding one more cause to reducing the already short shelf life of the tomatoes. According to (Ahmed, 2018), small and poor tomato producers suffer are particularly affected by high price instability in local markets. In addition, they often rely on the black market, where prices are usually very high, to acquire their inputs. In order to improve the economic sustainability of small tomato producers, a public-private partnership was formed between USAID, ACDI-VOCA, Heinz International, and 13 domestic tomato processors. The partnership improved the capacity of smallholder farmer associations to supply the industry with large and consistent tomato quantities and increased producer market outlets. Currently, smallholder farms' associations sell at least 30% of their production through forwarding contracts to processors that protect against price risk. (Qutb *et al.,* 2020), assessed that the average self-sufficiency of tomatoes amounted to 112 thousand tons, and the total production and marketing losses together amounted to 3.16 tons of tomatoes at a rate representing nearly 17.7% of the total production quantity. Total production losses amounted to 2.13 tons of tomatoes, representing approximately 11.95% of the total amount of production, at a value of about 4.9 thousand pounds. In comparison, the total marketing losses amounted to 1.03 tons of tomatoes, representing about 5.8% of total production, at a value of about 7.3 thousand pounds. The value of the qualitative loss represented by the loss in the case of sale at a reduced price amounted to about 3.3 thousand pounds. The missed opportunity was the result of the wasted area of about 63.7 thousand pounds at the level of Sharkia governorate. Human labor, natural fertilizers, azotic fertilizers, potassium fertilizers, and the amount of seeds for new lands were identified as the major factors influencing tomato crop production in Asyut Governorate, both in old and new lands (Eaid and Hanna, 2012). (Ahmed, 2016) found that the most significant problems facing the growers' tomatoes summer Sharkia, respectively, according to their relative importance, are the production requirements, high costs and lack of availability and the lack of irrigation water, and the difficulty of access to pesticides, seedlings, and fertilizers in addition to increasing losses and rising costs of rent per acre. Farmers have proposed solutions to these problems from their perspective, as evidenced by the need for cooperatives in production requirements.

Although previous studies collaborate the most variables that affect tomato production, they did not study the socioeconomic variables related to price fluctuation.

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2. Materials and Methods

The research used qualitative and quantitative analysis through two kinds of data. Time-series data were obtained to describe the production and economic variables such as cultivation areas, production quantity, yield, tomato price, production, and marketing efficiency. While primary data was collected using pretested questionnaire through personal interviews, during season 2020/2021, A sample survey was designed and administered on a sample from Sharqia governate because it had the highest cultivated area inside the valley in Egypt. As shown in Table 1 and Fig 1. then selection of Faqus district because it has a vital tomato producing area then Salhiya Owl village was selected as the first village in several tomatoes growers, 123 growers were selected as a random sample, according to the formula proposed by (Yamane, 1967).

$$n = \frac{N}{1+N\,(e^2)} \qquad (1)$$

Where n = Sample size; N = size of the population; e = significance level (0.05 for this study). A cross-sectional data was used for examining respondents in three categories according to the size of their cultivation area: (farmers that own less than one feeden, between one and three feddens, and more than three feddens of cultivation area).

Some socioeconomic variables were included in this research, which are defined as follows: Operational definitions of socioeconomic: Growers: They are farmers who cultivate tomatoes in holding or rent farms. Age: This variable was defined as the age of the respondent in years; Education: this variable was defined as the number of years which respondents succeeded in it in their school Family size: This variable was defined as the total number of people in the household, Annual income: This variable was defined as the total annual income in Egyptian Pound, cultural awareness: This variable was measured by asking the respondent about the degree of his access to books, exposure to various media such as newspapers, magazines, newspapers, radio, and television, interaction with social media and his attendance of training courses.

Table 1: Area, Production, and Yield of tomato in Egypt and Sharqia 2018-2020.

	Egypt			Elsharqia				
Item	**A**	**P**	**Y**	**A**	**%**	**P**	**%**	**Y**
2018	416.03	6770.75	16.27	48.64	11.69	756.44	11.17	15.55
2019	408.70	6793.69	16.62	40.08	9.81	750.98	11.05	18.74
2020	416.27	7026.78	16.88	42.46	10.20	964.79	13.73	22.72
Average	413.67	6863.74	16.59	43.73	10.57	824.07	12.01	18.85

Note: (1). A: Area in 1000 fed, P: Production in 1000 tones, and Y: Yield in ton/fed.

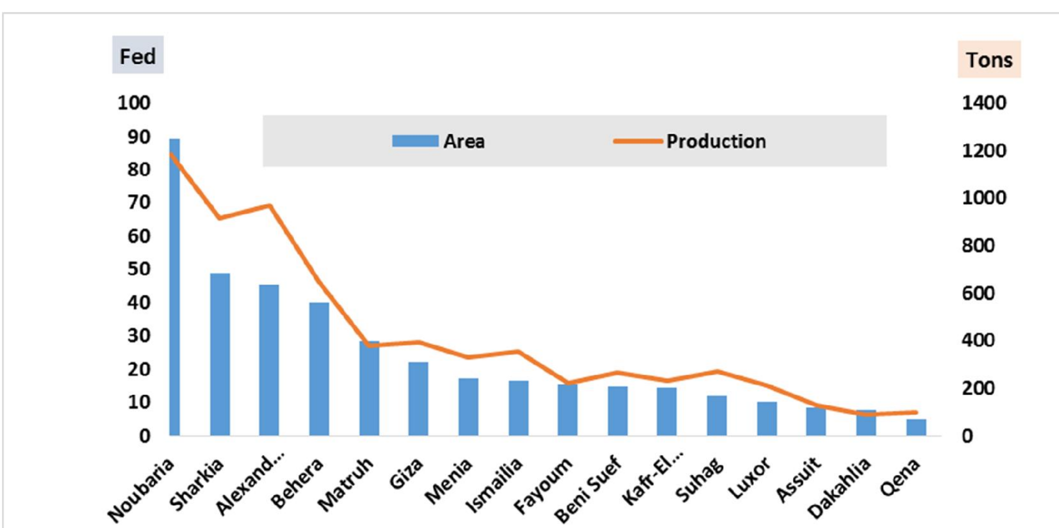

Fig. 1: Area and production of tomatoes in Egypt governorates during 2018-2020.

The responses were graded as (high, medium, low) for each response separately, and the scores were assigned 3, 2, and 1. The total scores obtained by the respondent from his answers to the previous questions represented a numerical indicator for measuring this variable. Geographic openness: This variable was measured by asking the respondent about the degree of his frequency to each of the neighboring villages and districts, the governorate, and other governorates and other countries. The responses were assigned to (high, medium, low) for each response separately, and the scores were given 3, 2 & 1. The total scores obtained by the respondent from his answers to the previous questions represented a numerical indicator for measuring this variable. Degree of facing production problems: This variable was measured by asking the respondent about the degree of his exposure to 13 types of production problems, including 1. High prices of production requirements, 2. Unavailability of production requirements in agricultural cooperative societies, 3. High costs of agricultural labor, 4. High control costs, 5. Low productivity of Fadden, 6. Spread of weeds, 7. Lack of agricultural mechanization, 8. High cost of agricultural mechanization, 9. Low efficiency of agricultural extension, 10. Poor agricultural drainage, 11. High irrigation costs, 12. Lack of mandatory agricultural rotation and 13. Climate change. The responses were assigned to (high, medium, low) for each response separately, and the scores were given 3, 2 & 1. Degree of facing marketing problems: This variable was measured by asking the respondent about the degree of his exposure to 9 types of marketing problems: 1. Low prices of the tomato crop, 2. Low net yield per acre of tomatoes, 3. Lack of market information, 4. Unavailability of tomato marketing outlets and centers close to production places, 5. Monopolization of the tomato market, 6. the high cost of transporting the tomato crop to the markets, 7. The high percentage of losses in the tomato crop, 8. The lack of refrigerators for storing tomatoes, and 9. decreased percentage of export of tomato crop the responses were assigned to (high, medium, low) for each response separately, and the scores were given 3, 2 & 1. Degree of financing problems: This variable was measured by asking the respondent about the degree of his exposure to 8 types of financing problems: 1. The high-interest costs on loans, 2. The complexity of the procedures for obtaining the loan, 3. The strictness of the loan repayment procedures, 4. The inappropriateness of the loan disbursement dates to the planting dates, 5. The presence of administrative problems when disbursing the loan, 6. The lack of insurance on the crop, 7. Low support for production requirements, and 8. Lack of awareness of how to deal with agricultural loans. The responses were assigned to (high, medium, low) for each response separately, and the scores were given 3, 2 & 1. Degree of facing social problems: This variable was measured by asking the respondent about the degree of his exposure to 4 types of social problems: 1. Inability to pay children's education expenses, 2. Inability to pay family members' medical expenses, 3. Family disputes, and 4. The conflict between farmers is due to the scarcity of irrigation water. The responses were assigned to (high, medium, low) for each response separately, and the scores were given 3, 2 & 1. In addition, studying some economic variables such as Net Profit (total revenue value - total production Cost), gross profit (total revenue value - Variable Cost), fixed cost, variable cost, and total revenue value (production value × price) were calculated. Total production cost is equal to the sum of the fixed and variable costs. Moreover, identify Productive and marketing efficiency. As Productive efficiency is concerned with producing goods and services with the optimal combination of inputs to produce maximum output for the minimum cost. Marketing efficiency has been estimated by following Acharyas modified method and shepherd formula. Under Acharya's modified formula (Acharya & Agarwal, 2011), the net price received by the farmers has been calculated by deducting transportation cost plus the value of loss incurred by farmers (during transportation of commodities to the market) from the absolute price received by the farmers. Estimated marketing efficiency is an index, and as the index value is high, more is the market efficiency. In order to investigate the relationship between variables, models where with lagged values of independent variables are utilized, such as the Koyck model, which is used to explain changes in the production of a product in terms of the lagged prices for that product (Koyck, 1955). This model is one of the most commonly utilized lag models in applied studies.
Initial model:

$$Y_t = \alpha_0 + b_0 X_t + b_1 X_{t-1} + b_2 X_{t-2} + \cdots + u_t \quad \ldots\ldots (2)$$

Koyck's distributed lag model presumes that lag coefficients decrease in line with a geometric progression. According to Koyck's geometric lag presumption, the value of explanatory variables in the

period t-1 has a more significant effect on the dependent variable than that in the period t-2 and later periods $b_1 = \lambda_1 b_0, b_2 = \lambda_2 b_0 , b3 = \lambda_3 b_0 \dots \dots b_i = \lambda_i b_0 , \ 0 < \lambda < 1$
Substituting these expressions into the initial model yields:

$$Y_t = \alpha_0 + b_0 X_t + (\lambda_1 b_0) X_{t-1} + (\lambda_2 b_0) X_{t-2} + \cdots + u_t \quad \text{.....(3)}$$

Regression analysis cannot be used in this model. Coefficients are non-linear. Therefore, Koyck developed the following model:

$$Y_{t-1} = \alpha_0 + \beta_0 X_{t-1} + \beta_0 \lambda X_{t-2} + \beta_0 \lambda_2 X_{t-3} + \cdots + u_{t-1} \quad \text{.....(4)}$$

Multiplying (4) through by λ gives:

$$\lambda Y_{t-1} = \lambda\alpha_0 + \lambda_1 \beta_0 X_{t-1} + \beta_0 \lambda_2 X_{t-2} + \beta_0 \lambda_3 X_{t-3} + \cdots + u_{t-1} \quad \text{.....(5)}$$

Removing (5) from (3) gives this equation:

$$Y_t - \lambda Y_{t-1} = \alpha_0 (1 - \lambda) + \beta_0 X_t + u_t - \lambda u_{t-1} \quad \text{.....(6)}$$

Reorganizing this equation yields:

$$Y_t = \alpha_0 (1 - \lambda) + b_0 X_t + \lambda Y_{t-1} + u_t \quad \text{.....(7)}$$

In this way, the lagged values of the explanatory variable have been removed. In addition, the absence of the lagged values of the explanatory variable in the model also resolved the problem of multicollinearity. This equation (7) can be solved with the least-squares method. By determining b_0 and λ through this equation, the Koyck model parameters are determined using equation number (8).

$$b_k = b_0 \lambda_k k = 0,1,2 \dots \ 0 < \lambda < 1 \quad \text{.....(8)}$$

In the Koyck model, parameters adhere to λ and b_0. λ has a value between 0 and 1, which is more significant if the effect of lagged variables on the dependent variable is close to 1 and smaller if the effect is close to 0 towards the distant past. On the contrary, the average lag time (9), is calculated using λ and explains the time needed for the changes in the independent variable to have a perceivable effect on the dependent variable.

$$Average\ Lag = \lambda/(1-\lambda) \quad \text{.....(9)}$$

Schwartz's criterion was used to determine the degree in the lags. The Koyck model represents the relationship between price and production. In this model, production is a dependent (descriptor) variable and explains how it is affected by the change in prices. Also, the study utilized some previous studies and statistical data from different researches and organizations.

3. Results and Discussion

This section of research includes results and discussion according to research objectives as follows:

3.1. Results regarding the First objective, which provides for identifying some social variables of tomato producers*:*

Table 2 displays summary statistics for the sample's social variables, including the age of respondents, the actual range for this variable ranged from a minimum of 40 years old to a maximum of 69 years old with a mean age of 54 years, and a standard deviation of 7.

Table 2: Descriptive statistics analysis of some social variables of the respondents.

Social variables	Theoretical range		Actual range		Mean	Std. Deviation
	Minimum	Maximum	Minimum	Maximum		
Age	-	-	40	69	54	7
Education	-	-	0	16	8	5.4
Family size	-	-	2	15	5	2.6
cultural awareness	0	18	1	15	5.2	3.7
geographic openness	0	18	6	14	8.7	2.3

Source: Results of the statistical analysis of the study data

With regard to the number of education years for respondents, the actual range for this variable ranged from a minimum of 0 to a maximum of 16 years with a mean of 8 years and a standard deviation of 5.4. In terms of family size, the actual range for this variable was 2 to 15 members, with a mean of 5 members and a standard deviation of 2.6. The theoretical range for cultural awareness was 0 to 18 degrees, while the actual range was 1 to 15 degrees, with a mean of 5.2 degrees and a standard deviation of 3.7. Geographic openness had a theoretical range between 0 to 18 degrees, while the actual range was between 6 to 14 degrees, with a mean of 8.7 degrees and a standard deviation of 2.3.

The actual range of the studied variables describing sample measures was used to construct three categories as demonstrated in Table 3. In terms of age, it was found that (1) low rating that ranged from 40 to less than 50 years old, 2) a medium rating category that ranged from 50 to less than 60 years old, 3) a high rating category that ranged from 60 to 69 years old. According to their responses, the respondents were assigned to the three categories, as depicted in Table 3. It was found that 46.3% of respondents were in the medium rating category, 29.3% were in the low rating category, and 24.4% of the total respondents were in the high rating category. With respect to the number of education years, It was found that (1) low rating category that ranged from 0 to less than 6 years, 2) a medium rating category that ranged from 6 to less than 12 years, 3) and a high rating category that ranged from 12 to 16 years. The respondents were assigned to the three categories based on their responses. It was found that 45% of respondents concentrated in the low rating category, while 41% in the medium rating category, while 14% of the total respondents were in the high rating category. With regard to the family size, (1) low rating that ranged from 2 to less than 7 members, 2) a medium rating category that ranged from 7 to less than 12 members, 3) and a high rating category that ranged from 12 to 15 members. The respondents were distributed on the three categories according to their responses. It was found that 64.2% of respondents were in the low rating category, 35% in the medium rating category, and 0.8% in the high rating category. The theoretical range of the studied variables describes the sample measures used to construct three categories, as displayed in Table 3.

Regarding cultural awareness**,** it was found that 1) the low rating category ranged from 0 to less than 6 degrees, 2) a medium rating category that ranged from 6 to less than 12 degrees, and 3) a high rating category that ranged from 12 to 18 degrees. The respondents were divided into three categories. It was found that most of them, 85.4% were in the low rating category, 10.6% were in the medium rating category, and 4.1% of the total respondents were in the high rating category. That means respondents need capacity building by training for increasing their cultural awareness**.** With regard to the geographic openness, it was found that 1) low rating category that ranged from 0 to less than 6 degrees, 2) a medium rating category that ranged from 6 to less than 12 degrees, and 3) a high rating category that ranged from 12 to 18 degrees. The respondents were divided into three categories according to their responses. It was found that 69.1% of the total respondents were in the low rating category, 27.6% were in the medium rating category, while the proportion of the respondents presented 3.3% were in the high rating category. That means respondents need capacity building by training for increasing their awareness to face their inability for geographic openness by using farmer field schools and other tools of agricultural extension.

The analysis results indicate that the characteristics of the respondents concentrated in the medium and low rating categories. That means they need more helps for increasing their abilities and access for enhancing them to produce tomatoes.

Table 3: Descriptive statistics analysis of some social variables of respondents according to the rating categories

Social variables	Rating Categories								
	Low			Medium			High		
	Category	Frequency	%	Category	Frequency	%	Category	Frequency	%
Age	40 -	36	29.3	50 -	57	46.3	60 - 69	30	24.4
Number of education years	0 -	55	45	6 -	50	41	12 - 16	18	14
family size	2 -	79	64.2	7 -	43	35	12 - 15	1	0.8
Cultural awareness	0 -	105	85.4	6 -	13	10.6	12 - 18	5	4.1
Geographic openness	0 -	85	69.1	6 -	34	27.6	12 - 18	4	3.3

Source: Results of the statistical analysis of the study data**.**

3.2. Results regarding the second objective, which provides for identifying the production, marketing, financing & social problems facing tomato producers:

Table 4 displays summary statistics for the respondents' opinions on the problems they encounter according to the responses rating categories, which include:

The theoretical range for this variable ranged between 13 to 39 degrees, while the actual range was from 19 to 36 degrees, with a mean of 28.5 degrees and a standard deviation of 3.6. The results in Table 4 show that the theoretical range of the measures of the studied variable was used to construct three categories, 1) the low rating category that ranged from 13 degrees to less than 23 degrees, 2) the medium rating category that ranged from 23 degrees to less than 31degrees, and 3) the high rating category that ranged from 31 degrees to 39 degrees. The Growers were distributed on the three categories according to their responses, as shown in Table 5.

Table 4: Descriptive statistics analysis of the respondents' opinions on the problems facing them according to the responses' degrees

Degree of facing problems	Theoretical range		Actual range		Mean	Std. Deviation
	Minimum	Maximum	Minimum	Maximum		
Degree of facing production problems	13	39	19	36	28.5	3.6
Degree of facing marketing problems	9	27	15	27	23.9	3
Degree of facing financing problems	8	24	8	24	21.4	3.4
Degree of facing social problems	4	12	4	12	7	2.2

Source: Results of the statistical analysis of the study data

It was found that 64.2% of the total respondents concentrated in the medium rating category, while the high rating category represented 31.7 % of the total respondents, while the proportion of respondents in the low rating category did not exceed 4.1% of the total respondents. That means the majority of the respondents who suffered from producing problems indicate that they are needed for enhancing the role of agricultural extension to transfer these problems to the agricultural research centers and agricultural colleges for solving it and transfer this solving again to the respondents. Degree of facing marketing problems: the results in Table 4 show that the theoretical range for this was 9 to 27degrees, while the actual range was 15 to 27 degrees, with a mean of 23.9 and a standard deviation of 3. The results in Table 4 show that the theoretical range of the measures of the studied variable was used to construct three categories, 1) a low rating category that ranged from 9 degrees to less than 15 degrees, 2) a medium rating category that ranged from 15 degrees to less than 21degrees, and 3) a high rating category that ranged from 21 degrees to 27 degrees. According to their responses, the growers were assigned to three categories, as shown in Table 5.

Table 5: Distribution of the respondents' opinions on the problems facing them according to the responses rating categories

Social variables	Rating Categories								
	Low			Medium			High		
	Category	Frequency	%	Category	Frequency	%	Category	Frequency	%
Degree of facing production problems	13 -	5	4.1	23 -	79	64.2	31 - 39	39	31.7
Degree of facing marketing problems	9 -	0	0	15 -	18	14.6	21 - 27	105	85.4
Degree of facing financing problems	8 -	1	0.8	14 -	31	25.2	19 - 24	91	74
Degree of facing social problems	4 -	41	33.3	7 -	73	59.3	10 - 12	9	7.3

Source: Results of the statistical analysis of the study data.

It was found that 85.4% of the total respondents concentrated in the high rating category, while the medium rating category represented 14.6 % of the total respondents, with no respondents in the low rating category. That means all respondents suffered from marketing problems, indicating that they need good marketing policies and facilities besides encouraging cooperative associations. Degree of financing problems: The results in Table 4 show that the theoretical range for this variable was 8 to 24 degrees, while the actual range was from 8 to 24 with a mean of 21.4 and a standard deviation of 3.4. The results in Table 4 show that the theoretical range of the measures of the studied variable was used to construct three categories, 1) the low rating category that ranged from 8 degrees to less than 14 degrees, 2) the medium rating category that ranged from 14 degrees to less than 19degrees, and 3) the high rating category that ranged from 19 degrees to 24 degrees. The growers were distributed on the three categories according to their responses, as shown in Table 4. It was found that 74% of the total respondents concentrated in the high rating category, and the medium rating category represented 25.2 % of the total respondents. In comparison, the proportion of respondents in the low rating category did not exceed 0.8% of the total respondents, indicating all the respondents suffered from financing problems that indicate they are needed for more financing and crediting facilities to support respondents in cultivating tomatoes.

Degree of social problems: the results in Table 4 show that the theoretical range for this variable ranged from 4 to 12 degrees, while the actual range was from 4 to 12 with a mean of 7 and a standard deviation of 2.2. The results in Table 4 show that the theoretical range of the measures of the studied variable was used to construct three categories, 1) the low rating category that ranged from 4 degrees to less than 7 degrees, 2) the medium rating category that ranged from 7 degrees to less than 10 degrees, and 3) the high rating category that ranged from 10 degrees to 12 degrees. The rowers were assigned to the three categories according to their responses, as shown in Table 5. It was found that 59.3% of the total respondents concentrated in the medium rating category, while the low rating category represented 33.3 % of the total respondents, while the proportion of respondents in the high rating category did not exceed 7.3% of the total respondents. That means the respondents need training relating to soft skills by applying to life schools.

3.3. Results regarding the third objective, which provides for identifying the main reasons which enforce tomato growers to cultivate tomato:

It was found that 86.2% of respondents referred their cultivated tomato decision to its profit, while80.4% of respondents referred their decision to minimize the production cost and 57.7% of respondents referred their decision to increase the marketing efficiency.

3.4. Results regarding the fourth objective state identifying some economic variables related to tomato production and marketing.

This part of the article discusses the most economic variables related to tomato production and marketing through studying productive and marketing efficiency, determining the time-lagged in price that affected producer decisions, and finally, the impact of the change in tomato price and production lagged year on the primary economic variable.

3.4.1. Productive and marketing efficiency of the tomato crop in the study sample

The tomato crop is regarded as the most crucial source of income for farmers. In addition, producers decided to increase supply based on the previous year's prices which they considered satisfactory (Arısoy and Bayramoğlu, 2017). Producer income varies greatly depending on annual fluctuations in tomato prices. As a result, the profitability of tomato growers is one factor that determines whether production will continue or shift to another crop. Table 6 shows that producers' net profit and gross profit in 2020/2021 were positive in all three layers. Net profit in the three layers was calculated to be 41670, 53664.44, and 51612.22 L.E./fed, respectively, while gross Profit was calculated to be 46170.10, 58164.44, and 56112.22 L.E./fed, respectively. The second layer was clearly superior to the others in terms of productivity indicators.

Table 6: Tomato production gross and net profits per unit area in sample study.

Cost and income items	Layers			Average
	0-1	1-3	3+	
Fixed cost (L.E/Fed.)	4500	4500	4500	4500
Variable cost (L.E/Fed.)	51829.90	50335.56	48887.78	50351.08
Total production cost (L.E/Fed.)	56329.90	54835.56	53387.78	54851.08
Total revenue (L.E/Fed.)	98000.00	108500.00	105000.00	103833.33
Net Profit (L.E/Fed.)	41670.10	53664.44	51612.22	48982.26
Gross Profit (L.E/Fed.)	46170.10	58164.44	56112.22	53482.26
profitability of L.E	0.74	0.98	0.97	0.89

There is a possibility of increasing the profitability of tomato growers, leading to an increase in tomato cultivated area through two methods. The first is decreasing costs of production, in addition to the availability of production requirements in the cooperative society, besides the excessive use of growth regulators, insecticides, and fungicides, a significant increase in fertilizer prices. The second method is trying to increase productivity by using hybrids in agriculture and treated trays. Furthermore, returning to the agricultural cycle, not loading corn on tomatoes to avoid the spread of "armyworm," predicting potential crises facing the agricultural sector such as climate changes, and knowing how to overcome them.

On the contrary, the marketing efficiency of tomatoes has been estimated by Acharya's method (Acharya and Agarwal, 2011). According to Acharya, an ideal measure of marketing efficiency, particularly for comparing the efficiency of alternate markets channels should consider the following: Prices received by the farmer (FP) (which is represented in the selling price of the product including all taxes and commodity fees, delivered at the farm gate), prices paid by the retailers (RP) (which represents the selling price of the commodity without changing its shape by retailers to the final consumer of that commodity), total marketing costs (MC) (are incurred by the various functionaries in the market starting from farmers, wholesalers and retailer), marketing margin (MM) (Marketing margins are the net profit by the market intermediaries and have been calculated by the difference between the consumer's and the producers' price is known as spread) total marketing margin for tomato has been calculated to be 3300 L.E. Furthermore, the measure should reflect the following relationship between each of these variables and the marketing efficiency, as well as knowing whether the conditions of perfect competition or monopoly for the tomato market in the sample study, in addition to the sensitivity of the crop to various natural conditions, and since the tomato crop was one of the most sensitive crops to various natural conditions as climate change, the change in its price is more significant than other crops. The marketing efficiency has been estimated at 30.36% for tomato marketing, see Table 7.

With respect to producers' share in consumer pound, it is an important criterion to judge how efficiently the producers are being marketed in the marketing channel. Therefore, a higher producer's share in the consumers' price implied higher market efficiency. Under the present study, the producers' share in the consumers' price was 47.62%, while intermediaries' share in the consumers' price was estimated to be 52.38%, which illustrates the predominance of competitive characteristics in the tomato market.

Table 7: Estimation of marketing efficiency of tomato in sample study.

Cost production (L.E/ton)	1438.60
Producer price (L.E/ton)	3000
Wholesale price (L.E/ton)	4200
Retail price (L.E/ton)	6300
Marketing margin	3300
Marketing efficiency %	30.36

3.4.2. The effect of the price with lag time on producer decisions

In terms of planning and policy development, the Koyck Model was used to determine the amount of time required, which influenced producer decisions. Indeed, price variations for tomatoes from year to year had an impact on producer decisions in the production and cultivation areas. The Koyck model was used to examine the effects of price on production quantity.

$$TTQ = \underset{(0.8)}{1048.5} + \underset{(2.86)*}{0.54\,TTPR} + 0.72\,TTQ_{t-1} \quad \text{.....(10)}$$

$$R^2 = 0.67 \qquad F = 8.1^{*} \qquad Prob.(F-statistic) = 0.01$$

The Koyck model had a 67 % explanatory power with a 1% significance level. Furthermore, the effect of the explanatory variables on the dependent variable was statistically significant. On the contrary, tomatoes' price and production have a positive relationship. Whereas the value of the parameters of equation No. 11, estimated at 0.54, 0.72, demonstrated that it was logical and consistent with the economic theory, which showed the effect of prices and production with a lag time, was positive value and less than one, which reflected that the tomato crop product takes more than a year to respond to the modification of the cultivated area as due to the price change. Assuming that the production reflects the tomato cultivation area with the stability of the technological level, which is reflected in the feddan productivity of the tomato crop and according to the results obtained, to estimate Koyck model, lag coefficients for the independent variables have to be determined lag coefficient, Schwartz's criterion was used. The lag coefficient was calculated to be approximately three years according to equation 12. The lagged tomato production variable parameter was calculated to be 0.72, which is equal to the "λ" value used for obtaining the parameters of the Koyck model. This value is also used to determine the average lag time (ALT).

$$ALT = \lambda / (1-\lambda) = 0.72 / (1-0.72) = 2.57\ years \quad \text{.....(11)}$$

This value indicates that the fluctuation in tomato prices has a relatively rapid effect on production and cultivated area.

Koyck model is calculated using the following equation:

$$TTQ = 1048.5 + 0.54\,TTPR + 0.39\,TTPR_{t-1} + 0.28\,TTPR_{t-2} + 0.2\,TTPR_{t-3} \quad \text{.....(12)}$$

The coefficient of TTPR is calculated by the least square method. The calculation of the $TTPR_{t-1}, TTPR_{t-2}, TTPR_{t-3}$ coefficients is given below:

$$ß_t = \lambda^0 b_0 = 0.72^0 \times 0.54 = 0.54$$
$$ß_{t-1} = \lambda^1 b_0 = 0.72^1 \times 0.54 = 0.39$$
$$ß_{t-2} = \lambda^2 b_0 = 0.72^2 \times 0.54 = 0.28$$
$$ß_{t-3} = \lambda^3 b_0 = 0.73^3 \times 0.54 = 0.2$$

In Koyck model, the impact of lagged prices on production persists with decreasing effect, and the change in tomato prices observed three years ago has less impact to n tomato production than the changes in prices in the previous year. This effect decreases as the lag number increases.

4.4.3 The impact of the change in tomato price and production by lagged year on the main economic variables

According to equations (11, 12), the study assumed that production reflected cultivated area only (consider the level of technology was constant, which reflected productivity of tomato crop). Therefore, tomato farmers have taken a year or more to respond to the adjustment of production due to a change in supply, as evidenced by the value of the adjustment factor, which was estimated at 28% and reflects the amount of change in tomato production in response to price changes. By calculating price elasticity in the short run, the production's response to a change in price was inelastic, which means that if prices increase by 1%, the production increases by 0.39%. In contrast, the elasticity, in the long run, indicates that the production's response to a change in price was elastic, was estimated at 1.3, which means that if prices increase by 1%, the production will increase by about 1.3 %. It is evident that the change in production with a lag year of about 0.72 percent leads to an increase in tomato cultivated area, production, and the number of farmers of about 3.26 thousand fed., 54.92 thousand tonnes, and 49 thousand farmers, respectively. It is also clear that an increase in lagged tomato prices of about 0.39 percent leads to an increase in tomato cultivated area, production, and the number of farmers of about 1.77 thousand fed., 29.34 thousand tonnes, and 27 thousand farmers, respectively, as depicted in Table 8 (Ali *et al.,* 2016).

Table 8: The impact of the change in tomato price and production by lagged year on main economic variables 2010-2020.

Item	Impact of the change in tomato price by 0.39	Impact of the change in tomato production by 0.72
Increasing in the cultivated area (1000 fed.)	1.77	3.26
Increasing in Production (1000 ton)	29.34	54.92
Increasing in No. of farmers (1000)	27	49

4. Conclusions

Depending on the results, there are some recommendations for decision-makers illustrated in increasing producers` abilities and access for enhancing them to produce tomato in addition, possibly increasing the profitability of tomato growers, which cause an increase in tomato cultivated area, through two methods, the first is decreasing costs of production. In addition, availability of production requirements in the cooperative associations. It was noted the significant increase in fertilizer prices, in addition to the excessive use of growth regulators, insecticides, and fungicides. The second method is to increase productivity by using hybrids in agriculture and treated trays, returns to the agricultural cycle, not loading corn on tomatoes to avoid the spread of armyworm, predicting potential crises facing the agricultural sector such as climate changes, and knowing how to overcome. In addition to establishing logistic services near tomato field to decrease transportation cost and tomato losses, generate tomato value-added, put good marketing policies, restore the role of cooperative associations, provide financing and crediting facilities for supporting respondents to cultivate Tomato. Moreover, supporting the role of agricultural extension to transfer producers` problems to the agricultural research center and agricultural colleges for solving it and transfer this solving again to the producer, equally important encouraging youth people and agriculture graduates to cultivate tomato and enabling training related to the soft skills by applying life schools.

Conflict of interest

The authors report that there are no competing interests to declare.

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