An Economic Analysis of The Costs of Producing Tomato Under Greenhouse in Anbar Governorate For the Agricultural Season 2019-2020

I A Mohammed¹, M A K Al Dulaimi²

¹ Department of Planning and Follow-up, Anbar Agriculture Directorate, Iraqi Ministry of Agriculture.
² Department of Agricultural Economics, College of Agriculture- University of Anbar, Iraq.

*Corresponding author's e-mail: ag.mishal@uoanbar.edu.iq

Abstract. The research aims to analyze the costs of producing tomato under greenhouses in Anbar Governorate for the agricultural season (2019-2020), based on field data of 16 samples selected randomly. The results of the analysis shows that fixed costs constitute about (44.20%), while variable costs constitute about (55.80%) of the total costs. The average production costs in the research sample are about (109808) dinars / ton. The long-term cubic function was the best among the functions that express the relationship between production costs as a dependent variable and production and the number of greenhouses on the farm as independent variables. This is due to its analogy with the logic of economic theory. The modified coefficient of determination in it $R^2$ reached (0.98). It is found that the optimal size of the farm includes (3) greenhouses. It achieves the optimum production volume of (21.17) tons / farm. The average cost is about (64193) dinars / ton. (62.5%) of the farmers in the study sample achieve capacity savings, while (31.25%) do not achieve any savings. As for the percentage of farmers who achieve low rates of economic efficiency, they reach about (6.25%). The supply function shows that the elasticity of supply decreases with the increase in production. This means that the farmer faces great difficulty in controlling production in the event of price changes. The study recommended the needed to raise the marketing efficiency of the products of the agricultural sector and to protect the local product to help the Iraqi farmer attain the ability to compete.

1. Introduction:
Protected agriculture is one of the important and advanced production methods in terms of the use of scientific methods and technological equipment that ensure the provision of appropriate climatic conditions for the growth and development of the crop outside its production times. The increase in demand for the tomato crop required the provision of the crop in the off-season. As the number of greenhouses planted with the tomato crop in Anbar governorate reached (42) houses in the research sample during the agricultural season 2019-2020. As well as cultivation in the open fields in order to provide crops throughout the year.
Tomato is a summer vegetable crop. It is a self-pollinating annual herbaceous plant grown in warm and temperate regions, originating in Central and South America. Tomato cultivation moved to Europe in the middle of the sixteenth century, and then spread to most countries of the world. [1].

The tomato crop is the most consumed and productive vegetable crop in the world. It ranks second in importance among vegetable crops, after potatoes. The reason is the high nutritional value and diversification of methods of consumption. It can be consumed fresh, cooked or processed. [2]

The suitable temperature for growing tomatoes range from 21 °C to 29 °C. With lighting that lasts up to 12 full hours per day. The crop is exposed to damage if the temperature drops during growth or if the temperature rises above 36 °C for a long period. As for the success of tomato cultivation, it depends on the quality of drainage for all types of land.

The debate about the optimal size of the farm which guarantees the producer to produce the unit of production at the lowest cost is still one of the main factors in increasing the profitability of the farmer and plays an important role in raising the economic efficiency of using the production elements. By transferring the relationship from the reality of hypotheses to the actual application, reinforced by the quantitative results that will confirm that the most optimal size of profit depends on the number of necessary homes that must be adhered to in order to achieve the greatest production at the lowest cost in the long run because greenhouses will introduce a variable element in the function [3]. The research problem is represented in the somewhat low levels of productivity of tomato crop in green houses compared to its counterparts in developed countries, the weakness of the ability to compete and the high rate of production cost which reflects the inefficiency in using the economic resources allocated in the optimal way. Besides, the lack of sufficient experience of the farmers towards achieving the optimum size. The research is based on the assumption that production costs are affected by the quantity of production on the one hand and the number of greenhouses in each farm on the other hand. The study also assumes that the majority of tomato growers in greenhouses do not achieve the optimum volume of production which led to the high production costs of tomato crop in the research sample. The study assumes that approaching the optimum sizes contributes to raising the economic efficiency in the use of vegetable production resources and reduces the average cost of producing the unit producing those vegetables. The study assumes that the supply of vegetable crops in the long run has greater elasticity than the supply in the short run. The importance of the research comes through the economic and nutritional importance of the tomato crop in general due to its frequent use in Iraqi tables. As the demand for this crop for food and industrial uses is constantly increasing, so it requires saving and increasing its production. Also, the high costs of production and the factors affecting it necessitated a study to determine the optimal volume of production that lowers costs. Then, we can achieve economic efficiency and its impact on the production process. Moreover, identifying the optimal levels that tomato growers can achieve to reach the highest possible economic efficiency in using the available resources and setting a minimum price that tomato growers get to continue the production process. The research aims at the following:

- Classifying production costs according to various bases and calculating their contribution to the formation of the total cost.
- Estimating and analyzing the long-term cost function and its economic derivatives.
- Determining the optimal size of the greenhouse farm and the optimum production level that minimizes costs.
- Derivation of the supply function of the long-term tomato crop.
- Proposing recommendations that would expand the field of greenhouses for tomato cultivation, raise the efficiency of agricultural resources, and increase agricultural production.

2. Materials and research methods:

2.1 Data sources
The research relies on primary data obtained through a field survey in the study area. The data are collected through a statistical form prepared for this purpose. This survey includes a cross section data
on (costs of producing tomato under greenhouses in Anbar governorate for the 2019-2020 agricultural season). A random sample is selected for the districts of Anbar governorate including tomato crop farmers under the greenhouse. The number of those farmers in each sample is [16]. The statistical and economic analysis is performed after checking, processing and classifying the data, depending on Eviews 10.

2.2. Method of analysis
The study depends on. Descriptive analysis of the data obtained through a description of production costs and their relative importance, which is based on the concepts of economic theory in line with the research objective and hypothesis. While Quantitative analysis, which is based on econometric methods in which the functions of production costs and their derivatives in the long term are estimated according to several models (linear, quadratic, cubic). Moreover, quantitative analysis is followed in terms of using the (OLS method) because of the advantage of this method in giving unbiased linear estimates with the lowest variance of the estimated constants of the economic model parameters, then, choosing the best among them in line with the logic of economic theory.

3. Results and discussion:

3.1. Production costs:
The production costs of producing one ton of tomato crop under the greenhouse are divided into several items, including the cost of traded inputs as in Table 1 as the costs of the traded production inputs were distributed among several items: the costs of compound fertilizers ranked firstly in terms of relative importance as its value is (32,182) dinars / ton, rating about (40.67%). Seed costs come in the second place, with a value of (15108) dinars / ton which has the percentage of about (19.09%). The pesticide costs come thirdly as its value is about (14700) dinars / ton which rates about (18.58%). The costs of extortions come in fourth place, reaching (8200) dinars / ton, which rates about (10.36%). Fuel costs came fifthly reaching about (3300) dinars / ton which has the rate 4.17%. While the cost of peat moss ranked sixthly reaching about (2083) dinars / ton which rates (2.63%). Whereas, the costs of climbing yarn are about (1990) dinars / ton which has the rate about (2.52%) and ranked seventhly.

Table 1. The costs of the traded and local production inputs and their relative importance from the total costs of the tomato crop under the greenhouse for the agricultural season (2019-2020).

| Cost details                      | Costs (dinars / ton) | Relative importance% |
|-----------------------------------|----------------------|----------------------|
| **Traded production inputs**      |                      |                      |
| Compound fertilizers              | 32182                | 40.67                |
| Seeds                             | 15108                | 19.09                |
| Pesticides                        | 14700                | 18.58                |
| Fractures                         | 8200                 | 10.36                |
| fuel                              | 3300                 | 4.17                 |
| Pettmuss                          | 2083                 | 2.63                 |
| Climbing filaments                | 1990                 | 2.52                 |
| dishes                            | 1562                 | 1.98                 |
| Total                             | 79125                | 100%                 |
| **Local production inputs**       |                      |                      |
| Family manual labor               | 95265                | 45.02                |
| Harvesting and packing operations | 27183                | 12.84                |
| Interest on capital               | 26150                | 12.36                |
| Hired manual labor                | 25107                | 11.86                |
| organic fertilizers               | 16000                | 7.56                 |
| Mechanical work                   | 9305                 | 4.40                 |
| Irrigation                        | 6943                 | 3.28                 |
| Other expenses                    | 5675                 | 2.68                 |
| Total                             | 211628               | 100%                 |

* Source: It was calculated by the researcher based on the statistical form.
The costs of the dishes come in the last place as their value reached (1562) dinars / ton, which constituted about (1.98%). As for the costs of local production inputs, they were also distributed among several items, as the costs of family manual labor occupied the first place in the local production inputs amounting to about (95,265) dinars / ton, which the rate about (45.02%). Marketing operations costs come in second place costing about (27183) thousand dinars / ton which rates about (12.48%). Meanwhile, interest costs on capital come in third place costing about (26150) dinars / ton which rates about (12.36%). The costs of leased manual labor amounted to about (25,107) dinars / ton which rates about (11.86 %) and it ranked fourthly. While the cost of organic fertilizers amounted to about (16000) dinars / ton which rates about (7.56%) and it ranked fifthly. As for the costs of mechanical work, it comes in the sixth place as its value amounted to about (9305) dinars / ton which takes the percentage of (4.40%). Irrigation costs come in seventh place reaching about (6943) dinars / ton which rates about (3.28%). Other expenses come in last place costing about (5675) dinars / ton which rates about (2.68%).

3.2 Total cost:
It is the sum of fixed and variable costs. It is also equal to fixed costs when production is equal to zero. It increases with the increase in production due to the increase in variable costs. [4]

\[ T.C = T.F.C + T.V.C \]

The total costs of the tomato crop under the greenhouses in Anbar governorate for the agricultural season (2021-2020) amounted to about (290753) dinars / ton. The fixed costs taking about (44.58%) of the total costs rating about (129,615) dinars / ton. While the variable costs rate takes about (55.42%) of the total costs reaching about (161,138) dinars / ton. As shown in Table 2.

Table 2. For fixed and variable costs and the relative importance of the total costs of tomato crop under greenhouses for the agricultural season 2019-2020.

| Cost items     | The amount of costs is thousand dinars / ton | Relative importance% |
|---------------|---------------------------------------------|----------------------|
| Fixed costs   | 129615                                      | 44.58                |
| Variable costs| 161138                                      | 55.42                |
| Total costs   | 290753                                      | 100%                 |

* Source: It was calculated by the researcher based on the statistical form.

3.3 Estimating cost functions:
Total cost function means the relationship between the amount of what the producer spends in exchange for obtaining the productive resources used in the production of a specific product and the size of that output as a function of the size of the output [5]. Tomato farmers in the study area adopt several models in estimating the long-term total cost function of the tomato crop using three forms of cost functions (linear, quadratic, cubic). It is found that the cubic function is the more appropriate to the standard scales since it is equal to the statistical, economic and standard tests. Based on the economic theory, the short-term cubic total cost function takes the following form [6].

\[ TC = b0 + b1Q + b2Q^2 + b3Q^3 + b4AQ + b5A^2 + ui \]

TC is an approved variable that expresses the long-term total costs (dinars).

b0: the parameter constant for the TFC.
b4, b3, b2, b1: represent the regression coefficients.
Q: an independent variable expressing the quantity of output (tons).
Q2, Q3: the square of the product and the cubic of the product are related semantic to the product Q.
A, A2: Represents the area and the square of the area (greenhouses).
ui: represents the random variable that reflects the effect of other related variables that were not included in the estimated model.
Through the evaluation of the above function by adopting the Eviews 10 program, the estimation results were shown as in Table 3, which shows the parameters of the estimated function, as well as the values of statistical and standard tests of the constants and the estimated function.

Table 3. The independent variables and their estimated parameters for tomato yield using the least squares method (OLS) before performing the heterogeneity test.

| Variable | Coefficient | Std. Error | t-Statistic | Prob.  |
|----------|-------------|------------|-------------|--------|
| Q        | 228063.8    | 7869.854   | 28.97942    | 0.0000 |
| Q2       | -3574.613   | 1169.433   | -3.056705   | 0.0109 |
| Q3       | 365.6914    | 26.30382   | 13.90260    | 0.0000 |
| AQ       | -184121.9   | 20116.61   | -9.152729   | 0.0000 |
| A2       | 711718.6    | 106603.3   | 6.676330    | 0.0000 |
| R-squared| 0.986755    |            |             |        |
| Adjusted R-squared| 0.981938 | S.D. dependent var | 374269.6 |
| S.E. of regression | 50299.86 | Akaike info criterion | 24.73970 |
| Sum squared resid | 2.78E+10 | Schwarz criterion | 24.98113 |
| Log likelihood | -192.9176 | Hannan-Quinn criter. | 24.75206 |
| Durbin-Watson stat | 2.219954 |             |             |        |

*Source: Prepared by the researcher using Eviews 10 program.

** Indicates the level of significance 1%.

3.4. Statistical analysis:
The (t) test proved the significance of the parameters estimated at 1% level of significance using the OLS method as the value of (t) reached as shown in Table 3. The modified coefficient of determination is $R^2$ (98.19%) and this indicates that (98.19%) of the changes in the level of production costs (the dependent variable) are caused by the factors included in the model (explanatory variables) whereas (1.81%) of those variables are not included in the model such as environmental conditions and others. Another factor is its effect which absorbs the random variable.

3.5. Standard analysis:
In order for the model to be acceptable and reliable in the interpretation of the studied phenomenon, it is necessary to conduct the necessary standard tests related to standard problems. Represented by the self-correlation problem, by analyzing the data using the method of least squares (OLS), it is found that the value of DW was (2.219954) which is greater than the value of du that is (1.66) and it is smaller than 4-du that is (2.34) under the 1% level of significance and degrees of freedom n = 16 That is, that (du <d <4-du) falls in the domain (1.66 <2.219954 <2.34). it is concluded that there is no

Table 4. The independent variables and their estimated parameters of tomato crop to detect the problem of heteroscedasticity unstable using a test Breusch-Pagan-Godfrey

| Variable | Coefficient | Std. Error | t-Statistic | Prob.  |
|----------|-------------|------------|-------------|--------|
| C        | 6.95E+09    | 1.07E+10   | 0.651601    | 0.5293 |
| Q        | -8.78E+08   | 2.81E+09   | -0.312882   | 0.7608 |
| Q2       | -281113.2   | 86936654   | -0.003234   | 0.9975 |
| Q3       | -643555.0   | 4910334.   | -0.131061   | 0.8983 |
| AQ       | 6.74E+08    | 2.60E+09   | 0.259106    | 0.8008 |
| A2       | -2.96E+09   | 1.03E+10   | -0.287156   | 0.7799 |
| R-squared| 0.162166    |            |             |        |
| Adjusted R-squared| -0.256751 | S.D. dependent var | 2.73E+09 |
| S.E. of regression | 3.06E+09 | Akaike info criterion | 46.79816 |
| Sum squared resid | 9.33E+19 | Schwarz criterion | 47.08788 |
| Log likelihood | -368.3853 | Hannan-Quinn criter. | 46.81299 |
| F-statistic | 0.387108 | Durbin-Watson stat | 1.950392 |
| Probf(F-statistic) | 0.846744 |             |             |        |

*Source: Prepared by the researcher using Eviews 10 program.

** Indicates the level of significance 1%.
autocorrelation problem between the remainders. [7]. The model also tomato crop the assumption that there is no multiple linear relationship between the independent variables (Multicollinearity) because the model is non-linear in terms of the variables as the variables are the square of the product (Q2). Output cubic (Q3). Functionally related to the variable (Q) but the relationship is not linear. [8].

In view of the reliance of the research on cross-section data, it is necessary to detect the problem of inconsistency of the uniformity of variance. The Breusch-pagan-Godfrey test was used to detect the problem of inconsistency of contrast uniformity. It is not significant at 5% level, meaning that the model does not suffer from a problem (heteroscedasticity).

3.6. Derivation of the long-term cost function of tomato crop under greenhouse for the season (2019-2020)
The estimated function can be adopted in the economic analysis to determine the optimum size of a greenhouse farm, average production cost, marginal costs, cost elasticity, and derive the supply equation for those farms, as below.

\[ \text{LTC} = 228063.8Q - 3574.6Q^2 + 365.7Q^3 - 184121.9AQ + 711718.6A^2 \]

We differentiate the function with respect to the area A and set it equal to zero, so we get

\[ \frac{\partial \text{LTC}}{\partial A} = -184212.9Q + 1423437.2A = 0 \]

\[ A = 0.129Q \] (1)

Substitute the value of A into the original cost function so we get

\[ \text{LTC} = 228063.8Q - 3574.6Q^2 + 365.7Q^3 - 184121.9Q + 711718.6(0.129Q)^2 \]

In short, we get

\[ \text{LTC} = 228063.8Q - 15482.6Q^2 + 365.7Q^3 \] (2)

It is the equation of costs in the long run as a function of production only, therefore, we express the costs as a function of the size of the output.

3.7. Average Total Costs Function:
Average total cost is defined as the product of dividing the total costs TC by the total units of output Q over a given period of time. It uses a measure to calculate the cost of one unit of production, unit cost, or the share of one unit of production from the total costs in the organization. It can be expressed in the following formula. [9]

\[ \text{LRATC} = \frac{\text{TC}}{Q} = 228063.8 - 15482.6Q + 365.7Q^2 \] (3)

To get the average costs at any level of output, that level is substituted into the average cost function.

3.8. Marginal costs:
Marginal costs are defined as the amount of increase in total costs resulting from increasing production by one unit. In other words, it is the costs of producing an additional unit of output or the last unit. [10]. The marginal cost function can be obtained by deriving the total cost function as in the following equation.

\[ \text{LRMC} = \frac{\partial \text{TC}}{\partial Q} = 228063.8 - 30965.2Q + 1097.1Q^2 \] (4)

LRMC represents marginal costs.
TC represents the change in total costs.
\( \partial Q \) represents the change in output.
To obtain marginal costs at any level of output, that level is substituted into the marginal cost function.

3.9. Cost elasticity:
It can be found by dividing the long-term marginal costs (LRMC) by the long-term average total costs (LRAC) as in the following formula [11].
EC = LRMC / LRAC

EC stands for cost elasticity.

LRMC represents long-term marginal costs.

LRAC represents the medium-term costs in the long run.

The following table shows the cost rate, marginal costs and cost elasticity at different levels of production according to the derivatives of the cost function.

Table 5. The average costs, marginal costs, cost elasticity and the economic stage of tomato growers in the research sample.

| Production (Tons) | Average costs (ID) | marginal costs (ID) | Cost Elasticity |
|------------------|--------------------|---------------------|-----------------|
| 4                | 171984.6           | 121756.6            | 0.71            |
| 8                | 127607.8           | 50556.6             | 0.40            |
| 12               | 94933.4            | 14463.8             | 0.15            |
| 16               | 73961.4            | 13478.2             | 0.18            |
| 21.17            | 64192.52           | 64216.62            | 1.00            |
| 28               | 81259.8            | 221164.6            | 2.72            |
| 34               | 124404.6           | 443494.6            | 3.56            |

* Source: Calculated by the researcher based on the average costs equation, marginal costs equation and elasticity equation.

Figure 1. The long-run average cost curve and the long-run marginal cost curve.

* Source: prepared by the researcher based on the data of Table 5.

It can be seen from Figure (1) that both curves begin to descend from the top to the bottom. The marginal cost curve is below the average cost curve and the marginal cost curve reaches its minimum end before the average cost curve reaches its minimum end achieving Volume savings. After that, the marginal cost curve begins to increase in height and intersects with the average cost curve at the lowest point. Then, the average cost curve starts to rise and after the intersection point of the two curves the marginal cost curve is higher than the average cost curve achieving no Volume savings.

3.10. Optimum production size and area (number of greenhouses):

The optimum size of tomato production is achieved when the rate of cost curve is at its lowest point, and we obtain that by equating the first derivative of the rate of cost function with zero and the solution to determine the quantity of production that lowers the long-term average cost (LRATC) as follows. [12]

\[
\frac{\partial LRATC}{\partial Q} = -15482.6 + 731.4Q = 0
\]

Q = 21.17 tons (Optimum volume of production).

As for the optimum size of the farm, expressed by the number of houses in it, it can be found by substituting the value of production Q in equation No. (1).
A = 0.129Q
A = 0.129 (21.17)
A ≅ 3 (Optimum greenhouse size).

3.11. Economic efficiency:
The primary objective of the product is to achieve economic efficiency which is the ratio between the value of the output achieved in relation to the value of the inputs used i.e. maximizing the ratio between the outputs and inputs and the more efficient use of available economic resources to achieve the maximum possible output [13].

Since the efficiency is relative and varies according to the size of the farm, it can be estimated based on the highest cost rate achieved in the study sample and assuming the number of greenhouses that fall within the scope of the study sample starting from (1) house and ending with (10) houses which represent the number of greenhouses planted with tomato crop. Throughout Compensating for the numbers of houses in Equation No. (1), We obtain the volume of production associated with each size of greenhouse sizes and by substituting the quantity of production in Equation No. (3). We obtain the average cost of production per ton as shown in Table 6 where it becomes clear to us that the average cost the long-term rate starts to decline and reaches its lowest value of (65777.06) dinars / ton at houses no. (3) which represents the optimal homes for production. Then, the long-term cost rate returns to rise and reaches the highest average long-term cost at the hypothetical houses which amounts to 1225472 dinars / Tons.

The long-term cost rate has been converted into a relative rate through the following law:

Relative average cost = \( \frac{\text{average cost}}{\text{highest average cost}} \times 100 \)  \( (5) \)

As for economic efficiency, it was obtained through the following law [14].

\[ E.C = \frac{H.A.C - R.A.C}{H.A.C - M.A.C} \times 100 \]  \( (6) \)

H.A.C represents the highest cost rate.
R.A.C represents the cost of the designated farm.
M.A.C is the lowest cost rate.

Table 6 shows that the economic efficiency starts from (94.46) and starts to rise until it reaches the percentage of economic efficiency 100% at the optimum houses for production which are (3) greenhouses which corresponds to the lowest average cost of production whose value is (64192.5) dinars / ton. Then, after that, the economic efficiency begins to decrease and reaches zero with an increase in the number.

Table 6. Preparing the supposed greenhouse, the yield achieved, the cost rate, the relative cost rate, and the economic efficiency of the tomato crop in the research sample.

| Assumed space | Achieved output | Cost rate | Relative cost rate | Economic efficiency |
|---------------|----------------|-----------|--------------------|---------------------|
| 1             | 7.75           | 130038.5  | 43.5               | 72.5                |
| 2             | 15.50          | 75942.93  | 25.4               | 95.6                |
| 3             | 23.25          | 65777.06  | 21.9               | 100                 |
| 4             | 31.01          | 99612.84  | 33.3               | 85.5                |
| 5             | 38.76          | 177363.1  | 59.3               | 52.2                |
| 6             | 46.51          | 299043    | 100                | 0                   |

*Source: Prepared by the researcher using the numbers of greenhouses within the scope of the research sample.

Through Figure 2, economies of size can be identified through the relationship between the size of greenhouses (houses planted with tomato crops) and the average total cost. We also note that economies of scale reduce the average cost per unit of production as the size of cultivated houses
expands. Capacity savings (100%) at the optimal size of production which corresponds to the lowest average cost. The increase in the number of houses after this size leads to an increase in production by less than the increase in costs which leads to an increase in the average total costs curve and this makes the farmer work within the area of volume savings (Dis Economies of size). It is also found that (62.5%) of the farmers in the study sample achieve capacity savings while (31.25%) do not achieve any savings whereas the percentage of farmers who achieve low rates of economic efficiency amounted to about (6.25%) of the total farmers.

Figure 2. Economic Efficiency and Relative Cost Rate Curves.
* Source: prepared by the researcher based on the data of Table 6.

3.12. Supply function of tomato crop in the long term:
To find out the reaction of tomato farmers in greenhouses to the changes that occur in the price of the output, the supply function was derived by equating marginal costs with the price of the product. It means that the supply function can be derived from the necessary condition of the profit function as follows [15].

\[ \pi = TR - TC \]
\[ \frac{\partial \pi}{\partial Q} = P - LMC = \text{Min LRATC} = 0 \]
\[ LRMC = P = \text{Min LRATC} \]

By substituting the above marginal cost equation derived from the estimated long-term total cost function, we obtain the following:
\[ LRMC = \frac{\partial LRTC}{\partial Q} = P. \]

\[ 228063.8 - 30965.2Q + 1097.1Q^2 = P \] (7)

by ordering the equation
\[ 1097.1Q^2 - 30965.2Q + 228063.8 = P. \]
\[ 1097.1Q^2 - 30965.2Q + 228063.8 - P = 0 \]
\[ a = 1097.1, b = -30965.2, c = 228063.8 - p \]

It is a second-class equation and compensation in the Constitution method:
\[ Q = S = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \]
\[ Q = S = \frac{-30965.2 \pm \sqrt{(30965.2)^2 - 4(1097.1)(228063.8 - p)}}{2(1097.1)} \]
\[ Q = S = \frac{-30965.2 \pm \sqrt{958843611 - 1000835180 + 4388.4p}}{2194.2} \]
\[ S = \frac{-30965.2 \pm \sqrt{4388.4p - 41991569}}{2194.2} \] (8)
Through the estimated supply function of the tomato crop with the aim of studying the farmers' response to different price levels, several price levels were imposed for the tomato crop taking into account the setting of the minimum price of the product that the product would be accepted. It represents the lowest point of the average total costs in the long term which amounted to (64.193) dinars / ton. From it, we get the quantity supplied which amounted to about (21.17) tons, but if the price of the product falls below the minimum price (64.193) thousand dinars / ton, a loss will be realized that leads to the farmer's stopping production, but if the price is higher than (64.193) (Dinar/ton). So, the quantity supplied is appropriate with the price of the product.

The output function represented by the tomato supply curve can be illustrated as in Figure 3 which is the rising portion of the long-term marginal cost function (LMC) curve, starting from the lowest point on the long-term average total costs (LATC) curve.

3.13. Price elasticity of supply:

The price elasticity of supply for tomato crop was calculated which is one of the most important indicators that can be estimated from the computed supply function by applying the price elasticity law (16).

\[ E.S = \left( \frac{\partial Q_S}{\partial P} \right) \left( \frac{P}{Q} \right) \]  

By reviewing the data in Table 7, it appears that the minimum price that farmers will accept is (64.193) dinars / ton as the quantity offered by the farm of tomato crop at this price is about (21.17) tons. The quantity supplied of tomatoes increases to (44.16) tons when prices rose to nearly (1,000,000) dinars / ton, and it is clear from Figure 3 the relationship between the quantity of production and the price of the tomato crop. When farm prices increase by (10%) above their minimum limit, the quantity supplied in the market increases by 1.4%, this means that the farmer faces great difficulty in controlling production in the event of price changes. This is mainly due to the low response of production to productive resources. In addition to the weak ability of farmers to expand in size and this may be due to the fact that the farms on which the research relied are family farms that depend mainly on family work. Therefore, changing the farm's ability to respond to price changes is dependent on changing the mode of production. In addition, the market supply may increase with the entry of new producers, which makes the elasticity of the crop supply in the market higher than those levels.

Table 7. Prices, the expected quantities of tomato crop, and the price flexibility of the research sample.

| Price (ID / T) | Quantity (Tons) | Elasticity of supply |
|---------------|----------------|---------------------|
| 64.193        | 21.17          | 0.14                |
| 200           | 27.29          | 0.21                |
| 400           | 32.98          | 0.26                |
| 600           | 37.31          | 0.29                |
| 800           | 40.95          | 0.31                |
| 1000          | 44.16          |                      |

* Source: prepared by the researcher based on the estimated supply function of the option crop.
Figure 3. Curve of the long-term supply function of tomato crop for the research sample.

4. Conclusions
The average cost of producing a ton of tomato under the greenhouse is higher than the optimum cost rate which indicates the possibility of reducing production costs. By analyzing the cost structure of the research sample, As for it was found that the fixed costs formed a percentage (44.42%), while the variable costs accounted for (55.58%) for the tomato crop as the largest part of the fixed costs is manual family work while the largest part of the variable costs is composite fertilizer. Through the study, it was found that the cubic functions are the best functions used in the study for the tomato crop for the research sample due to its similarity with the economic logic and the compatibility of the estimated parameters in terms of statistical, economic and standard. The study showed that the cost elasticity in the long term amounted to about (0.26) for tomato crop and this means that tomato growers produce in the first stage which is the stage of increasing yield, i.e. As for when costs increase by a certain percentage, we get more production. Which evident through the supply function that there is a positive relationship between the offered quantities and the selling price when the price is higher than (64193) dinars / ton. As for however, the elasticity of supply is low which indicates the difficulty of responding to the farm supply vertically.

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