International Journal of Multidisciplinary Education and Research
www.multidisciplinaryjournals.in
ISSN: 2455-4588
Received: 11-01-2024, Accepted: 27-01-2024, Published: 13-02-2024
Volume 9, Issue 1, 2024, Page No. 54-60

The optimal size of production and farm for the parchment crop for the 2022 production season in Salah al-din governorate, Samarra district, as a model

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Abstract
The research aims to study the production economics of the popular crop in the Samarra district in order to reach the optimal size of production and area that enables the farmer to realize the resources optimally in terms of profits by estimating cost functions and deriving the relevant economic relationships. The importance of the research aims to address the study of the achieved economies of scale. For the pruning crop, which is considered nutritionally and economically important to me in Salah al-Din Governorate, the farms that operate within the no-savings zone constituted (28%) of the percentage of farms for the pruning crop in the study sample, while the percentage of farms operating within the savings zone amounted to (72%), while The percentage of farms operating within the capacity savings zone (100%) at optimal production reached (16%) for the cultivated crop in the study sample. As for the percentage of economies of scale achieved, the results showed that it increases with the increase in production volume and reaches its maximum value at the optimal volume of production (100%). The study recommends working to support production requirements, including providing certified seeds, good pesticides, and fertilizers at optimal prices, in addition to the use of modern mechanization in Agricultural operations that increase optimal economic efficiency.

Keywords: Crop yield, cost functions, economies of scale

Introduction
Raqqa is one of the important crops in Iraq in terms of its great nutritional value. It is also very rich in minerals and salts, which contain appropriate amounts of vitamins and proteins, and is also rich in sugars and carbohydrates. It is considered one of the main vegetables in Iraq and is grown in many countries of the world, as Raqqa is a fruit. It is used fresh for making jams and juices. This crop is due to the plant of the Cucurbit family. This crop is grown in countries with a hot and dry climate and is also grown in the central regions in abundance, in addition to the foreign and hybrid varieties that are currently grown in Iraq. The cultivation of the sophistication crop does not keep pace with the demand for it due to the presence of Small increases in the areas used for agriculture, as well as a decrease in the productivity of the dunum. Hence, it is necessary to increase the yield of one dunum in terms of vertical expansion in its cultivation, using modern scientific methods and means such as fertilization and irrigation, as well as using good agricultural distances and taking scientific methods for good control, in addition to Horizontal expansion of the cultivation of rice crops.

Research importance
The importance of the research aims to address the study of the economies of scale achieved for the ruqyah crop, which is considered nutritionally and economically important to me in Salah al-Din Governorate, and to identify the economics of producing the two crops in the Samarra district as a selected sample across Iraq in general and the governorate in particular and in terms of farmers' proximity or distance from the economies of scale. The achieved size, and it is of great importance to provide guidance applications that lie in increasing production, then encouraging farmers to expand agriculture to meet the local need for the growing demand for sophistication.

Research problem
The problem of the study can be summarized in the reluctance of some rural farmers to grow the crop in recent years due to the high prices of materials and low levels of production, which gives an opposite image of the inefficiency in using available resources and their belief in lack of profits and they have not achieved the optimal economies of scale, whether in production or in the size of the farm, as It requires a study to determine the optimal size of the farm and the production achieved in this study.

Research objective
The research aims to study the production economics of the meadow crop in Samarra District to reach the optimal size of production and area that enables the farmer to realize the resources optimally in terms of profits by estimating cost functions and deriving the relevant economic relationships, in order to know the percentage of economies of scale that farmers achieve in terms of The economic efficiency achieved by crop farmers in the research sample.

Research hypothesis
The research is based on the hypothesis that most farmers do not have the ability to achieve the optimal size of production and area, as it leads to high production costs for the upscale crop, and that most farmers do not have the ability and efficiency to choose the optimal combination in terms of production elements due to their reliance on skills in growing this crop and beyond. About the scientific methods through which production elements can be mixed in a way that achieves the optimal combination that minimizes costs and maximizes profit.

Search method

This research relied on two forms of analysis: the first was descriptive, as it was based on previous studies that dealt with the subject of the study or close to it, and the second was quantitative economic analysis, based on the quantities taken from the questionnaire form and in a manner consistent with the concepts and foundations of economic theory, through the use of the (SPSS 25) program to estimate The cost function is in the cubic form and through the use of (Excel) to complete, arrange and tabulate the data.

Theoretical framework

Cost concept

The cost is the value of the money paid in exchange for benefiting from the services of production factors or using the energies resulting from them in a specific production process to obtain goods and services in that process, as it is the sum of the amounts that the producer bears in exchange for his use of economic resources to obtain the output and can be viewed from the economic aspect. It is the total expenses incurred by the producer in exchange for his use of economic resources to obtain the output (Salman, 2000, 207).

The practical importance of the cost function in the long run Estimating the volume of civil production costs-:

To study the optimal production volume, there are two main aspects:

1. It mentions the relationship of production volume to total costs through estimating the total cost function, from which the average total cost curve is agreed upon to show economies of scale.
2. Directly estimating the average total cost function in the long run, from which the optimal size of the farm is determined.

The research arrived at the first method in studying the optimal size for a sample of soy and watermelon farmers, after introducing the assumptions of economic theory directly into the functional form of the estimated standard model, especially since what relates to it is the average cost curve that takes the shape of the letter (U).

Hence, the total cost function in the long run can be derived based on the short-run cost functions in the following general formula: (Henderson, 1980; 83-92) [7]

$$SRTC = bo + b1Q - b_2Q^2 + b3Q^3 - b4QA + b5A^2 + Ui \ldots\ldots (1)$$

If another element is introduced to represent the area (A), the cost function takes the following form:

$$TC = bo + b1Q - b2Q^2 + b3Q^3 - b4QA + b5A^2 + Ui$$

Since:

TC = total costs (thousand dinars)

Q = total production quantity per farm (kg)

A = means area or size of the farm (dunams)

Bi = means the regression coefficients, Ui = means the random variable

By writing equation (1) in its implicit form, where TC means an implicit function of A, Q.

$$V = LRTC - b_1Q + b_2Q^2 - b_3Q^3 + b4QA - b5A^2 - Ui = 0 \ldots\ldots\ldots (2)$$

We take the partial derivative in terms of the area (A) and equate it to zero, we get :

$$b4Q - 2b5A = 0 \qquad (3)$$

$$A = b4 \backslash 2b5\, Q \qquad (4)$$

Where the area (A) was reached in terms of Q) and by substituting the value of (A) into the original function (1), we obtain the long-term cost function..

LRTC = b1Q – b2Q2 + b3Q3 – b4Q (b4 \ 2b5 Q) + b5 (b4Q \ 2b5) 2 + Ui

= b1Q – b2Q2 + b3Q3 - b42 Q2 \ 2b5 + b5b42Q2 \ 4b52 LRTC

= b1Q – b2Q2 + b3Q3 - b42Q2 \ 2b5 + b42Q2\ 4b5 LRTC

= b1Q – b2Q2 + b3Q3 - (1 \ 2) b42Q2\ b5 + (1 \ 4) b42Q2\ b5 LRTC

By adding the terms of Q2, it is obtained

= b1Q–b2Q2+b3Q3–1\4 b42\b5Q2 LRTC

= b1Q – b2Q2 - (1 \ 4) b42 \b5 Q2+ b3Q3 LRTC

= b1Q – (b2 -(1 \ 4) b42 \ b5) Q2+ b3Q3 LRTC

The final formula for the long-run total cost function is as follows:

LRTC = b1Q - b2Q2 + b3Q3 when □2 = b2 – (1 \ 4) b42\ b5

:or

LRTC = b1Q – b2Q2 + b3Q3

Total cost function in the long run

Function Coefficient (R)

The accuracy of determining the Economies of scale and the elasticity of the total cost as indicators, but there must be a clear interpretation of the function parameter (R), which explains the yield to scale. Here it is the relative response to production as a result of an equal change in the factors of production and is equal to the sum of the elasticities. The response to the factors of production in the event of a change in the same ratio, which is the inverse of the cost elasticity coefficient, where it is equal to the average total cost divided by the marginal cost in the long run.

R = LAC \ LMC, E = LMC \ LAC or E = 1 \ R R= 1\E

Whereas, the values of R and E are equal to 1 at the lowest point on the LRAC curve, which is at the optimal size of production at which high capacity savings are achieved. This is another indicator of the presence of the cost when the average total cost curve decreases, as it increases when there is a decrease in the average cost curve. Its value is the inverse of the value of the elasticity coefficient, which is positive whenever the elasticity is negative, and they are equal at the optimal size only when the losses are high and the elasticity is zero. After that, the optimal size is where the elasticity becomes positive, so the average total cost curve increases and the lavoir is achieved, at which the function coefficient is less than one. (Al-Jubouri, 2022, p. 224).[1]

Cost flexibility: Elasticity of Cost (E)
Cost elasticity is the response of total costs to a change in the volume of production, as the relative increase in costs is a result of the increase in the volume of production. When measuring cost elasticity, we actually infer the type of yield to which production is subject. When we want to measure cost elasticity at a specific volume of production here We differentiate the total cost function to arrive at marginal costs, and by dividing them by the average total costs, we obtain cost elasticity. If the elasticity of total costs is less than one, then the marginal cost is less than the average total cost. This happens when production is subject to increasing yields, and this means that we achieve a relative increase in production at a lower relative cost. However, if the elasticity of costs is greater than one, then the cost is true. Marginal costs are greater than the average total costs, and production is subject to diminishing returns, as we obtain a relative increase in production at a greater cost. However, if the cost elasticity is equal to one, the marginal cost is equal to the average total costs, then production is subject to constant returns, as we obtain an increase A relative increase in production with the same increase in costs (Al-Samarrai 2004:40). Where flexibility can be found from the following law

$E = \partial LRAC \setminus \partial Q * Q \setminus LRAC$

The concept of economies of scale
There are two basic aspects to achieving economies of scale or increasing returns to scale:
The first factor: The greater the volume of production, the greater the benefit in terms of the efficiency of work produced from the division of labor and specialization. On the other hand, in small production operations, the worker may be forced to move to another job that he may not know, in addition to the loss of time as a result of moving from one job to another.
The second factor: Taking advantage of modern technology to increase volume yield. A large enterprise can adopt this technology to increase production. (Melemore, *et al*, 1983)

= LRATCm _ LRATCi\ LRATCm _ LRATCo econ

Whereas:
Econ = economies of scale.
LRATCm= The expected average total cost when the level of achieved production decreases
LRATCi = expected average total cost at production level i.
LRATCo= The expected average total cost at the optimum level of production volume

Results and discussion
Estimating the long-term total cost function for the cultivated crop in the study sample for the production season (2022)
The research was based on the analysis using the method of least squares (OLS). The total short-term cost function of the agricultural crop for the study sample was estimated in its three forms of cost functions (linear, quadratic, and cubic). It was found that the cubic model is the most appropriate for the relationship adopted in the study. It was found to be compatible with economic logic and passed the tests. Statistical and measurement as follows:

$$SRTC = 143.175 + 2714723.57Q - 79.462576\,Q^2 + 0.00309\,Q^3 - 0.000004204\,AQ + 0.00161\,A^2$$

Table 1: The total cost function of the irrigation crop in the short term

Independent variables	Estimated parameters	Statistical parameters
Q	2714723.57 (3.440)*	$R^2 = 0.82$
Q^2	79.462576 - *(5.106 -)	$R^{-2} = 0.80$
Q^3	0.00309 (3.090)*	F = 46.615
AQ	0.000004204- *(-4.204)	D.W = 2.061
A^2	0.00161 (5.367) *	*= t

Source: Calculated according to the SPSS25 program, based on the data from the questionnaire form

When we write the function in its implicit form, we get:

$$V = C - 2714723.57Q + 79.462576Q^2 - 0.00309Q^3 + 0.000004204AQ - 0.00161A^2 = 0$$

By taking its first partial derivative with respect to the cultivated area (A) and setting it equal to zero, we obtain:

$$\frac{\partial V}{\partial A} = 0.000004204\,Q - 0.00322\,A = 0$$

$$A = 0.001305\,Q$$

By substituting the value of A into the original function and summing the terms of Q2, we obtain the cost function for the meadow crop in the long run:

$$LRTC = 2714723.57\,Q - 79.462576\,Q^2 + 0.00309\,Q^3$$

The long-run cost function of the soy crop
statistical analysis
After ensuring the soundness of the estimates of the parameters of the estimated models for the agricultural crop from the economic point of view, which were consistent with the economic theory in terms of sign and in a way that supports the fact that the shape of the total cost curve is convex and therefore the shape of the average total cost curve takes the shape of the letter (U), comes the role of statistical standards. The estimated parameters were statistically significant according to the t-test at a significance level of (5%). To demonstrate the goodness of fit of the estimated regression line, the significance of the estimated functions as a whole was proven at a statistical level (5%) and based on the F test, which has a value of (46.615). The coefficient of determination showed that 82% of the changes in total costs were caused by the change in the total yield of the meadow crop, and that 18% of the remaining changes did not appear in the model and their effect was absorbed by the random variable.

Econometric analysis
In order for the model to be acceptable and reliable in explaining the studied phenomenon, the necessary standard tests related to standard problems must be conducted, which are:

Autocorrelation problem for a random variable

The problem of autocorrelation among random residuals occurs when the random residuals are correlated with each other, and it affects the results of regression analysis, so the tests give results that are less accurate than those that appear in their absence, and cross-section data are less exposed to this problem. (Al-Adhari, 2010: 99) [3]. This problem is revealed by the Durbin-Watson test because it is suitable for testing the presence of first-degree autocorrelation (Attiya, 2004: 448), which demonstrated that there is no problem of autocorrelation in this estimated model because the value of (D.W) was located in the region Accepting the null hypothesis, meaning that D.W is equal to (2.061), and from the D.W table for a significance level of 5% and degrees of freedom (5), we find that D.W falls between:

1.77< 2.061< 2.23 That is du < D.W < ***4*** –du

From this we conclude that there is no positive or negative autocorrelation for the first-order random variable.

Multicollinearity problem

This problem occurs if there is a linear relationship between two or more independent variables in the regression model, which hinders the isolation of their individual effects on the dependent variable (Al-Adhari, 2010: 89) [3]. But the model fulfilled the assumption that there is no multicollinearity between the independent variables, because the model is non-linear in that the variables Q2 (the square of the result) and Q3 (the cube of the result) are linked in evidence to the variable Q, but the relationship is non-linear.

The problem of heteroskedasticity

The third assumption related to the random variable ui is that the probability distribution of the variable ui remains constant for all values of the independent variable, meaning that the variance for each ui remains constant for all values of the independent variable. This is expressed in the following formula:

$$Var(u) = E[(ui - E(ui)^2] = E(ui)^2 = \delta^2 u \text{ constant}$$

Given that the study relied on cross-sectional data, in which this phenomenon may be more prevalent than time series data, it must be revealed. (Attiya, 2000: 439). There are tests to detect the presence of the problem of non-homogeneity, which are the Spearman and Coldfield test, the Kelser test, and the (Park) test. The (Park) test was adopted, which includes estimating the regression equation of the error squared as a dependent variable and the result as an independent variable according to the following formula:

$$Log(ei)^2 = a + bLog(Q)$$

The relationship estimated in the logarithmic form for the foliage yield was as follows:

$$\log e_i^2 = 0.119 + 0.044 \log Q$$

t = (0.082) (0.029)

$R^2 = 0.047$ F= 0.062 D. W= 1.991

Since the estimated function is not significant below the 5% significance level according to the F test, and the calculated t value for the slope of the error regression coefficients is less than the tabular t value at the 5% significance level, this indicates that there is no problem of non-stationarity of homogeneity of variance.

Economic analysis

It includes the practical importance of the cost function in the long run, represented by calculating and estimating the optimal volumes of production and cultivated areas for civil crops, costs, marginal costs, cost elasticity, and the function coefficient.

Determine the optimal civil production volume and costs for the cultivated crop

In order to calculate the optimal size that minimizes costs (economies of scale) in the production of a cultivar crop, we must first find the long-run average total cost equation (LRATC), as all production costs are variable costs in the long run. The average cost equation was derived from the total cost equation by dividing the latter by The size of the output, Q, and the equation for the average total cost in the long run for the meadow crop was as follows:

$$LRATC = 2714723.57 - 79.462576\, Q + 0.00309\, Q^2$$

In order to determine the optimal size of production that minimizes costs, it is necessary to apply the first necessary condition to minimize the cost function, which is taking the first derivative of the average total cost function in relation to output and equaling it to zero, and then solving the equation with respect to Q, so we obtain:

$$\frac{\partial LRATC}{\partial Q} = -79.2462576 + 0.00618\, Q = 0$$

$$Q = \frac{79.2462576}{0.00618} = 12858.019\ kg/donum$$

$$Q = 12.858\ Ton$$

The optimal size for producing a crop that minimizes costs and maximizes profit

Determine the optimal areas for the cultivar crop:

For the purpose of obtaining the optimal areas cultivated with the cultivar crop, we substitute the value of Q into the value of A, we obtain:

$$A = 0.001305\, Q$$

$$A = 0.001305\,(12858.019) = 16.779\ donum$$

The optimal area that arable crop farmers must exploit to reach the optimal size of production that minimizes costs and maximizes profits

Table 2: Actual and optimal volumes of production and areas cultivated with the cultivar crop

Efficiency % 1/2	Optimum size (2) of production (tons)	Actual volume (1) of production (tons)	Efficiency % 1/2	The optimal size (2) of the area (acres)	Actual size (1) per area (acre)	The crop
%79	12.85	11.21	81***%***	16.77	13.6	**Sophistication**

Source: Calculated by the researcher based on the questionnaire form data

It is clear from Table (10) that the optimal size of the areas of (16.77) dunums for the pruned crop exceeds the actual sizes of the areas cultivated with the crop of the study sample, as the farmers of the pruned crop must expand their areas by (3.17) dunums, and the optimal size of production came at a rate exceeding the actual rate. For the crop of the study sample, the optimal size of production was (12.85) tons, and since the optimal size of production exceeds the actual size, the farmers of the cultivar crop in the study sample must increase their production by (1.64) tons***.***

The percentage of economies of scale and flexibility achieved for the cultivated crop

According to economic theory, production levels that are less than the optimal level achieve increasing proportions of economies of scale, and when they reach the optimal production level, they achieve stability in volume, while production levels higher than the optimal level achieve decreasing proportions, resulting in no economies of scale, and this can be calculated quantitatively according to the well-known formula for economies of scale. The results were obtained as in Table (4***)***

It is clear from Table (3) that the average total cost begins to rise after the optimal production level and as the volume of output increases, then it continues to rise when the expansion of production continues, as economies of scale begin to increase as the average total cost curve decreases until economies of scale reach (100%) It is the stage of (yield stability) at the optimal size of production, and in this stage it is the (yield increasing stage) in which the average total cost curve decreases as the size of the farm expands, which achieves increasing proportions of capacity savings (Economies of scale), and capacity savings occur for two factors, one of which is expansion. In specialization and division of farm labor, the other factor is increasing the possibility of using modern methods in agricultural production, which leads to reducing the average unit cost of output, but when continuing to increase the size of the farm, capacity savings appear (Diseconomies of scale) that occur as a result of establishing production capacities larger than Those that achieve the advantages of large production and then will result in a decrease in the efficiency of farm performance. After that, the farm faces some difficulties in farm management and it is difficult to link the agricultural economic resources with which economic efficiency is achieved, and then it will lead to an increase in the average total cost curve after the optimal size of production, and these This stage of production is called the stage of diminishing returns***.***

The results showed that the elasticity of the cost function takes a negative sign at production levels that are less than the optimal size, indicating an inverse relationship between output and average cost. This means that the average total cost decreases as the size increases. While the elasticities of the cost function take a positive sign at production levels that exceed the optimal level, thus reinforcing the direct relationship between output and average cost for production levels that exceed the optimal size, meaning that the average total cost increases with the increase in the volume of output that exceeds the optimal size.

The function coefficient showed that its positive value is greater than the correct one for production levels less than the optimal size, as its value increases with the increase in production volume, meaning that the rate of increase in production volume exceeds the rate of increase in costs that appear in the first stage of production stages (the increasing yield stage). By knowing the marginal cost, we infer the economies of scale achieved. In the area of savings, the marginal cost function is below the average total cost function, and when the two cost curves (marginal and average) intersect, the optimal volume of production is achieved, in which the value of the average total cost is equal to the marginal cost. After this size, the marginal cost curve will be higher than the average total cost curve, thus achieving an area of no capacity savings. Thus, 100% economies of scale are achieved when the marginal cost curve is equal to the average total cost curve, that is, at the optimal size of production, and both the coefficient of the function is equal to the integer one and the elasticity of the cost function is equal to zero, which is achieved by about (16%) of the farmers of the agricultural crop. This means that These farms have achieved capacity savings (100%), and the rest of the farmers who work within the categories of less than optimal sizes must expand their size categories until they reach the optimal area that achieves the optimal size, which is (17.79) dunams, because they have the ability to reduce their production costs in a way that suits them. With the optimal size reached by this study. As for farms whose area is higher than the optimal area, farmers are required to reduce the area of their farms to the area that achieves the optimal volume of production for this crop.

As for the percentage of economies of scale achieved, the results showed that it increases with the increase in production volume and reaches its maximum value at the optimal size of production (100%). However, by increasing the volume of production beyond the optimal size, the percentage of economies of scale begins to decrease in increasing proportions, as the farms operating within the area of diseconomies formed... (28%) of the percentage of farms for the cultivar crop in the study sample, while the percentage of farms operating within the savings zone amounted to (72%), while the percentage of farms operating within the capacity savings area (100%) at optimal production amounted to (16%). For the cultivar crop in the study sample***.***

Table 3: shows the production levels of cultivar crop farmers in the study sample

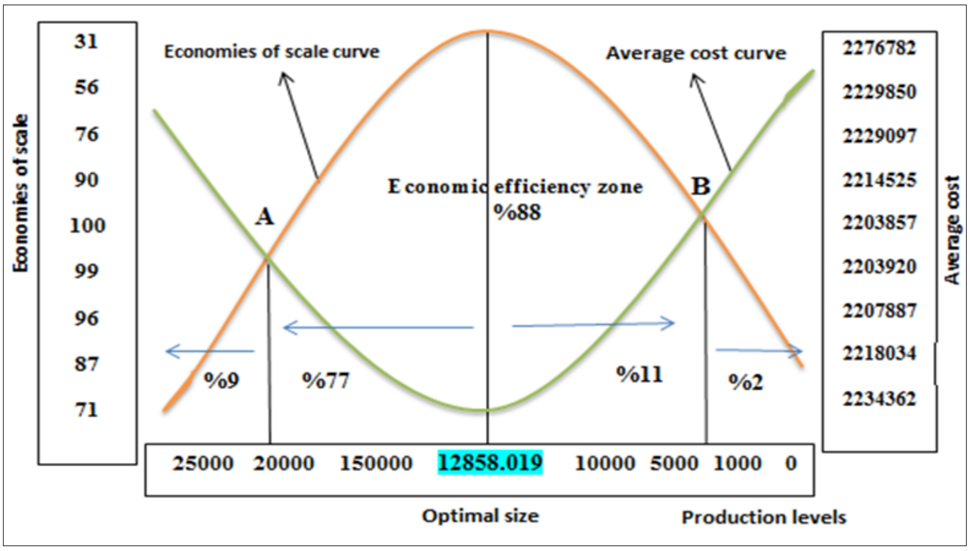
Yield stage	Contribution percentage %	Number of farmers	Production level (kg)
Increasing yields	9 %	5	8000
Increasing yields	14 %	8	9000
Increasing yields	13 %	7	10000
Increasing yields	20 %	11	11000
Optimal size	16 %	9	12858.019
Diminishing returns	11 %	6	13000
Diminishing returns	9 %	5	14000
Diminishing returns	4 %	2	15000
Diminishing returns	4 %	2	16000
	%100	*55*	*المجموع*

Source: Calculated by the researcher based on the questionnaire form

Table 4: Percentage of economies of scale achieved, cost elasticity, and function coefficient at the level of production achieved for agricultural crop farmers

Capacity returns	Percentage of economies of scale achieved %	Elasticity of average cost function	Function parameter	The expected marginal cost at the achieved production level (Thousand dinars)	The expected average total cost at the achieved production level (Thousand dinars)	The level of production achieved (tons/acres)	Number of farmers	Views
Economies	31	-0.16	1.12	2036602.354	2276782.962	8000	*12*	*1*
Economies	56	0.00	1.10	2035267.202	2229850.386	9000	*19*	*2*
Economies	76	-0.07	1.09	2052472.05	2229097.81	10000	*16*	*3*
Economies	90	-0.03	1.06	2088216.898	2214525.234	11000	*22*	*4*
Economies	100	0.00	1.00	2203857.556	2203857.795	12858.019	*15*	*5*
Diseconomies	99	0.02	0.99	2215326.594	2203920.57	13000	*10*	*6*
Diseconomies	96	0.06	0.96	2306691.442	2207887.506	14000	*8*	*7*
Diseconomies	87	0.11	0.92	2416596.29	2218034.93	15000	*5*	*8*
Diseconomies	71	1.00	0.88	2545041.138	2234362.354	16000	*3*	*9*

Source: Calculated by the researcher based on the questionnaire form, the estimated cost function, the marginal cost function, the cost elasticity, and the function coefficient.



Source: Prepared by the researcher based on the results of the analysis of the seed crop cost function
Fig 1

Conclusions

1. According to the t-test with a significance level of (5%). To demonstrate the goodness of fit of the estimated regression line, the significance of the estimated functions as a whole was proven at a statistical level (5%) and based on the F test, which has a value of (46.615). The coefficient of determination showed that 82% of the changes in total costs were caused by the change in the total yield of the watermelon crop, and that 18% of the remaining changes did not appear in the model, their effect being absorbed by the randomly variable. The results of the study showed that areas cultivated with watermelon improve the nature of the soil, as It has been proven that the process of plowing the soil several times (3 times) and at different time periods before planting watermelon has improved the properties of the soil and increased its fertility as a result of exposing it to sunlight and storing large amounts of water during the winter.
2. The average actual production volume for arable crop farmers was about (10.21) tons, while the optimal production volume was (12.85) tons, the optimal size for maximum profit, and the average actual cultivated

area was (13.6) dunums, while the optimal area volume was (16.77) dunums. This means that reducing the cost of producing one ton of the cultivated crop to the lowest possible extent requires expanding its production at the single farm level**.**

3. The percentage of Al-Raqi farmers in the sample who achieved capacity savings was (72%), while the percentage of farmers in the sample who did not achieve capacity savings was (28%), and these farms achieved capacity savings (100%)**.**

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