Estimating Economies of Scale for Honey Bee Production Projects in Nineveh Province for the 2024 Production Season

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Abstract

The research aims to identify the structure of production costs and estimate cost functions and economies of scale for honey bee production projects, and Nineveh Governorate was elected as an applied model for the study due to its relative importance in bee honey production. The size of the sample according to its percentage in the community for (120) projects, and the percentage was (29.62%) of the study population. The results of the quantitative analysis showed that the cubic total costs function is the most suitable for the relationship adopted in the study according to the statistical, standard and economic tests, and that the optimum volume of production that costs less amounted to (6.947) kg / cell, while the number of optimal cells that can be exploited to achieve that optimum size reached about (53.193) cells, and the long-term supply function was derived, and it was found that there is a positive relationship between the supplied quantities of bee honey and the price when the price is greater than (24976.366) dinars, The results of the study also reached to the achieved ratios of economies of scale and cost flexibility, and it was found that the average costs decrease until it reaches the lowest at the optimum production level, while the achieved economies of scale reach its maximum value of 100% at the optimum production level and that the average cost elasticity is equal to zero at the level of optimum output.

.**Keywords:** cost functions, honey production, economies of scale.

Introduction

The activity of beekeeping is one of the areas that can contribute significantly to the movement of economic and social development through its contribution of food and medical products as well as creating job opportunities due to its limited investments and at the same time produces quick returns **[8]**, and beekeeping is one of the activities of the agricultural sector that contribute effectively to increasing agricultural production and improving its quality, as studies have proven that bees are one of the most important aids in pollination of flowers of fruitful trees and some crops and vegetables, as it increases the quantity of production by no less about (25%), and this contributes to an increase in production per unit area and achieves a profitable profit **[5]**. Also, bees are economically important insects. They produce honey, royal jelly, wax, bee gum, bee venom, and pollen (or the so-called propolis, which is a source of plant proteins and is useful as a treatment for wounds and burns, and increases red blood cells) **[1]** More important than what was mentioned is the production of honey, as it is used in many medical and industrial uses **[9]**. It is also described as a treatment for many diseases, and therefore it is a healing and tonic witness to the human body because of its carbohydrates, proteins and vitamins. And enzymes and various

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mineral elements, and it has a high .percentage of sugars (81%)

Research problem: The research problem is that although the environment of Nineveh Governorate is suitable for beekeeping due to its vast agricultural areas, which is one of the important factors for the success of local honey production, which is characterized by its high quality, but the quantities supplied from the production of honey bees at the level of these The governorate is low according to the statistics. The reason for this may be attributed to technical factors such as low plant density, use of pesticides and migration of the queen with the hive, as well as the economic reasons represented by the inefficient use of economic resources and the failure of beekeepers to achieve the optimum production volumes that lead to a reduction in production costs that achieve economic efficiency and that achieve maximum profit Maybe, Therefore, it was necessary to study the optimal size of production and identify the economies of scale achieved so that the results of this study have important field applications that guide beekeepers to production that approaches the rates that achieve them the best profits and then increase the efficiency of resource use.

The aim of the research: The research aims to estimate the function of long-term total costs to estimate the optimum volume of production, which reduces the cost of producing one kilogram of honey to the lowest total cost, as well as estimating the function of supply and .economies of scale

Research hypothesis: The research is based on the hypothesis that the majority of honey bee breeders in Nineveh Governorate do not achieve the optimum volume of production, which led to an increase in the production costs of honey bees.

The importance of the research: The importance of the research comes from that it is the first economic study concerned with estimating the cost functions in the economies of scale for the production of bee honey in Nineveh Governorate, which establishes an information base through which the beekeeper can determine the amount of production that he can produce, which leads to a decrease in production costs. Important applications for the purposes of the agricultural policy (such as the subsidy policy, for example), which aims to reduce production costs and then encourage beekeepers to develop and expand their projects, in addition to its economic, nutritional and medical importance, and that its production requirements are available in the country.

Material and Methods

This research a questionnaire for a random sample of beekeepers in Nineveh Governorate for the production season 2024, as 120 questionnaire forms were distributed to a random sample that represented (29.62%) of the total beekeepers in the study community. The production, costs, number of beehives ... etc., were unloaded and analyzed using the computer represented by the statistical program (Eviews 12) and the Ordinary Least Squares (OLS) method was used to estimate the parameters of the model, as this method is one of the most applied methods in estimating the relationships of the econometric model, Because of its typical properties such as unbiased and the smallest variance, as well as the ease of making calculations.

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Several mathematical models have been formulated to represent the relationship between the total costs of honey as a dependent variable, and production and capacity are illustrative variables, including linear, square, cubic, double logarithmic, and half-logarithmic functions for the purpose of obtaining the model that was determined to study the cost function, and based on the evaluation of estimated transactions according to economic theory and tests Statistical and standard, the estimation results in Table (1) showed that the cubic function is the most consistent function with economic logic and a representative of the relationship between costs, production and capacity, as it shows the three stages of production, and the parameters indication is consistent with what is expected according to the logic of .economic theory

According to the economic theory, the total cost function takes the following form:

$$TC = b_1Y - b_2Y^2 + b_3Y^3 - b_4AY + b_5A^2 \quad \ldots\ldots\ldots\ldots.. (1)$$

)Refer to the total cost (JD/cell = TC

Refer to the amount of production = Y)(kg/cell

Refer to the number of cells = A

Refer to the regression coefficients = bi)(I=1,2,3,…n

.Refer to the random variable = ui

:statistical analysis

The t-test proved the significance of the estimated parameters, and the F-test proved the significance of the function at the level of 1%, and the coefficient of determination showed that 95% of the changes in total costs were caused by the change in the total output of honey bees, and that 5% of those changes were attributed to other factors not included in .the model

:Standard Analysis

First: The problem of autocorrelation of :the random variable

The model showed that there is no autocorrelation problem because the calculated D.W value is equal to (1.977) and lies between (du<D.W <4-du), ie (2.31 < 1.977 < 1.69), and from it we conclude that there is no autocorrelation between the .residuals

:**Second**: The Auto Correlation Problem

The model fulfilled the assumption that there is no linear multiple relationship between the independent variables, because the model is non-linear, as the variables Y2 (the square of the output), Y3 (the output cube) are functionally related to the variable Y, but the relationship is non-linear **[4]**

:**Third**: Heteroscedasticity

In view of the reliance of the research on cross-sectional data, it is necessary to reveal the problem of the inconsistency of hetroscedasticity, where the (Park) test **[7]** was adopted, which includes estimating the regression equation of the error square as being a dependent variable and the result being an independent variable, and that the function estimated in the logarithmic :formula as follows

$$\text{Log}(ei)^2 = a + b\,\text{Log}(Y)$$

$$= -74.046 + 13.224\,\text{Log}\,Y$$

$$t \quad (-0.990) \quad (0.972)$$

$$D.W = 2.140 \qquad R^2 = 0.007 \qquad F = .945$$

Since the estimated function is not significant under the 5% level according to

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the F test, and the calculated t value of the slope of the error regression equations is less than the tabular t value with a significant level of 1%, this indicates that there is no problem of heterogeneity of variance.

Results and Discussion

First: the relative importance of the fixed and variable costs of honey production

In general, the total costs are the second part of the study of profitability in agricultural projects, while agricultural production represents the first part, and the total costs are important to accomplish that agricultural production, and the study of costs is necessary for those who make productive decisions, as the profit achieved by the product is the difference Between the selling price of his commodity and the costs he spent on producing this commodity **[2]**. Table (2) shows that the fixed costs constitute (11.96%) of the total costs, while the variable costs represent (88.03%) of the total costs. --- (5)

Second: Determining the optimum level of production and optimum capacity

In order to study the optimal level of production in honey bee breeding projects, it is necessary to know the equation of the average total cost in the long run after dividing the equation of the long-run total cost by the output.

To derive the estimated long-run total cost function in terms of production, we follow the following steps:

- Write the estimated function

$$\mathbf{SRTC = 311.265Y - 5.628Y^2 + 0.637\,Y^3 - 0.842AY + 0.055A^2 - - - (1)}$$

Converting the function to implicit form:

$$V = TC - \mathbf{311.265Y + 5.628\,Y^2 - 0.637\,Y^3 + 0.842AY - 0.055A^2} = 0 - - (\mathbf{2})$$

Taking the first derivative of the implicit function in terms of amplitude (A) and setting it equal to zero:

$$\frac{\partial V}{\partial A} = 0$$

$$A = \frac{0.842Y}{0,11} = 0$$

A = 011Y - 0.842 = 0.

A = 7.654Y --- (3)

When we substitute the value of (A) with its equivalent in the original function, we get the long-run cost function, as follows:-

$LRTC = 311.265Y - 5.628Y^2 + 0.637Y^3 - 0.842Y\,(7.657Y) + 0.055\,(7.657Y)^2$ --- (4)

$= 311.625Y - 5.628Y^2 + 0.637Y^3 - 6.447Y^2 + 3.224Y^2$

By summing the terms for Y2, we get the long-run total cost function, which is:

$LRTC = 311.625Y - 8.851Y^2 + 0.637Y^3$ ------- (6)

In order to calculate the economies of scale in honey bee production, we must first find the equation of the long-term average total cost (LRATC), since all production costs are considered variable costs in the long run. :

$LRATC = \frac{LRTC}{Y} = 311.625 - 8.851Y + 0.637Y^2$ ---- (7)

In order to determine the optimal volume of production that lowers costs, the necessary condition for minimizing the total average costs must be applied by taking the partial derivative of it relative to Y and equalizing it to zero. This represents the necessary condition, as follows:-

$\frac{\partial LRATC}{\partial Y} = -8.851 + 1.274Y = 0$ ----(8)

$Y = \frac{8.851}{1.274} \Rightarrow Y = 6.947$ kg

optimum volume of production

That is, the amount of production that lowers the total average costs and at which the lowest point of the average cost is achieved and at the same time the best

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possible net income (normal profit) is achieved is production (6.947) kg / cell.

To achieve the sufficient condition, we take the second differential of the long-run average total costs function:

Substituting the value of Y into equation (3), we get:

A = 7.654 Y

= 7.657 (6.947) =53.193

Optimal cell count

It is the optimum capacity (number of cells) that can be reared by honey bee breeders to reach the optimum volume of production that lowers the long-term average cost.

Third: The long-term function of the honey beekeeper's supply

The supply curve of output is that part of the curve of the long-run marginal cost function (LRMC) starting from the lowest point on the long-run average total cost (minLATC) **[6].**

Si = Si (P) for P >= min LATC

That is, when the unit price of output from honey bees is less than the lowest point of the long-run average total costs (minLATC), the amount of output is equal to zero, meaning that the product is not produced when the price is less than this level, and we get this level when compensating the optimal volume of production In the long-term average cost function (LRATC), it reached (18490) dinars per kilogram of honey.

The honey beekeeper's supply function can be derived by equating the marginal cost function with the unit price of the output, that is, through the necessary condition of the profit function (LRMC=Py) and solving it with respect to the quantity of output y, as follows:

$$LRTC = 311.625Y - 8.851Y^2 + 0.637Y^3 \quad (1)----$$

$$LRMC = \frac{\partial LRTC}{\partial Y} = 311.625 - 23.308Y + 1.911Y^2 \quad (2)----$$

By ordering the equation

$$LRMC = 1.911Y^2 - 23.308Y + 311.625 \quad -------(3)$$

By equating marginal cost with the output price

$$LRMC = P_y$$

Substituting in the value of LRMC, we get:

$$1.911Y^2 - 23.308Y + 311.625 = P \quad -------(4)$$

$$1.911Y^2 - 23.308Y + 311.625 - P = 0 \quad -------(5)$$

And by solving equation (5) by the constitution method:

$$y = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

whereas:

1.911 = α

-23.308= b

311.625 – P = c

$$Y = \frac{23.308 + \sqrt{558.14 - 7.644(311.625 - P)}}{2\,(1.911)} \quad -----(6)$$

$$Y = \frac{23.308 + \sqrt{558.14 - 2382.061 + 7.644P)}}{3.822} \quad ------ (7)$$

$$Yi = Si = \frac{23.308 + \sqrt{7.644P - 1823.921)}}{3.822} \quad -------(8)$$

$$Yi = Si = \frac{23.308 + (7.644P - 1823.921)^{\frac{1}{2}}}{3.822}$$

$$P \geq \min LATC$$

The output supply curve can be derived from the output supply function to represent the nature of the relationship between the price and the quantity supplied of honey bee product, by giving different values to the output prices, bearing in mind that the lowest price is (18490) dinars. Table (3) and Figure (1) show the display function of honey bee breeders in Nineveh Governorate.

Fourth: economies of scale and cost flexibility for honey bee production projects

According to economic theory, production levels that are less than the optimum level achieve increasing proportions of economies of scale as the level of production approaches the optimum level. As for the expansion above the optimum level of production, it results in the existence of no economies of scale. The economies of scale can be calculated quantitatively according to the following relationship:

$$Econ = \frac{LRATC_m - LRATC_i}{LRATC_m - LRATC_0}$$

Percentage of economies of scale achieved. = Econ

The long-run average total cost at the lowest level of production achieved. = $LRATC_m$

The long-run average total cost at production level i. = $LRATC_i$

The long-run average total cost at the optimum production level. = $LRATC_o$

According to the (Mele more) formula, we reached the estimated results, in which it becomes clear that the achieved economies of scale increase with the increase in the volume of production and reach a maximum of (100%) at the optimum level of production.

In order to know the validity of the economies of scale achieved for honey bee production projects and to support the results that were reached regarding the average cost values that were deduced from the equation of the long-run average total cost curve, this must be tested by calculating the elasticity of the total cost function **[3]** and according to the following law:

$$\text{Elasticity} = \frac{\partial LRATC}{\partial Y} \cdot \frac{Y}{LRATC}$$

The amount of achieved output (kg). = Y

The expected long-run average total cost curve. = LRATC

The amount of change in the expected average total cost curve = $\partial LRATC$

The amount of change in expected output. = ∂Y

In order to calculate the economies of scale, beekeepers were divided into 7 categories according to the rate of productivity per hive, as shown in Table (4).

Since the economies of scale are increasing whenever the average total cost curve decreases until the economies of scale reach (100%), which is the stage of (yielding stability) at the optimum volume of production, and after this stage it becomes (the stage of increasing yield) in which the average total cost curve decreases as it expands The size of the apiary that achieves an increasing percentage of economies of scale, but when you continue to increase the size of the apiary, there are no economies of scale that lead to a rise in the average total cost curve after the optimum size of production and it is called (the stage of diminishing return).

This can be confirmed by the function coefficient (R), which means the yield of volume, that is, the relative response to production as a result of an equal change in the factors of production, and it is equal to the sum of the elasticities of response to the factors of production if they change in the same proportion, and it is the inverse of the cost elasticity coefficient (E), which is equal to Average total cost over marginal cost as follows:

$$R = \frac{LATC}{LMC} \qquad E = \frac{LMC}{LATC} \text{ or } E = \frac{1}{R}$$

function parameter = R

Cost elasticity factor = E

The value of E is equal to zero and the value of R is equal to one at the lowest point on the LAC curve, that is, at the optimum volume of production at which capacity savings of 100% are achieved.

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Table (4) shows that honey bee production projects in Nineveh Governorate for the 2024 production season were divided into seven volumetric categories, as each volumetric category showed the economies of scale achieved through the results obtained using the previous formulas and equations to obtain On the achieved economies of scale, which showed flexibility to be negative for production levels less than the optimum production level (6.947) kg, and this indicates the inverse relationship between output and average cost in the savings area and the reason for this is due to the fact that the marginal cost is below the average total cost

As for the value of cost elasticity at the optimum size of production, it reached (0) for about (18.3%) of honey bee breeders who produce production levels that approach the optimum size, and in the negative elasticity phase (increasing yield) in which a relative increase in production is achieved at a relative cost. Less, as for the stage of flexibility with a value of (0) (stability stage of yield), which is followed by the stage of positive flexibility (stage of diminishing returns) so that a relative increase in production occurs at a greater .relative cost

As for the coefficient of the function, its value is greater than one, true for levels of production less than the optimum size, as its value decreases with an increase in the volume of production, meaning that the rate of increase in the volume of production exceeds the rate of increase in costs, which reflects the first stage of production (the stage of increasing yields). When its value becomes one, the optimum .volume of production is achieved

As for the achieved economies of scale, it increased with the increase in the volume of production and its maximum value reached at the optimum volume of production (100%), but with an increase in the volume of production from the optimum volume, the proportion of economies of scale begins to decrease in increasing proportions, as the beekeepers operating within the savings area constituted (30.85 percent) of the total number The percentage of beekeepers operating within the savings area was 69.51%, as shown in tables (4 and 5)

The beekeepers whose hives number (53.193) are the ones who achieved capacity savings (100%). This requires the honey beekeepers to expand the size of their apiaries until they reach the number of cells that achieve the optimum size, which is (53.193). As for beekeepers whose hives number is higher than the optimum number of hives and who achieved no capacity savings, they need to reduce the size of their apiaries (the number of their hives) to the optimum .number that achieves the optimum size

It is noted that the economies of scale increase whenever the average total cost curve decreases, and this stage is called (the stage of increasing returns) in which the average total cost curve decreases as the size of the facility expands (the number of cells), which achieves increasing percentages of capacity savings (Economies of scale) until it reaches (100%) at the optimum size of production (which is the stage of steady yield), and when you continue to increase the size of the number of cells, it appears to capacity savings (Diseconomies of scale) that leads to a rise in the average total cost curve after the optimum size of production and it .is called (decreasing stage yield)

The coefficient of the function (R) (Function Coefficient) expresses the percentage of change in production as a result of changing all factors of production in the same proportion. It indicates the region of capacity savings when its value is greater than the integer one, and the region of capacity savings when its value is less than the integer one, and its value is true one. , when the LRMC curve cuts at

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its lowest point the LRATC curve at the optimal output volume (6.947) kg, which achieves capacity savings of 100%, as in .Table (4)

The elasticity of the cost function (EC) takes a negative sign at production levels that are less than the optimal size, indicating the inverse relationship between output and average cost, and this means that the average total cost (LRATC) decreases with the increase in volume, while the elasticities of the cost function take the positive sign. At levels of production that exceed the optimum level, thus reinforcing the direct relationship between the output and the average cost for the levels of production that exceed the optimum size, that is, the average total cost increases with the increase in the volume .of output that exceeds the optimum size

As a result of knowing the marginal cost, we infer the economies of scale achieved for honey bee breeding projects, when the long-run marginal cost function (LRMC) is below the long-run average total cost function (LRATC) and intersects with it, achieving the optimum volume of production in which the average total cost in the term is equal Long-run marginal cost (LRATC) with long-run marginal cost .(LRMC)

After this size, the long-run marginal cost curve (LRMC) is higher than the long-run average total cost curve (LRATC), thus achieving the area of no capacity savings, so the long-run marginal cost curve (LRMC) is equal to the average total cost curve in the run The long term (LRATC) at the optimum size of production, as well as achieving 100% volume savings, and each of the function coefficients is equal to the right one and the elasticity of the cost .function is equal to zero

Through the sample data, there are approximately (70%) of breeders working within the capacity savings area and (30%) working within the savings area, while the percentage of breeders whose production is .close to the optimum size was (18%)

The rest of the breeders (beekeepers) who are below the optimal size must expand their production either through the optimal exploitation of the cells or reduce their production costs in line with the optimal size reached by this study through the optimal exploitation of the available resources. As for the breeders who produce higher than The optimum level of production They have to reduce their ..production to the optimum volume

Table (1) The total cost function on the long run of honey bee production projects

Independent variable	Coefficients	Estimator	
Constant	b_0	617.325	1.796
Yeild	Y	311.265	6.553*
Yeild square	Y^2	-5.628	-4.115*
output cube	Y^3	0.637	3.698*
The number of cells and the output	YA	-0.842	-10.786
square number of cells	A	0.055	11.039
R SYuare (R^2)	0.95		
Adjusted R^2 ($\bar{R}^2$)	0.94		
D-W Test	1.977		
F Test	197.255		
N	120		

.Reference: Prepared by the researcher based on the questionnaire

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Table (2) the Refer to of the contribution of fixed and variable costs to the total costs

cost items	Total value (million dinars)	Relative importance (%)
Total fixed costsTFC	64	11.96
Total variable costsTVC	471	88.03
Total costs TC	535	100.00

Reference: From the researcher's work based on the questionnaire

Table (3) The long-run supply curve of honey bees for the study sample

Price (dinars / kg)	Quantity supplied (kg)
18490	103.862
19000	105.182
19500	106.493
20000	107.788
20500	109.066
21000	110.329
21500	111.577
22000	112.810
22500	114.029

.Reference: computed based on the estimated long-run width function

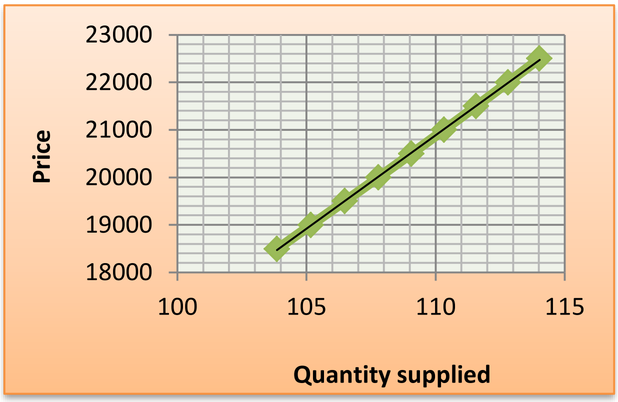

Figure (1) The curve of the long-run width function of a beekeeper in Nineveh Governorate

Reference: Plotting based on the estimated long-run supply function

Table (4) shows the volume categories of honey bee production projects

Cell production rate (kg)	number of beekeepers	Contribution %	yield stage
6 – 5	7	%5.83	Yield increasing
7 – 6	17	%14.16	Yield increasing
8 – 7	37	%30.83	Yield increasing
9 – 8	22	%18.33	Yield stability (optimal (size

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10 – 9	18	%15	yield diminishing
11 – 10	10	%8.33	yield diminishing
12 – 11	9	%7.5	yield diminishing
Total	120	100%	

.Reference: Calculated based on the questionnaire

Conclusion

The results of estimating the achieved 1 economies of scale and based on the function of cubic costs showed that the percentage of beekeepers that operate in light of increasing yields (economies of scale) before the economic efficiency area (50.8%), while the percentage of projects that operate under diminishing returns (no economies of scale) after The area of economic efficiency amounted to about (30.9%), and thus we -
conclude that most of the apiaries of the study .sample operate in light of increasing yields

By deriving the supply function for honey 2- bee production projects in the short and long terms, it was found that there is a positive relationship between the supplied quantities of bee honey and the price in both terms when the price is greater than (24976.3) dinars in the short term and greater than (18490) dinars in .the long term

Recommendations

1- The study recommends the need to find a policy to protect the local product from foreign competition, as protection is provided to the local product according to a policy set by the state, such as placing restrictions on imported honey products (application of the quota system, leave and agricultural reservation) in order to enable the local product to compete with the importer and at the same time take the Take into account .consumer conditions

Importing high-productivity breeds of bees 2- that would raise production, leading to an increase in the individual income of .beekeepers

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