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AN ECONOMIC STUDY TO ESTIMATE THE COST FUNCTIONS AND ECONOMIES OF SCALE FOR CALVES BREEDING PROJECTS IN BABYLON PROVINCE FOR THE YEAR OF 2019

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ABSTRACT

The study aimed to estimate the cost functions for calves breeding projects in Babylon province for the year of 2019 and to identify the structure of production costs for these projects based on field data for a sample of calves breeders in the province that included (60) breeders who represent (10%) of calves breeders in the province for the year of 2019. The results indicated that the cubic cost function is the most appropriate for the relationship adopted in the study according to statistical, standard, and economic tests, and the optimum production scale amounted to (26561 kg). The rate of the product that maximizes profits amounted to (3559 kg), and the minimum price at which the breeders would accept to sell their produce amounted to (5965.9 dinars). The results of the study for the ratios of achieved economies of scale and cost elasticities concluded that average costs decrease until it reaches its lowest level at the optimum level of production, while the proportion for the achieved economies of scale reaches its maximum value of 100% at the optimum level of production and the elasticity of average cost is equal to zero at the optimum level of production.

Keywords: cost functions, economies, calves breeding

Introduction

Livestock represents one of the components of agricultural production, where it contributes to increasing agricultural income and increasing its contribution to national income. Animal products also contribute to achieving food security. Red meat is considered one of the essential foodstuffs for the human body because it is a rich source for vitamins and amino acids, as well as essential proteins, where the consumption of animal protein is considered an important and clear indicator to the living and economic level for any society. Iraq produces about 65% of its actual need for red meat and imports the rest from various countries, foremost among which is India and Pakistan (Ministry of Planning 1995, 2013). As for the Arab world, it produces about 85% of its actual needs and equates to 3% of the global production of red meat. (Arab Organization for Agricultural Development, 2004-2013). There are many studies conducted in this field, including (Salim *et al.*, 2010), who estimates the costs function and economies of scale and supply functions for calves rearing projects in Hait District, Where the study showed that the optimum production quantity for calves fattening farm is (32944) kg per year and the optimum scale was (244) calves. Al-Akwa *et al.* (2013) conducted an economic analysis to estimate the production and cost functions for farms of Broilers chickens in Dhamar province, the Republic of Yemen, based on a random sample that included (53) farms for the productive season 2008, where the sample was divided into three categories according to the size of the herd to know the economic efficiency of each category and the total sample. The results of the study showed that the three groups achieve increasing returns to scale, while at the level of the total sample, it appears that

production achieves decreasing returns to scale and the optimum scale for production at the sample level depending on the cost function which estimated by (10.61 tons). Al-Muhaisin *et al.* (2007) prepared a study of Econometrics analysis for the cost function of sheep, goats, and cows in the mid-region of Jordan, where the study concluded that the achieved economic scale to reduce costs which amounted in the sheep (419 heads), buffalo (85 heads), and cows (110 heads). Kavoi, (2010) studied the technical competence for smallholders of dairy cattle farmers in western Kenya using the random cost function. Tomy Pardon, (1991) conducted there are profits realized at the level of private and social prices in the event of government intervention when it supports local projects or when it is imported from abroad in the case of projects for fattening calves and It also gives a good incentive towards the optimal use of local resources.

Materials and Methods

Research Problem

Despite the fact that Iraq is an agricultural country with material and human resources, the level of local production of red meat does not cover domestic consumption, due to the increase in the volume of demand for red meat resulting from the increase in population and the rise in individual incomes, so it was necessary to identify the most important obstacles faced by projects. Breeding calves, especially the production costs and the efficiency of these projects, so that breeders can minimize them and maximize their profits.

Research importance

The importance of the study comes through the economic importance for calves meat where it is a source of

farm income in addition to studying the costs of its production in Babylon province and it is considered one of the few studies in this field in addition to its reliance on cross-sectional data for a sample of calf breeders in the province in order to provide a solid database benefiting both breeders and specialists who are decision-makers.

Research hypothesis

The research hypothesis is based on the fact that the vast majority of calf breeders in Babylon province do not achieve the optimal size of production, in addition to their inability to approach the efficient level of production, which led to high production costs, so efficient methods can be used to reduce costs and maximize profits.

Research goal

The study aims to identify the structure of production costs, analyze it, and estimate the long-run cost function to estimate the optimal size of production that minimizes costs and the maximum output for breeders' profits, the minimum price that breeders accept to supply their products, and estimating the proportion of economies of scale achieved for calves breeders in Babylon province.

Data sources

The data were obtained from its field sources in Babylon province from its districts and sub-districts, namely Al-Musayyib, Al-Muhawil, Alexandria, Al-Imam, Madhatah, Al-Qasim, Al-Shomali, Al-Kifl, Al-Tali'a, Abu Gharq, Al-Markaz, Al-Nil, Al-Hashemiya, and Al-Mashroa, and through a field survey for these areas according to a questionnaire prepared for this purpose and in cooperation with the Directorate of Agricultural in babylon and the sub-departments affiliated to it, the sample included (60) breeders of the total calves breeders in the province, whose number is (600) breeders, representing (10%) of the calves breeders in the province.

Results and Discussion

First: The relative importance of the variable and fixed costs for calves breeding projects

The variable and fixed costs for calves breeding projects and their various paragraphs were studied for the research sample and the percentage of each of them's contribution to the total costs. where the variable costs paragraphs consisted of (the value of calves, feeds, medicines, vaccines, and Leased work, water and electricity costs). As for the fixed costs paragraphs, (depreciation, interest on capital, permanent work, and rent of the land). Table (1) shows the percentage of the contribution of variable cost paragraphs in total costs, where it is observed from the table below that the percentage of calves' contribution is (approximately 67.74%), followed by feeds and constitutes up to (30.49%), then followed by the costs of medicines and vaccines (0.92%) and Leased work (0.49%), and then the costs of water and electricity which constitutes about (0.36%) of the total variable costs. It is evident from the above that the calves and feed costs represent the largest part of the variable costs, where they constitute about (98.23%) of the total variable costs.

Table 1: paragraphs of variable costs and the percentage of their contribution to the study sample.

Cost paragraphs	Costs (1000 dinars)	percentage of Contribution
Calves	1504762	67.74
Feed	677240	30.49
Medicines and vaccines	20440	0.92
Leased work	10900	0.49
water and electricity	8022	0.36
Total	2221364	100%

Source: It was calculated by the researcher based on the questionnaire form

As for the fixed costs paragraph, they are as shown in the following table:

Table (2) indicates that interest on capital ranked first at the sample level with a percentage of 36.07%, followed by land rent with a percentage of 27.44%, after that permanent work with a percentage of 25.02%, and depreciation with percentage of 11.47% from the total fixed costs.

Table 2: paragraphs of fixed costs and the percentage of their contribution to the study sample.

Cost paragraphs	Costs (1000 dinars)	percentage of Contribution
Depreciations	47675	11.47
Interest on capital	150000	36.07
Permanent work	104040	25.02
Land rent	114100	27.44
Total	415815	100%

Source: It was calculated by the researcher based on the questionnaire form

Second: Contribution of the variable costs and fixed costs paragraphs from the total costs:

Table (3) shows that the total variable costs constituted about (84.23) of the total production costs while the fixed costs constitutes about (15.77) of the total production costs. The reason for the high total variable costs is due to the high costs of calves and feed, which constitute about (82.74) of the total production costs.

Table 3: the percentage of the contribution of variable costs and fixed costs and their paragraphs from the total costs

Cost paragraphs	percentage of Contribution
Variable costs	57.06
Calves	
Feed	
Medicines and vaccines	
Leased work	
water and electricity	
Total percentages of variable cost contribution	
Fixed costs	1.81
Depreciations	
Interest on capital	
Permanent work	
Land rent	
Total percentages of variable cost contribution	
Total	100%

Source: It was calculated by the researcher based on the questionnaire form

Model characterization and formulation:

The cost functions have a great importance in the economic planning of industries in general and agricultural industries in particular, through which the economically efficient production patterns are evident in light of the prevailing technical information, and the production pattern means that pattern which is characterized by achieving a specific production goal with the least amount of costs, or achieving the maximum amount of production With a certain amount of costs (Halloum, 2016). It also is not necessary for the production that achieves the lowest cost per unit of production to be equal to the production that achieves the maximum return. This is achieved in one case when both the selling price and the marginal revenue are equal to the lowest point for the curve of total cost (Al-Najafi, 1985). The level of production at which the average total costs are the lowest is that production that determines the optimal size of the project, and at this scale the marginal costs are equal to the average total costs. The share of the production unit from average costs is the lowest possible, and at this level of production the efficiency of the production factors is the greatest possible (Lefwich, 1978). Several models have been adopted for estimating the function of total cost, including linear, quadratic and cubic. The cubic model was the most appropriate for the adopted relationship, due to its consistency with the logic of economic, statistical and analogical theory. Depending on economic theory, the short-term cubic total cost function takes the following form (John and Orazem, 1978):

$$TC = B_0 + B_1 Q - B_2 Q^2 + B_3 Q^3 + U_i$$

whereas:

TC = total cost of production (dinars)

Q = Quantity of production (tons)

B, S = the regression coefficients

U_i = the random variable that absorbs the effect of other related variables that were not directly included in the model and whose quantities are difficult to measure and estimation.

The short-term function was as follows:

$$TC = 10220139 + 6514436Q - 41299.76Q^2 + 777.4388 Q^3 \quad (1)$$

$$T(5.869243) \quad (9.312397) \quad (-0.811382) \quad (0.759596)$$

$$\text{sig.} \quad (0.000) \quad (0.4206) \quad (0.4507) \quad (0.0000)$$

$$R^2 = 0.995031 \quad R'^2 = 0.994764 \quad F^{**} = 3737.694 \quad D.W = 1.862006$$

Statistical analysis

It is noticed from the above function that it has passed all the statistical tests, and the coefficients are as follows: a very high level of significance for Q and insignificant for Q3 and Q2. Also, (F) as a test for the significance of the model for all the explanatory variables together indicates the superiority of the calculated value of (F), which amounted to (3737.694). The coefficients of determination also showed that 99% of the total fluctuations in the total costs of raising calves are due to the changes that occur in the size of total product. As for the remaining percentage which amounted to 1% is due to other factors whose effect is absorbed by the random variable.

Standard Analysis

Standard tests were conducted, which included testing the presence of the autocorrelation problem for the random variable by relying on the test (Breusch-Godfrey) to the absence of the standard model from the autocorrelation problem, where the value of Obs * R-squared amounted to (0.275468) with the value of Chi - Square (2) which is equal to (0.8713). We conclude from this that there is no positive or negative self-correlation from the first degree between the residues, and also there is no problem of multiple linear correlation between the explanatory variables (Multicollinearity) because those explanatory variables Q, Q2, and Q3 are indicatively related to each other, but the relationship between them is non-linear. It was confirmed that the problem of Heteroscedasticity is not dangerous according to the ARCH test, where Obs * R-squared, which equals (0.081209), with a Chi - Square (1) probability value, which equals (0.7757). From the perspective of the estimated production costs function, the marginal cost function, average total costs and average variable costs have been derived. It can be expressed in the following equations:

$$ATC = 6514436 - 41299.76Q + 777.4388Q^2 \dots (2)$$

$$MC = 6514436 - 82599.52Q + 2332.3164Q^2 \dots (3)$$

Through the equations of marginal cost (MC), average total costs (ATC), and average variable costs, it is possible to estimate the optimum product of minimizing costs, the maximum product of profit, and the minimum price that breeders would accept to supply their production.

Average of minimizing product for cost

The average of product that minimizing cost can be obtained by equating the marginal cost function with the average cost function, or by finding the lower end for the function of average total costs on the other hand, and this has been relied upon to find the lower end for the function of average cost by making the first differentiation of function (2). The necessary condition is represented as follows:

$$ATC/\partial Q = -41299.76 + 1554.878 Q \quad \dots (4)$$

$$Q = 41299.76 / 1554.878 = 26561.4$$

The quantity of the product that minimizes the total variable costs is (26561.4) kg, and to achieve the sufficient condition we take the second differentiation for the function of average variable costs.

$$\partial^2 ATC/\partial Q^2 = 1554.878 > 0$$

Maximum profit product

The producer can maximize his profits by equating the marginal cost function of the productive unit with the selling price of one unit, where the selling price of one unit was (6000) dinars per kilogram in babylon province.

$$MC = 6514436 - 82599.52Q + 2332.3164Q^2 = 6000 \quad (5)$$

$$6508436 - 82599.52Q + 2332.3164Q^2 = 0 \quad (6)$$

Solve equation (6) using the following law:

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

It is evident through this economic analysis that the level of production for the most profit amounted to (3.559) tons, i.e. the value of the level of production is estimated (21354000) dinars in light of the prevailing price and and

referred to above. In order to ensure the correctness of the obtained results, the profit function was estimated, which could be expressed as follows:

$$\Pi = TR - TC$$

$$\Pi = 6000 Q - (6514436Q - 41299.76 Q^2 + 777.4388Q^3) \quad (7)$$

$$\Pi = -6508436Q + 41299.76 Q^2 - 777.4388Q^3 \quad (8)$$

$$\partial \Pi / \partial Q = -6508436 + 82599.52Q - 2332.3164Q^2 \quad (9)$$

$$\partial^2 \Pi / \partial Q^2 = 82599.52 - 4664.6328Q \quad (10)$$

Substituting the value of the maximum level of production for profit into equation (10) it becomes clear that the second derivative takes a negative value (-9.960848621) and this is the characteristic of the maximum term of the profit function .

The minimum price that breeders would accept to supply their products

Through knowing the lowest point of the average variable costs, the minimum price that the breeders would accept to supply their production was estimated, as long as the unit selling price of the product was greater than or equal to the lowest point of the average variable costs and the first differentiation was made for it and equaled to zero as follows:

$$AVC = 6514436 - 41299.76Q + 777.4388Q^2 \quad (11)$$

$$\partial AVC / \partial Q = -41299.76 + 1554.8776Q \quad (12)$$

From equation (12) it was possible to obtain the size of the product at the lowest point of the average variable costs, which was estimated by (26,561 tons.kg⁻¹). This value is the lowest price at which the product can sell or continue to produce according to economic theory.

Elasticity Cost

Cost flexibility can be found by dividing the marginal costs by the average total costs and for the production levels represented by the optimum minimizing production level of costs which amounted to (26,561) tons and the level of production for the most profit, which is about (3.559) tons, as follows:

$$MC = 6514436 - 82599.52(26.561) + 2332.3164(26.561)^2 \quad (13)$$

$$ATC = 6514436 - 41299.76(26.561) + 777.4388(26.561)^2 \quad (14)$$

$$EC = \frac{MC}{ATC}$$

$$EC = 1$$

This means that at the optimum production level of (26,561) tons, the relative increase in production is equal to the relative increase in costs, and this means that the production of these projects is subject to the stage of steady yield. As for the quantity of the most profitable production, which amounted to about (3.559) tons, the cost elasticity was as follows :

$$MC = 6514436 - 82599.52(3.559) + 2332.3164(3.559)^2$$

$$ATC = 6514436 - 41299.76(3.559) + 777.4388(3.559)^2 \quad (3)$$

$$EC = \frac{MC}{ATC}$$

$$EC = 0.98$$

This means that at the level of the most profitable production of (3.559) tons, a proportional increase in production can be obtained with a smaller relative increase in costs, and this means that the production of these farms is subject to the stage of increasing yield.

Economies of scale and cost elasticities achieved for raising calves:

According to economic theory, levels of production that are less than the optimal level achieve increasing rates from economies of scale, and when they reach the level of optimum production, the stability of scale is achieved. As for production levels higher than the optimum level, decreasing rates are achieved, which result in economies of scale. This can be calculated according to the following formula (Shadid, 2003).

$$\text{Economies} = \frac{LRAC_m - LRAC_i}{LRAC_m - LRAC_o}$$

where:

Economies = percentage of economies (realized economies of scale.)

LRAC_m = long-run average cost at the minimum level of product achieved.

LRAC_i = long-run average cost at production level.

LRAC_o = long-run average cost at the optimum product level.

As for the elasticity of cost, it was calculated from the following formula (Al-Aqili, 2006):

$$\text{Elasticity} = \frac{dLTC}{dQ} \cdot \frac{Q}{LTC}$$

where:

Elasticity = represents elasticity of the average cost function.

dLTC / dQ = the first derivative of the long-run total costs related to the quantity of product.

=Q represents the quantity of product.

LATC = Long-run average total cost

The average total expected costs at the lowest level of achieved production amounted to (6000) dinars. As for the average total expected cost at the optimum production level, which amounted to (5965.9) dinars. By applying the previous relationship, we find that the achieved economies of scale increased with the increase in production, as shown in Table (4). Table (4) shows that the percentage of achieved economies of scale increases with the increase in the volume of production, and its maximum value amounted to 100% at the optimal size of production which amounted to (26561) kg, but with the increase in the volume of production than the optimum scale, the percentage of economies of scale begins to decrease with increasing rates. It showed that the elasticity of the average cost function takes a negative sign at production levels that are less than the optimum scale, indicating the inverse relationship between product and average cost, and this means that the average total cost decreases with increases in scale, while the elasticities of the cost function take a positive sign at production levels that increase on the optimal level, thus reinforcing the direct relationship between production and the average cost for

production levels that exceed the optimum sale, meaning that the average total cost increases with the increase in the scale of production that exceeds the optimum. It is also clear from the table (4) that the average total cost decreases before reaching the optimum size with an increase in the size of the product, while the average total cost is (5999.4 dinars) at the production level of (20000) kg and the average total cost

continues to decrease until it reaches its lowest level, which is (5965.9 dinars) at the optimum production level (26561 kg) . After the optimal production level, the average total cost starts to rise whenever the volume of production increases to become (6035.2) dinars at the production level (36,000) kg, after which it continues to rise when the production continues to expand.

Table 4: Percentage of achieved economies of scale and elasticity of the average cost function at achieved levels for calves rearing.

Product level (kg)	Average total expected cost (IQD/ kg)	The expected marginal cost (IQD/ kg)	The elasticity of the average cost function	Returns to scale	Percentage of achieved economies of scale (%)
20000	5999.4	5795.4	-0.034	Economies	0.017
21000	5990	5808.4	-0.03	Economies	0.293
22000	5982.1	5826.1	-0.026	Economies	0.524
23000	5975.8	5848.4	-0.021	Economies	0.709
24000	5971	5875.5	-0.015	Economies	0.85
25000	5967.8	5907.1	-0.01	Economies	0.944
26561	5965.9	5965.9	0	Economies	100
27000	5966.1	5984.5	0.003	Diseconomies	0.994
28000	5967.6	6030.2	0.01	Diseconomies	0.95
29000	5970.6	6080.5	0.018	Diseconomies	0.862
30000	5975.1	6135.5	0.026	Diseconomies	0.73
31000	5981.3	6195.2	0.035	Diseconomies	0.548
32000	5988.9	6259.5	0.045	Diseconomies	0.325
33000	5998.2	6328.5	0.055	Diseconomies	0.052
34000	6009	6402.2	0.065	Diseconomies	-0.263
35000	6021.3	6480.5	0.076	Diseconomies	-0.624
36000	6035.2	6563.5	0.087	Diseconomies	-1.032

Source: It was calculated by the researcher based on the questionnaire form

Conclusions

The study reached some conclusions that were reflected on the subsequent recommendations. They can be summarized as follows:

- The study showed that at the optimum production level amounted to 26,561 tons, the cost elasticity is equal to one. This means that the projects are subject to the steady yield stage, meaning that any relative increase in production leads to an equal increase in costs.
- The study also showed that at the level of production with the greatest profit amounted to 3.559 tons, the cost elasticity is less than one, and this means that the projects are subject to the stage of increasing yield, meaning that any relative increase in production leads to a smaller relative increase in costs.
- Lack of optimum utilization for the breeding halls. Most of the breeders have large breeding halls that are not commensurate with the small numbers of animals, and 83.3% of the sample members do not work within the optimum scale which amounted to 26,561 tons.
- The study showed that most of the calves breeders in the province are farmers who own small agricultural holdings, which makes their tendency to raise animals inevitable for the purpose of making the most of the land.
- The study showed that farmers did not continue to raise calves due to the ability of calves fattening projects to

change their activities to raising cows to benefit from the births resulting from them.

- The vast majority of farmers sell their products at a price very close to the lowest price that the breeder accepts due to the lack of marketing outlets, thus they only cover their variable expenses.
- The study showed that breeders do not pay any attention to organizing records for their fields because there is no tax accountability or fear of it.

Recommendations

- Providing government marketing outlets to ensure that breeders market their meat products at favorable prices, ensuring that breeders continue the production process
- The need to encourage investment in the field of animal husbandry in general and calves in particular through the establishment of companies that enjoy the advantages of large production due to the great qualifications that Iraq enjoys for the success of these projects, similar to the neighboring countries, to reach the stage of self-sufficiency in meat.
- Encouraging breeders to establish concentrated feed laboratories in their fields to ensure that they get good quality feed, free from harmful diseases and fungi, at reasonable and economical prices.
- Providing sources of Loan for breeders while providing them with facilities, such as reducing interest rates, to enable breeders to make the best use of their fields.

- Legalizing the import process according to the actual need of the country and not flooding the market with frozen imported meat while spreading health awareness about the importance of fresh local meat that is rich in proteins, vitamins, and minerals.
- The necessity to encourage breeders to organize records for their fields and link the organizing process with the support provided by the state, especially the subsidized feed.
- Establishing a research center in the field of developing animal species and crossbreeding, as well as creating good relationships, according to local resources.

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