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# Cost Estimation Function Productivity and the Size of the Optimal Production of Fish in Iraq for a period (1990-2019)

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**Abstract**

The research aims to study the costs of fish production in Iraq due to its economic and nutritional importance. Using estimate the total cost function as well as the optimal production volume. The years of the studied period witnessed a continuous increase in the amount of costs and a decrease in the level of production, especially during the nineties, when the level of production did not reach the optimal level. One of the reasons for the high costs was the increase in the prices of fodder and veterinary supplies, as the greater amounts of the cost value were in addition to being affected by the country's political, social and regional conditions. The optimum production amount reached (171.66) thousand tons, but the annual production did not reach this amount. The function factor and cost elasticity indicate that production is subject to increasing yields for all years due to the fact that all values of cost elasticity are less than one. Also, the average variable cost reached the lowest value of 39,276 during the year 2013, during which the level of production increased and higher relative savings were achieved than in the rest of the other years.

**Keywords:** Cost function, optimum size, fish, local production

## Introduction

Fish is an important food product for humans, consumer demand has increased in the recent period for many reasons such as ease of digestion, in addition to its high content of good animal protein, fats, salts and vitamins that the body needs for the purpose of growth. In Iraq, it encouraged producers and production establishments to develop fish production and use scientific methods (Hussein, 2020). The presence of water resources represented by the presence of two main rivers (the Tigris and Euphrates) and small lakes and rivers encouraged the expansion of fish projects and providing them in the market significantly. However, the large fish projects run by the government were subjected, as in the rest of the other projects, to poor production and high costs, especially the costs of feed and veterinary materials due to the wars and economic blockade during the 1990s, as well as the political conditions and the change of governments, all of this is the reason for the projects to stop working and expose them to losses, the reason for this is the decrease in annual production. For fish, the owner of which is greatly increased in the amount of costs, this basic problem that revolves around the study. The continuous rise in the amount of costs and the low annual production will prevent this from reaching the optimal volume of production, which in turn brings profits, lowers costs and

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increases production. In Iraq, the Ministry of Agriculture supported the fish sector through a rehabilitation program at the end of the nineties by providing production requirements at subsidized prices for the purpose of working to reduce production costs and thus increase production and expand projects through small and dispersed projects managed by individuals in order to increase profits and provide production at reasonable prices In the local markets (Al-Waeli, 2000). This research aims to study the production costs of fish in Iraq by estimating the cost function and calculating the economic derivatives of the cost function, such as the average total variable cost and the marginal cost. In addition to determine the optimal size of production during the period (1990-2019). The topic takes great importance in the field of economic and agricultural knowledge in order to address the problem of production costs in the field of fish meat production and to take appropriate decisions in directing agricultural policy aimed at solving problems for the sake of advancing and developing these projects through scientific research. There are many studies and reports published In the field of production costs in order to address specific commodity problems and study the optimal production volume and the extent of approaching or moving away from it, studies are carried out by following a number of research methods, such as the relationship of production volume to quantitative costs, by estimating the total cost function, from which the average total cost curve is derived to clarify the economies of scale. (Conner, et. al, 1976), (Hall, Leven, 1987) or estimating the average total cost function for the long term directly, from which the optimal size of the farm is determined (Soltani, 1976). Many local studies in the field of costs and optimum size, for example (Chedid and Yasmine, 1994) estimate the cost functions of the lentil and chickpea crops and the economies of scale achieved in Nineveh. The two researchers (Al-Najafi and Al-Sayegh, 1997) estimate the cost functions and economies of scale for barley. (Al-Samarrai, 2001) studded the costs of cotton production in Salah Al-Din City . Also (Sakab, 2005) completed a master's thesis entitled "Estimating the cost functions and economies of scale for the sesame crop in Wasit." (Ali and Farhan, 2012) estimate the cost functions and economies of scale for yellow maize in Babil for the fall season of 2008, as well as a study (Gburi and Zanzal, 2014). In addition to a lot of other research in the field of cost study. This study will take the second aspect of agricultural production, which is the animal production aspect of fish product, as a starting point for studying the rest of other animal commodities besides plant production, in the field of costs and economies of scale. Issue will study at the level of the country as a whole and over a long period of time, with the aim of obtaining the results of agricultural policy orientation, such as the subsidy policy and the production policy, in order to reduce costs, expands production and improve farmers' incomes.

## Methods and Materials

One of the main problems of declining fish production in Iraq is the high amounts of production costs. In order to address the problem by studying the cost function and addressing the economic concept of production costs, their importance and determinants. A cost means the opportunity that enterprises or establishments have to give up in order to produce a certain commodity in return, whether they are cash or non-cash costs. There are three factors specific to the cost of production of a particular commodity, which are the quantities and prices of production factors and the amount of production per unit of production factors (Ali, 1984). The production costs of any project are called the total costs, which in turn are divided into fixed costs and are not affected by the volume of production (in the short term), as they are paid regardless of the level of production, such as interest on invested capital, taxes, and the rental of buildings and machinery. Variable costs, which are closely related to the volume of production, as they change with a change in the level of production, such as the costs of production requirements such as (seeds, fertilizers, chicks, veterinary medicines, workers' wages, fuel, water ...) and that the optimal level of production depends in its calculation on this second type, i.e. the variable costs. The change in production costs as a result of changing the volume of production depends on the time factor, meaning that the nature of the project costs is affected by the length of time, during which the project can adapt to the prevailing market conditions (Sakab, 2005) when a project decides to increase or decrease its production (Control By supply), he will face the problem of flexibility in that, i.e. the extent of the freedom of the project or industry in matching the volume of its production with the prevailing market conditions. Therefore, the study of the issue of production costs is of importance to economists as they differentiate between short-term costs and long-run costs. We also note that not only the length of time has an effect on production, but also the conditions surrounding production have an effect on it, especially the technological progress that enables us to change all production factors. Production costs are a function of the quantity of production, that is, the relationship between production and costs, depending on economic theory.

$C= F(Q)$ ……….(1)

The total costs are divided into two parts: variable costs, which change with the change in the volume of production, and fixed costs, as they have nothing to do with the volume of production, that is:

$C= VC + FC$ ……….(2)
$C= F(Q)+B$……….(3)

Where: C: total costs, VC: total variable costs, FC: fixed costs, F: function code, Q: output, B: fixed costs in the cost function

Where equation 3 above represents the general form of the estimated total cost function, as it represents the linear form. There are also other forms of cost functions such as quadratic and cubic, where the cubic formula is considered the best types of formulas in estimating functions that the cost function cubic takes the following general formula: (Nicholson, 1985)

$C= B0 + B1Q - B2Q^2 + B3Q^3 + Ui$………..(4)

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whereas

C: total cost, B0: constant term of the function, (B1, B2, and B3), estimated regression parameters

Q: output quantity, Ui: limit of error (random variable)

That cost is a function of the level of production, so the model can be described as costs A dependent variable and the level of production represented by the independent variables (Q3, Q2, Q). Through the total cost function, it is possible to derive many other cost functions, which are functions of the level of production as well. These derivatives (Henderson 1980):

1. Average total cost (AC): It is the result of dividing the total costs (C) by the level of output (Q).

AC = C / Q ………… (5)

2. Average variable cost (AVC): is the quotient of dividing the total variable cost (TVC) by the output level (Q).

AVC = VC / Q …………… (6)

3. Average Fixed Cost (AFC): It is the sum of the total fixed costs (TFC) divided by the output level (Q).

AFC = FC / Q …………….. (7)

4. Marginal costs (MC): It is the amount of change in total costs, TC, or variable costs, VC.

Divided by the change in the volume of output Q

MC=ΔVC/ Q Δ OR MC=ΔC/ Q Δ………(8)

The functions of the second-order average costs begin to decrease after that and increase if production increases. It depends on the degree of homogeneity of the production function or the degree of savings achieved. The derivatives of the cost functions help in determining the optimal volume of production for the production facility or farm and the optimum volume of production is the volume of production that achieves the best level of net income for the producer, in the short term this volume that achieves the lowest level of average costs (but does not achieve

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economic efficiency) differs from the size of the output that It achieves the best level of net income (which achieves economic efficiency), as the volume of output that achieves the lowest level of average costs is often less than the volume of output achieved for economic efficiency. As for the long term, in which all production elements are variable, the volume of economic efficiency achieved corresponds to the size of the civil product of the average cost, meaning that the two sizes of output do not differ in the long term as is the case in the short term (Sakab, 2005). As for fixed costs, they do not affect the decisions of the producer regarding the optimum size of production because they are paid regardless of the level of production.

## Results and Discussion

### The reality of fish production in Iraq

Production is related to relationship with costs of various commodities, called cost function, whose importance we previously explained in order to determine the optimal volume of production of the commodity that maximizes profits and minimizes costs for the producer or the production facility. Before discussing the results of the cost function of fish in Iraq during the period (1990-2019), one should get acquainted with the reality of Iraq's fish production during the studied period. During the nineties, it was characterized by fluctuation up and down due to the cessation of fish enterprises to work during the period of the economic blockade, which prevented the import of production requirements such as concentrated feed and veterinary medicines. As a result, local production decreased significantly from what it was during the eighties, reaching its lowest level within a year. 1991, it reached 18 thousand tons, but the decline in fish production during the 1990s did not positively affect the costs, but production costs were increasing due to the above reasons in addition to the deterioration of the value of the country's local currency against the dollar (Al-Waeli, 2000). After the year 2000 production continued to fluctuate, but its levels were higher than that. It was during the 1990s. During this period, especially after the end of the war after 2003, the state took care to support this important sector through the rehabilitation program for some projects and encourage and support the private sector by providing imported production elements to the producers working on this project at reasonable prices. This led to a relative improvement in local production, as it reached the highest level of production in 2013, reaching 110.5 thousand tons, which is a good level compared to what it was during the 1990s. Table (1) shows the annual production levels, as well as the amount of production costs for fish meat during the study period. On the other hand, when studying the side of production costs, we note that they increased gradually and continuously during the study period, noting a relative decrease during some years due to a decrease in the amounts of production during those years, due to the stopping of a large number of local production projects due to their exposure to losses, according to Table (1) The amount of costs during the school years. Therefore, the state, through the Ministry of Agriculture, worked to support the prices of imported production inputs, so it took action to reduce the state of inflation by calculating a symbolic accounting price for the dollar used in the pricing of imported production supplies (such as machinery, machinery, chicks, fodder, and medicines ...) by the

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state to keep the price of these inputs low. On the price of commercial markets, and the distribution of those inputs to the projects covered by the primary subsidy, 2000. Some of the subsidized materials include feed costs that are more important than the other paragraphs, and after them come the costs of labor wages, vaccinations, medicines and disinfectants, fuel, electricity and water. The subsidy provided had some good results, as large quantities of production were put on the market at reasonable prices for consumers.

Table (1) Annual production quantities and the amount of production costs per kilogram of fish meat in Iraq for the period (1990-2019)

| **years** | **Cost ID/ Kg** | **Production 000 ton** |
|---:|---:|---:|
| 1990 | 1.4 | 31.500 |
| 1991 | 7.2 | 18.000 |
| 1992 | 16.4 | 21.600 |
| 1993 | 39.4 | 24.500 |
| 1994 | 299 | 25.600 |
| 1995 | 583 | 33.400 |
| 1996 | 892.3 | 35.100 |
| 1997 | 1047 | 37.000 |
| 1998 | 811 | 27.700 |
| 1999 | 749 | 30.400 |
| 2000 | 767 | 28.000 |
| 2001 | 1152 | 26.000 |
| 2002 | 1093 | 45.500 |
| 2003 | 1035 | 21.000 |
| 2004 | 1299 | 18.400 |
| 2005 | 1545 | 34.700 |
| 2006 | 1855 | 56.800 |
| 2007 | 2197 | 54.400 |
| 2008 | 2126 | 47.900 |
| 2009 | 2258 | 53.000 |
| 2010 | 2331 | 55.900 |
| 2011 | 2328 | 48.800 |
| 2012 | 2677 | 67.900 |
| 2013 | 2484 | 110.500 |
| 2014 | 2526 | 84.000 |
| 2015 | 2378 | 46.300 |
| 2016 | 2094 | 55.900 |
| 2017 | 2079 | 63.300 |
| 2018 | 2087 | 89.940 |
| 2019 | 2083 | 99.800 |

**Source:** Ministry of Planning - Central Bureau of Statistics - Department of Agricultural Statistics

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**Fish Cost Function Analysis**

In order to estimate the total cost function of the fish product in Iraq, analyze it statistically and economically, and determine the volume of production from the derivatives of the cost function. The cost functions take many forms, cubism, which is considered one of the best formulas of cost functions, based on the previously explained economic theory. The cost is a function of the level of production, and through the data of the time series of total costs and the level of production in Table (1) above, estimated cost function for fish is as follows:

$C = - 1591.94 + 116.46\ Q – 1.03\ Q^2 + 0.003\ Q^3 + Ui$ …………… (9)

t: (- 4.331*) (6.297*) (- 3.682*) (1.774)

F=34.621 R= %89.4 $R^2$=%80 D.W=1.267

The above estimated model showed that the parameters were significant at the level of significance (5%), except for the independent variable parameter ($Q^3$), according to the calculated t-test values. The estimated parameters are economically acceptable in terms of their signals and values. The value of the F-test indicates the significance of the model as a whole at the level of (5%), and the value of the coefficient of determination $R^2$ indicates that 80% of the changes that occur in the dependent variable (costs) are explained by the independent variable (production) and that 20% are explained by other factors not included in the model. Note the data in Table (1), and as we explained previously, that during the nineties, production decreased significantly without affecting the amount of costs. The value of the D.W test also indicates that the model is free from the second degree problem, such as self-correlation, multiple correlation, the clustering problem, and the inconsistency of variance because the data are time series, as shown by the following analysis of the D.W value:

$du < D.W < 4 – du$
$1.204 < 1.267 < 4- 1.204$
$1.204 < 1.267 < 2.796$

**Determine the optimal size of production**

The optimum size is the volume of production, which minimizes costs and maximizes project profit. According to economic theory, the marginal cost MC and the average total variable cost AVC in the long run (the analysis being for time series data) intersect at the lowest point on the average total variable cost and thus the optimum output size is determined. In other words, the optimal size of production is determined by the equality of the marginal cost function with the average variable cost function as follows (Dahla, 2007):

AVC=MC…………..(10)

$AVC = TVC/Q = 116.46 - 1.03\,Q + 0.003\,Q^2$ ……………(11)

$MC = \Delta TVC/\,Q\,\Delta = 116.46 - 2.06\,Q + 0.009\,Q^2$ ……………(12)

When equations 11 and 12 are equal

$$116.46 - 1.03\,Q + 0.003\,Q^2 = 116.46 - 2.06\,Q + 0.009\,Q^2$$

$1.03Q - 0.006Q^2 = 0$
$Q\,(1.03 - 0.006Q) = 0$
$Q = 0$
$Q = 1.03 / 0.006$
$Q = 171.66$

The optimum annual production volume of fish has become (171.66) thousand, at which time the lowest average variable total cost is achieved and through which the best net income of the productive project is required from fish. If we return to Table (1) and notice the actual production levels during the years, we find that they did not reach the optimal level that was calculated through the above estimated cost function, so the actual production level ranged between its lowest level, which was 18 thousand tons during 1991 and the highest level during The period was 110,500 during the year 2013, and it is considered slightly less than the optimal level. Therefore, it becomes clear to us that Iraq's fish production did not reach the optimum level due to the difficult conditions that the country went through, represented by wars and siege during the nineties, as well as post-2003 events, political conditions, and the continuous changes of governments. In addition to the economic conditions, including the depreciation of the local currency, the absence of foreign investment, and the reduction of budgetary support to finance major fish projects for the country, and production was limited to farms and fish ponds owned by the private sector represented by small projects run by individuals. The government is required to work on developing and operating major fish projects by encouraging domestic and foreign investment in order for it to expand its production through financial support for these projects and the introduction of modern scientific methods through scientific research and studies that work to increase the level of production and reach the level Optimization as well as reducing costs and thus maximizing profit.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 8713 - 8724
Received 25 April 2021; Accepted 08 May 2021.

**Elasticity of cost (E) and Function coefficient (R):**

Cost elasticity is defined as the relative change in total costs as a result of a change in the volume of production, for the purpose of measuring the cost elasticity, it is done by differentiating the cost function with respect to output to obtain marginal costs MC and dividing it by the average total costs AVC (SAKAB, 2005) i.e.:

E = MC / AVC ………… (13)

And it is inferred from its measurement on the type of yield to which production is subject. If the cost elasticity is less than 1 correct, that is, the marginal cost is less than the average total cost, meaning that production is subject to increasing yields and this means that we achieve a relative increase in production at a lower relative cost, but if the cost elasticity is greater than 1 correct, i.e. the marginal cost is greater than the average total costs. Production is subject to diminishing returns, as we obtain a proportional increase in production at a greater relative cost. If the elasticity of costs is equal to one, production is subject to constant yield, that is, we obtain a proportional increase in production. As for the parameter of the function R: which is the relative response to the product as a result of an equal change in the factors of production and is equal to the sum of the elasticity of the response to the factors of production in the case of changing by the same proportion and is the inverse of the coefficient of elasticity of cost, i.e. equal to the average total cost divided by the marginal cost (Ferguson, 1975)

R = AVC / MC ……… (14)

The function parameter is used to accurately determine the area of Economies of scale and Diseconomies of scale as well as cost elasticity as indicators. That is, at the lowest point on the AVC curve, that is, at the optimum size of the output, the capacity savings will be 100%, that is, the values of E, R are equal to 1 true and it is positive if it is Flexibility is positive. From Table (2), we can notice that the lowest value of the AVC during the year 2013 was 39,276 at the production level of 110.5 thousand tons, which is the highest level of production during the study period, but it is much less than the optimal production level previously calculated which reached 171.66 thousand tons. We also note from Table (2) the values of cost elasticity and the computed function coefficient, where the values of cost elasticity were less than the correct one for all years of study, meaning that the annual production of fish is subject to increased yield, while the values of the function factor were greater than the correct one for all years of study. The elasticity of cost as well as the function coefficient was negative during the year (2013) to clarify the inverse relationship between production and average cost as savings increase during 2013 as it achieved the highest production during the period as well as due to the decrease in the value of the average cost compared to the rest of the other years in which the function coefficient or the elasticity of cost is positive, we conclude That fish production will be economically feasible during the year 2013, therefore, work should be done to increase the production of fish projects

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to more than 110 thousand tons at least in order to lead to a decrease in the value of the average total cost and thus increase production and reduce costs to achieve project profits.

Table (2) the values of the average total variable cost, marginal cost, cost elasticity and the calculated function coefficient corresponding to the levels of annual fish production for the period (1990-2019)

| **years** | **AVC** | **MC** | **E** | **R** |
|---|---|---|---|---|
| 1990 | 86.992 | 60.500 | 0.695 | 1.438 |
| 1991 | 98.892 | 82.296 | 0.832 | 1.202 |
| 1992 | 95.612 | 76.163 | 0.797 | 1.255 |
| 1993 | 93.026 | 71.392 | 0.767 | 1.303 |
| 1994 | 92.058 | 69.622 | 0.756 | 1.322 |
| 1995 | 85.405 | 57.696 | 0.676 | 1.480 |
| 1996 | 84.003 | 55.242 | 0.658 | 1.521 |
| 1997 | 82.457 | 52.561 | 0.637 | 1.569 |
| 1998 | 90.231 | 66.304 | 0.735 | 1.361 |
| 1999 | 87.920 | 62.153 | 0.707 | 1.415 |
| 2000 | 89.972 | 65.836 | 0.732 | 1.367 |
| 2001 | 91.708 | 68.984 | 0.752 | 1.329 |
| 2002 | 75.806 | 41.362 | 0.546 | 1.833 |
| 2003 | 96.153 | 77.169 | 0.803 | 1.246 |
| 2004 | 98.524 | 81.603 | 0.828 | 1.207 |
| 2005 | 84.331 | 55.815 | 0.662 | 1.511 |
| 2006 | 67.635 | 28.488 | 0.421 | 2.374 |
| 2007 | 69.306 | 31.030 | 0.448 | 2.234 |
| 2008 | 74.006 | 38.436 | 0.519 | 1.925 |
| 2009 | 70.297 | 32.561 | 0.463 | 2.159 |
| 2010 | 68.257 | 29.429 | 0.431 | 2.319 |
| 2011 | 73.340 | 37.365 | 0.509 | 1.963 |
| 2012 | 60.354 | 18.080 | 0.300 | 3.338 |
| 2013 | 39.276 | -1.278 | -0.033 | -30.738 |
| 2014 | 51.108 | 6.924 | 0.135 | 7.381 |
| 2015 | 75.202 | 40.375 | 0.537 | 1.863 |
| 2016 | 68.257 | 29.429 | 0.431 | 2.319 |
| 2017 | 63.282 | 22.124 | 0.350 | 2.860 |
| 2018 | 48.089 | 3.986 | 0.083 | 12.063 |
| 2019 | 43.546 | 0.512 | 0.012 | 84.991 |

**Source:** Calculated by the researcher based on the estimated previous equations

## Conclusion

The study showed the effects of costs through changing the level of production. It referred to the decrease in the level of production and the continuous rise in the amount of costs. The reason for fish production was affected by the political and social conditions that the country is going through. Feed costs constitute the largest proportion of the total costs, which had a major role in the increase in the amount of costs. The cost function was estimated using the cubic formula, which is considered one of the best formulas in representing the relationship between the volume of production and costs. It became clear that the country's production did not reach the optimum level, as production levels were below the desired level, which reduces costs and achieves profits. In addition, production is subject to increasing yields through the values of cost elasticity. The 2013 production also achieved significant economic savings over the rest of the years through the function factor. Fish projects need to develop their production in order to increase it, through financial support, the use of modern scientific methods in production, the use of modern production requirements, advanced equipment and feed concentrates. The role of the private sector should also be activated and local and foreign investments that support fish projects and increase their areas in order to expand production at the country level, noting that the country has many water areas such as rivers and lakes that must be exploited and operated in order to increase production and meet the needs of the local demand for fish. Conducting studies similar to other commodities, especially meat, in order to identify possible weaknesses that may occur and reduce them through the development of scientific aspects.

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