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Research Article

The Economics of Production of Fish Hatcheries for Nile Tilapia Seed in Kafr El-Sheikh Governorate

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Abstract

Fish farming in general and fish spawning activities in particular depend on the size and quality of the productive inputs for these activities, and the impact of those inputs on the quantity of fish seed production in these hatcheries, Therefore, the research aimed in general to study the most important economic factors affecting the spawning activities of Nile tilapia fish in Kafr El-Sheikh governorate, By estimating the economic efficiency of hatcheries, Estimating and analyzing the items of production costs and determining their importance, And the research has an applied importance in guiding its results in raising the efficiency levels of using production inputs in hatcheries for the production of Nile tilapia fish, And the consequent increase in the production capacity of hatcheries in general.

In achieving its objectives, the research relied on both the descriptive and quantitative methods of analysis in the interpretation and analysis of the economic variables under study, The research also relied on secondary data from the General Authority for Fish Resources Development, And primary data were collected from a sample of 30 fish hatcheries during 2021 in the Kafr El-Sheikh governorate.

Keywords: Fish farming; hatcheries; fry; fingerlings; cost function; Economic

Abbreviations

TC: refers to the total production costs of the hatchery in thousand L.E
M.C: refers to marginal costs
ATC: refers to the average total costs of a hatchery
AD: Anno Domini

Introduction

Fish production is one of the main sources of agricultural income. The monetary value of fish production in Egypt during 2019 amounted to about 61.1 billion LE, representing about 12.2% of the total monetary value of agricultural production in Egypt, which amounts to about 500.4 billion LE.

Fish production in Egypt achieved a significant increase in the recent period, as it rose from 724,000 tons in 2000 AD to about 2.038 million tons in 2019 AD. This great development in fish production relied largely on fish farming, as the product amounted to about

1,642 million tons, representing about 80.5% of the total fish production in 2019. This confirms the importance of fish farming in Egypt as the most important source of fish production. Through fish farming, it is possible to obtain high production rates of fish in a relatively short period, as well as to exploit lands that are unsuitable, marginal, and unsuitable for agriculture. In addition, fish farming contributes to reducing the seasonal effects of fish production and expanding the production of desired and desired fish locally and abroad, which are of good quality.

Egypt is one of the countries with the appropriate capabilities with regard to establishing fish farms and increasing the percentage of self-sufficiency in fish by using lands not suitable for agriculture. And adopting methods, systems, and levels of intensive and semi-intensive fish farming, in addition to adopting non-traditional methods in fish farming, such as the cultivation of agricultural drains, Re-cultivation of the Nile River with Nile tilapia fingerlings, the use of partial fishing systems in fish farms, and the spread of fish farming in rice fields [1].

Materials and Methods

In achieving its objectives, the research relied on both descriptive and quantitative methods through the use of simple statistical methods such as percentages and arithmetic averages. In addition to the following economic methods and models:

Simple linear regression

To estimate the annual growth rates of production capacity for hatchery production of fry and fingerlings, using the following mathematical model:

$$Y_i = \alpha + \beta X_i$$

Y_i : Refers to the estimated numbers of fry and fingerlings produced during the study period.
X_i: refers to the time variable in the year AD(1, 2, 3 ……. 20)

Multiple regression model

To reach the relationship between the production of fish hatcheries for the production of seed and fingerlings of Nile tilapia fish (as a dependent variable) and the economic factors as independent variables using the following mathematical model:

$$y = a + b_1x_1 + b_2x_2 + b_3x_3 \text{ ..... } + b_6x_6$$

y: indicates the number of fry produced for the hatchery in the observation.
X_1: The total area of the hatchery in fadan.
X_2: Number of tilapia mothers for the hatchery.
X_3: Feed quantity per ton for hatchery.
X_4: the productive life of the mother in years.
X_5: The number of technical workers in the hatchery.
X_6: The number of normal labor for the hatchery.

As well as estimating the cost functions of the product of Nile tilapia fry and fingerlings by using the cubic form to estimate the total cost function as the most appropriate form of the functions for estimating costs and take the following form.

$$T.C = a + bx_1 - cx_2^2 + dx_3^3$$

T.C: The value of production costs in LE.
X_i: Quantity of product from Nile tilapia fingerlings and fry in million units.
i : Views

a: Fixed

b, c, d: Function parameters.

The research relied on two main sources of data, namely

1. Secondary data derived from the published annual statistical bulletins issued by the General Authority for Fisheries Development of the Ministry of Agriculture and Land Reclamation, In addition to some references, letters and scientific research related to the topic of the research.
2. Preliminary data through a field study conducted on a sample of 30 fish hatcheries during the year 2021 AD. The number of fish hatcheries in Egypt was counted from the records of the General Authority for Fish Resources Development during the year 2019. The number of fish hatcheries reached about 103, distributed over some governorates of the Republic. Kafr El-Sheikh governorate was chosen according to the relative importance of the number of hatcheries in it, and it was the representative. The number of hatcheries in it reached about 89, representing about 86.4%of the total number of hatcheries in Egypt. A stratified random sample was selected from Kafr El-Sheikh Governorate, which amounted to about 30 hatcheries. , representing about 33.7% of the total number of hatcheries in Kafr El-Sheikh.

Results and Discussion

First: The development of seed production

Evolution of the quantity of fish hatcheries production of fry in Egypt

The data of Table No. (1) indicate that there is a fluctuation in the total number of fry produced from fish hatcheries in Egypt during the study period, The minimum production quantity was about 184.17 million units in 2017, It represents about 56.05 % of the average total of fry and fingerlings produced from fish hatcheries in Egypt, fingerlings produced from fish hatcheries in Egypt represents about 354 million units [2, 3].

The data of tables No. (1) and No. (2) indicate a decrease in the number of fry produced from fish hatcheries in Egypt From about 358.1 million units in 2000 AD to about 304 million units in 2019 AD, with a decrease of about 15.21% compared to the year 2000 AD, By estimating the equation of the general time trend of the total numbers of fry produced from fish hatcheries in Egypt during the study period, it was found that there was a statistically significant decrease, amounting to about 1.46 million fry, with a change rate of about 0.44% of the total average production of fish hatcheries in Egypt [4].

Evolution of the production of seed produced from freshwater hatcheries

The data in Table No. (1) shows the fluctuation in the number of fry produced from fresh water hatcheries in Egypt between a minimum production of about 171.75 million units in 2017, It represents about 56.13% of the average production of freshwater hatcheries and a maximum of about 547.09 million in 2014, representing about 178.8% of the average production of freshwater hatcheries during the period. The percentage of the contribution of freshwater hatcheries production to the total fish hatcheries production of fry ranged between a minimum of about 84.01% during 2016 and about 99.6% as a maximum during the year 2004, and it was found that the production of these hatcheries represents the predominant percentage of hatcheries in Egypt.

The data of tables No. (1) and No. (2) indicate a decrease in the quantity of fry produced from fresh water hatcheries, from about 346.9 million units in 2000 to about 286.1 million units in 2019. With a decrease of about 17.5%from what it was in 2000, The results of estimating the equation of the general time trend of the numbers of fry produced from fresh water hatcheries in Egypt during the study period showed, There is a decrease in the number of seedlings, and the significance of the function has not been statistically proven at any level of morale. The decrease amounted to about 1.57 million Snuba fry, with a rate of change of about0.51% of the average total of fry produced from fresh water hatcheries in Egypt, which amounted to about 339.7 million fry during the study period.

% Total	Percentage of fresh water to total %	Total hatchery production			years
		Total	Nautical	Fresh	
3.1	96.9	358.1	11.2	346.9	2000
2.9	97.1	406.5	11.7	394.8	2001
7.6	92.4	336.8	25.5	311.3	2002
0.9	99.1	331.61	3.1	328.51	2003
0.4	99.6	352.39	1.35	351.04	2004
0.9	99.1	297.54	2.55	294.99	2005
0.8	99.2	271.88	2.25	269.63	2006
1.2	98.8	306.3	3.69	302.61	2007
4.2	95.8	347.32	14.57	332.75	2008
8.3	91.7	304.8	25.41	279.39	2009
3.8	96.2	400.12	15.06	385.06	2010
3.3	96.7	474.87	15.8	459.07	2011
2.4	97.6	410.6	10.01	400.59	2012
1.8	98.2	509.07	8.92	500.15	2013
2.34	97.66	560.2	13.11	547.09	2014
7.84	92.16	375.27	29.41	345.86	2015
15.99	84.01	276.63	44.24	232.39	2016
6.74	93.26	184.17	12.42	171.75	2017
6.54	93.46	272	17.8	254.2	2018
5.76	94.24	304	17.5	286.1	2019
4.3	95.7	354.0	14.3	339.7	Average

Source: Compiled and calculated from: Ministry of Agriculture and Land Reclamation, General Authority for Fisheries Development, Fish production statistics book, miscellaneous issues.

Table 1: Production of fish hatcheries from fry according to water type in Egypt During the period 2000-2019.

% change percentage	average period	2019	2000	the statement
-17.5	339.7	286.1	346.9	Fresh water fry (Production per million fry)
56.25	14.3	17.5	11.2	sea water fry (Production per million fry)
-15.11	354.01	304	358.1	Produced seed mass (Production per million fry)

Source: Calculated from the data of Table No. (1).

Table 2: Evolution of fresh and marine water seed production and total production in Egypt During the period 2000-2019.

% change rate	R^2	T	Function	statement
0.51	0.01	(-0.43)	$Y = 356.194 - 1.57 X_n$	Fresh water fry
3.51	0.19	(2.04)*	$Y = 5.935 + 0.787 X_n$	sea water fry wrong estimation
0.44	0.01	(-0.39)	Y = 354.328 - 1.459 Xn	Produced seed mass

Source: Calculated from the data of Table No. (1).

Table 3: Results of estimating the growth equation for fresh and marine water seed production and bulk production In Egypt during the period 2000-2019.

Whereas: Y= the number of freshwater and marine fry, and the number of fry per million in Egypt.
X_n= The time variable in the year n, (1, 2 ..... 20).
(*)=: significant at the statistical probability level 0.05.

Evolution of the production of seed produced from marine water hatcheries

It is clear from the data of Table No. (1) that the production of marine water hatcheries represents a very small percentage of the total fish hatcheries production in Egypt Where the percentage of the production of marine hatcheries production to the total production of fish hatcheries of fry was between a minimum of about 0.4% during the year 2004 and about 15.99% as a maximum during the year 2016, With an average of about 4.3% of the total number of fry produced in Egypt, It was also found that the average number of fry and fingerlings produced from marine water hatcheries in Egypt amounted to about 14.3 million units, The production ranged between a minimum production of about 1.35 million units in 2004, representing about 6.02% of the average production of marine water hatcheries, , and a maximum of about 44.24 million in 2016, represents about 197.5% of the average total production of marine water hatcheries during the study period [5].

The data of tables No. (1) and No. (2) indicate an increase in the number of fry produced from fish hatcheries in marine waters from about 11.2 million units in 2000 to about 17.5 million units in 2019. With an increase of about 56.25% compared to the year 2000, The results of estimating the general time trend function of the numbers of fry produced from marine water hatcheries in Egypt during the study period show. That there is a statistically significant increase. The increase amounted to about 0.787 million seedlings, with a rate of change of about 03.51% of the average total of fry produced from marine water hatcheries in Egypt, which amounted to about 14.3 million fry during the study period [6].

It is clear from the foregoing that the development of freshwater seed production in Egypt amounted to about 347 million seed units in the year 2000 Then it fluctuates between increase and decrease for the study period until it decreased and reached about 286 million fry units in 2019 With a change rate of about 17.5%, as for marine water seed, it was found that during the study period it increased from 11.2 million seed units in 2000 to about 17.5 million seed units in 2019. With a change rate estimated at 56.25%, it was also found that the total seed for fresh and marine water amounted to about 358 million seed units in 2000, then decreased during the study period and amounted to about 303.6million seed units in 2019 with a change rate estimated at 15.21%than it was at the beginning of the study period.

Evolution of the quantity of tilapia seed production

The data of Table No. (4) show that the number of tilapia fish fry fluctuated between a minimum of about 93.2 million fry units in 2009, represents about 61% of the average total production of tilapia fish fry of about 153 million units, and a maximum of about 333.5 million fry unit in 2014, It represents about 218% of the average total production of tilapia fish fry, The contribution of tilapia fish fry production to the total fish hatcheries production of freshwater seed ranged between a minimum of about 33.4% during 2009, And about 68.6% as a maximum during 2017, The tilapia fish fry contributed about 46.5% of the average production of freshwater

hatcheries seed production in Egypt during the study period.

Total	*tilapia fry*		*years*
	% Total	*Number*	
346.8	36.1	125.1	2000
394.7	36.3	143.3	2001
311.3	48.9	152.3	2002
328.51	42.8	140.6	2003
351.04	41.6	146.11	2004
294.99	48.8	144.07	2005
296.63	49.9	134.5	2006
302.61	45.9	139	2007
332.75	42.6	141.6	2008
279.39	33.4	93.18	2009
385.06	54.6	210.9	2010
459.07	53.4	245.02	2011
400.59	60.6	242.56	2012
500.15	58	289.91	2013
560.19	59.5	333.5	2014
375.27	36.6	137.5	2015
276.63	36.8	101.8	2016
184.17	68.6	126.4	2017
272.02	38.9	105.8	2018
303.64	41.7	126.5	2019

Source: Compiled and calculated from: Ministry of Agriculture and Land Reclamation, General Authority for Fisheries Development, Fish production statistics book, miscellaneous issues.

Table 4: Freshwater hatchery production according to tilapia seed during the period 2000-2019. (Production is one million fry).

% change percentage	*average period*	*2019*	*2000*	*statement*
1.12	164	126.5	125.1	Tilapia fry total (production per million fry)

Source: Calculated from the data of Table No. (4).

Table 5: Evolution of the quantity of freshwater hatchery production according to the type of seed In Egypt during the period 2000 – 2019.

% change rate	*R^2*	*F*	*T*	*Function*	*statement*
1.06	0.02	0.04	(0.63)	Y = 147 + 1.628 X	Tilapia fry total

Source: Calculated from the data of Table No. (4).

Table 6: Results of estimating the growth equation for freshwater seed production according to the type of seed in Egypt during the period 2000 - 2019.

Where: Y = which is the number of tilapia fry per million units in Egypt, and X =refers to the time variable in the year.

The data of tables No. (5) and No. (6) indicate an increase in the quantity of tilapia fish fry production from about 125.1 million

units in the year 2000 to about 127 million units in 2019, an increase of about 1.12% compared to the year 2000, From the results of estimating the equation of the general time trend of the numbers of tilapia fish fry produced in Egypt, That there was a statistically insignificant increase of about 1.6 million fry, with a rate of change of about 1.06% of the average total of tilapia fry and fingerlings in Egypt during the study period, The reason for the increase in the production of fresh water hatcheries for tilapia seed may be due to the increased demand for tilapia fish, which is characterized by an acceptable taste to the consumer, which facilitates the marketing process short.

It is evident from the above that the total number of tilapia fry reached about 125 million units in 2000, then increased to about 126.5 million units of tilapia fish in 2019, with a change rate of about 1.12%.

Second: The Economic Analysis of the Total Costs and Revenues of Nile Tilapia Spawning Activities

Investment costs of Nile tilapia hatchery activities

Studying the investment costs of fish hatcheries for the production of Nile tilapia seed in the study sample in Table No. (7) It was found that the average invested capital for a hatchery is estimated at about 1.4 million LE, and the average invested capital for a hatchery per acre is estimated at about 262 thousand LE. The average value of the hatchery's fixed assets was estimated at about 473.3 thousand LE, representing about 34.4% of the total invested capital. And the acre's share of the value of fixed assets amounted to about 90.14 thousand LE.

The value of construction and equipment was estimated at 647.5 thousand LE, and the value of construction and equipment per acre was estimated at about 123.3 thousand LE, representing about 47.1% of the total invested capital. While the value of an faddan of land as an area for a hatchery was estimated at about 400 thousand LE, representing about 29.1% of the total invested capital, The average working capital was estimated at about 277.2 thousand LE for the hatchery, and the working capital per acre was about 52.8 thousand LE, representing about 19% of the total invested capital [7].

Production costs of Nile tilapia spawning activities

Total production costs

By studying the total production costs of fish hatcheries for the production of Nile tilapia seed in the study sample, The average total production costs of the hatchery were estimated at 370.2 thousand LE. The total production costs of an faddan of the hatchery amounted to about 70.5 thousand LE.

Fixed production costs

The data of Table No. (7) shows that the average fixed costs of the hatchery, which includes the depreciation premium for facilities, equipment and hatchery brood stock only, amounted to about 100 thousand LE, The average share of an faddan was about 19.1 thousand LE, representing about 5.15%of the total costs of the hatchery.

Variable production cost

The average variable production costs of the hatchery in the study sample were estimated at about 277.2 thousand LE per hatchery. The variable production costs per faddan amounted to about 52.8 thousand LE, representing about 74.8%of the total costs of the hatchery. The feed value ratio represents the highest percentage of the total value of the variable costs estimated at 48.4% [8].

Total revenues of Nile tilapia hatchery activities

The value of the total revenue represents the value of fry sales, and the total revenue is affected by the quantity of production, the types of seed produced and their prices. By examining the total revenues of Nile tilapia hatchery activities, it was found that the quantity of seed produced from the hatchery amounted to about 4.3 million, of whom 3.3 million are single-sex tilapia. The average price

of one thousand was about 115 LE per thousand fry, along with 1.03 million fry of ordinary Nile tilapia Which were excluded from the hormonal treatment at an average price of about 64 LE per thousand fry, and thus the hatchery achieved a total revenue of about 598.3 thousand LE, With a net return of about 14.6 thousand LE per feddan hatchery, the rate of returns to costs was estimated at 1.21% meaning that each LE invested in the production of tilapia seed gives 21 piasters.

Value in LE	*Quantity*	*Unit price in LE*	*Unit*	*Statement*
381225	3315	115	in thousand	Total Revenue: Fry of monosexual tilapia
65920	1030	64	in thousand	Fry of ordinary Nile tilapia (*)
598345	-	-	-	Total revenue
118989	13	9153	ton	Variable costs 1- Artificial feed 35% protein for mothers.
60274	6.5	9273	ton	2- 40% protein feed for fry.
37986	487	78	day	3- normal labor wages.
2645	23	115	day	4- Fixed technical labor wages.
15750	315	50	gram	5- Testosterone.
6525	421	15.5	liter	6- Ethyl alcohol.
15750	131.25	120	M^2	7- Organic fertilizer.
14180	-	-	-	8- Electric fuels, oils and greases.
1423	-	-	-	9- Equipment maintenance.
1926	-	-	-	10- Pesticides and drugs.
1712	-	-	-	11- Other expenses
277160	-	-	-	total variable costs
93013	-	-	-	total fixed costs
370173	-	-	-	Total costs = fixed + variable
76972	-	-	-	Average net yield of the hatchery
14661	-	-	faddan	Average net return for a hatchery area
1.21	-	-	%	Cost-benefit ratio
- 647508	-	-	-	investment costs Construction and equipment value.
400000	-	-	-	The value of an acre as an area for a hatchery.
277160	-	-	-	Working capital.
1374668	-	-	-	total investment costs

(*)- The quantity produced from fry that is outside the treatment of the hormone.

** The average area of the hatchery for the sample is 5.25 faddan.

Source: Compiled and calculated froma questionnaire for the research sample in Kafr El-Sheikh Governorate.

Table 7: Average total revenues and total costs of hatcheries Production of Nile tilapia seed in the study sample in 2021.

Third: Furnished furniture for indigo tilapia hatchery furniture:

The cost function shows the nature of the relationship between the amount of product produced from Nile tilapia seed and its production costs, Through the total costs function, it is possible to obtain some important economic indicators such as marginal costs, average total costs and cost elasticities, as well as the volume of production that maximizes the net return and the volume of production

that lowers average costs, It was possible to estimate the cost function for producing Nile tilapia fingerlings and fingerlings in their cubic form from the production data and costs obtained from the questionnaire, which are shown by the following equation:

$$T.C = 104.11\ X - 0.0034\ X^2 + 0.00000022\ X^3$$

$$(4.65)^{**}\ \ (-0.53)\ \ (0.52)$$

$$F=353.2\ ^{**}\ \ R/^2= 0.93$$

** Significant at 0.01

Where: (TC) refers to the total production costs of the hatchery in thousand L.E, (X) indicates the production volume of Nile tilapia seed, in million units.

It is clear that the estimate of the function is statistically significant, as the calculated "F" value is significant at the 1% probability level, and the significance of some of the estimated coefficients of the function was also proven at the 1% level of significance, and the rest of the transactions did not prove to be significant at any level of significance, and this is consistent with the economic logic, It is also clear from the value of the modified coefficient of determination "$R^{\backslash 2}$" that about 93% of the changes in the total costs of the hatchery are due to changes in the volume of seed production.

It has been possible to reach the optimum volume of production that maximizes the return through the function of marginal costs and its equality with marginal revenue It is the average price of a thousand fry, which is 214.5 LE. By finding the first differential for the total costs function, the following marginal cost function was obtained:

$$M.C = 104.11 - 0.0068X + 0.00000066\ X^2$$

Where: (M.C) refers to marginal costs, , while (X) indicates the production volume of Nile tilapia seed.

By equating the marginal cost function with marginal revenue, it was possible to obtain two values of the volume of production (X) One of them is that which maximizes production and is achieved by the intersection of the rising portion of the marginal cost curve with the marginal revenue curve Which gives a positive value, which was estimated at about 18.545 million fry units, By dividing the optimal size of the hatchery production by the average production of the hatchery with sample hatcheries, which was estimated at 5145.6 thousand fry, It was found that the optimal hatchery area, which maximizes the yield, is about 3.58 faddan. The average total costs function (MTC) was estimated by dividing the total costs function by the volume of production (X), and it was as follows:

$$A.T.C=104.11 – 0.0034 + 0.0000002X^2$$

Where: (ATC) refers to the average total costs of a hatchery, While (X) indicates the production volume of the hatchery.

Divide marginal costs by average costs to find the elasticity of production costs Which was estimated at 0.936, which indicates that an increase in production by 10% leads to an increase in costs by 9.36% which means that the hatcheries for Nile tilapia production are operating in the second stage of production, which means that there is a possibility to intensify the production elements on the area used to reach the size that maximizes the return.

By finding the first derivative of the function of the average total costs, it was possible to obtain the volume of production that brings the average costs to the lowest point, reaching about 7.727 million seed units, By dividing the optimal size of the hatchery production by the average production of the hatchery with sample hatcheries, which was estimated at 5145.6 thousand fry, It was found that the optimal hatchery area, which is below the average total costs, is about 1.5 feddans [9].

Fourth: Factors affecting the production of spawning activities of Nile tilapia fish in the study sample

The factors affecting the production of Nile tilapia spawning activities include the production inputs that include the production

costs of the spawning operations at the sample hatcheries, which are represented in: The total area of the hatchery in faddan, the number of mothers for the hatchery, the amount of feed in tons, the productive age of the mother, the number of workers in the hatchery.

The total area of the hatchery

The hatchery area is one of the most important production inputs on which the production of fish hatcheries depends, This is related to the size of the productive activity, as the average total area of the sample hatcheries was about 5.25 feddans with a value of about 438.6 thousand LE for the hatchery, representing about 32%of the investment costs of about 1.4 million LE for the hatchery, with an average of about 262 per hatchery, Thus, it occupies the first place among the items of investment costs.

Number of productive mothers

The number of mothers is one of the most important factors affecting the hatchery production of fry, Where it was found that the average was about 6125 for Nile tilapia mothers during the year as an average of the sample.

Amount of fodder in tons

Which represents the quantity consumed to feed the fry of the Nile tilapia spawning process, It was estimated at about 18.2 tons as an average for the hatchery, at a cost of 179.3 thousand LE , representing about 48.4% of the total costs.

Mother's useful life

It was found that the average productive life of the mother for the spawning process of Nile tilapia reaches five years, during which they are produced efficiently.

The number of workers in the hatchery

The trained technical labor is considered one of the most important productive inputs affecting the production of tilapia fish hatcheries, Where it was found that the average number of workers employed in the hatchery amounted to about 48 men/month, with an average wage of about 2138 LE per month, As for the ordinary labor, it was estimated as an average of about 487 men/day, with an average daily wage of about 77.5 LE per hatchery.

Statistical estimation of the spawning function of Nile tilapia fish

By studying the most important productive inputs affecting the production of hatchery production of Nile tilapia fish in the study sample, , where the inputs of the productivity function are represented in each of the total area of the hatchery in feddans (X_1),The number of productive mothers (X_2), the amount of fodder in tons (X_3), the productive life of the mother in years (X_4), the number of technical workers in the hatchery (X_5), The number of normal labor for the hatchery (X_6).While the outputs of the productive function are represented in the amount of production per million fry (Y), and by estimating the production function for hatcheries of Nile tilapia fish fry in the study sample using the phased multiple regression method in its double logarithmic form, which is shown in the following equation:

$$\text{Log } Y = \text{Log } 5.444 + 0.632 \text{Log } X_1 + 0.155 \text{ Log } X_2 + 0.099 \text{ Log } X_3 + 0.272 \text{ Log } X_4$$

$$(7.57)^{**} \qquad (2.24)^{*} \qquad (2.32)^{*} \qquad (3.00)^{**}$$

$R^{\backslash 2} = 0.98$ f = 577 ** Durban - Watson value = 2.33

* Significance at the 0.05 level.

** Significant at 0.01.

It was found that the most important inputs affecting the quantity of seed production of Nile tilapia fish are represented in the

positive effect of each of the following: The total area of the hatchery in faddan, the number of mothers for the hatchery, the amount of feed for the hatchery, the productive age of the mother, the number of workers in the hatchery, The production elasticity of these variables was about 0.032, 0.155, 0.099, 0.272, In the sense that an increase in each of those variables by 10%leads to an increase in the quantity of seed production of Nile tilapia fish by about 0.32%, 1.55%, 0.99%, 2.72%.these results were statistically significant, The productivity elasticity of the function was estimated at 1.159, which means that increasing the inputs with the estimated productivity function by 10% leads to an increase in the quantity produced from Nile tilapia fish fry by about 11.59%, which means that increasing in the return to capacity.

The value of (f) indicates the statistical significance of the function at the level of significance of 1%, and the Durban - Watson value is less than the upper limit of about 2.47, and then there is no autocorrelation at the 1% probability level, The value of the adjusted coefficient of determination ($R^{\2}$) shows that these factors are responsible for about 98% of the changes in the quantity of Nile tilapia seed production

Problems of producing private fish hatcheries and suggested solutions

Fish hatcheries in Kafr El-Sheikh governorate face many problems that affect their production and economic efficiency. The problems facing private fish hatcheries are varied and varied, where these problems facing fish hatcheries can be divided into production problems represented in: Labor problems, production requirements such as fodder, fertilizers, fuels, oils and other problems of production requirements, as follows:

Productivity problems

Private hatcheries face many production problems, the most important of which are labor problems. The problems related to production requirements represented in the problem of fodder, the problem of fuel and oils, in addition to the problem of the lack of mothers in the appropriate sizes, and the problem of water pollution, and other problems as follows:

Employment Problems

Most of the fish hatcheries suffer from employment problems, as Table No. (8) shows that the first employment problems facing the owners of private fish hatcheries were In the absence of skilled technical labor, with a relative importance that amounted to about 96.67% of the total sample hatcheries, which amounted to about 30 hatcheries, Then came the problem of high wages, especially for technical workers, with a relative importance that amounted to about 93.3% of the total sample hatcheries. Then, finally, the problem of unavailability of temporary workers in some seasons, with a relative importance that amounted to about 86.7% of the total sample hatcheries.

Table No. (8) also shows that the most important proposals submitted by the owners of private fish hatcheries to overcome employment problems In the first place came the proposal to establish cooperative societies for fisheries and training centers for the necessary labor for fish hatcheries, with a relative importance that reached 96.7% of the total sample hatcheries owners. Then the proposal to contract with workers on the basis of paying part of the wages at the end of the season to ensure that they continue to work in the hatchery until the end of the season, with a relative importance that amounted to about 83.3%of the total sample hatchery owners.

Production Input Problems

Fish hatcheries face many problems related to production requirements, represented in the problem of fodder, the problem of fertilizers, the problem of fuel and oils, in addition to the problem of the lack of mothers in the appropriate sizes, the problem of water pollution and other problems where these problems are studied separately as shown below:

1. *Feed problems:* Table No. (8) shows that the first feed problems facing the owners of private fish hatcheries were the risein feed prices with a relative importance that reached about 90% of the total sample hatcheries. Then came the problem of lack of quali-

ty and adulteration of feed, due to the low percentage of protein, with a relative importance that amounted to about 83.3% of the total sample hatcheries. Table No. (8) shows that the most important proposals submitted by the owners of private fish hatcheries to overcome feed problems came in the first place, the proposal for fisheries cooperatives to provide feed at reasonable prices, with a relative importance that amounted to 86.7% of the total sample hatchery owners. Then he proposed provisions for control over feed factories, with a relative importance that amounted to about 83.3% of the total sample hatcheries owners.

2. *Fuel and oil problems:* Table No. (8) shows the fuel and oil problems facing private fish hatcheries, It was found that the first of these problems was the rise in the prices of fuel and oils, with a relative importance that amounted to about 90% of the total sample hatcheries., then came in second place the problem of unavailability of fuel, and the problem of after fuel supply stations from hatcheries and sometimes refraining from selling, with a relative importance that amounted to about 76.7% of the total sample hatcheries.

Employment problems and proposals to solve them	*Frequencies*	*Frequencies%*
Problems		
Unavailability of skilled technical workers	29	96.7
Unavailability of temporary workers in some seasons	26	86.7
High wages, especially technical workers	28	93.3
solutions		
Training of fisheries cooperatives for the necessary labor for fish hatcheries	29	96.7
Contracting with temporary workers to ensure that they work in the hatchery until the end of the season	25	83.3
Feed problems and suggestions for their solutions		
problems		
Feed price hike	27	90
Inadequate feed quality and adulteration	25	83.3
solutions		
Fisheries cooperatives provide feed at reasonable prices	26	86.7
Tightening control over feed mills	25	83.3
Fuel and oil problems and suggestions for solving them		
problems		
Sometimes there is no fuel available	23	76.7
Increase in fuel and oil prices	27	90
the fuel supply stations are far from the hatchery, and sometimes refrain from selling	23	76.7
solutions		
Making cards for hatcheries to be presented to gas stations to obtain fuel	23	76.6
Subsidizing fuel and oil prices through Tawuniya stations	26	86.7
It provides the hatchery with paved roads to reach the fuel supply stations	19	63.3
Other problems of production requirements and proposals for their solutions		
Problems		
Mothers are not available in suitable sizes	14	46.7
Difficulty obtaining the hormone and its high prices	27	90
Unavailability of fresh water	28	93.3
Electricity price hikes and outages	23	76.7

solutions		
The hatchery itself prepares the mother's generation	14	46.7
Providing mothers from trusted fish farms	14	46.7
Providing the hormone through fisheries cooperatives at reasonable prices	27	90
Work of artesian wells to obtain groundwater	26	86.7
Subsidizing electricity prices for fish hatcheries	23	76.7

Source: Compiled and calculated from sample data.

Table 8: The relative importance of the problems of employment, fodder, fuel, oils, production requirements, and proposals for solutions to the private fish hatcheries in the study sample in 2021.

Table No. (8) also shows that the most important proposals submitted by the owners of private fish hatcheries to overcome the problems of fuel and oil, came in the first place, the proposal to support the prices of fuel and oil through cooperative supply stations, with a relative importance that amounted to about 86.7% of the total sample hatchery owners. Then a proposal for making hatchery cards to be presented to gas stations to obtain fuel, with a relative importance of about 76.7% of the total sample hatchery owners. Finally, a proposal was made to provide the hatcheries with paved roads to reach the fuel supply stations, with a relative importance that amounted to about 63.3% of the total sample hatcheries owners.

Other production input problems

Civil fish hatcheries face problems such as the lack of mothers, fresh water problems, and the hormone problem. Table (8) shows the other production requirements problems facing fish hatcheries, as it was found that the first of these problems was the lack of fresh water, with a relative importance that amounted to about 93.3% of the total sample hatcheries owners, despite allowing fish hatcheries to use fresh water. The problem of the high prices of the hormone used for the production of single-sex tilapia and its unavailability, in addition to its lack of availability, especially if it was from an unreliable source, came in second place, with a relative importance of about 90% of the total sample hatcheries owners. The problem of high electricity prices and interruptions came with a relative importance, which amounted to about 76.7% of the total sample hatcheries owners. Finally, the problem of mothers' lack of suitable sizes came with a relative importance that reached about 46.7% of the total sample hatchery owners, as the success of the hatching process requires the availability of the mothers' herd of appropriate sizes and at the right time for spawning, and some fish hatcheries are exposed to the lack of sufficient numbers of mothers at the beginning of the spawning season. Standard sizes required.

Table No. (8) also shows that the most important proposals submitted by the owners of private fish hatcheries to overcome other problems of production requirements: Overcoming the problem of difficulty obtaining hormones, and high prices, The proposal to provide the hormone through fisheries cooperatives at reasonable prices and the use of safe hormones came from reliable sources, With the preparation of a meticulous scientific study showing the pros and cons of using the hormone used to produce monosex tilapia fry and the extent of the danger of this method on the environment and human health, and whether there is a possibility to allow fish hatcheries to use this hormone in a safe scientific way, especially since there are scientific studies that have supported the use of this hormone Noting that the use of this hormone in tilapia fish hatcheries is carried out by feeding the fry at the age of one to 28 days on fodders treated with a male hormone, its effect disappears from the fry completely after a week, so it does not pose any danger either to the environment or to the fish consumer, Several sources also indicated that there is no risk of using the hormone to produce single-sex tilapia fry, with a relative importance of about 90% of the total sample hatcheries owners.

In order to overcome the problem of the lack of mothers in the appropriate sizes, the proposal to coordinate with the General Authority for Fish Resources Development to provide the required quantities of mothers for fish hatcheries of economic sizes, The hatchery itself prepares the generation of broodstock that will need it when renewing the herd or providing these broodstock from reliable fish farms, with a relative importance that amounted to about 46.7% of the total sample hatchery owners.

In order to overcome the lack of fresh water, a proposal came to make artesian wells to obtain groundwater, and it is considered an alternative and best water source in terms of being free of pollution, but it may cause some problems for the seed due to its chemical properties. As it is poor in its oxygen content, and the percentage of carbon dioxide and iron in it is high, so it is necessary to make a receiving basin in which water is first pumped in order to be saturated with oxygen and toxic gases are disposed of until its iron content is deposited, with a relative importance of about 86.7% of the total sample hatchery owners, Finally, the proposal to support electricity prices for fish hatcheries came with a relative importance of about 76.7% of the total sample hatcheries owners.

The results resulted in a number of results, the most important of which are

1. It was found that the number of produced fry decreased from about 358.1 million fry units in 2000 AD to about 303.6 million fry units in 2019 AD. With a decrease of about 15.21%, the number of fry produced from fish hatcheries in Egypt took a general decreasing trend that was not statistically significant.
2. It was found that the number of fry produced from fresh water hatcheries decreased by about 17.5%, The number of fry produced from marine water hatcheries increased by about 56.2% compared to the year 2000 AD, The numbers of fry produced from freshwater hatcheries took a general decreasing trend that was not statistically significant, while the estimate of marine hatcheries was significant.
3. It is noted that the clear fluctuation in the production of tilapia fry from one year to another, and it was found that the production of tilapia fry increased by an annual statistically insignificant amount, when about 1.4 million fry were swallowed, representing about 0.92% of the average production of tilapia fry during the study period.
4. The value of the invested capital for hatcheries producing Nile tilapia seed amounted to about 1.4 million LE, of which about 647.5 thousand LE, the value of construction costs, representing about 47.1% of the value of investment costs. and about 277.2 thousand LE, the value of variable costs represents about 22.2% of the value of investment costs. and about 74.8% of the total costs, which amount to about 370.2 thousand L.E, of which about 93.01 thousand LE are the value of fixed costs, representing about 6.7% of the value of total costs.
5. Total revenues from hatcheries for Nile tilapia seed production were estimated at 598.3 thousand L.E, The estimation of the production costs function shows that the average production costs are minimized when production reaches about 7.73 million fry, and this is done in a hatchery area of about 1.5 faddan, and that the quantity of production that maximizes the return must reach 18.54 million fry, and this is done in a hatchery area of about 3.6 faddans.
6. It was found that the most important production inputs affecting the production of hatchery production of Nile tilapia seed in the study sample are the total area of the hatchery, the number of mothers, the quantity of feed, the productive age of the mother, and the significance of the effect of these results has been statistically proven. Increased yield to capacity from the use of productive elements in the production of hatchery seed for Nile tilapia fish, and that it works in the first stage of the productive function stages.
7. The results showed that the most important problems facing private hatcheries for the production of seed, the most important of which are labor problems, represented in the lack of skilled technical labor, and the owners of private hatcheries suggested establishing training centers for the necessary labor for hatcheries in fisheries cooperative societies.
8. It turned out that the most important problems of feed were its high prices, and the most important proposals submitted by the owners of private fish hatcheries to overcome this problem were the fisheries cooperatives to provide feed at reasonable prices.
9. While it was found that the most important problems of fuel and oil facing private fish hatcheries are the high prices of fuel and oil, and it became clear that the most important proposals submitted by hatchery owners to overcome the problem is to support the prices of fuel and oil through cooperation supply stations.
10. Private fish hatcheries also face the problem of the high prices of the hormone used to produce Nile tilapia seed and its unavailability, in addition to its lack of quality, especially if it is from an unreliable source. Hatchery owners suggested the need to provide the hormone through fisheries cooperatives at reasonable prices and to use a safe hormone from reliable sources.

Recommendations

It is recommended to search for the following:

1. The need to work on providing fish hatcheries production inputs through cooperative societies at low prices so that those hatcheries can raise the efficiency rate of their use of these inputs.
2. Work to support the feed used in the production of single-sex duck fish fry.
3. Facilitating obtaining loans with low interest rates for the spawning activities of Nile tilapia fish, not exceeding 5%.

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