



An Economic Analysis of Fish Wealth in Egypt

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ABSTRACT

The research aimed to analyze the current status of fish production in Egypt from different sources. The study relied on quantitative and qualitative analytical statistical methods. It was found that the total fish production from natural fisheries represented only about 20.16% of the total fish production in Egypt. The results revealed a diversity of fish species produced on a commercial scale, with approximately 84.57% focused on three main types: tilapia, mullet, and sea bream. The most important variables affecting the quantity of fish production from natural fisheries was the number of fishermen and the number of mechanized fishing boats. Increasing these variables by 10% leads to an increase in the quantity of fish production from fisheries by 0.50 and 0.21%, respectively. The area of farms, the quantity of fish hatcheries production, and the real value of fry are considered the most important variables affecting the quantity of farmed fish production from fish farming. Increasing both hatcheries production quantity and the area of farms by 10% leads to an increase in the quantity of aquaculture production by 0.66 and 0.45%, respectively, while decreasing the real value of fry by 10% leads to an increase in the quantity of aquaculture production by 0.34%. The most important variables affecting the total quantity of fish consumption are the real retail price of red meat, the real retail price of tilapia, and the quantity of fish imports. It was found that a 10% decrease in the real retail price of tilapia leads to an increase in the quantity of fish consumption by 0.90%, while increasing both the real retail price of red meat and the quantity of fish imports by 10% leads to an increase in fish consumption by 3.2% and 1.96%, respectively.

INTRODUCTION

Fish are considered a crucial food source for humans and can help meet the growing demand for animal protein, serving as an alternative to other protein sources. In developing countries, fish contribute about 30% of the total animal protein consumed per capita (Wang *et al.*, 2015). Despite Egypt's vast water resources, including its location on the Mediterranean and Red seas, the presence of the Nile River and numerous lakes, fish production does not meet the needs of the Egyptian population. This has led to a fish food gap due to technical difficulties and some production issues. Therefore, there is a need to study and analyze the fish production and

consumption conditions in Egypt. This will help agricultural policymakers develop programs to promote the development of the fishery sector (**El-Seesy, 2006**). The Egyptian fish production sector contributes approximately 72.74 billion Egyptian pounds (LE), equivalent to 9.89% of the total agricultural production value, which is about LE 735.78 billion, during the period from 2019 to 2022 (**MALR, 2022**). The Arab Republic of Egypt has vast water areas and rich fisheries, including marine, lake & the Nile River fisheries, which together represent about 13 million water-feddan (1 feddan = 4200m²). The domestic fish production quantity was about 1997 thousand tons with a value of approximately LE 59.39 billion. Fish imports amounted 379 thousand tons with a value of approximately 12.56 LE billion, while Egyptian fish exports reached about 29.37 thousand tons with a value of LE 704.32 million. The self-sufficiency rate was approximately 85.18% during the same period from 2018 to 2021 (**LFRPDA, 2021**).

Egypt is suffering from continuous population growth, which led to an increased demand for food in general and animal protein in particular, as it is relatively more affordable compared to other sources. The per capita fish consumption amplified from 9kg in the 1990s to up to 19kg in 2018, although Egypt has suitable climatic conditions for aquaculture and multiple sources of fish production, natural resources are subject to pollution and overfishing (**Mehanna, 2022**), which affect the fish stock and lead to its deterioration year after year. This forces the country to increase imports to fill the deficit, placing a burden on the country's balance of payments. Therefore, it is necessary to study the different sources of fish production and develop it to meet the increasing demand of fish and increase self-sufficiency rate.

The primary objective of this research was to analyze the current situation of fish production from various sources in Egypt. This will be achieved by identifying local production, fish consumption in Egypt and its development, demonstrating the relative importance of fish production according to fish species. It also examined the most influential factors on fish production and consumption during 2005-2021.

MATERIAL AND METHODS

The research obtained the necessary data to achieve its objectives from published and unpublished secondary data sources. The data for the current study were collected from the Ministry of Agriculture and Land Reclamation, the Central Agency for Public Mobilization and Statistics, the General Authority for Fish Resources Development, and the Bulletin of Fish Production Statistics (various issues). Additionally, specialized research studies in the field of fisheries were employed. This research relied on both descriptive and quantitative statistical analysis to fulfill its objectives. The study used general time trend equations and employed methods such as averages & percentages. It also utilized simple and multiple regression analysis to identify the most influential factors on fish production and consumption in Egypt during the study period. Multiple logarithmic linear regression was used to detect the relationship between dependent variable (one variable) and independent variables (two or more).

The equation of multiple log-linear regression is $\log Y^i = \alpha + \beta X$.

Y: Dependent variable X: Independent variable;

B: Regression coefficient.

The Breusch-Pagan test was used to determine whether or not heteroscedasticity is existing in the regression model. Breusch- Godfrey test was used to see if there is autocorrelation in errors in the regression model. The ADF (Augmented Dickey-Fuller) test was used to discover if a time series is stationary or not.

RESULTS

1. The most important economic variables and indicators for fish wealth in Egypt

The overall average for the local production of fish during the period from 2005-2021 reached 1473 thousand tons and LE 28,142 million, respectively, as indicated in Table (1), and increased with an annual significant growth rate by 4.59 and 13.28% for each of them, respectively (The general time trend equation, Table 2). The overall average quantity and value of Egyptian fish imports reached about 281 thousand tons and LE 5.89 billion, respectively, as shown in Table (1). The results of estimating the general time trend indicated a statistically significant increase at an annual growth rate of about 5.20 and 18.48%, respectively (Table 2). Meanwhile, the overall average quantity and value of Egyptian fish exports reached about 19.49 thousand tons and 312.66 million pounds, respectively. The results of estimating the general time trend indicated their increase at a statistically significant annual growth rate by 11.13 and 18.15%, respectively (The general time trend equation, Table 2).

The available quantity for consumption and the per capita share of fish in Egypt amounted 1.73 million tons and 19.96kg/ year, respectively, during the study period from 2005 to 2021. The available for consumption and the per capita consumption significantly increased with a growth rate of 5.14 and 2.77%, respectively. The self-sufficiency of fish in Egypt was 84.94% during the study period.

2. The relative importance of fish production sources

As presented in Table (3) and Fig. (1), the marine fish production during 2016 to 2021 reached about 102,348 thousand tons, which represented 5.33% of the overall average quantity of the Egyptian fish production (1,919,224 tons). It was clear that the average quantity of fish production from lakes (northern - inland - coastal depressions) was 208483 tons, representing about 10.86% of the overall average quantity of fish production. The average quantity of fish production from the Nile River and its branches was approximately 76,061,7 tons, representing about 3.96% of the overall average fish production. The total fish production from natural fisheries was 386,217, representing 20.16% of the overall average quantity of Egyptian fish production (1,919,224 tons) during the period from 2016 to 2021.

Table 1. Local production, imports, exports, available of consumption, per capita consumption, self-sufficiency and gap size of fish during the period from 2005 to 2021

Item	Local Production		Imports		Exports		Available for consumption*	Average consumption	Self-sufficiency	Fish gap size ***
	Quantity	Value	Quantity	Value	Quantity	Value				
	Thousand tons	Million LE	Thousand tons	Million LE	Thousand tons	Million LE	Thousand tons	Capita/year/kg	%	Thousand tons
Year										
2005	889	7828	189	524	5.12	22.98	1072	15.32	82.90	186
2006	971	9305	208	593	4.05	19.33	1174	16.62	82.67	202
2007	1008	10827	259	1222	4.42	25.35	1263	16.98	79.84	217
2008	1068	10814	137	2035	6.73	59.51	1198	15.95	89.14	83
2009	1093	11662	136	-	7.59	-	1206	15.89	90.64	171
2010	1305	14495	257	2781	10.60	85.70	1551	19.70	84.13	176
2011	1362	16819	182	3106	9.49	140.03	1535	19.09	88.75	164
2012	1372	17652	335	4769	15.81	112.63	1691	20.55	81.12	233
2013	1454	19629	236	2984	20.45	161.92	1670	19.73	87.10	181
2014	1482	22280	355	5354	28.00	239.47	1808	20.83	81.94	222
2015	1519	23409	296	5753	19.70	236.05	1795	20.18	84.61	188
2016	1706	32309	311	4805	47.81	432.98	1970	21.64	86.63	122
2017	1823	43811	367	10087	34.11	649.34	2154	22.72	84.61	307
2018	1935	48251	324	12306	26.30	578.22	2233	22.98	86.66	355
2019	2039	61084	506	13809	35.01	885.89	2510	25.38	81.24	524
2020	2011	61884	300	10821	28.11	547.99	2282	22.68	88.10	572
2021	2002	66353	385	13293	28.07	805.19	2359	23.12	84.86	226
The overall Average	1473	28142	281	5890	19.49	312.66	1733.59	19.96	84.94 **	243

* Available quantity for consumption = Local production + imports - Exports

** Geometric mean

*** Fish gap size = Local production – available quantity of consumption

Source: - Data collected from the Ministry of Agriculture and Land Reclamation, General Authority for Fish Resources Development, the Bulletin of Fish Production Statistics - various issues.

Table 2. The general time trend equations of the most important economic variables and indicators of fish in Egypt during the period from 2005 to 2021

No	Variable	Equation	R ²	t	F	Mean	Rate of change %
1	Production quantity (thousand tons)	$\hat{y}_1 = 783.5 + 76.60 h_1x$	0.98	25.09**	629.45**	1473	4.59
2	Production value (million LE)	$\hat{y}_2 = -5464 + 3737 h_2x$	0.87	10.06**	101.14**	28142	13.28
3	Imports quantity (thousand tons)	$\hat{y}_3 = 149.8 + 14.62 h_3x$	0.58	4.60**	21.14**	281	5.20
4	Imports value (million LE)	$\hat{y}_4 = -1864 + 912 h_4x$	0.87	9.98**	99.68**	5890	18.48
5	Exports quantity (thousand tons)	$\hat{y}_5 = -0.002 + 2.17 h_5x$	0.71	6.07**	36.85**	19.49	11.13
6	Exports value (million LE)	$\hat{y}_6 = -170 + 56.76 h_6x$	0.84	8.73**	76.18**	312.66	18.15
7	Available for consumption (thousand tons)	$\hat{y}_7 = 930.8 + 89.20 h_7x$	0.95	17.69**	312.90**	1733.59	5.14
8	Average capita consumption (kg/year)	$\hat{y}_8 = 14.98 + 0.554 h_8x$	0.88	10.38**	107.83**	19.96	2.77
9	Self-sufficiency %	$\hat{y}_9 = 84.43 + 0.063 h_9x$	0.01	0.39	0.15	84.94*	-

(**) is significant at the level of 0.01

 \hat{y} = the estimated value of the dependent variable
percentage

h x = the time variable

* The geometric mean of

Rate of change = Regression coefficient / Variable average x 100

Source: - Collected from Table 1

Table 3. Fish production from the different sources in Egypt during 2016-2021

Year	Natural fisheries				Aquaculture (fish farming)	Total
	Seas (marine)	Lakes	Nile River	Total		
2016	103,654	158,475	73,484	335,613	1,370,660	1,706,273
2017	109,764	183,463	77,732	370,959	1,451,841	1,822,800
2018	104,695	194,851	73,739	373,285	1,561,457	1,934,742
2019	98,953	220,713	77,376	397,042	1,641,949	2,038,991
2020	101,392	237,758	79,533	418,683	1,591,896	2,010,579
2021	95,627	255,636	74,506	425,769	1,576,189	2,001,958
Average	102,348	208483	76,061,7	386,217	1,532,332	1,919,224
Total %	5.33	10.86	3.96	20.16	79.84	100

Source: Ministry of Agriculture and Land Reclamation, General Authority fish resources development, Annual Fisheries Statistics Book, Thirtieth Edition, 2021, p. 19.

As mentioned earlier, aquaculture (fish farming) is the most important source of fish production. The Egyptian government encouraged the expansion of fish production from fish farms. Aquaculture production in Egypt is the largest in Africa with about one million tons per annum (Shaalan *et al.*, 2017). Fish farms have contributed to approximately 79.84% of the total fish production during the period from 2016 to 2021, with the aim of providing more fish for consumption, hence reducing the fish food gap (El-Bana 2016). Moreover, aquaculture industry provides about 77% of the total domestic fish production (El-Sayed *et al.*, 2015; FAO, 2016).

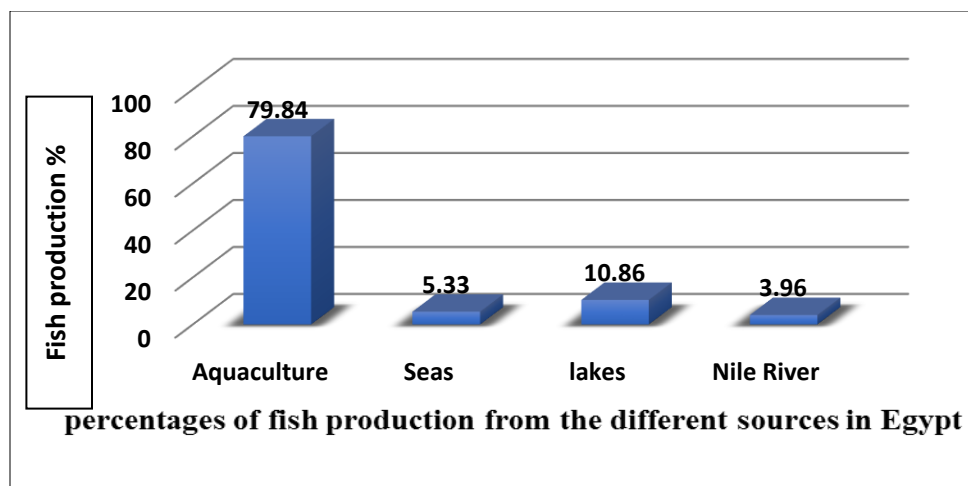


Fig. 1. Percentages of fish production from the different sources of in Egypt during the period from 2016 to 2021

2.1 Fish production evolution from fish farming systems in Egypt

The various fish farming patterns in Egypt are diverse, as illustrated in Fig. (2). Fish farming is the process in which fish are raised in an enclosed area for the purpose of economic and commercial production, under favorable conditions, where they were fed and protected from predators. The semi-intensive aquaculture in earthen ponds is considered the most widespread and important fish farming system in Egypt. **Shaalan *et al.* (2018)** reported that the majority of the Egyptian fish production (>85%) is based on earthen ponds situated within and around the Nile Delta and its associated lakes. Fish farming industry is part of the profitable investment projects in the field of food security.

A. Fish production from governmental farms

Governmental farms in Egypt are established and supervised by the General Authority for Fish Resources Development. Fish production from governmental farms represents only 0.99% of the total fish production in Egypt. Data from Table (4) show that fish production from governmental farms witnessed a clear fluctuation during the study period (2005-2021), as it was 7.59 thousand tons in 2005, and increased to 17501 thousand tons in 2021.

The total fish production from governmental farms showed a significant yearly increase of about 588 tons at an annual rate of 5.38% of the overall average of fish production (10.922 thousand tons) for governmental farms during the period (2005-2021). The R^2 value was 0.70, which means that the changes reflected by the variable of time were responsible for about 70% of the changes that occurred in the total fish production in governmental farms, as indicated in Table (5).

B. Fish production from private farms

The production of private fish farms is estimated at about 907104 thousand tons, and fish production from private farms exhibited a clear increase during the study period (2005-2021), as it increased from 492246 thousand tons in 2005 to 1,410017 million tons in 2019, thereafter it decreased a little bit to 1.355287 million tons in 2021 (Table 4). The total fish production of private

farms significantly increased by an annual amount of 65.43 thousand tons; the annual rate of increase was about 7.21% of the overall average for the private farms being 907104 thousand tons during the period 2005-2021. The private farms have a leading role in fish production (**GAFRD, 2012**). The R^2 value was 0.93, which means that the productive, technological and economic changes reflected by the variable of time were responsible for about 93% of the changes that occurred in the total production of fish farming in private farms during the study period (Table 5).

C- Fish production from floating cages

Floating cages are the most widespread intensive fish farming system in Egypt. Fish production from floating cages system fluctuated during the period from 2005 to 2021. It reached 19839 thousand tons in 2005 and increased in 2021 to 195764 thousand tons, as indicated in Table (4). The equation of general time trend number 3 showed that the total fish production from cages has taken an increasing trend by an annual quantity of 9.45 thousand tons with an annual rate of 5.93% of the overall average of fish production (159382 thousand tons) during the studied period (2005-2021). Additionally, the R^2 value was 0.38, which means that about 38% of the changes in total fish production were due to time, as indicated in Table (5).

D - Fish production from rice fields

Fish production from rice fields was 17.603 thousand tons in 2005. However, it decreased markedly in 2021 being 5525 thousand tons (Table 4). This decline in production may be due to many constraints such as decreasing the cultivated area of rice crop by 63%. By estimating the general time trend equation (No.4), it is clear that the total production from rice fields did not prove any statistically significant difference (Table 5).

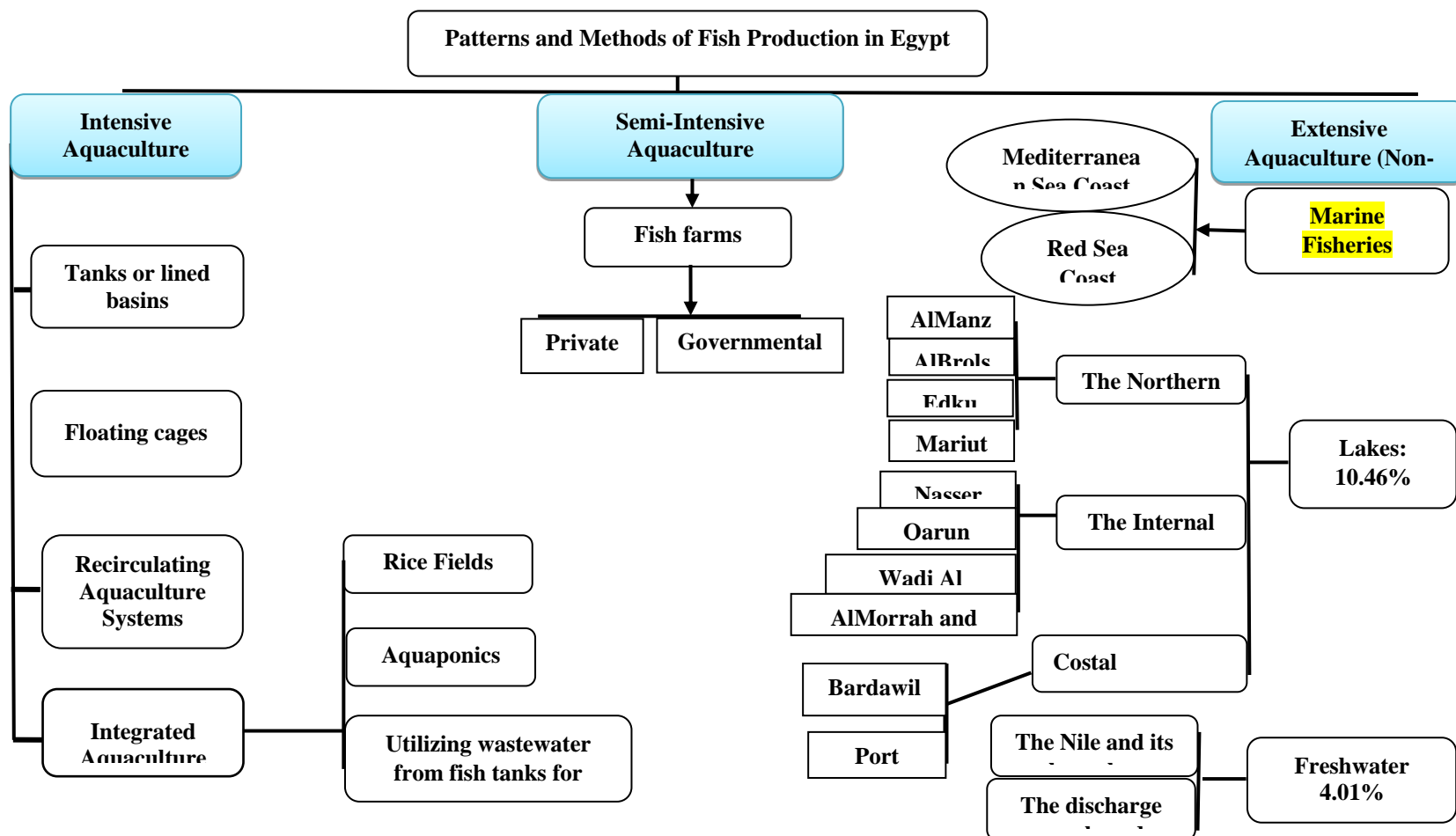


Fig. 2. Various patterns and methods of fish production in Egypt

Source: Researcher's Design based on the categorization of the Ministry of Agriculture and Land Reclamation, General Authority for Fisheries Development, Annual Fisheries Statistics Book, Thirtieth Edition, 2020.

Table 4. Yearly evolution of the different types of fish farming during the period from 2005 to 2021. (Production Quantity: in Tons)

Item	Fish farming systems							Total production from fish farming
Year	Semi-intensive production			Intensive production				
	Governmental	Private	High prod. Semi- intensive	Intensive	Cage fish	Raceways *	Rice fields	
2005	7588	492246	2472	-	19839	-	17603	539748
2006	7955	498885	2472	-	80141	-	5576	595029
2007	8539	557822	1580	-	62276	-	5300	635517
2008	8547	586435	1825	-	69108	-	27900	693815
2009	6605	591276	1860	-	68049	-	37700	705490
2010	10680	716801	1893	700	160288	-	29223	919585
2011	10092	721684	3115	700	216122	-	35107	986820
2012	9509	720412	1451	2444	249385	-	34537	1017738
2013	9300	722870	1451	2444	327344	-	34135	1097544
2014	8255	916757	-	1835	176266	-	33978	1137091
2015	9747	972503	-	2412	172632	-	17537	1174831
2016	13078	1166147	-	2268	175632	-	13535	1370660
2017	12190	1260735	-	1912	169269	-	7735	1451841
2018	13652	1368314	-	2324	165352	18	11797	1561457
2019	12611	1410017	-	2420	200980	28	15893	1641949
2020	19822	1362577	-	2447	201040	68	5942	1591896
2021	17501	1355287	-	2042	195764	70	5525	1576189
The overall Average	10922	907104	1066	1409	159382	11	19943	1099835
Total%	0.99	82.84	0.10	0.13	14.49	0.00	1.81	100

(*) This system was implemented in 2018.

Source: Ministry of Agriculture and Land Reclamation, General Authority for Fisheries Development, Annual Fisheries Statistics Book, Various Issues.

Table 5. The general time trend equations of fish production under different fish farming systems in Egypt during the period (2005 - 2021)

No	Variable	Equation	R ²	t	F	Mean	Rate of change %
1	Fish production from governmental farms	$\hat{y}_1 = 5629 + 588 h_1x$	0.70	5.86**	34.29**	10922	5.38
2	Fish production from private farms	$\hat{y}_2 = -318209 + 65433 h_2x$	0.93	14.40**	207,35**	907104	7.21
3	Fish production from cage system	$\hat{y}_3 = 74280 + 9456 h_3x$	0.38	3.01**	9.06**	159382	5.93
4	Fish production from rice fields	$\hat{y}_4 = 26861 - 769 h_4x$	0.10	-1.29	1.66 **	19943	-
5	Total fish production	$\hat{y}_5 = -427473 + 74707 h_5x$	0.97	23.29**	572,36**	1099835	6.79

(**) Significant at 0.01 level.

Rate of change = Regression coefficient / Phenomenon average x 100

(^y) Estimated value of the phenomenon under study.

(h X) Time factor in years 1, 2,

Source: Calculated from Table (4).

E- The total fish production from the different fish farming systems in Egypt

Total fish production from fish farming in Egypt increased gradually from 2005 until 2019, where it was 539.75 thousand tons in 2005 and increased throughout the aforementioned period reaching its maximum quantity in 2019 (1.642 million tons), as shown in Table (4). However, it decreased in 2021 being 1.58 million tons. This reduction of production refers to decreasing the operating farms, especially the private one due to water shortage, in addition to a nearly 63% decrease of the cultivated area of rice fields. By estimating the general time trend equation, the total fish production from all the farming systems showed a significant ($P < 0.05$) yearly increase of about 74.71 thousand tons at an annual rate of 6.79% of the overall average of fish production (1.10 million tons) during the period (2005-2021). The R² value was 0.97, which means that the changes occurred by the variable of time (such as economical, managerial, and technology adoption) were responsible for about 97% of the changes that occurred in the total production from fish farming during the studied period (2005-2021), as indicated in Table (5).

3. The relative distribution of the most important fish species produced from various sources in Egypt

The number of fish species commercially produced in Egypt exceeds fifty species. Undoubtedly, these fish species vary greatly in many of their natural traits, breeding seasons, strength of generations, and sizes at maturity (Soliman & Amer, 2002). An analysis of the relative importance of fish production in Egypt shows that around 84.57% is concentrated in three main species: tilapia, mullet, and carp, during the period from 2015 to 2021.

The data in Table (6) indicates that the total fish production from 2015 to 2021 amounted 1.86 million tons. Tilapia came in first place with a production of 1.11 million tons, about 59.55% of the total fish production for Egypt. It is followed by the mullet in second place with a production quantity of 276.45 thousand tons, (about 14.85%), and lastly the carp with 189.28 thousand tons (10.17%). Other species such as the catfish, gilt-head bream, sea bass, and meagre, recorded 43.18,

33.83, 28.87, and 24.53 thousand tons, respectively, accounting for approximately 2.32, 1.82, 1.55, and 1.32% of the average fish production, respectively.

Table 6. Main fish species produced in Egypt, the average for the period from 2015 to 2021. (Quantity in tons)

Sources	Natural fisheries					Aquaculture		Overall total	%
	Marine	Lakes	Nile River	Total	%	Total	%		
Species									
Tilapia	-	108,992	23,681	132,673	34.84	976255	65.91	1108928	59.55
Mullet	17,75	34,748	522	36,995	9.72	239460	16.17	276455	14.85
Family									
Carp	-	5715	10,393	16,108	4.23	173,177	1169	189,285	10.17
Catfish	-	20,609	14,367	34,977	9.19	8201	0.55	43,177	2.32
Gilt-head bream	386	1253	-	1639	0.43	32,190	2.17	33,829	1.82
Sea bass	279	1365	-	1644	0.43	27227	1.84	28,871	1.55
Meagre	789	192	-	981	0.26	23,545	1.59	24,526	1.32
Sardines	15,365	53	-	15,419	4.05	-	0.00	15,419	0.83
Horse mackerel	10,463	-	-	10,463	2.75	-	0.00	10,363	0.56
Shrimp	7838	4265	-	12,103	3.18	872	0.06	12,974	0.70
Whitefish (Bagrus)	620	1561	5491	7673	2.02	287	0.02	7960	0.43
Other species	66,372	24,443	20,699	111,513	29.29	48	0.00	111,561	5.99
Overall Total	102,431	203,196	75,153	380,780	100	1,481,260	100	1,862,041	100

Source: Ministry of Agriculture and Land Reclamation, General Authority for Fisheries Development, Annual Fisheries Statistics Book, Various Issues.

4. The important factors affecting fish production from natural fisheries

The results of Unit Root Test 1 (Appendix 1) indicate that the values of time series for all variables are not stationary at their level but are stable at their first differences, which means that they are integrated of the first degree I (1) during the period from 2004-2021.

Multiple logarithmic regression model was used to determine and quantify the relationship between the dependent variable (Y, fish production / thousand ton) and independent variables which is

X ₁	fishermen number	(Thousand fisherman)
X ₂	mechanized fishing boats	(Thousand boat)
X ₃	un-mechanized fishing boats	(Thousand boat)
X ₄	True price of tilapia fish	(LE/kg)
X ₅	Fish imports quantity	(Thousand ton)
X ₆	True value of fuel, oil, and depreciation for fish boats	(Million LE)

The multiple regression was conducted after ensuring the stability of the data at the first difference. Many attempts were made to obtain the best possible statistical estimates. The best functions were chosen according to the criteria of economic theory and statistical criteria. The best

was in the double logarithmic form, as shown in Table (8). The results of the analysis show that the estimated model is acceptable from the economic and statistical perspective. It was shown that the most important explanatory variables affecting the quantity of fish production from natural fisheries in Egypt are the number of fishermen (Log X_1), and the number of mechanized fishing boats (Log X_2). The statistical significance of these variables was proven. The value of R^2 indicates that the independent factors are responsible for about 59% of the changes occurring in the quantity of fish production from natural fisheries in Egypt.

The model shows that there is a direct relationship between the number of fishermen, the number of mechanized fishing boats and the quantity of fish production from natural fisheries, at rates of 0.498 and 0.213%, respectively.

The dataset in the estimated model was tested for the normal distribution; the Jarque Bera test (JB) showed that the probability value was 0.7252, which was greater than 0.05, therefore the null hypothesis was accepted, meaning that the dataset is normally distributed. The Breusch-Pagan test in Table (9) shows no issue with variance instability, as the probability value of 0.4925 was greater than 0.05. Godfrey- Pagan test (Table 10) showed that there was no autocorrelation, the probability was 0.5944, which was greater than 0.05, meaning that there were no errors in autocorrelation, and therefore the model was statistically acceptable.

Table 7. The most important factors affecting fish production from natural fisheries during the period from 2004 - 2021

Item year	Total natural fisheries production Thousand ton	The Number of fishermen Thousand fisherman	Mechanized fishing boats Thousand boat	Non- mechanized fishing boats Thousand boat	Current price of tilapia fish LE/kg	True price of tilapia fish LE/kg	Fish imports quantity Thousand ton	Current value of fuel, oil, and depreciation for fish boats Million LE	True value of fuel, oil, and depreciation for fish boats Million LE	Producer price general index number Base year 2004- 2025
2004	393.50	49.19	4.25	35.33	7.88	7.83	204.0	576.04	572.03	100.7
2005	349.55	49.85	4.38	30.99	7.34	6.82	188.5	600.91	558.47	107.6
2006	375.90	61.03	4.49	35.16	8.73	7.37	206.0	672.25	567.78	118.4
2007	372.49	55.03	4.54	34.51	9.42	7.27	220.8	771.82	596.00	129.5
2008	373.81	58.01	4.81	25.64	8.95	5.73	104.6	808.96	517.90	156.2
2009	387.40	65.55	4.71	30.27	9.90	6.72	147.0	652.01	442.34	147.4
2010	385.21	42.96	4.83	30.25	9.91	5.97	183.1	754.83	454.45	166.1
2011	375.35	43.47	4.85	24.69	11.59	6.08	175.0	876.67	460.20	190.5
2012	354.24	38.06	4.91	25.92	12.85	6.58	249.0	919.05	470.83	195.2
2013	356.86	31.15	4.86	24.28	14.59	7.23	202.8	899.05	445.51	201.8
2014	344.79	37.33	4.83	25.15	16.78	7.97	244.3	1165.72	553.79	210.5
2015	344.11	51.84	4.92	25.92	17.58	8.62	204.2	1387.08	680.28	203.9
2016	335.61	48.30	4.96	24.38	17.81	8.00	220.4	1551.99	696.89	222.7
2017	370.95	59.86	5.05	27.70	25.58	8.50	339.1	2040.73	678.44	300.8
2018	373.30	52.00	4.69	23.35	22.78	6.28	386.1	2744.54	756.70	362.7
2019	397.10	43.78	4.80	21.52	27.45	7.21	555.0	3663.16	961.71	380.9
2020	418.69	32.40	4.10	17.21	22.69	6.41	600.3	4826.72	1362.71	354.2
2021	425.78	34.59	3.71	23.38	22.78	6.20	323.3	5026.90	1367.68	367.6

- Tilapia fish represented the first class in natural fisheries production amounted 35%
- Current price of Tilapia fish and the current value of fuel oil, of fishing boats transferred to true value by using producer price general index number and the base year was 2004/2005
- True value = (current value ÷ Producer price general index number for 2004/2005 as a base year) × 100.

Table 8. The results of logarithmic multiple regression analysis for the study variables during the period 2004-2021.

Variable	Coefficient	Std. Error	t-Statistic	Prob
C	0.011361	0.003966	2.864882	0.0125
DLOGX ₁	0.049756	0.010818	4.599322	0.0004
DLOGX ₂	0.021295	0.006613	3.220143	0.0062
R-squared	0.644665	Mean dependent var	0.002014	
Adjusted R-squared	0.593902	S.D. dependent var	0.022568	
S.E. of regression	0.014382	Akaike info criterion	-5.486959	
Sum squared resid	0.002896	Schwarz criterion	-5.339921	-
Log likelihood	49.63915	Hannan-Quinn critter	-5.472343	
F-statistic	12.69970	Durbin-Watson stat	2.239764	
Prob(F-statistic)	0.000715		-	

Source. The results of Table (7) data analysis by E-Views.

Table 9. Breusch–Pagan test's results test to detect non-stationarity of variance

F-statistic	0.6364	Prob. F(4,13)	0.5438
Obs*R-squared	1.4167	Prob. Chi-square(4)	0.4925
Scaled explained SS	0.7209	Prob. Chi-square(4)	0.6974

Table 10. Godfrey- Pagan serial correlation

F-statistic	0.2205	Prob. F(1,12)	0.6464
Obs*R-squared	0.2836	Prob. Chi-square(1)	0.5944

5. The most important factors affecting the quantity of farmed fish production from fish farming

Fish production (Y) in thousand tons (dependent variable) from fish farming was affected by the most important economic independent variables during the period from 2004-2021, which were:

X1 The real product price of tilapia fish	LE/kg
X2 Quantity of fish imports	Thousand tons
X3 Quantity of fish hatcheries production (fry and fingerlings)	Million units
X4 Quantity of fry production from fry collection centers	Million units
X5 Area of fish farms	Thousand feddan
X6 The real value of fish feed	Million LE
X7 The real value of fry	Million LE

Table 11. The most important factors affecting the quantity of farmed fish production from fish farming during the period 2004-2021

Item	Farmed fish quantity	True price of tilapia fish	Fish imports quantity	Fish hatcheries quantity	Quantity of fry production from fry collection centers	Area of fish farms	Fish feed current value	Real value of fish feed	Current value of fry	Real value of fry
Year	Thousands ton	LE/kg	Thousand ton	Million unit	Million unit	Thousand feddan	Million LE	Million LE	Million LE	Million LE
2004	471.54	7.83	204.0	354	96.0	207.51	5.18	5.14	105.11	104.38
2005	539.75	6.82	188.5	298	69.0	264.59	5.47	5.08	110.18	102.4
2006	595.03	7.37	206.0	270	41.0	335.30	6.02	5.08	117.89	99.57
2007	635.52	7.27	220.8	306	77.0	360.28	6.38	4.93	145.01	111.98
2008	693.82	5.73	104.6	347	77.0	359.37	6.89	4.41	154.71	99.05
2009	705.49	6.72	147.0	305	57.0	361.31	225.37	152.90	163.99	111.26
2010	919.59	5.97	183.1	400	78.0	305.03	345.25	207.86	190.23	114.53
2011	986.82	6.08	175.0	475	63.0	285.84	401.02	210.51	220.89	115.95
2012	1017.74	6.58	249.0	411	73.0	287.41	420.41	215.37	231.57	118.63
2013	1097.54	7.23	202.8	509	43.0	292.62	621.31	307.88	233.32	115.62
2014	1137.09	7.97	244.3	560	72.0	298.13	553.41	262.90	263.82	125.33
2015	1174.83	8.62	204.2	375	95.0	310.35	572.33	280.69	270.42	132.62
2016	1370.66	8.00	220.4	277	51.0	320.80	653.68	293.52	312.33	140.25
2017	1451.84	8.50	339.1	184.2	77.1	302.65	769.45	255.8	19.96	6.64
2018	1561.50	6.28	386.1	272	45.5	307.24	998.77	275.37	26.85	7.40
2019	1641.90	7.21	555.0	303.6	62.3	295.21	1107.01	290.63	28.58	7.50
2020	1591.90	6.41	600.3	673.9	46.7	307.11	21490.60	6067.36	968.75	273.50
2021	1576.19	6.20	323.3	900.3	49.4	300.96	23800.45	6475.43	1186.00	322.68

- Tilapia fish was used as it ranks first in natural fisheries production in Egypt, equivalent to about 65%
- Current price of tilapia and total current value of fish feed and fry were converted to real values using the producer price index for the base year (2004/2005).
- The area of fish farms includes the area of government farms and the area of private farms (owned, rented, and temporary)
- Source: Collected and calculated from: - Central Agency for Public Mobilization and Statistics, Annual Bulletin of Estimates of Income from the Agricultural Sector - Various Issues. - Ministry of Agriculture and Land Reclamation, General Authority for Fish Resources Development, Annual Fisheries Statistics Book, Various Issues. - Central Agency for Public Mobilization and Statistics, Annual Bulletin of Fish Production Statistics, Various Issues. - Central Agency for Public Mobilization and Statistics, Annual Statistical Book, Chapter Nine on Prices, Various Issues. - Central Agency for Public Mobilization and Statistics, Annual Bulletin of Prices of Foodstuffs and Products and Services (Producer - Wholesale - Consumer), Various Issues

Table 12. The results of logarithmic multiple regression analysis for the study variables during the period 2004-2021

Variable	Coefficient	Std. Error	t-statistic	Prob
C	0.033198	0.009010	3.684390	0.0028
DLOGX ₃	0.066418	0.027729	2.395288	0.0324
DLOGX ₅	0.045232	0.020645	2.190988	0.0473
DLOGX ₇	-0.033531	0.013602	-2.465127	0.0284
R-squared	0.638923	Mean dependent var	0.028843	
Adjusted R-squared	0.555598	S.D. dependent var	0.054604	
S.E. of regression	0.036401	Akaike info criterion	-3.586129	
Sum squared resid	0.017225	Schwarz criterion	-3.390079	-
Log likelihood	34.48210	Hannan-Quinn critter	-3.566641	
F-statistic	7.667817	Durbin-Watson stat	1.881774	
Prob(F-statistic)	0.003353		-	

Source. The results of data analysis in Table 11 by E-Views.

The results of the Unit Root Test1 (Appendix 1) showed that the values of the time series for all variables are not stationary at their level but are stable at their first differences, which means that they are integrated of the first degree I (1) during the period from 2004-2021.

The multiple regression was performed after ensuring the stability of the data at the first difference, and many attempts were made to obtain the best possible statistical estimates. The best functions were chosen according to the criteria of economic theory and statistical criteria, and the best was in the double logarithmic form, as shown in Table (12). The results of the analysis showed that the estimated model was acceptable from an economic and statistical point of view. It was found that the most important explanatory variables affecting the quantity of fish production from aquaculture in Egypt are the quantity of fish hatcheries production (Log X3), and the area of fish farms (Log X5 and the real value of fry (Log X7). The statistical significance of these variables was proven, and the value of R^2 indicated that the independent factors are responsible for about 56% of the changes occurring in the quantity of farmed fish production from aquaculture in Egypt, and the rest is due to other factors not measured by the model.

The model clearly indicates a direct relationship between the quantity of fish fry and fingerling production, the area of fish farms, and the quantity of fish produced from aquaculture. Increasing both the quantity of fry and the area of fish farms by 10% results in an increase in fish production by 0.66 and 0.45%, respectively. Conversely, there is an inverse relationship between the real value of fry and fish production from aquaculture. A 10% decrease in the real value of fry leads to a 0.34% increase in fish production from fish farming.

The dataset in the estimated model was tested for normality using the Jarque-Bera (JB) test, which reported a probability value of 0.1218, greater than 0.05. Therefore, the null hypothesis was accepted, indicating that the dataset is normally distributed. Regarding variance instability, the Breusch-Pagan test in Table (13) shows no evidence of variance instability, with a probability value of 0.7308, which is greater than 0.05. Additionally, the Godfrey-Pagan test (Table 14)

reported a probability value of 0.9742, also greater than 0.05, indicating no issues with autocorrelation. Thus, it can be concluded that the model is statistically acceptable.

Table 13. Breusch–Pagan test results to non-stationarity of variance

F-statistic	0.3568	Prob. F(4,13)	0.7852
Obs*R-squared	1.2931	Prob. Chi-square(4)	0.7308
Scaled explained SS	1.1489	Prob. Chi-square(4)	0.7653

Table 14. Godfrey- Pagan serial correlation LM detect

F-statistic	0.0007	Prob. F(1,12)	0.9788
Obs*R-squared	0.0010	Prob. Chi-square(1)	0.9742

6. The most important factors affecting the total quantity of fish consumption during the period from 2004-2021

The consumed quantity of a commodity affected by many economic and social factors, including individual income, commodity price, the prices of alternative and complementary goods, population number, consumer taste, customs and traditions, age, and gender. Some of these factors cannot be measured quantitatively, while others can be measured. Therefore, the relationship between the total quantity of fish consumption in thousand tons as a dependent variable (Y) and each independent variable was studied (Table 15), which were

X₁ Real retail price of poultry	LE/kg
X₂ Real retail price of red meat	LE /kg
X₃ Real retail price of tilapia	LE /kg
X₄ Quantity of fish imports	thousand tons
X₅ Total population of Egypt	million people
X₆ Fish import price	LE/ thousand ton
X₇ Average per capita share of gross national income at real price	thousand LE

The results of the Unit Root Test1 (appendix 1) indicated that the values of the time series for all variables are not stable at their level but are stable at their first differences, which means that they are integrated of the first degree I (1) during the study period 2004-2021. Many attempts were made to obtain the best possible statistical estimates. The best functions was the multiple regression double logarithmic form (Table 16), the estimated model is acceptable from an economic and statistical perspective. The most important explanatory variables affecting the total quantity of fish consumption in Egypt were the real retail price of red meat (LogX2), the real retail price of tilapia (LogX3) and the quantity of fish imports (LogX4). The statistical significance of these variables was proven, and the (R^2) value indicates that independent factors are responsible for about 80% of the changes in total fish consumption in Egypt. The model showed that a 10% decrease in the real retail price of tilapia leads to an increase in the total quantity of fish consumption in Egypt by 0.895%, while there is a direct relationship between the real retail price of red meat and the quantity of fish imports and the total quantity of fish consumption, as an

increase in the real retail price of red meat (a substitute for fish) and the quantity of fish imports by 10% leads to an increase in the total quantity of fish consumption in Egypt by 3.2 and 1.96%, respectively.

The normal distribution of the residuals in the estimated model was tested by Jarque Bera (JB) test, the probability was 0.2507, which is greater than 0.05, hence the null hypothesis is accepted meaning that the residuals are normally distributed. For the problem of instability of variance, Table (17) shows that there was no problem of instability of variance because the estimated probability value was greater than 0.05 being 0.1298. For the problem of autocorrelation, the results of Godfrey- Pagan test showed that the probability value was greater than 0.05 being 0.6828 (Table 18), hence there are no errors in autocorrelation, and thus it can be said that the model is statistically acceptable.

Table 15. The most important factors affecting the total quantity of fish consumption in Egypt during the period from 2004-2021

Item Year	Fish consumption total quantity	current Poultry retail price	Real retail price of poultry	current red meat retail price	Real retail price of red meat	Current retail price of Tilapia	Real retail price of tilapia	Fish imports quantity	Total population of Egypt	Fish import price	Average per capita share of gross national income at current price	Average per capita share of gross national income at real price	average general index number for consumers prices
	Thousands ton	LE/kg	LE/kg	LE/kg	LE/kg	LE/kg	LE/kg	Thousands ton	Million people	Thousands LE/ton	Thousands LE	Thousands LE	Thousands LE
2004	1064	8.07	13.99	24.51	42.48	10.02	17.37	204.00	74.17	2.97	6.53	11.31	57.7
2005	1075	7.30	12.16	26.86	44.73	8.61	14.34	188.50	75.52	2.78	7.11	11.84	60.1
2006	1173	8.37	12.96	29.37	45.46	9.50	14.71	206.00	76.87	2.84	8.07	12.50	64.6
2007	1225	8.61	12.08	32.85	46.11	10.86	15.24	220.80	78.23	4.23	9.61	13.48	71.3
2008	1151	11.94	14.04	36.26	42.63	10.86	12.77	104.60	79.64	19.05	11.34	13.33	85.1
2009	1264	12.02	12.67	40.48	42.68	12.01	12.66	147.00	81.13	17.65	12.86	13.55	94.9
2010	1481	14.62	13.87	53.73	50.98	12.26	11.63	183.10	82.76	15.19	14.29	13.56	105.4
2011	1526	16.63	14.28	58.60	50.32	14.02	12.04	175.00	84.53	17.75	15.80	13.57	116.5
2012	1605	20.36	16.28	62.90	50.30	17.34	13.87	249.00	86.42	19.15	18.93	15.14	125.1
2013	1635	22.63	16.39	67.15	48.64	20.32	14.72	202.80	88.40	14.67	20.50	14.85	138.1
2014	1704	24.92	16.39	77.94	51.26	31.03	20.41	244.30	90.42	16.53	23.00	15.12	152.1
2015	1707	24.50	14.56	86.69	51.52	22.78	13.54	204.20	92.44	21.07	25.98	15.44	168.3
2016	1828	27.92	14.49	97.67	50.67	23.81	12.35	220.40	94.45	21.77	28.30	14.68	192.8
2017	2130	32.92	13.06	139.33	55.28	31.58	12.53	339.10	96.44	29.75	35.28	14.00	252.1
2018	2290	30.58	10.64	148.32	51.61	28.77	10.01	386.10	98.42	25.00	43.95	15.29	287.4
2019	2563	29.30	9.40	144.31	46.28	33.42	10.72	555.00	100.39	27.21	51.09	16.38	311.8
2020	2583	27.80	8.48	132.94	40.55	32.94	10.05	600.30	102.33	19.36	55.44	16.91	327.8
2021	2228	30.94	8.92	137.51	39.62	30.19	8.70	323.29	104.26	30.18	58.95	16.99	347.0

Average annual general index number for consumers prices in rural and urban areas, with 2010 as the base year

The current retail price was converted to the real retail price using general consumer price index with 2010 as the base year

Average per capita of current national income was converted to real value using the average general consumer price index with 2010 as the base year.

Source collected and calculated from, Central Agency for Public Mobilization and Statistics, www.capmas.gov.eg - Central Agency for Public Mobilization and Statistics, Annual Bulletin of Prices of Foodstuffs and Products and Services (Producer-Wholesale-Consumer), Various Issues. - Central Agency for Public Mobilization and Statistics, Annual Bulletin of Production Movement, Foreign Trade and Available for Consumption of Agricultural Commodities, Various Issues. - Central Agency for Public Mobilization and Statistics, Statistical Yearbook, Chapter Nine on Prices, Various Issues. - World Bank Website, World Development Indicators, www.databank.worldbank.org

Table 16. Results of multiple logarithmic regression for the study variables during the period from 2004-2021

Variable	Coefficient	Std. Error	t-Statistic	Prob
C	0.019785	0.003560	5.558285	0.0001
DLOGX ₃	0.320176	0.110289	2.903060	0.0123
DLOGX ₅	-0.089516	0.039197	-2.283747	0.0398
DLOGX ₇	0.196032	0.028245	6.940347	0.0000
R-squared	0.839865	Mean dependent var	0.021527	
Adjusted R-squared	0.802911	S.D. dependent var	0.032907	
S.E. of regression	0.014609	Akaike info criterion	-5.412034	
Sum squared resid.	0.002774	Schwarz criterion	-5.215984	-
Log likelihood	50.00229	Hannan-Quinn critter	-5.392546	
F-statistic	22.72716	Durbin-Watson stat	1.669349	
Prob(F-statistic)	0.000019		-	

Source. Results of data analysis of Table (15) using E-Views program.

Table 17. Breusch–Pagan test results to detect non-stationarity of variance

F-statistic	2.1581	Prob. F(4,13)	0.1421
Obs*R-squared	5.6517	Prob. Chi-square(4)	0.1298
Scaled explained SS	4.8001	Prob. Chi-square(4)	0.1870

Table 18. Godfrey- Pagan serial Correlation LM

F-statistic	0.1190	Prob. F(1,12)	0.7360
Obs*R-squared	0.16700	Prob. Chi-square(1)	0.6828

DISCUSSION

The increase in the quantity of local fish production can be attributed to policies aimed at expanding fish farming to meet the growing demand for fish, especially with the significant decrease in natural fishing production. Moreover, the increase in the quantity of exports may be attributed to the government's policy within the agricultural development strategy to cultivate new high-quality varieties of fish and export them at higher prices (**Sadek, 2022**). Based on the aforementioned points, the reliance on domestic production to provide fish protein increased, consequently leading to a higher self-sufficiency ratio. Fish prices are affordable compared to red meat as a good source of animal protein; in addition, there are a lot of constraints hindering the expansion of animal and poultry production such as the high prices of feed ingredients and prevalence of certain diseases. Hence, fish can play important role in nutrition of a large segment of the world's population.

The lower percentages of fish production from natural fisheries are due to several factors, including overfishing, which has led to the collapse of entire fish stocks; violations of fishing cessation periods; destructive fishing methods; heavy pollution from sewage, industrial wastewater, and chemicals that have harmed fish health; accidents involving ships, which result in

pollution that negatively impacts production; illegal, unreported, and unregulated fishing; excessive encroachment, such as filling and building large areas of lakes; neglect of lake maintenance, including the cleaning of straits; and inadequate enforcement of legislation, along with the absence of effective monitoring, control, and surveillance (MCS). All these factors have contributed to a significant decline in fish production. Recently, government efforts have been initiated to clean these lakes and remove excessive encroachment, which is likely to improve lake conditions and to increase fish production.

It is crucial to expand aquaculture practices, which only gained prominence in the early seventies, and implement the latest scientific methods for their dissemination and development. The optimal solution for improving nutritional levels and health standards lies in bridging the gap in individuals' consumption of animal proteins in general, and fish proteins in particular (Abu Zeid, 2017).

Fish farm production can be increased by adopting modern management systems, including proper feeding and the use of high-quality fry and fingerlings. Fish farming intensity is often categorized based on the degree of control over the production process.

RECOMMENDATIONS

- 1- Developing natural fisheries, increasing their efficiency, and removing obstacles that limit fish production, as they contribute only 26% of fish production in Egypt.
- 2- Increasing the number of licenses issued to fishermen, the number of mechanized fishing boats, protecting fishermen from the control of some wholesalers, and provide equipped means of transportation to maintain the quality of fish, as the research showed that increasing the number of fishermen and the number of mechanized fishing boats leads to an increase in the quantity of fish production from natural fisheries by 0.5 and 0.21%, respectively.
- 3- Expanding the establishment of national fish farming projects is crucial, as they contribute approximately 74% of the total fish production in Egypt. The data also show that increasing both hatchery production and the area of fish farms leads to a rise in aquaculture production by 0.66% and 0.45%, respectively. Additionally, decreasing the cost of fry results in a 0.34% increase in fish production from aquaculture.
- 4- Develop and expand fish hatcheries, increase the area of fish farms, and promote intensive farming and fish cage systems, while utilizing modern technologies to maximize the benefits of water resources.
- 5- Establish training courses for fishermen on modern fishing techniques to enhance their skills, raise awareness about environmental issues, and promote sustainable fisheries management.

Conflict of interest

The authors have no conflicts of interest to declare.

Availability of data

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Authors' contributions

A.M.M.A. El-Bana conceived the idea and performed the analytical calculations.

M.A.E. Salem contributed to the idea and design, and collected the research data.

Amal S. Omar wrote the manuscript.

Shahira M.M. El-Ganainy interpreted the results and contributed to writing the manuscript.

All authors discussed the results and contributed to the final manuscript.

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Appendix 1. Results of the unit root test for total fish production, value, and the most important factors affecting the quantity of fish production from natural fisheries, fish farming, and the total quantity of fish consumption in Egypt, by using the Augmented Dickey-Fuller test.

Variables	At level		At first difference		Result
	t-Statistic	Prob	t-Statistic	Prob	
Total quantity of fish production in Egypt	3.773	0.999 ^{n.s}	-2.028	0.043 ^{**}	I(1)
Total value of fish production	4.353	0.999 ^{n.s}	-2.984	0.041 ^{**}	I(1)
Fish production quantity from natural fisheries	0.349	0.774 ^{n.s}	-5.394	0.001 ^{**}	I(1)
Fishermen number	-0.703	0.397 ^{n.s}	-4.451	0.000 ^{**}	I(1)
Mechanized fishing boats	0.042	0.948 ^{n.s}	-2.012	0.041 ^{**}	I(1)
Un-mechanized fishing boats	-2.219	0.207 ^{n.s}	-5.820	0.000 ^{**}	I(1)
True price of tilapia fish	-0.487	0.489 ^{n.s}	-6.370	0.000 ^{**}	I(1)
Fish imports quantity	-0.382	0.531 ^{n.s}	-3.579	0.002 ^{**}	I(1)
True value of fuel, oil, and depreciation for fish boats	2.101	0.988 ^{n.s}	-2.370	0.021 ^{**}	I(1)
Quantity of farmed fish	3.202	0.999 ^{n.s}	-2.217	0.029 ^{**}	I(1)
The real product price of tilapia fish	-0.487	0.489 ^{n.s}	-6.370	0.000 ^{**}	I(1)
Quantity of fish imports	-0.382	0.531 ^{n.s}	-3.579	0.002 ^{**}	I(1)
Quantity of fish hatcheries production	0.940	0.899 ^{n.s}	-2.151	0.034 ^{**}	I(1)
Quantity of fry production from fry collection centers	-0.506	0.480 ^{n.s}	-6.439	0.000 ^{**}	I(1)
The area of fish farms	0.467	0.805 ^{n.s}	-2.773	0.009 ^{**}	I(1)
The real value of fish feed	0.474	0.807 ^{n.s}	-3.590	0.001 ^{**}	I(1)
The real value of fry	-0.294	0.561 ^{n.s}	-6.753	0.000 ^{**}	I(1)
Total quantity of fish consumption	1.592	0.967 ^{n.s}	-2.649	0.022 ^{**}	I(1)
Real retail price of poultry	-0.991	0.275 ^{n.s}	-4.731	0.009 ^{**}	I(1)
Real retail price of red meat	-0.313	0.558 ^{n.s}	-3.662	0.042 ^{**}	I(1)
Real retail price of tilapia	-1.180	0.208 ^{n.s}	-5.046	0.005 ^{**}	I(1)
Quantity of fish imports	-0.382	0.531 ^{n.s}	-3.579	0.002 ^{**}	I(1)
Total population of Egypt	5.194	1.000 ^{n.s}	-3.907	0.039 ^{**}	I(1)
Fish import price	0.397	0.787 ^{n.s}	-5.104	0.005 ^{**}	I(1)
Average per capita share of gross national income at real price	1.960	0.984 ^{n.s}	-3.598	0.063 ^{**}	I(1)

Source: analysis results of Tables 1, 7, 11, 15, calculated using E-Views program.