

Some Economic Aspects of Fish Food Security in Egypt

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Abstract

Egypt suffers from the problem of low production of fish from consumption, despite Egypt owning vast areas of marine and lake fishing, amounting to about 13.4 million acres of water, which led to the insufficient strategic stock of fish, which led to the problem of Egyptian food security. The main objective of the research was to study the production, consumption and food security of Egyptian fish. In achieving its objectives, the research relied on the use of the descriptive analysis method, such as percentages, arithmetic and engineering averages, and the quantitative analysis method represented in estimating the economic indicators for estimating the strategic stock and food security coefficient for fish, as well as linear regression in both its simple and multiple sides to estimate the equations of the general temporal trend of the study variables as well as to estimate the most important factors responsible for the food gap of fish. To achieve search objectives, the research depends on the use of descriptive statistical methods and economic indicators for estimating the strategic stock and the food security factor for fish. By estimating the growth rate of fish production and consumption, the fish food gap, the average per capita consumption, the self-sufficiency ratio, and the quantity of imports, it was found that the annual growth rate for each of them took a general increasing trend during the study period, where the annual growth rate is estimated at 5.4%, 5%, 3.2%, 2.8%, 0.5%, and 3.9% for each of them, respectively, during the study period (2001-2018), and this indicates that fish food security in Egypt depends on both production and imports. It was also found that the surplus in fish amounted to about 0.1 thousand tons on average during the study period, and this surplus is very small and does not suffice for one day's consumption. It is also clear that the fish food security coefficient amounted to about 0.0001 on average during the period (2001-2018), and this indicates a decrease in the rate of fish food security. It turns out that the available fish for consumption depends mainly on the local production of

fish, which represents about 84.39% of the available for consumption, and on the imports of fish, which represent about 15.61% of the average total available for consumption of fish in Egypt, indicating that fish food security is achieved from the continued flow of both domestic production and imports of fish. Therefore, the state must pay attention to increasing investments in local fish production and expanding the establishment of various fisheries projects. It was found from the research that the amount of fish gap as a dependent variable is affected by both the local production of fish and the average individual annual consumption of fish as independent variables. A change of 0.31% in the amount of that gap in the opposite direction, and a change in the average per capita consumption of fish by 1% lead to a change of 55.2% in the amount of that gap in the same direction. The research showed that the value of the fish food security coefficient is close to zero, and this indicates a low rate of fish food security. Therefore, the state and the private sector must be important to increasing fish production from its various sources, and thus increase the surplus, which leads to an increase in the food security coefficient of fish.

Keywords

Fish Production, Fish Consumption, Food Security, Strategic Stocks, Egypt

1. Introduction

Fisheries in Egypt has achieved remarkable growth in the provision of animal protein from fish, especially for low-income levels, compared with other sources of animal protein, where the annual growth rate reached about 5.4% during the period (2001-2018), and the average per capita consumption increased from about 15.8 kg/year 2001 to about 21 kg/year in 2018, with an increase rate of about 32.9%. There has been a significant change in the sources of fish production in Egypt during the period (2001-2018), where fish production in Egypt increased from about 772 thousand tons in 2001, including about 342.9 thousand tons from natural fisheries, representing about 44.4% of the Egyptian fish production, to about 1934.8 thousand tons in 2018, of which about 1561.1 thousand tons were from aquaculture, representing about 80.7% of the total Egyptian fish production in 2018 (General Authority for Fisheries Development, Annual Fish Statistics Book, different volumes).

The weakness of food security in order to meet the population requirements and their healthy food preferences leads to instability of society in terms of security, economics and politics (FAO, 1996; Shehata, 2015, 2017). Therefore, Egypt seeks to increase self-sufficiency rates and reduce the food gap between production and consumption to achieve food security from food commodities in general and fish in particular, where the economic progress of countries is measured by what the individual obtains from animal protein, so the fisheries sector in Egypt represents a fundamental pillar in food security at the present time to

provide a large part of animal protein, especially that red and white meat face many obstacles and limitations that limit its development, while fisheries represents the best solution to bridge the food gap and the individual's needs from animal protein (Shehata & Aoun, 1998). Egypt has the economic potential that enables it to achieve high levels of fish self-sufficiency, which amounted to about 86.7% according to the statistics of 2018. From this point, the state seeks to double the production of fish to about 2 million tons within the objectives of the sustainable agricultural development strategy 2030, and to maintain an increase in the average per capita consumption of fish to more than 18 kg/person (Shehata et al., 2019). To increase fish production, Egypt depends on various aquaculture operations, which led to Egypt occupying the eighth rank in the world and first in Africa in the field of fish farming (Younes & Al-Khatib, 2013; El-Sonbaty, 2021).

The total fish production from different sources in Egypt amounts to more than 1.9 million tons, fish farming contributes about 80.7% of it, and the capture fisheries production contributes about 19.3% of the total Egyptian fish production according to 2018 statistics (General Authority for Fisheries Development, Annual Fish Statistics Book, different volumes).

As one of the important sources of animal protein production, fish is distinguished by its content of animal protein, which are 6% - 16% more than vegetable sources. Many fish (particularly fatty fish) are a source of cholesterol-free long-chain omega-3 fatty acids that contribute to human visual and cognitive development compared to red meat, which contains more saturated fat than any other form of meat, which may negatively affect the Human health as a result of the high level of cholesterol in the blood and contribute to heart disease, as it is rich in important nutrients for humans such as calcium, iodine, phosphorous, zinc, iron, selenium and iodine as well as vitamins A, D, and B, which helps reduce the risk of food shortage (Othman & Amer, 2007).

Fish is also distinguished by its lower prices than other animal protein sources, and therefore it is within the reach of low-income levels (Shehata, 2013). Also, the costs of fish production are much lower than the costs of producing other animal protein sources, and therefore the return on investment in fish is higher than that of other animal protein sources.

1.1. Research Problem

Despite the comparative advantage that Egypt enjoys through its location and its possession of about 13.8 million feddan (1 feddan = 0.42 hectare) of natural fisheries, the amount of production from these sources is not commensurate with their size, as their production rate is about 31.3% of the total fish production in Egypt.

The problem of Egyptian food security of fish is represented in the insufficient strategic stock of fish, especially in light of the increasing demand for fish and the decline in production from consumption, which indicates the existence of a food gap in fish, and this gap is filled by imports, which constitutes a burden on

the agricultural trade balance and then on the balance of payments, and despite the multiple sources of fish production in Egypt, there is no optimal exploitation of these sources, especially natural fisheries.

1.2. Research Objectives

The main objective of this research is to study the food gap and the Egyptian food security of fish, and this objective can be achieved by achieving the following sub-objectives:

- 1) Estimating models of the general trends function of some economic indicators of fish in Egypt during the period (2001-2018).
- 2) Estimating the size of the food gap of fish and knowing the most important factors responsible for it.
- 3) Studying the most important indicators of Egyptian food security in terms of fish.

1.3. Research Methodology and Data Sources

This research is based on both descriptive and quantitative analysis methods, represented in estimating some vector models of the economic variables in question in their linear and semi-logarithmic in dependent variable to calculate the annual growth rates for those variables, and the multiple regression analysis method was used to find out the most important factors responsible for the size of the fish gap (Daniel & Terrel, 1989), and some economic indicators were used to estimate the strategic stock and the food security factor for fish.

Which Semi-logarithmic function is: $\ln Y = a + bX$

To achieve its objectives, the research relied on secondary data published by the General Authority for Fish Resources Development and the Central Agency for Public Mobilization and Statistics.

2. Research Results and Discussion

2.1. Statistical Analysis of Some Economic Indicators of Fish in Egypt during Period (2001-2018)

By reviewing the data received and the statistical analysis contained in **Table 1** it is generally clear in the light of the estimated models in their linear form for the economic indicators, and based on the values of (F), (R²) of the estimated model, and the value of (T) for the independent variable in the model, the following appears:

2.1.1. Sources of Egyptian Fish Production during the Period (2001-2018)

The sources of fish production in Egypt include the following: 1) natural fisheries, 2) fish farming, and 3) total fish production (Al-Toukhi & Al-Butah, 2018).

1) Development of fish production from natural fisheries:

It is clear from the data of **Table 1** that the amount of fish production from natural fisheries amounted to about 376.57 thousand tons on average, representing

Table 1. Evolution of fish production in Egypt according to different sources during the period (2001-2018) production in thousand tons.

Year	Natural fisheries	% from total production	Production fish farming	% from total production	Total fish production
2001	428.7	55.6	342.9	44.4	771.5
2002	425.2	53.1	376.0	46.9	801.2
2003	431.1	49.2	444.9	50.8	876.0
2004	393.5	45.5	471.6	54.5	865.1
2005	349.6	39.3	539.8	60.7	889.3
2006	375.9	38.7	595.1	61.3	971.0
2007	372.5	37.0	635.5	63.0	1008.0
2008	373.8	35.0	693.8	65.0	1067.6
2009	387.4	35.4	705.5	64.6	1092.9
2010	385.2	29.5	918.9	70.5	1304.1
2011	375.4	27.6	986.1	72.4	1361.5
2012	356.9	26.0	1016.3	74.0	1373.2
2013	354.2	24.4	1096.1	75.6	1450.3
2014	344.1	23.2	1137.7	76.8	1481.8
2015	344.8	22.7	1174.3	77.3	1519.0
2016	371.0	21.3	1370.3	78.7	1714.2
2017	335.6	18.8	1452.2	81.2	1787.8
2018	373.3	19.3	1561.5	80.7	1934.8
Annual average	376.6	33.42 ⁽¹⁾	862.1	66.58 ⁽¹⁾	1237.2
Min. limit	335.6	18.80	342.0	44.40	771.5
Maxi. limit	431.1	55.60	1561.5	81.20	1934.8
Amount of change	-4.00**	-2.14	70.69**	2.14	66.33**
Growth rate %	-1.00**	-6.5	8.80**	3.40	5.40**

⁽¹⁾Geometric mean **: Significant at 0.01, *: Significant at 0.05 n: non-significant. Source: Ministry of Agriculture and Land Reclamation, General Authority for Fisheries Development, Annual Fish Statistics Book, different volumes.

about 33.42% of the total average fish production from its various sources during the study period, and the amount of fish production from natural fisheries fluctuates between a minimum of about 335.6 thousand tons in 2017, and a maximum of about 431.1 thousand tons in 2003. By estimating the annual growth rate of fish production from natural fisheries, it is clear from **Table 1** that the growth rate of fish production from natural fisheries took a general, statistically significant decreasing trend at the level of Significant 1%, and the annual decline rate was about 0.9%, equivalent to about 3.5 thousand tons, according to the annual average of the total fish production from natural fisheries during the study period.

2) Development of production from fish farming

It is clear from **Table 1** that the fish production from different fish farming is about 862.1 thousand tons on average, representing about 66.58% of the total average fish production from different sources during the study period. The quantity of fish production from fish farming tends to increase, as the quantity of production increased from about 342.9 thousand tons as a minimum in 2001 to about 1561.5 thousand tons as a maximum in 2018, and the average annual increase in fish production from fish farming is about 70.69 thousand tons, a reference to increasing the efficiency of fish farming systems in Egypt, and the annual growth rate of the amount of fish production from fish farming is about 8.8%, which is equivalent to about 75.86 thousand tons, according to the annual average of the total fish production from different aquaculture operations during the study period.

3) Development of total Egyptian fish production

Table 1 shows that the total fish production in Egypt amounted to about 1.24 million tons on average during the period (2001-2018). The quantity of production tends to increase from about 771.5 thousand tons in 2001 as a minimum to about 1934.8 thousand tons in 2018 as a maximum. The average annual increase in fish production is about 66.33 thousand tons during the study period. The annual growth rate of total domestic fish production is about 5.4%, equivalent to about 66.81 thousand tons, according to the annual average of total fish production during the study period.

3. Evolution of Fish Available for Consumption in Egypt during the Period (2001-2018)

3.1. Development of the National Consumption of Fish in Egypt during the Period 2001-2018

Table 2 shows that the quantity of fish consumption is about 1468.1 thousand tons on average during the study period. The amount of fish consumption tends to increase, as it increased from about 1032 thousand tons in 2001 as a minimum to about 2233 thousand tons in 2018 as a maximum.

The average annual increase in fish consumption is about 74.3 thousand tons. Referring to the annual increase of fish demand more than in increase the annual local production by about 18.5% of the annual average of local production of fish. This indicates the need for the state to import fish to equalize the demand for fish. The annual growth rate of the amount of fish consumption is about 5%, which is equivalent to about 73.41 thousand tons, according to the average consumption of fish during the study period.

3.2 Development of Egyptian Imports of Fish during the Period (2001-2018)

Table 2 shows that the quantity of Egyptian imports of fish is estimated at about 243.9 thousand tons on average during the study period. The annual increase in

Table 2. Evolution of some economic aspects of fish food security in Egypt during the period (2001-2018).

Year	Domestic production 10 ³ ton	Quantity of imports 10 ³ ton	Consumption 10 ³ ton	Gap 10 ³ ton	Average per capita share (kg/year)	Self-sufficiency %
2001	772	261	1032	260	15.8	74.8
2002	801	154	953	152	14.3	84.1
2003	876	163	1036	160	14.2	84.6
2004	865	221	1084	219	15.6	79.8
2005	889	189	1072	183	15.3	82.9
2006	971	208	1174	203	16.6	82.7
2007	1008	259	1263	255	17	79.8
2008	1068	137	1198	130	15.6	89.1
2009	1093	136	1206	113	15.9	90.6
2010	1305	257	1551	246	19.7	84.1
2011	1362	182	1535	173	19.1	88.8
2012	1372	335	1691	319	20.6	81.1
2013	1454	236	1670	216	19.7	87.1
2014	1482	355	1808	326	20.8	81.9
2015	1519	296	1795	276	20.2	84.6
2016	1706	311	1970	264	21.6	86.6
2017	1823	367	2154	331	22.7	84.6
2018	1935	324	2233	298	23	86.7
Annual average	1238.9	243.9	1468.1	229.1	18.2	84.1 ⁽¹⁾
Min. limit	772.0	136.0	953.0	113.0	14.2	74.8
Maxi. limit	1935.0	367.0	2233.0	331.0	23.0	90.6
Amount of change	66.79**	9.64**	74.3**	7.5**	0.5**	0.3 ^b
Growth rate %	5.4**	3.9**	5.0**	3.2*	2.8*	0.4 ^b

⁽¹⁾Geometric mean. Source: Ministry of Agriculture and Land Reclamation, General Authority for Fisheries. Development, Annual Fish Statistics Book, different volumes.

fish imports is estimated at 9.6 thousand tons. The annual growth rate of the quantity of fish imports is about 3.9%, equivalent to about 9.51 thousand tons, according to the average of total fish imports during the study period.

3.3. Development of the Average per Capita Consumption of Fish during the Period (2001-2018)

Table 2 shows that the average per capita share of fish was about 18.2 kg/person on average during the study period. The annual increase in the average per capita consumption of fish is about 0.51 thousand tons, and the growth rate of the average per capita consumption is about 2.8%, equivalent to about 0.6 kg, ac-

ording to the average total per capita consumption of fish during the study period.

3.4. Development of the Fish Self-Sufficiency Rate during the Period (2001-2018)

Table 2 indicates that the fish self-sufficiency rate reached about 84.1% on average during the study period. The rate of self-sufficiency fluctuates between a minimum of about 74.8% in 2001 and a maximum of about 90.6% in 2009. The annual growth rate of the self-sufficiency ratio is about 0.4%, which is equivalent to about 0.34%, according to the average total percentage of self-sufficiency in fish during the study period.

From the above it is clear that the available fish for consumption depends mainly on the local production of fish, which represents about 84.39% of the available for consumption, and on the imports of fish, which represent about 15.61% of the average total available for consumption of fish. An indication that fish food security is achieved by the continued flow of both local production and fish imports. Therefore, the state should pay attention to increasing investments in local fish production and expanding the establishment of various fisheries projects.

3.5. Development of Fish Food Gap during the Period (2001-2018)

It is evident from **Table 2** that the fish gap amounted to about 229.1 thousand tons on average during the study period. This gap fluctuates between a minimum of about 113 thousand tons in 2009 and a maximum of about 331,000 tons in 2017. The annual increase in the fish food gap is estimated at 7.5 thousand tons, and the growth rate of the fish gap is about 3.2%, equivalent to about 7.3 thousand tons, according to for the average total fish gap during the study period.

4. Determinants of Egyptian Food Gap of Fish

The food gap of fish is determined by production and local consumption of it and covered by an amount of imports equal to it, and it is assumed that the change in production will have a negative impact in the opposite direction on the amount of imports from it, while the effect of the change in consumption will have a positive effect in the same direction. Theoretically, the Egyptian fish import price variable was introduced as one of the determinants of that gap, and its impact is assumed to have a negative impact on that gap.

Econometric Estimation of the Most Important Variables Determining the Food Gap of Fish

To study and measure the impact of some specific variables of the food gap of fish, the relationship between the amount of fish gap (thousand tons) was estimated as a dependent variable, and each of the local production of fish (X_1) (thousand tons), and the average individual annual consumption of fish (X_2)

(kg) and the real average price of Egyptian imports of fish (X_3) (dollars/ton) during the study period (2001-2018). It was found that the best mathematical function that reflect that relationship are the following (Barry & Ralph, 1998):

$$Y = -392.20 + 55.20 X_2 - 0.31 X_1$$

$$(-4.49)^{**} (5.73)^{**} (-4.00)^{**}$$

$$F = 31.99^{**} R^2 = 0.81$$

It is clear from the previous equation that the effect of each of X_1 , X_2 on the fish gap, as a change in the local fish production sites by 1% will lead to negative effect of 0.31% in the amount of that gap, and a change in the average per capita consumption of fish by 1% leads to positive effect of 55.2% in the amount of that.

5. Egyptian Fish Food Security

Increased interest in the issue of food security in most parts of the world, which suffer from a gap between production and consumption of the main food commodities that may be caused by variables, including the continuous increase in the population and the increase in individual income levels, and the inability of agricultural resources in those countries to adequately produce these commodities to meet these numbers of the population, in addition to increase in the prices of food commodities in the international markets, which leads to a rise in their prices in the local importing markets.

It should be noted that the concentration of surplus agricultural food production in a limited number of developed countries in North America and Europe, and the tendency of these countries to consider food surplus as one of the strategic weapons to impose the political trends of those countries on other importing countries makes the problem of providing food a major and influential party in achieving the national security of those countries that import the bulk of food, which means that the ability to buy food from the world surplus does not necessarily mean that it can be easily obtained, and therefore food security has become a major component of national security (Abu Zaida, 2014).

The interest in food security issues has doubled after the applied agreements of the World Trade Organization (WTO), especially the Agreement on Agriculture and the related cancellation of subsidy for food producers and consumers, as well as cancellation of food export subsidies and the transformation of all quantitative restrictions in trade into non-quantitative ones, which led to an increase import value of a large number of food commodities (Al-Zahir, Ragab, & Shehata, 2018).

This part deals with a review of the most important indicators of the Egyptian national food security of fish. This is done by reviewing and analyzing the annual coverage period for both Egyptian domestic production and Egyptian imports for national fish consumption, as well as estimating the food security factor for the statistical analysis period covered by the research (2001-2018). After that, a review of some aspects and means of policies to achieve Egyptian food security

from fish is presented as a top priority because it is linked to the lives of all Egyptians because it is one of the most important and cheap sources of animal protein.

5.1. The Most Important Indicators of Egyptian Fish Food Security

This part of the study deals with the most important indicators of food security for fish in Egypt during the study period (2001-2018) to calculate the food security factor of this commodity, which is represented in the Egyptian fish production, which amounts to about 1.935 million tons in 2018, and the Egyptian national consumption of fish about 2.233 million tons in 2018, which leads to the average Egyptian per capita consumption of fish about 23 kg in 2018, and this results in the food gap of Egyptian fish reaching about 298 thousand tons in 2018.

The length of the production coverage period and the low period of imports covering the national consumption is a good step indicative of the tendency to achieve somewhat food security, which indicates a reduction in dependence on imports from abroad.

5.1.1. The Evolution of Egyptian Daily Consumption during the Period (2001-2018)

It is evident from **Table 3** that the daily local consumption of fish amounted to about 4.1 thousand tons on average. The daily local consumption of fish tends to increase, as it increased from about 2.8 thousand tons in 2001 to about 6.1 thousand tons in 2018. The increase is estimated at 3.3 thousand tons. An indication of the increased demand for fish is due either to the annual increase in the population or to the high prices of alternative commodities such as meat, poultry and other sources of animal protein. The daily domestic consumption growth rate is about 5.1%, equivalent to about 205 tons, according to the average daily total domestic consumption during the study period.

5.1.2. The Period of Sufficiency of Egyptian Production for Daily Consumption of Fish

It is clear from **Table 3** that the period of covering the local production of fish for consumption amounted to about 307 days on average. The period of adequacy of local production for consumption of fish tends to increase, as it increased from about 273 days in 2001 to about 316.3 days in 2018. An increase of about 43.1 days, representing about 15.78% of the period of adequacy of production for local consumption in 2001. An indication of the decline in Egyptian food security of fish during the study period. The annual growth rate is about 0.4%, which is equivalent to about 1.23 days, according to the average total period of production sufficiency for local consumption of fish during the study period.

From the above it is clear that despite the insufficiency of production for local consumption, but as a result of the increasing trend in the period of adequacy of production, over time it is possible to rely in achieving fish food security on local production if fish resources, especially natural resources, are optimally exploited.

Table 3. The most important indicators of Egyptian food security of fish during the period (2001-2018).

Year	Production 10 ³ ton	National consumption 10 ³ ton	Per capita consumption (kg/year)	Quantity of imports 10 ³ ton	Daily domestic consumption ton
2001	772	2.8	15.8	261	2.8
2002	801	2.6	14.3	154	2.6
2003	876	2.8	14.2	163	2.8
2004	865	3.0	15.6	221	3.0
2005	889	2.9	15.3	189	2.9
2006	971	3.2	16.6	208	3.2
2007	1008	3.5	17	259	3.5
2008	1068	3.3	15.6	137	3.3
2009	1093	3.3	15.9	136	3.3
2010	1305	4.2	19.7	257	4.2
2011	1362	4.2	19.1	182	4.2
2012	1372	4.6	20.6	335	4.6
2013	1454	4.6	19.7	236	4.6
2014	1482	5.0	20.8	355	5.0
2015	1519	4.9	20.2	296	4.9
2016	1706	5.4	21.6	311	5.4
2017	1823	5.9	22.7	367	5.9
2018	1935	6.1	23	324	6.1
Annual average	1238.9	4.01	18.2	243.9	4.01
Min. limit	772.0	2.6	14.2	136.0	2.6
Max. limit	1935.0	6.1	23.0	367.0	6.1
Amount of change	66.79**	0.20**	0.5**	9.64**	0.20**
Growth rate %	5.4**	5.1**	2.8**	3.9**	5.1**

Source: compiled and calculated from tables No. (2), (3).

5.1.3. Period of Coverage of Egyptian Imports of Fish for Daily Consumption

It is clear from **Table 3** that the period of imports covering fish consumption amounted to about 61.24 days on average. Moreover, the import coverage period for fish consumption tends to decrease, as it decreased from about 92.3 days in 2001 to about 53 days in 2018, an estimated decrease of 39.3 days, representing about 42.58% of the import coverage period for local fish consumption in 2001. Food security from fish on imports, increasing dependence on local production, and achieving the concept of self-sustaining fish food security, especially with the trend of the production coverage period for consumption increasing, this is considered a good indicator for the Egyptian economy because it leads to an increase in dependence on local production of fish and thus a reduction in the

deficit in the Egyptian trade balance and then the balance of payments, in addition to alleviating the impact of the exposure of Egyptian fish food security to the political and economic influences of countries with highly competitive capabilities in the world. By estimating the growth rate for the period of imports covering the consumption of fish, it turns out that the period of imports covering the consumption of fish took a general decreasing trend estimated at 1.2%.

6. Estimating the Strategic Stock and Fish Food Security Coefficient in Egypt

6.1. Strategic Inventory

The strategic stock of a commodity is defined as the quantities maintained by the government and the private sector to meet the expected domestic and export demand for this commodity during a future period of time. The strategic stock is estimated during a certain period of time as the sum of the surplus directed to the development of the strategic stock in some years and the amount of the deficit that is withdrawn from that stock during other years in which a deficit appears in domestic consumption.

Therefore, maintaining a strategic stock of fish is one of the most important considerations for Egyptian national food security. The strategic stock is formed through local production or through imports or both. Maintaining a strategic stock of fish is one of the most important aspects of achieving fish food security. In light of the Egyptian fish production, consumption, imports and exports data, the fish stock is calculated as follows:

6.1.1. Size of the Strategic Stock

Table 4 indicates that the size of the surplus in fish amounted to about 0.1 thousand tons on average during the study period, and this surplus is very small and is not enough to consume a day, and the size of the surplus of fish is decreasing 0.22 thousand tons in 2001 to a deficit of about -0.3 thousand tons in 2018. Although the surplus amount was the highest during the study period, the tendency of the surplus amount of fish to decrease may make the deficit greater than the surplus, and this deficit is supposed to be covered by drawing from the strategic stockpile and importing from abroad. According to the concept of strategic stock as a sum of both surplus and deficit during the study period, it turns out that the strategic stock of fish in Egypt is very small, 0.1 thousand tons is not enough even for one day's consumption, and therefore it requires the state to work on providing a strategic stock of fish in order to achieve the concept of food security fishy.

The value of the food security factor for fish ranges between (0 - 1) and when the value approaches zero, this indicates a decrease in the food security rate, and when the value approaches one, the greater the food security rate for fish. Since the strategic stock of fish is estimated at about 0.1 thousand tons and the average national consumption of fish is estimated at about 1.46 million tons during the

Table 4. Evolution of the period of coverage of domestic production and imports of Egyptian national consumption of fish, strategic stocks and food security factors during the period (2001-2018).

Year	Production (10 ³ tons)	Imports (10 ³ tons)	Consumption (10 ³ tons)	Period of adequacy of production and import coverage for domestic consumption of fish			Amount of surplus and deficit, size of the strategic stock	Food security factor
				Production sufficiency period per day	Import coverage period per day	Total period Per day		
2001	772	261	2.8	273	92.3	365.4	-0.224	-0.0002
2002	801	154	2.6	306.8	59	365.8	-0.558	-0.0006
2003	876	163	2.8	308.6	57.4	366.1	-0.131	-0.0002
2004	865	221	3	291.3	74.4	365.7	0.088	0.0001
2005	889	189	2.9	302.7	64.4	367	0.880	0.0008
2006	971	208	3.2	301.9	64.7	366.6	0.954	0.0008
2007	1008	259	3.5	291.3	74.8	366.2	-0.417	-0.0003
2008	1068	137	3.3	325.4	41.7	367.1	0.273	0.0002
2009	1093	136	3.3	330.8	41.2	372	0.154	0.0128
2010	1305	257	4.2	307.1	60.5	367.6	0.404	0.0003
2011	1362	182	4.2	323.9	43.3	367.1	-0.489	-0.0003
2012	1372	335	4.6	296.1	72.3	368.5	0.193	0.0001
2013	1454	236	4.6	317.8	51.6	369.4	-0.450	-0.0003
2014	1482	355	5	299.2	71.7	370.9	1.000	0.0006
2015	1519	296	4.9	308.9	60.2	369.1	0.300	0.0002
2016	1706	311	5.4	316.1	57.6	373.7	-0.810	-0.0004
2017	1823	367	5.9	308.9	62.2	371.1	0.890	0.0004
2018	1935	324	6.1	316.3	53	369.2	-0.300	-0.0001
Annual average	1238.9	243.9	4.01	307.01	61.24	368.25	0.1	0.0001
Min. limit	772.0	136.0	2.6	273.0	41.2	365.4	-0.81	-0.0004
Maxi. limit	1935.0	367.0	6.1	330.8	92.3	373.7	1.0	0.01
Amount of change	66.79**	9.64**	0.20**	1.17 ⁿ	-0.8 ⁿ	0.4**	0.01 ⁿ	-
Growth rate %	5.4**	3.9**	5.1**	0.4 ⁿ	-1.2 ⁿ	1.00**	-	-

1) Daily local consumption = annual consumption of fish ÷ number of days of the year. 2) The period of production sufficiency for consumption = local production ÷ daily domestic consumption. 3) Import coverage period for consumption = imports ÷ daily domestic consumption. 4) Amount of surplus and deficit in fish) = [(total length of production adequacy and import coverage periods - 365) × daily domestic consumption] - quantity of exports. 5) Food security factor = the size of the strategic stock (sum of surplus and deficit) ÷ average annual domestic consumption. Source: compiled and calculated from tables No. (2), (3).

study period (2001-2018) as a general average during that period, therefore, food security is estimated at about 0.0001 on average during the study period.

6.1.2. Fish Food Security Coefficient

Fish food security coefficient tends to fluctuate between a minimum of about -0.00059 in 2002 and a maximum of about 0.013 in 2009. By estimating the

growth rate of fish food security, it was found to be statistically insignificant. Therefore, it is necessary to take various measures that lead to an increase in the size of the strategic stock of fish to suffice half of the needs of it for local consumption so that the value of the food security factor approaches at least one to one (**Table 4**).

From the above it is clear that the value of the coefficient of food security is close to zero, and this indicates a decrease in the rate of fish food security. Therefore, the state and the private sector must pay attention to increasing fish production and thus increase the surplus, which leads to an increase in the fish food security coefficient.

7. Recommendations

Related to the results obtained, the research recommends the following:

- 1) Interest in increasing investments in local fish production and expanding the establishment of various fish projects.
- 2) Expanding the establishment of fish products factories to increase the added value of fish and encourage the Egyptian consumer to use these products and open export markets for them.
- 3) Follow-up training programs in cooperation with various scientific bodies to raise the skill performance of workers in the fisheries sector.
- 4) Exploiting the available water spaces in Egypt optimally to increase the Egyptian fish production, which contributes significantly to increasing the achievement of fish food security?

8. Conclusion

Egypt suffers from the problem of low production of fish from consumption, despite Egypt owning vast areas of marine and lake fishing, amounting to about 13.4 million acres of water, which led to the insufficient strategic stock of fish, which led to the problem of Egyptian food security. The main objective of the research was to study the production, consumption and food security of Egyptian fish. In achieving its objectives, the research relied on the use of the descriptive analysis method, such as percentages, arithmetic and engineering averages, and the quantitative analysis method represented in estimating the economic indicators for estimating the strategic stock and food security coefficient for fish, as well as linear regression in both its simple and multiple sides to estimate the equations of the general temporal trend of the study variables as well as to estimate the most important factors responsible for the food gap of fish.

The weakness of food security in order to meet the population requirements and their healthy food preferences leads to instability of society in terms of security, economics and politics. Therefore, Egypt seeks to increase self-sufficiency rates and reduce the food gap between production and consumption to achieve food security from food commodities in general and fish in particular, where the economic progress of countries is measured by what the individual obtains from

animal protein, so the fisheries sector in Egypt represents a fundamental pillar in food security at the present time to provide a large part of animal protein, especially that red and white meat face many obstacles and limitations that limit its development, while fisheries represents the best solution to bridge the food gap and the individual's needs from animal protein, Egypt has the economic potential that enables it to achieve high levels of fish self-sufficiency, which amounted to about 86.7% according to the statistics of 2018. From this point, the state seeks to double the production of fish to about 2 million tons within the objectives of the sustainable agricultural development strategy 2030, and to maintain an increase in the average per capita consumption of fish to more than 18 kg/person. To increase fish production, Egypt depends on various aquaculture operations, which led to Egypt occupying the eighth rank in the world and first in Africa in the field of fish farming.

The research found that the surplus in fish amounted to about 0.1 thousand tons on average during the study period, and this surplus is very small and does not suffice for one day's consumption. It is also clear that the fish food security coefficient amounted to about 0.0001 on average during the period (2001-2018), and this indicates a decrease in the rate of fish food security. It turns out that the available fish for consumption depends mainly on the local production of fish, which represents about 84.39% of the available for consumption, and on the imports of fish, which represent about 15.61% of the average total available for consumption of fish in Egypt, indicating that fish food security is achieved from the continued flow of both domestic production and imports of fish. Therefore, the state must pay attention to increasing investments in local fish production and expanding the establishment of various fisheries projects.

It was also found from the research that the amount of fish gap as a dependent variable is affected by both the local production of fish and the average individual annual consumption of fish as independent variables. A change of 0.31% in the amount of that gap in the opposite direction, and a change in the average per capita consumption of fish by 1% lead to a change of 55.2% in the amount of that gap in the same direction.

The research showed that the value of the fish food security coefficient is close to zero, and this indicates a low rate of fish food security. Therefore, the state and the private sector must be important to increasing fish production from its various sources, and thus increase the surplus, which leads to an increase in the food security coefficient of fish.

In light of the results obtained from the research, it recommends some recommendations that may be important to develop Egyptian fish production to achieve Egyptian fish food security.

Conflicts of Interest

The research showed that the value of the fish food security coefficient is close to zero, and this indicates a low rate of the fish food security. Therefore, the state

and the private sector must be important to increase fish production from its various sources, and thus increase the surplus, which leads to an increase in the food security coefficient of fish. In light of the results obtained from the research, it recommends some recommendations that may be important to develop Egyptian fish production to achieve Egyptian fish food security.

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