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Study of seasonal production and prices of the most important kinds of fish using Model ARIMA

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Abstract: Fish is considered an inexpensive source of animal protein compared to the rising prices of red and white meat, which has led many consumers to distance themselves from consuming it and turn to alternatives such as fish, which are characterized by seasonality. Due to shortcomings in the models used to analyze time series data, the study aimed to analyze the time series of prices and production of some kinds of fish (Nile Tilapia, Mullet and Catfish) using the autoregressive integrated moving average (ARIMA) model. This allows for accurate predictions as much as possible to benefit policymakers in formulating production policies for these kinds of fish. It is expected that the production of Nile Tilapia, Mullet and Catfish will increase by 3.78%, 2.36%, and 1.08%, respectively, during the period (2024-2026). An increase in prices is expected by approximately 15.4% for Nile Tilapia, while a decrease of about 7.7% and 3.04% is anticipated for Mullet and Catfish respectively during the period from (2024 - 2026). The study recommends the state working on solving the problems facing Egyptian fishermen in regional and international waters.

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Introduction:

Achieving food security depending upon local sustainable sources. Fish is one of the main sources for animal protein specially for those had a limited Income. As a result of rise in red meat prices compared to prices of many fish Species, It considered also as a substitute for white meat that rose its prices also, So consumers had reducing the consumption of white and red meat to fish as an alternative source of meat whish Increasing the Importance of fish in Egyptians food.

Egypt owns many sources of fish wealth represented in the Mediterranean sea, the Red sea, the Nile And lakes, addition to many fish farms, The Production of Egyptian fish increased from 1822.8 thousand tons in 2017, to 2001.96 thousand tons in 2021, which the rise the self-sufficiency rate and average share of individual from 84.60%, 22.72 kg in 2017 to 84.86%, 23.12 kg in 2021 (Lakes and Fish Resources Protection and Development Agency (LFRPDA), Fish Statistics Year Book, Different versions).

Problem and goal of the study:

The problem of the study represents Seasonality Production of fish which affected the prices of fish, in addition to failure existence in Models used in analysis of time series, As linear Regression Methods and moving averages where the failure is clear on total term for the series. When using linear Regression in series analysis and forecasting, The predicted value move away a lot of reality, so these values multiply when the condition is positive regression factor, and when the condition is negative regression factor the values reach zero.

As for the moving averages methodology and using seasonal guide in modefied time series and subsequently forecasting in coming years. But the assumptions are valid only within the span of the set of weights of the moving average.

The aim of the study is to analyze chains time series for the seasonality of production and prices of the most important fish Species, and because seasonality becomes clear in the natural environment, so the study will include Tilapia, Grey Mullet and Catfish in natural traps for the period (2017- 2021). The study target forecasting production and prices of consumer for these fish species by using private statistical methodology to analyze moving prices that fit and project well the original series. Series with various moving averages of variant of which ARIMA is abbreviation for Auto Regressive Integrated

Moving Average. Subsequently this can help to reach minute forecasts of production and prices for fish species that help economic policy makers to drew economic and productive policies needed for this field.

Methodology and data resources:

The research dependent upon both descriptive and quantitative analysis methods In addition to using ARIMA model to Identify ingredients of moving prices for time series which are :(1) General Direction (2) Seasonality Changes (3) Trend-cycleity Changes (4) Spin-off Random Changes. And that by using X-13-ARIMA model in estimating these components and this model consists of merging X-13 program with model ARIMA and this statistical model Used in analysis time series, moving averages, seasonal adjustment and measured the model ranking (p,d,q),(P,D,Q)s where :

P, p: rank Scale self-Regression ordinary and seasonal on arrangement,

D, d: rank the difference ordinary and seasonal original series that makes it fixed,

Q,q: rank moving averages standards and explains periods number that slow it down the residual . ARIMA models used in X-13 program must achieve good data fit and generate acceptable logical forecasts for the last three years. By logical forecasts, it means that the absolute error of the average does not exceed 5% for good series and is less than 12% for series with high Irregular variation.

There were using two models for the decomposition of time series (Ot) into trend, seasonal and irregular components.

Multiplicative model (M) Ot = Tt * St * It

Additive model (A) Ot = Tt + St + It

Where T, is trend (or trend-cycle), St is seasonal and It is irregular Component.

The trend (T_t) is medium - or long - term movements of time series. The trend cycle combines the long-term trend and business-cycle movements in the data.

The research relied on some previous studies in addition to using secondary data published by both the Lakes and Fish Resources Protection and Development Agency (LFRPDA) and the Central Agency for Public Mobilization and Statistics. The period from January 2017 to December 2021 was chosen to represent monthly data on retail prices for fish production and prices of various kinds of fish as the subject of the study to identify the components and effects of Trend-cycle changes - general trend, seasonality, and Irregular variations, and thus predict their production and prices. The measures resulting from time series analysis and hence the accuracy of forecasts for future years depend on the representation of the selected time period for the developmental stage through which fish production and prices are going and the extent to which this stage continues beyond the period under study.

Results:

The relative importance of fish:

Tilapia fish is considered one of the most important kinds of fish produced in natural fisheries in Egypt, with an average of about 141.33 thousand tons, representing 35.40% of the total average production of the Republic from natural fisheries, which amounted to about 397.1 thousand tons for the average period of (2017-2021). Followed by second and third rank Grey Mullet and Catfish, with an average production of about 39.68 and 37.10 thousand tons, representing 9.99% and 9.35% respectively of the total average of natural fisheries during the period (2017-2021)

The study reached several results related to the seasonality of production and prices of some kinds of fish using the ARIMA-X-13 model, and the most important results were.

Firstly Production:

Time series analysis of fish production indecated the best models selected by the ARIMA-X-13 method for adjusting the seasonality of time series were model (2 1 2) (0 1 1) for Tilapia fish, model (0 1 2) (0 1 1) for the Mullet family, and model (0 1 1) (0 1 1) for Catfish by using:

1- F-Test the presence of seasonality assuming stability from original series (prior adjusted)

Seasonality has been found to be significant between months at a 1% level of significance for the production of Tilapia and Catfish, but was not for Grey Mullet, where the calculated F-values were 29.95, 5.06, and 1.91 for the three species respectively.

2-The presence of seasonality assuming stability from Final unmodified SI ratios

A- F-test

It has been revealed that there were seasonality in production between months at 1% level of significance for Tilapia, Mullet, and Catfish, where F-values were 42.32, 3.95, and 11.20 respectively for the three species.

B-Kruskal-Wallis Test (Nonparametric Test)

It has been revealed that there is seasonality at 1% significance level in the production of Tilapia, Mullet, and Catfish, where the statistical evidence values were 53.16%, 27.61%, and 46.30% respectively at 11 degrees of freedom.

3-Moving Seasonality Test Between Years

That there were no moving seasonality between years at 5% significance level for Tilapia, Mullet, and Catfish.

4-Changes Irregular Component, seasonal and Moving seasonality ratio

During the period study (2017-2021), the data in Table (1) indecated that the seasonal movement rate in production reached maximum in Tilapia production during the months of May, December, and October, represented 13.74, 10.83, and 8.50 respectively, while it was at its minimum in June, July, and April, represented 1.32, 1.99, and 2.07 respectively. As for the Mullet family, production was maximum in May, April, and February, represented 20.32, 18.45, and 11.06 respectively, while it was minimum in December, August, and June, by 1.22, 1.40, and 1.46 respectively. Regarding Catfish production, the ratio was maximum in August, March, and December, by 14.68, 7.11, and 6.16 respectively, while it were minimum in May, February, and April by 1.10, 1.87, and 1.99 respectively. The final I/S Ratio for the time series of Tilapia, Mullet, and Catfish production was 3.31, 3.95, 3.23 respectively. The final I/C Ratio reached 1.61, 1.91, 1.58 for the three species respectively.

Table. (1): Occasional and seasonal changes and movement rate for the production of Tilapia, Mullet, and Catfish during the period (2017 - 2021)

Month	Tilapia			Mullet			Catfish		
	Irregular	Seasonal	Moving seasonality ratio	Irregular	Seasonal	Moving seasonality ratio	Irregular	Seasonal	Moving seasonality ratio
Jan	1.37	0.60	2.30	4.03	1.70	2.36	2.91	0.60	4.88
Feb	0.80	0.32	2.50	3.03	0.27	11.06	2.45	1.31	1.87
Mar	1.45	0.41	3.55	6.96	1.18	5.91	4.25	0.60	7.11
Apr	2.02	0.97	2.07	9.00	0.49	18.45	2.36	1.19	1.99
May	1.79	0.13	13.74	10.90	0.54	20.32	1.45	1.32	1.10
Jun	1.43	1.08	1.32	6.28	4.31	1.46	1.11	0.48	2.30
Jul	2.20	1.10	1.99	8.35	2.06	4.06	2.24	0.55	4.11
Aug	2.55	0.37	6.96	4.75	3.41	1.40	3.39	0.23	14.68
Sep	3.14	0.95	3.31	1.65	0.29	5.62	2.04	0.90	2.27
Oct	0.87	0.10	8.50	8.58	3.51	2.44	1.12	0.53	2.10
Nov	1.21	0.22	5.58	7.26	1.01	7.18	1.50	0.48	3.12
Dec	2.73	0.25	10.83	5.22	4.28	1.22	3.30	0.54	6.16

Source: Calculated from data provided by the Lakes and Fish Resources Protection and Development Agency (LFRPDA), Fish Statistics Year Book, **previous reference.**

5-Test for the presence of residual seasonality:

A- No evidence of residual seasonality in the entire series at the 1 percent level.

The calculated F-values were 0.34, 0.25, and 0.11 for Tilapia, Mullet, and Catfish production respectively.

B-No evidence of residual seasonality in the last 3 years at the 1 percent level, for all three species, the calculated F-values at 1% significance level were approximately 0.20, 0.30, and 0.46 respectively.

6-Relative contributions to the variance of the percent change in the components of the original series for fish production in period (2017- 2021).

(Table 2) indected,

A-That Tilapia production is subject to fluctuating Irregular changes, was maximum in January, March, and February by 6.0%, 3.06%, and 2.78% respectively, while was minimum between 0.83% in August and 0.87% in May. As for Mullet production, was its maximum in December, January, at rate of 38.62%, 28.77% respectively, then gradually decreased to reach its minimum during May and August at rate of 10.22% and 11.29% respectively. As for Catfish production, it was maximum in January and December at rates of 17.41% and 12.58% respectively, then gradually decreased in June and August at rates of 2.94% and 3.67% respectively.

B- As for the Trend-cycle changes - the general trend, has been gradual increase in Tilapia production, its maximum in December, November, October at rates of 97.67%, 61.31%, 35.51% respectively, and its minimum in January, February at rates of 1.61%, 3.02% respectively. Mullet production was maximum in December, September at rates of 58.86%, 43.92% respectively, then gradually decreased until reaching minimum in January and February at rates of 4.58%, 11.98% respectively. As for Catfish production, it

was maximum in December at rate of 87.12%, then gradually decreased to reach its minimum in January at a rate of 4.16%.

C-As for the seasonal variations, the seasonal effect on Tilapia production fluctuates from January to April, reaching its maximum in February at 94.20%, then gradually decreases from May to the end of the year, reaching its minimum in December at 0.29%. As for Mullet production, the seasonal effect fluctuates from January to April, reaching its maximum at 66.64%, then gradually decreases until reaches its minimum in December at 2.52%. As for Catfish production, the seasonal effect was maximum from February, reaching 83.84%, then gradually decreases until the end of the year 0.30% in December.

Secondary: Price

Analysis of retail sale prices for consumer, it found that the best models selected by the ARIMA-X-13 method to adjust the seasonal time series were: model (2 1 0) (0 1 1) for Tilapia, model (2 1 2) (0 1 1) for Mullet, and model (2 1 2) (0 1 1) for Catfishes.

Table (2): The relative importance of the occasional, Trend-cycle, and seasonal components of the production of Tilapia, Mullet, and Catfish in the original series during the period (2017 - 2021)

Month	Tilapia			Mullet			Catfish		
	Irregular	Trend-cycle	Seasonal	Irregular	Trend-cycle	Seasonal	Irregular	Trend-cycle	Seasonal
Jan	6.00	1.61	92.39	28.77	4.58	66.64	17.41	4.16	78.43
Feb	2.78	3.02	94.20	23.28	11.98	64.74	8.21	7.95	83.84
Mar	3.06	5.75	91.19	23.13	22.45	54.42	6.40	9.99	83.61
Apr	1.06	5.87	93.06	14.40	21.01	64.59	5.48	13.61	80.91
May	0.87	6.48	92.65	10.22	26.70	63.07	5.39	15.22	79.39
Jun	0.90	7.73	91.38	16.77	31.52	51.71	2.94	15.94	81.13
Jul	0.95	10.68	88.37	12.55	29.48	57.97	4.09	18.92	77.00
Aug	0.83	15.99	83.19	11.29	29.64	59.07	3.67	22.73	73.60
Sep	1.22	27.15	71.63	14.34	43.92	41.74	4.50	26.41	69.09
Oct	1.27	35.51	63.22	15.05	36.73	48.22	6.55	35.64	57.81
Nov	1.54	61.31	37.15	17.94	36.80	45.26	9.57	52.89	37.53
Dec	2.04	97.67	0.29	38.62	58.86	2.52	12.58	87.12	0.30

Source: Calculated from data provided by the Lakes and Fish Resources Protection and Development Agency (LFRPDA), Fish Statistics Year Book, , previous reference.

1-Test the presence of seasonality assuming stability from original series (prior adjusted)

F-Test presence seasonality between months and it is significance at level of 1% for Tilapia prices, while significance was not confirmed for Mullet and Catfish, the calculated F-values were 4.24, 1.43, and 1.67 for the three species respectively.

2-The presence of seasonality assuming stability from Final unmodified SI ratios

A- F-Test

Seasonality has been established between months at a significance level of 1% for Tilapia prices, while significance was not confirmed for Mullet and Catfish prices, the F-values were 15.45, 2.95, and 1.96 respectively.

B- Kruskal-Wallis Test (Nonparametric Test)

It was found that there is seasonality at a significance level of 1% in Tilapia prices, while significance was not confirmed for both Mullet and Catfish prices. The statistical evidence values were 46.82%, 22.70%, and 23.38% for the three species respectively at 11 degrees of freedom.

3-Moving Seasonality Test Between Years

The presence of moving seasonality between years at a 5% significance level was evident for the price of Catfishes, was 8.47, while it was not confirmed for both Tilapia and Mullet prices.

4-Changes Irregular Component, seasonal and Moving seasonality ratio

During the pried study (2017-2021), Table (3) indicated that the maximum seasonal variation in production rate for Tilapia during months May and March, reached 22.40 and 12.72 respectively, while the minimum points were in November and December, by 1.67 and 1.87 respectively. As for Mullet, it was maximum in November, April, and September, by 14.89, 13.90, and 9.50 respectively, while it was minimum in February and June, by 1.12 and 1.16 respectively. Regarding Catfish, these ratios were maximum in July and June, by 6.88 and 6.84 respectively, while it were their minimum in November and December by 1.11 and 1.20 respectively. The final I/S Ratio for the time series

of Tilapia, Mullet, and Catfishes was 4.03, 2.32, and 2.49 respectively. The final I/C Ratio was 0.98, 1.61, and 1.33 for the three species respectively.

5-Test for the presence of residual seasonality:

A- No evidence of residual seasonality in the entire series at F 1% level, the calculated F-values were 0.13, 0.35, and 0.73 for Tilapia, Mullets and Catfishes respectively.

B- No evidence of residual seasonality in the last 3 years at1% level, for the three species, the calculated F-values at level of 1% were 0.12, 0.05, and 0.04 respectively.

6-Relative contributions to the variance of the percent change in the components of the original series for fish production in period (2017- 2021)

A- From the data in Table (4), it is evident that Tilapia prices experienced Irregular changes, reaching their maximum in January and February at 13.0% and 4.87% respectively, then gradually declining to their lowest value in August and September by 1.03% and 1.06% respectively. As for Mullet prices, the maximum was in January and February by 26.22% and 13.29% respectively, then gradually decreasing during December and November by 2.61% and 2.71% respectively. Regarding Catfishes prices, the maximum was in January and February by 27.52% and 12.38% respectively, then gradually declined, in September and August by 1.81% and 2.56% respectively.

Table (3): Occasional and seasonal changes and the rate of movement in the prices of Tilapia, Mullet, and Catfish during the period (2017 - 2021)

Month	Tilapia			Mullet			Catfish		
	Irregular	Seasonal	Moving seasonality ratio	Irregular	Seasonal	Moving seasonality ratio	Irregular	Seasonal	Moving seasonality ratio
Jan	0.33	0.40	3.34	1.78	0.77	2.32	0.90	0.59	1.53
Feb	1.27	0.52	2.43	1.09	0.98	1.12	0.91	0.20	4.61
Mar	0.68	0.05	12.72	1.00	0.39	2.55	1.96	0.78	2.52
Apr	1.99	0.48	4.15	1.03	0.07	13.90	1.09	0.74	1.47
May	1.67	0.08	22.40	1.61	0.39	4.09	0.89	0.58	1.54
Jun	0.67	0.19	3.65	1.06	0.91	1.16	1.51	0.22	6.84
Jul	1.60	0.25	6.40	0.44	0.35	1.25	1.17	0.17	6.88
Aug	0.72	0.12	6.31	1.05	0.85	1.23	0.89	0.42	2.14
Sep	1.29	0.44	2.92	1.45	0.15	9.50	2.03	0.46	4.44
Oct	1.15	0.17	6.91	0.74	0.11	7.03	1.54	062	2.50
Nov	0.57	0.34	1.67	1.06	0.07	14.89	0.46	0.41	1.11
Dec	0.64	0.34	1.87	0.69	0.56	1.24	0.43	0.36	1.20

Source: Calculated from data provided by the Central Agency for Public Mobilization and Statistics, the monthly bulletin average consumer price of the most important food commodities, varying numbers.

B- For the Trend-cycle changes - general trend, there was a gradual increase in Tilapia prices, reaching their peak in December, November, and October by 98.81%, 92.08%, and 80.72% respectively, and declining in January and February by 17.57% and 23.85% respectively. As for Mullet, its maximum was in December and November by 97.08% and 91.84% respectively, then gradually decreased to its minimum value in January by 15.01%. Regarding Catfish, their maximum was in November and December by 90.42% and 90.26% respectively, then gradually decreased to the minimum in January at 28.61%.

C- For the seasonal changes, found evident that the seasonal effect on Tilapia fluctuated from January to April, reaching its maximum in February by 71.29%, then gradually decreased from May to the end of the year, reaching its minimum in December by 0.04%. As for Mullet, the seasonal effect gradually decreases from January to December, reaching its maximum in January by 58.78%, then gradually decreases until it reaches its minimum in December by 0.30%. As for Catfishes, the seasonal effect was maximum in February by 45.82%, then gradually decrease until the end of the year, by 0.79% in December.

Table (4): The relative importance of the occasional, Trend-cycle, and seasonal components of Tilapia, Mullet, and Catfish prices in the original series during the period (2017-2021)

Month	Tilapia			Mullet			Catfish		
	Irregular	Trend-cycle	Seasonal	Irregular	Trend-cycle	Seasonal	Irregular	Trend-cycle	Seasonal
Jan	13.00	17.57	69.43	26.22	15.01	58.78	27.52	28.61	43.87
Feb	4.87	23.85	71.29	13.29	32.60	54.11	12.38	41.80	45.82
Mar	2.45	29.57	67.89	7.82	44.40	47.79	8.33	52.57	39.11
Apr	2.03	35.37	62.60	9.15	53.36	37.49	4.87	58.45	36.68
May	1.31	38.48	60.21	6.10	64.72	29.18	4.22	61.73	34.04
Jun	1.14	41.59	57.27	6.17	68.63	25.21	2.64	66.80	30.56
Jul	1.41	50.41	48.18	3.72	75.04	21.25	2.91	71.11	25.89
Aug	1.03	60.74	38.23	2.86	77.70	19.44	2.56	76.02	21.42
Sep	10.6	68.70	30.24	2.92	81.87	15.21	1.81	80.26	17.93
Oct	1.18	80.72	18.10	2.34	87.66	10.00	2.63	83.97	13.39
Nov	1.25	92.08	6.67	2.71	91.84	5.45	2.59	90.42	6.99
Dec	1.25	98.71	0.04	2.61	97.08	0.30	2.95	90.26	0.79

Source: Calculated from data provided by the Central Agency for Public Mobilization and Statistics, the monthly bulletin average consumer price of the most important food commodities, previous reference.

Thirdly: Forecasting of prices and fish production

One of the purposes of the time series analysis conducted to describe time series and identify its components (general, seasonal, Trend-cycle, and Irregular) is to use its results as a basis for issuing as accurate predictions as possible about future quantities and prices of fish. This enables the formulation of economic policies that ensure their availability at affordable prices for everyone. However, statistical forecasting is not devoid of personal judgment from those issuing it, despite the objectivity of the phenomenon. As long as accurate forecasting depends on the validity of judgments on the components of the time series and the results of previous tests, it is expected that fish prices will continue to rise in the coming years if the government does not intervene with new projects to develop fish wealth. This includes expanding the establishment of fish farms to limit price increases at rates exceeding the increase in the income of the middle class, which bears the burden of economic development.

Furthermore, forecasts have been made for the production quantity and retail prices for consumers of Tilapia, Mullet and Catfish for the years 2024, 2025, and 2026, as illustrated in Tables (5, 6, 7). It is expected that the average production of Tilapia will increase from 14.93 thousand tons in 2024 to 15.21 thousand tons in 2025, then further increase to 15.49 thousand tons in 2026. This represents an increase in production by 1.89% in 2025 compared to 2024, and by about 1.85% in 2026 compared to 2025, and by 3.78% in 2026 compared to 2024. Meanwhile, the average production of Mullet is expected to decrease from 3.32 thousand tons in 2024 to 3.28 thousand tons in 2025, then further decrease to 3.24 thousand tons in 2026. This represents a decrease in production by about 1.17% in 2025 compared to 2024, and by about 1.2% in 2026 compared to 2025, and by 2.36% in 2026 compared to 2024.

It is expected that the average production of Catfish will increase from 3.33 thousand tons in 2024 to 3.35 thousand tons in 2025, then further increase to 3.37 thousand tons in 2026. This represents an increase in production by about 0.54% in 2025 compared to 2024, and by about 0.54% in 2026 compared to 2025, and by 1.08% in 2026 compared to 2024.

By studying the data from Tables (5, 6, 7), it is indecated that the average of retail prices of Tilapia will decrease from 28.44 pounds/kg in 2024 to 27.35 pounds/kg in 2025, then further decrease to 26.25 pounds/kg in 2026. This represents a decrease in price by about 3.80% in 2025 compared to 2024, and by about 4.0% in 2026 compared to 2025, and by approximately 7.7% in 2026 compared to 2024.

Meanwhile, the average retail prices for consumers of Mullet are also expected to decrease from 59.22 pounds/kg in 2024 to 58.35 pounds/kg in 2025, then further decrease to 57.47 pounds/kg in 2026. Thus, the price of Mullet is expected to decrease by about 1.49% in 2025 compared to 2024, and by about 1.51% in 2026 compared to 2025, and by 3.04% in 2026 compared to 2024. On the other hand, it is expected that the average retail prices for consumers of Catfish will increase from 27.55 pounds/kg in 2024 to 29.67 pounds/kg in 2025, then further increase to 31.79 pounds/kg in 2026. This represented an increase in price by 7.70% in 2025 compared to 2024, and by about 7.14% in 2026

compared to 2025, and by 15.4% in 2025 compared to 2024.

Schedule (5): Consumer retail price and expected production of Tilapia fish during the period (2024 - 2026)

Month	Production in tons						Price in pounds /kg					
	2024		2025		2026		2024		2025		2026	
	Original series	Seasonally adjusted	Original series	Seasonally adjusted	Original series	Seasonally adjusted	Original series	Seasonally adjusted	Original series	Seasonally adjusted	Original series	Seasonally adjusted
Jan	12383.60	14848.44	12665.68	15132.23	12947.76	15432.37	27.73	28.89	26.64	27.81	25.55	26.67
Feb	12744.80	14871.41	13026.88	15147.53	13308.96	15457.56	27.63	28.84	26.54	27.73	25.44	26.58
Mar	15077.90	14869.72	15359.98	15132.99	15642.06	15410.90	29.34	28.76	28.24	27.69	27.15	26.62
Apr	14296.30	14876.48	14578.38	15170.01	14860.46	15447.46	31.08	28.75	29.99	27.67	28.89	26.63
May	13567.04	14892.47	13849..12	15185.44	14131.20	15494.74	30.83	28.65	29.73	27.58	28.64	26.54
Jun	15821.11	14897.47	16103.19	15177.37	16385.27	15457.80	29.89	28.55	28.80	27.45	27.70	26.38
Jul	14572.08	14930.41	14854.16	15219.43	15136.24	15508.44	28.78	28.44	27.68	27.32	26.59	26.25
Aug	16686.56	14938.73	16968.64	15218.51	17250.72	15471.50	27.76	28.30	26.67	27.19	25.57	26.07
Sep	15464.05	14970.04	15746.13	15243.11	16028.21	15516.18	27.17	28.16	26.08	27.05	24.98	25.94
Oct	16956.34	14992.34	17238.42	15255.24	17520.50	15518.60	27.19	28.06	26.09	26.95	25.00	25.85
Nov	16441.08	15028.41	16723.16	15286.25	17005.24	1558.60	27.49	27.99	26.40	26.88	25.31	25.77
Dec	15117.07	15056.84	15399.15	15337.80	15681.23	15603.21	26.42	27.87	25.33	26.78	24.23	25.64
Average	14927.33	14931.06	15209.41	15208.83	15491.49	15489.76	28.44	28.44	27.35	27.35	26.25	26.25

Source: Calculated from data obtained from:

1- Lakes and Fish Resources Protection and Development Agency (LFRPDA), Fish Statistics Year Book, , previous reference.
2- The Central Agency for Public Mobilization and Statistics, the monthly bulletin average consumer price of the most important food commodities, previous reference.

The increase in Tilapia production by 3.78% as an average for the forecast period (2024-2026), will decrease by prices 7.7% during the same period. As for Mullet, prices are expected to decrease by 3.04% compared to a decrease in quantity representing 2.36%. Catfish prices, on the other hand, will increase by 15.4% during the forecast period compared to an increase in production by 1.08%. The expected decrease in price ratios compared to the increase in production for Tilapia is consistent with economic theory. However, it is observed that there is a simultaneous decrease in the expected values for both production and prices of Mullet, as well as an increase in both production and prices of Catfish, which is not consistent with economic theory. This may be due to other factors affecting production besides price, such as tastes, income, or kinds of fish farms, which affect their production and, consequently, prices. The increase ratios are considered warning indicators, especially for production, as Tilapia is the only protein alternative for a large proportion of the Egyptian middle and working class, being a cheap protein source. Therefore, the state must focus on fishery resources and work on their development.

Table (6): Retail Price and expected Production of Mullet Fish During the Period (2024 - 2026)

Month	Production in tons						Price in pounds /kg					
	2024		2025		2026		2024		2025		2026	
	Original series	Seasonally adjusted	Original series	Seasonally adjusted	Original series	Seasonally adjusted	Original series	Seasonally adjusted	Original series	Seasonally adjusted	Original series	Seasonally adjusted
Jan	3261.47	3338.25	3223.12	3305.76	3184.76	3263.07	59.25	59.37	58.38	58.61	57.50	57.79
Feb	3840.63	3336.78	3802.28	3300.59	3763.92	3267.29	59.20	59.38	58.32	58.55	57.45	57.74
Mar	3173.41	3329.92	3135.06	3293.13	3096.71	3256.27	60.17	59.34	59.30	58.54	58.42	57.73
Apr	2835.12	3339.36	2796.76	3290.31	2758.41	3245.19	62.97	62.97	62.10	58.58	61.22	57.70
May	2904.28	3338.25	2865.93	3286.62	2827.57	3242.63	58.10	59.35	57.22	58.51	56.35	57.62
Jun	3727.81	3328.40	3689.45	3288.28	3651.10	3251.20	58.47	59.42	57.59	58.47	56.72	57.53
Jul	3476.80	3320.73	3438.44	3280.95	3400.09	3244.36	58.62	59.33	57.75	58.39	56.87	57.44
Aug	3961.75	3306.97	3923.40	3280.43	3885.04	3248.36	58.82	59.29	57.95	58.30	57.07	57.36
Sep	3291.60	3314.80	3253.24	3272.88	3214.89	3234.30	58.96	59.08	58.08	58.20	57.21	57.32
Oct	2796.78	3294.20	2758.42	3284.40	2720.07	3222.83	58.92	58.92	58.04	58.10	57.17	57.23
Nov	3797.22	3301.93	3758.87	3268.58	3720.52	3235.23	59.26	58.85	58.38	58.97	57.51	57.17
Dec	2789.77	3309.34	2751.42	3259.98	2713.06	3214.53	57.90	58.72	57.03	58.90	56.15	57.06
Average	3321.39	3321.58	3283.03	3282.66	3244.68	3243.77	59.22	59.5	58.35	58.34	57.47	57.47

Source: Calculated from data obtained from:

1- Lakes and Fish Resources Protection and Development Agency (LFRPDA), Fish Statistics Year Book, , previous reference.
2- The Central Agency for Public Mobilization and Statistics, the monthly bulletin average consumer price of the most important food commodities, previous reference.

Table (7): Retail Prices and expected Production for Catfish During the Period (2024 - 2026)

Month	**Production in tons**						**Price in pounds /kg**					
	2024		**2025**		**2026**		**2024**		**2025**		**2026**	
	Original series	Seasonally adjusted	Original series	Seasonally adjusted	Original series	Seasonally adjusted	Original series	Seasonally adjusted	Original series	Seasonally adjusted	Original series	Seasonally adjusted
Jan	2900.59	3334.01	2918.66	3347.09	2936.73	3363.95	26.32	26.56	28.45	28.71	30.57	30.88
Feb	2805.39	3343.73	2823.46	3345.33	2841.53	3366.74	25.87	26.75	27.99	28.95	30.11	31.11
Mar	3244.39	3320.77	3262.46	3342.68	3280.53	3361.20	25.65	26.92	27.77	29.11	29.90	31.34
Apr	3497.39	3311.92	3515.46	3341.69	3533.53	3362.06	26.41	27.09	28.54	29.27	30.66	31.45
May	3411.19	3308.62	3429.26	3342.36	3447.33	3363.25	26.61	27.24	28.73	29.44	30.85	31.61
Jun	3385.59	3325.73	3403.66	3346.76	3421.73	3367.84	28.75	27.46	30.87	29.51	32.99	31.57
Jul	3684.19	3331.09	3702.26	3350.46	3720.33	3366.81	28.76	27.63	30.89	29.67	33.01	31.74
Aug	3558.19	3337.89	3576.26	3354.84	3594.33	3371.79	28.33	27.80	30.45	29.88	32.57	31.96
Sep	3858.19	3346.22	3876.26	3356.07	3894.33	3371.71	28.19	27.99	30.32	30.08	32.44	32.18
Oct	3256.39	3346.75	3274.46	3358.42	3292.53	3376.95	28.45	28.17	30.57	30.27	32.69	32.37
Nov	3248.99	3352.93	3267.06	3361.17	3285.13	3376.29	28.61	28.33	30.73	30.46	32.85	32.56
Dec	3144.79	3338.42	3162.86	3361.17	3180.93	3380.37	28.63	28.52	30.76	30.64	32.88	32.75
Average	3332.94	3333.17	3351.01	3350.67	3369.08	3369.08	27.55	27.54	29.67	29.66	31.79	31.79

Source: Calculated from data obtained from:

1- Lakes and Fish Resources Protection and Development Agency (LFRPDA), Fish Statistics Year Book, , previous reference.
2- The Central Agency for Public Mobilization and Statistics, the monthly bulletin average consumer price of the most important food commodities, previous reference

Summary

Fish is considered an inexpensive source of animal protein compared to the rising prices of red and white meat, which has led many consumers to distance themselves from consuming it and turn to alternatives such as fish, which are characterized by seasonality. Due to shortcomings in the models used to analyze time series data, the study aimed to analyze the time series of prices and production of some kinds of fish (Nile Tilapia, Mullet and Catfish) using the autoregressive integrated moving average (ARIMA) model. This allows for accurate predictions as much as possible to benefit policymakers in formulating production policies for these kinds of fish.

The results:

1. There were seasonality in production among months at a significance level of 1% for Nile Tilapia and Catfish, while significance was not established for Mullet during the period (2017-2021).
2. There were variations in the seasonal and Irregular components and the proportion of seasonal variation in production during the period (2017-2021). It was found that the seasonal movement rate in production reached its maximum for Nile Tilapia during the months May, December, and October, while it was at its minimum in June, July, and April, respectively. As for Mullet, its maximum was in May, April, and February, while its minimum was in December, August, and June, respectively. Regarding Catfish, these proportions reached their maximum in August, March, and December, while their minimum was in May, February, and April. The final proportion of the combined seasonal/trend variations for the time series of Nile Tilapia, Mullet and Catfish was 1.10, 1.87, and 1.99, respectively.
3. It is expected that the production of Nile Tilapia, Mullet and Catfish will increase by 3.78%, 2.36%, and 1.08%, respectively, during the period (2024-2026).
4. There were seasonality in prices between months at a significance level of 1% for Nile Tilapia, while it is not present for Mullet and Catfish, with the values of (F) 4.24, 1.43, and 1.67 for the three species during the period (2017-2021).
5. There were variations in the seasonal and Irregular components and the moving seasonal percentage of prices. It was observed that the seasonal movement rate was maximum for Nile Tilapia during the months of February, January, March, while it was at minimum in December. As for Mullet, it maximum in January followed by February, was the minimum in December. The highest percentage for Catfish was in February, followed by January and March, while the lowest price was in December and November respectively. The final percentage of the combined seasonal/Irregular changes for Nile Tilapia, Mullet and Catfish were 4.03, 2.32, and 2.49 respectively. The percentage of combined Irregular/Trend-cycle changes was 0.98, 1.61, and 1.33 for the three species respectively.
6. An increase in prices is expected by approximately 15.4% for Nile Tilapia, while a decrease of about 7.7% and 3.04% is anticipated for Mullet and Catfish respectively during the period from (2024 - 2026).

Recommendations: the study recommends:

1. The contribution of the General Authority for Fish Wealth Development in enhancing the production methods of fishermen and fish farm owners through conducting specialized training courses to assist them and familiarize them with the latest production techniques.
2. Working on expanding private and governmental fish farms with a focus on producing Tilapia, as it is considered the staple fish for most Egyptians due to its affordability compared to other kinds of fish.
3. The state providing low-interest loans targeted towards small fishermen to contribute to the development of their fishing boats, in addition to increasing investments directed towards developing the Egyptian fishing.
4. The state working on solving the problems facing Egyptian fishermen in regional and international waters.

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