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Predicting the demand and supply of prawn in Nigeria from 2015 to 2025, a grafted model approach

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ABSTRACT

The study forecasts demand and supply of prawn in Nigeria from 2015-2025. Times series data from 1950-2015 were collected from secondary sources and analyzed using descriptive statistics like % ages and inferential statistics like linear and grafted models. Results from the analysis indicated that Nigeria is still self-sufficient with respect to prawn production and there is an increasing level of demand. The trend in prawn production shows a steady increase from 1950-date.The projection for demand and supply shows that the quantity of prawn demanded in Nigeria would increase from 3.4 million metric tonnes in 2015 to 4.1 metric tonnes in 2025, while the supply of prawn is projected to rise from 0.67 million metric tonnes to 0.8 million metric tonnes in 2025. The gap from production and demand is wide with a % age of 80% each year. This projected wide gap calls for prompt policy measures in order to

monitor the volume of prawn production in Nigeria; provision of loans at low interest rate to farmers to help increase production is also advocated. The locals should be stimulated to increase production by placing embargo on importation of prawn to avoid the anticipated food insufficiency crises in the future especially that of prawn.

Keywords: Prawn, demand, supply, grafted model and gap

1. INTRODUCTION

World prawn production has grown tremendously, rising from 20 million tons in 1950 to 156.2 million tons in 2012, 97% of which was used for direct human consumption. Per capita prawn consumption increased from 9.9 kg in 1960 to 19.1 kg in 2012. The increase in production is due in part to aquaculture, which has retained high levels of growth since the 1980's [1]. By 2012, aquaculture production had increased to 66.5 million tons, or about 43 % of total supply. Growth in productivity and technological progress were important factors that buttressed production growth in aquaculture [1]. According to the Organization for economic Co-operation and Development (OECD), [2] projections, this trend is likely to continue, with global prawn production hitting 181 million tons by 2022, the main driver of this increase being aquaculture production. Meanwhile, since the mid-1980s, growth in captured prawns has shrunk to around 85 to 95 million tons per year, the main reason for this being the depletion of prawn resources.

With global population of over six billion people, meeting the world nutrient demand becomes a challenge. The trend in prawn production, prawn deficit and gross domestic product in Nigeria indicates that there has been an increase in prawn production over the years with fluctuations but the observed increase has not been able to meet up with local demand with the demand supply gap (deficit) rising much faster than growth in prawn production. Despite the growing deficit, the gross domestic product grew primarily from contributions from other agricultural sub-sectors and other economic sectors [3]. [4] Studies on future demand and supply for prawn and prawn products predicted a sequential increase in demand for prawn. Majority of this increase will result from expected economic developments, population growth and changes in food habits while the supply from artisanal prawn is expected to remain constant or even close to decline [5]. In reality, prawn supplies from most countries are thought to be approaching or near to the maximum sustainable yield [5].

Prawn is an important source of protein for many households. According to the [6] prawn contributes more than 60% of the world supply of protein, especially in the developing countries. Aquatic foods have high nutritional value and are one of the most widely traded and exported food products around the globe [7]. Prawn being a 'rich food for the poor people' is well placed to make an important contribution to the Millennium Development Goals (MDGs). Though the most visible contribution is in terms of food security and living standards, it also has an important nutritional role in reducing child mortality, improving maternal health and combating HIV/AIDS and other diseases. Prawns also contribute directly to several of the MDGs through improved nutritional status and enhanced livelihood, and to gender equality through women's prawn – related livelihood activities [6]. Prawn consumption contributes significantly to the enhancement of natural health as it contains omega III fatty acid that reduces risk of cardiovascular diseases, hypertension and arteriosclerosis. Prawn is thus medically prescribed as prescribed as preferred animal protein especially to the age bracket of 50 years and above. Also, Omega III responsible for proper development of brain cells in developing foetus. Prawn is welcomed diet for pregnant women and young children for good health and mental development. It is said to enhance intelligence quotient (IQ) in developing children. Prawn farming is one of the fastest growing agriculture enterprises in Nigeria. The input of prawn to Nigeria economy is indicated by its contribution to the gross domestic product (GDP) being 5.4% in 2002 [8].

Research on prawn demand and supply projections has been conducted [1] but with no particular emphasis on prawn demand and supply projections in Nigeria [9]. Worked on availability and consumption of cultured prawn in Katsina State, Nigeria, [3] researched on prawn production and economic growth in Nigeria. Available works have left out demand and supply projections for prawn; it is in the light of this that this study proposes to answer the following research questions:

(i) What is the trend of prawn demand and supply in Nigeria?

(ii) What is the demand-supply gap of prawn between 2015 and 2025?

(iii) What is the demand and supply of prawn between 2015 and 2025?

The broad objective of this study is to predict demand and supply of prawn in Nigeria between 2015 and 2025. Specifically, this study seeks to:

(1) Determine the trend of prawn demand and supply in Nigeria.

(2) Investigate the demand-supply gap of prawn between 2015 and 2025.

(3) Estimate demand and supply of prawn between 2015 and 2025.

2. MATERIALS AND TECHNIQUES

The area of research is Nigeria. Nigeria is situated in West African region where it is bordered by Niger and Chad to the north, Cameroon to the east and Benin Republic to the southwest. It has a total area of 923,800 sq. km. And it occupies about 14 per cent of West Africa's land area. The nation sits between the 4th and 14th latitudes, and the 3rd and 15th latitudes, respectively. Nigeria is located within the tropics and therefore experiences high temperatures which vary from 32˚C along the coast to 41˚C in the far north, while the mean minimum figures range from 21˚C in the coast to below 13˚C in the north. The country's climate ranges from a very wet coastal area with annual rainfall reaching 3,500 mm to the north Sahel region. It is divided into six geopolitical regions: North Central, North East, North West, South West, South East and South South. It can also be divided based on the geo-ecological zones into the dry savannah (North East, North West and part of North Central), the humid forest (parts of South West, South East, North Central and South South) and moist savannah, some part of South West, South East and mainly South South [10]. Times series data on prawn production, quantity of prawn demanded and supplied, per capita income (GDP of agricultural product) were collected from secondary sources (Publications of Central Bank of Nigeria, CBN statistical bulletin and National Bureau of statistics for a period of eleven years (2015-2025).

Objectives one and two were analyzed using descriptive statistics, while objective three was analyzed using grafted model.

Model Specification

The regression model (linear and grafted) as shown by [11] is as specified below:

Demand Model

$Y_d = Pop_t^* \quad Pc_i$

Where: Y_d = quantity of prawn demanded

Pc_i = per capita demand of prawn

Po_i = population

Supply Model

The supply equation was also used to determine the effects of the below stated explanatory variables on the supply of locally prawn production in Nigeria. The ordinary least square result (OLS) for the linear and linear and grafted model was considered as shown by [11]. The grafted model was adopted as the best for estimation. The model is specified below as:

$Q_t = \alpha_0+\beta_1 t+\beta_2 t^2$ for $2015 \le t \le 2025$..... 1

Where: Q_t= Quantity of prawn supplied in tonnes

βs are estimated parameters.

α_0 is the intercept which is constant.

t trend= 1, 2, 3, 4 Driving the mean function as noted by [12] cited by [11], the mean function must be continuous, linear in structural parameters and differentiable at the joints of the pairs of the trend functions. That is, the following restrictions are required to hold.

$\alpha+\alpha_1 k_1=\beta_0+\beta_1 k_1+\beta_2 k_1^2$.....2

$\beta_0+\beta_1 k_2+\beta_2 k_2^2=c_0+c_1 k_2$.....3

Where the ks are the joints of the years k_1= 2015, k_2 =2025

In the case of equation 3, $k_1 \le t \le k_2$, we have

$Q_t= cX_0+c_1X_1+\beta_2X$.....4

Where X_0=1, for all t

X_1=t for all t

$X_2=[k^2_2-k^2_1-2(k_2-k_1)t]$, for all $t \le k_1$

$=(t-k_2)^2$, for $k_1 \le t \le k_2$

=0, otherwise

Prawn production, quantity of prawn demanded and supplied was measured in tons, population was measured in millions, per-capita demand of prawn was measured in kg. Trend of prawn demand and supply was measured based on increase or decrease in quantity demanded and supplied respectively while the demand-supply gap was measured in tonnes.

Production Models

The supply projections for the years 2015 – 2025 were made using grafted model while demand projections was made by multiplying the per capita demand of prawn by the population in the base year.

3. RESULTS AND DISCUSSION

Figure 1 shows that the trend of prawn production in Nigeria was on the increase between 1950 and 1975 but there was a dwindling/fluctuating trend between 1976 and 2005. The growth in prawn production had been on the decreasing rate with growth being negative between 1975 and 1990. The production trend took another turn as it increases upwards from 1990 to 2007. This increase was probably due to increase in the practice of prawn rather than depending on artisanal prawn. These findings are in line with the work [3].

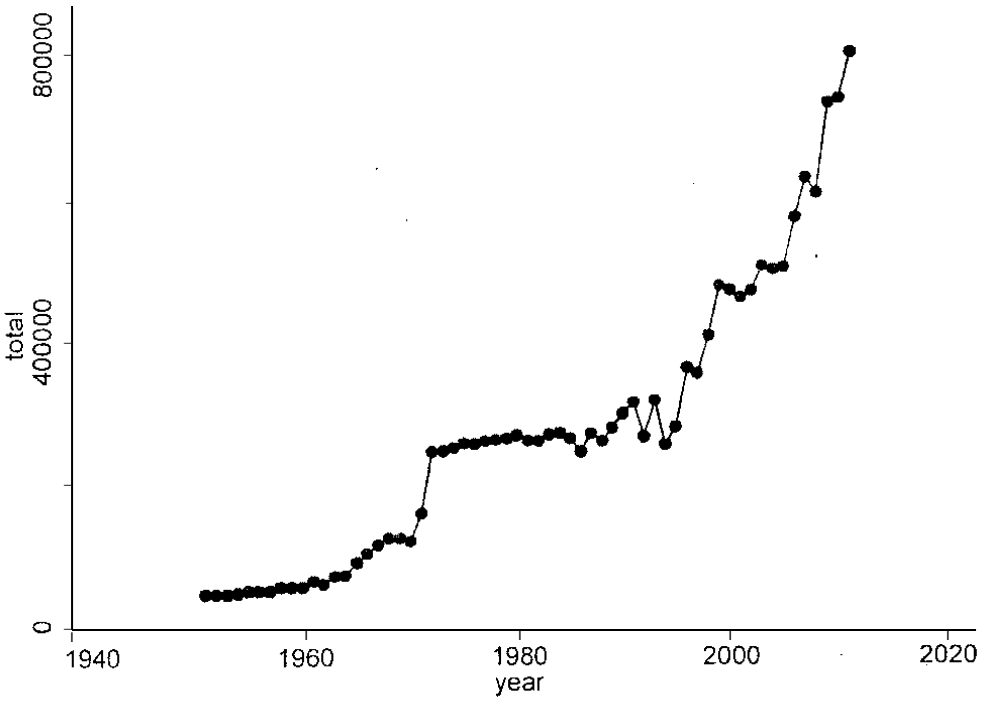

Figure 1 Trend of Prawn Supply

Estimate of Demand and Supply of Prawn

Two models were employed in estimating the supply of prawn; linear and grafted model. The grafted method was adopted as the best for production because it has a higher coefficient of determination. The result is as shown in table 1

Table 1 Estimate of Structural Parameters for Linear and Grafted Functions for Prawn (2015 – 2025)

Variable	Linear Equation	Grafted Equation
X_1	9333.6	13705.9
		(t = 11.5)
X_2		114.54
Intercept		(t = 3.85)
	- 28254.15	- 234534.4
	(- 2.09)	(- 4.27)
Adj R^2	0.9060	0.9245
DF	56	55

Source: Data analysis (2019).

Demand, Supply Projections and Deficit in Prawn Production

Demand Projections

The demand projections for the quantity of prawn that would be demanded in Nigeria as shown in Table 2 were made for the years 2015 to 2025. These were obtained by multiplying the population of the country by the required quantity of prawn per year put at 19.1 kg [1]. The actual demand of prawn in 2015 (base year) was 3.4 million metric tons. Total demand is projected to grow to 4.1 million tons in 2025. This indicates that the demand for prawn is growing without any concerted effort to mitigate it. This supports the findings of [13] as well as [14]. One of the enormous challenges in the drive to increase prawn production to meet the animal protein requirement of the growing population would be to raise the productivity and efficiency of the prawn sector. More so that Nigeria's rapid population growth had outstripped the nation's capacity to grow food [15].

Supply Projections

The supply projections of local production as well as domestic consumption into the future require adequate knowledge of the future values of the exogenous variables. The supply projections for the prawn were made using the grafted polynomial. The supply projection for the year 2015 to 2025 is as shown in Table 2. As at 2015, the total prawn quantity of local prawn supplied in Nigeria was 0.67 million metric tons. The supply is likely to increase 0.8 million metric tons in 2025. The rate at which the supply of prawn production rises compared to the rate of increase in demand for prawn indicates that if Nigeria continues to depend on artisanal prawn alone, we will get nowhere as this could be subject to natural conditions such as flood, weather and pollutions, etc. These findings agree with the works of [16] and [17].

Table 2 Demand, Supply Projections and Deficit (Gap)

Year	Projected Demand (tons)	Projected Supply (tons)	Demand-Supply Gap (Deficit) in tons	Percentage Gap (%)
2015	3496285	670057.9	2826227.1	80.83
2016	3539409	683763.5	2855645.5	80.68
2017	3575991	697469.7	2878521.3	80.50
2018	3620099.4	711175.6	2908923.8	80.35
2019	3688881	724881.5	2963999.5	80.34
2020	3758970	738587.4	3020382.6	80.35
2021	3830390	752293.3	3075097.7	80.36
2022	3903853	765999.2	3137853.8	80.37
2023	3978895	779705.1	3199189.9	80.40
2024	4052897	793411	3259486	80.42
2025	4129902	807116.9	3322785.1	80.46

Source: Data analysis (2019).

Demand-Supply Gap

The demand-supply gap is shown in Table 2 above. The result shows the deficit in all the years predicted for. The percentage gap for each of the year projected for is averagely 80%. The increasing gap yearly is alarming. This shows that if there is a ban on prawn importation, Nigerians will have to pay heavily to secure a little quantity of prawn in the future (that will be very high since demand outstripped supply). This finding is in line with works of [18] and [3].

4. CONCLUSION

The production of prawn in Nigeria had been increasing on a decreasing rate and had not been able to meet up with the rate of demand which is increasing rapidly. The estimate for the demand of prawn in Nigeria shows that prawn consumption had been increasing at a constant geometric rate while there trend result for supply shows that supply of prawn (local production) is growing at an arithmetic progression. Demand-supply projection indicates that prawn demand in the country will continue to grow geometrically while supply will grow at an arithmetic rate. And if this continues, in the near future, demand for prawn will far surpass its local supply which poses a great challenge to the citizens and government of Nigeria. The deficit from the demand-supply gap of prawn in Nigeria will be so wide and this call for prompt policy measures that must be implemented to avoid the anticipated food crises in future. In view of this, provision of loans at low interest rate to farmers to help increase production is also advocated. The

locals should be stimulated to increase production by placing embargo on importation of prawn to avoid the anticipated food insufficiency crises in the future especially that of prawn.

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Conflict of Interest:
The authors declare that there are no conflicts of interests.

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Data and materials availability:
All data associated with this study are present in the paper.

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