



FORECASTING THE NIGERIAN CASHEW NUT PRODUCTION AND HARVESTED AREAS

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ABSTRACT

The main purpose of this study was to forecast Nigeria total cashew nut area production and total crop harvested. Forecasting future land that may be used under cultivation will help Nigeria Government to make policies on available land use and further cash crop production capacity. Projection of total cash crop production is important for implementing proper measures to increase earnings from exports in the country. The study was conducted to forecasts total area and production for Cashew in Nigeria. The findings of the study are based on data from the years (1961 to 2020) and was taken from the database of FAO (2022). ARIMA Models from time series analysis were applied. In the model selection criteria, the model with the lowest Akaike coefficients, SBIC, AIC, sum of squared residual and Mean Absolute Percentage Errors (MAPEs) of forecasting values were used in selecting an adequate model. Thus, ARIMA 1,1,0 was selected for both the harvested area and total production. Forecasting of the data was done up to 2040. The forecasted values were area harvested (190,779.74ha) and production (129,541.18 metric tonnes). The study presents an insight to national policy makers regarding this essential crop and provides them with a reference range of values in area harvested and production in future so that they may be able to effectively deal with cashew production in Nigeria.

Keywords: Area, Cashew, Forecasting, Harvested and Production.

INTRODUCTION

Cashew (*Anacardium occidentale* L.) is a tropical nut tree crop, and a source of food, income, industrial raw materials, and foreign exchange for many countries of Africa, Asia, and Latin America. In Nigeria, current cashew trading and exports is worth 24 billion naira (\$160 million) and over one million people depend on the industry. Commercial cultivation of cashew in Nigeria dates to more than 60 years, while research and development into its production, processing and marketing started in 1972 (Adeigbe *et al.*, 2015). Cashew is reportedly ranked third in world production of edible nuts that are traded globally (Akanni and Adams, 2011). The introduction of Brazilian cashew biotype with improved and desirable nuts and quality characteristics by the Cocoa Research Institute of Nigeria (CRIN) has further increased the popularity of the crop and the spread in Nigeria (Hammed *et al.*, 2007). In Nigeria, cashew nuts exports represent 7- 8% of non-oil export earnings. The estimated export value varies from US\$ 25- 35 million annually and supplements the income of about 50,000 farmers and an additional 55,000 people who are employed down its value chain (Adejo, 2011). Nigeria tops the countries that produce the best cashew nuts, followed by India, Cote d Ivoire and Philippines (FAO, 2017).

Nigeria has about 600,000 surviving cashew trees spread across the country, in all parts of the country. Currently, 75 per cent to 80 per cent of cashew nuts produced in Nigeria are exported, as only very few companies are involved in the local processing of the produce. The



industry is also a vibrant employer, providing about 600,000 jobs and an annual trade worth N24 billion. The cashew industry is a major contributor to the nation's non-oil GDP. (This Day, 2022).

In 2020, cashew nut exports from Nigeria yielded around 192 million U.S. dollars. The highest value was achieved from trading in unshelled nuts. In the previous year, a higher amount of approximately 229 million U.S. dollars was exported. Cashew nuts exports from Nigeria has followed a steady decrease since 2017. That year, a peak of around 342 million U.S. dollars was achieved. The country is one of the leading exporters of cashew nuts in Africa. (Sasu, 2022). The government's liberalization policy on commodity crops has impacted significantly on the prices and demand for raw cashew nuts in the recent past. The role of local buying agents in the supply chain did not only increase the supply of the product but also healthy competition. Also, is the increase in holding capacity of the product through the expansion of warehouses by the Nigeria Commodity Exchange (NCX). The NCX commissioned 12 delivery warehouses in 2020. These additional warehouses spread across the six geopolitical zones have a combined capacity of more than 26,000 metric tonnes. Nigeria's cashew has low patronage at home and high demand abroad (This Day, 2022).

In Nigeria, cashew is increasing in its important as an export-oriented cash crop since in the 1990s. it has become an important source of non-oil earnings. It is a commercial crop cultivated in 27 states of the country including FCT (This day, 2023). Cashew crop constitutes a source of income, employment, and raw materials for the producing nations (Nayar, 1995). More than 65% of farming families who are smallholder farmers all depend on the crop as a major source of income in Nigeria (CBN, 2005). Cashew is grown throughout Nigeria, but the cultivation is centralized primarily in the south and middle belt regions in smallholder farms and plantations (Olife *et al.*, 2013).

The main purpose of crop forecasting is to provide advance information on cash crop production and its supply in the country. One of the most important and highly popularized time series models is Box-Jenkins approach, commonly known as ARIMA (Autoregressive Integrated Moving Average). The rationale behind the model is to identify, estimate and diagnosis a time series model where time is the main explanatory variable. According to Rahman (2001) the estimation models for forecasting the probable future value of an economic time series is one of the econometric methods of information management. While Makindakis *et al.* (1998) and Maurice *et al.* (2013) affirmed that the need for forecasting increased in recent times by administrators and managers of various economies in order to decrease their very dependence on chance. They further noted that managers are becoming more scientific in dealing with issues, thereby obtaining a more accurate and reliable future forecast for economic variables.

This study is set to forecast the area harvested under cashew nuts and the total production for the next twenty years. This forecast we believe will be useful for policy makers in taking policy decisions.

MATERIALS AND METHODS

Respective time series data for this study were collected from Food and Agriculture statistics yearbook for 2022, Nigeria. Production and harvested area data covering the period 1961 to 2020 were used in the forecasting. Box and Jenkins (1976) linear time series model was applied. Auto Regressive Integrated Moving Average (ARIMA) is the most general type of model for forecasting a time series. The methodology of ARIMA estimation and model selection is a classical topic covered in most textbooks on time series analysis (Brockwell and Davis, 2003; Tsay, 2005; Wei, 2005). According to Meyler *et al.* (1998), the main advantage of ARIMA forecasting is that it requires data on the time series in question only. First, this

feature is advantageous if one is forecasting a large number of time series. Second, this avoids a problem that occurs sometimes with multivariate models. The model was introduced to restore the behavior of a process subjected to random shocks over time between two successive observations of series measuring the activity of the process. A random event is called disturbance affects the temporal behavior of this process and thus changes the observation values of the time series. In general, an ARIMA model is characterized by the notation ARIMA (p, d, q), where p, d and q denote orders of auto-regression, integration (differencing) and moving average respectively (Woodridge, 2013).

A Pth-order autoregressive model:

AR (p), which has the general form:

$$Y_t = \phi_0 + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \dots + \phi_p Y_{t-p} + \varepsilon_t \quad \dots(1)$$

where, Y_t = Response (dependent) variable at time t Y_{t-1}, Y_{t-2}, \dots ,

Y_{t-p} = Response variable at time lags $t-1, t-2, \dots, t-p$, respectively

$\Phi_0, \Phi_1, \Phi_2, \dots, \Phi_p$ = Coefficients to be estimated

ε_t = Error term at time t

A Qth-order moving average model:

MA (q), which has the general form:

$$Y_t = \mu + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - \dots - \theta_q \varepsilon_{t-q} \quad \dots(2)$$

where, Y_t = Response (dependent) variable at time t

μ = Constant mean of the process $\theta_1, \theta_2, \dots$,

θ_q = Coefficients to be estimated

ε_t = Error term at time t $\varepsilon_{t-1}, \varepsilon_{t-2}, \dots$,

ε_{t-q} = Errors in previous time periods that are incorporated in the response Y_t

Autoregressive moving average model:

ARMA (p, q), which has the general form:

$$Y_t = \Phi_0 + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \dots + \Phi_p Y_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - \dots - \theta_q \varepsilon_{t-q} \quad \dots(3)$$

If the original series is stationary, $d = 0$ and the ARIMA models is reduced to the ARMA models. The difference linear operator (Δ), defined by:

$$\Delta Y_t = Y_t - Y_{t-1} = Y_t - B Y_t = (1 - B) Y_t \quad \dots(4)$$

The stationary series W_t obtained as the d th difference (Δ^d) of $Y_t, W_t = \Delta^d Y_t = (1 - B)^d Y_t$

ARIMA (p, d, q) has the general form:

$$\Phi_p(B) (1 - B)^d Y_t = \mu + \theta_q(B) \varepsilon_t \text{ or } \Phi_p(B) W_t = \mu + \theta_q(B) \varepsilon_t \quad \dots(5)$$

B is the lag or backward linear operator (B) defined by $B Y_t = Y_{t-1}$.

Using this, we build ARIMA models for the total harvested area and total cashew output in Nigeria. The model specification was automatically made by the SPSS package. The minimum Mean Absolute Percentage Errors (MAPEs) of forecasting values were used in selecting an adequate model.

RESULTS AND DISCUSSIONS

For the specification and estimation of model edited, time series data were analyzed by using the "SPSS" package. The process consisted of three steps as follows: model identification (the specification of p, d, q), model estimation (estimation of parameters of the model) and model diagnostic. The results thus obtained were put to various diagnostic checks like residual

analysis, Normality tests and Goodness of fit. The model specification involved the plots of the Auto Correlation Function (ACF), Partial Auto Correlation Function (PACF) and the plot of different series. Auto correlation function indicated the order of the autoregressive components 'q' of the model, while the partial correlation function gave an indication for the parameter p. in the first step to check the stationary of the data used, it was plotted. The plot of time series of area and production showed increasing trend. The auto correlation functions of both series showed nonstationary. To make the series stationary, the data was differenced.

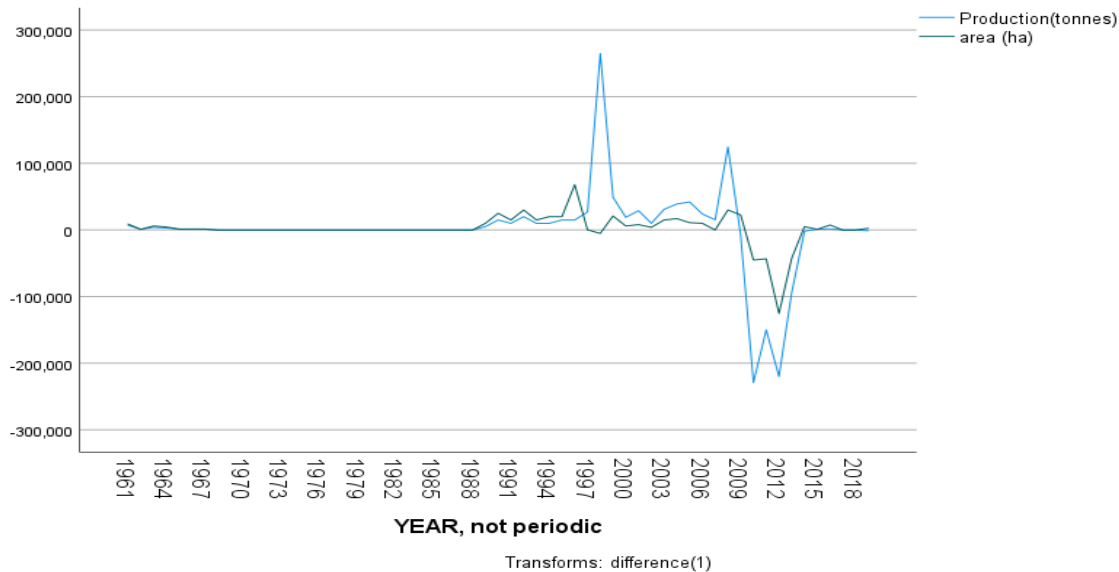


Figure 1: Time series for the total production and area harvested for cashew nuts production in Nigeria.

It shows a steady growth rate from 1961 to about 1998. The production gradually increased upwardly up to year 2000. While from the 2000 onward, yield of cashew experienced a continuously increased until 2009. The trends show that production of Cashew nuts was not very impressive from 1961 to 1999. The reasons for slower growth of area could be due to climatic changes, improper management, and other economic issues. Based on these analyses, forecasts for the coming 20 years (i.e., up to 2040) were worked out at 95% confidence interval values.

Forecasting for total harvested area and total production

ARIMA (1, 1, 0) model are found to be appropriate for both total harvested area and total cashew nuts production and the parameters are presented on the Table 1 and 2.

Table 1: Estimates for Cashew nuts total area parameters ARIMA (1,1,0)

Type	Co-efficient	SE	t	Sig.
Constant	2283.333	5235.561	0.436	0.664
AR Lag 1	0.506	0.114	4.460	0.000

Table 2: Estimates of total cashew nuts production (tonnes) parameters (ARIMA 1,1,0)

Type	Co-efficient	SE	t	Sig.
Constant	1601.986	14152.623	0.113	0.910
AR Lag 1	0.510	0.113	4.505	0.000



Table 3: Augmented Dickey-Fuller Test for Total Area harvested.

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.243031	0.0013
Test critical values: 1% level	-3.548208	
5% level	-2.912631	
10% level	-2.594027	

*MacKinnon (1996) one-sided p-values.

Table 4: Augmented Dickey-Fuller Test for Total production

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.213084	0.0014
Test critical values: 1% level	-3.548208	
5% level	-2.912631	
10% level	-2.594027	

*MacKinnon (1996) one-sided p-values.

Thus, from the model statistics we obtained the model in the form:

$$\hat{Y}_t = 2283.333 + 0.506(Y_{t-1} - Y_{t-2}) \quad \dots(6)$$

Diagnostic checking for the model: Augmented Dickey-Fuller unit root test on time series data of Total Area was applied (Table 3). As the absolute value of ADF test-statistic is greater than the critical values at 5% level of significance, therefore, time series is stationary of the ARIMA (1, 1, 0) Hence, ARIMA (1, 1, 0) is fit for the forecasting total area. The forecast for total area in 2040 will be 190779.74 hectares with upper and lower limit of 550590.71 and -169031.22 hectares, respectively (as shown in Table 5).

For total cashew nuts production, we obtain the model in the form:

$$\hat{Y}_t = 1601.986 + 0.510(Y_{t-1} - Y_{t-2}) \quad \dots(7)$$

Diagnostic checking for the model: Augmented Dickey-Fuller unit root test on time series data of Total production was applied (Table 4). As the absolute value of ADF test-statistic is greater than the critical values at 5% level of significance, therefore, time series is stationary of the ARIMA (1, 1, 0) Hence, ARIMA (1, 1, 0) is fit for the forecasting Total production. The forecast for total production in 2040 will be 129541.18 Metric tonnes with upper and lower limit of 1101811.66 and -842729.30 Metric tonnes, respectively (as shown in Table 5).



Table 5. Forecast for total harvested area and total cashew output from 2020 up to 2040.

YEARS	AREA HARVESTED (HA)	TOTAL PRODUCTION(METRIC TONNES)
2020	144972.91	98985.95
2021	147325.42	99860.86
2022	149643.79	101091.88
2023	151944.87	102504.59
2024	154237.19	104010.01
2025	156525.08	105562.72
2026	158810.71	107139.56
2027	161095.22	108728.72
2028	163379.14	110324.17
2029	165662.77	111922.81
2030	167946.26	113523.09
2031	170229.67	115124.21
2032	172513.04	116725.75
2033	174796.39	118327.51
2034	177079.74	119929.38
2035	179363.07	121531.31
2036	181646.41	123133.26
2037	183929.74	124735.23
2038	186213.08	126337.21
2039	188496.41	127939.19
2040	190779.74	129541.18

From 2020 to 2040; the total harvested area would increase about 24% that is 45,807 ha of new farmland will be cultivated while the total cashew production may have increased by 23.6% in the same period. The total output will continue to be affected by many factors such as climatic conditions, diseases and pests, fire outbreaks, post-harvest losses, low soil fertility and tree aging. Future increase in cashew nut production will only be possible if there is huge investment in high yielding varieties, replacement of older trees, good cultivation practices combine with extension services.

CONCLUSION AND RECOMMENDATIONS

The study concluded that cashew nuts is one of the major cash crops produced in Nigeria. Increment in production would be achieved through extension of new farming areas. Forecasting using ARIMA model for the coming 20 years revealed that harvested area would be 190,779 ha and Total crop output of about 130,000 metric tonnes. These forecasting results will assist the Nigerian government in developing strategy in increasing the country's GNP. The projected values of production give an estimation of the capacity of cash crop that the country can produced in future and to compare with actual economic growth.

Thus, based on the findings of this study, the following recommendations are suggested to enhance the Nigeria cashew nuts production and harvested area:

- Encouragement of adoption of advanced and sustainable good agricultural practices among the cashew farmers. This could include provision of training programmes, use of improved seed varieties, rejuvenations of aged trees.
- The Nigerian government should develop financial mechanisms and programmes that provide accessible loans, credit, and insurance services to cashew farmers. This will



enable them to invest in improved farming inputs, technologies, equipment, thus increasing productivity and mitigate risks.

- iii. The Nigerian government should also prioritize and streamline policies related to cashew nuts production, ensuring a conducive regulatory environment, and providing incentives, and technical assistance to farmers.

By implementing these recommendations, stakeholders can contribute to the sustainable growth of Nigeria cashew nuts production and the expansion of the harvested area. This will not only lead to increased income and better livelihood opportunities for cashew farmers but also position Nigeria as a major player in the global cashew market.

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