Resurrecting Nigeria's groundnut pyramid

M.S. Sadiq,1* I.P. Singh,2 M.M. Ahmad3 and S.M. Umar4

1 Department of Agricultural Economics and Extension, Federal University Dutse, Nigeria
2 Department of Agricultural Economics, Swami Keshwanand Rajasthan Agricultural University, Bikaner, India
3 Department of Agricultural Economics, Bayero University Kano, Nigeria
4 Department of Agricultural Economics and Extension, Federal University Gashua, Nigeria
* Corresponding Author: sadiqsanusi30@gmail.com  https://orcid.org/0000-0003-4336-5723

Abstract: This study empirically reviewed the production trend of groundnut (Arachis hypogaea L.) that was once the pride of Nigeria, with the aim to resurrecting the groundnut pyramid in the country. The study used FAO-sourced annual data that spanned throughout 1961 to 2017 and covered production, area, yield of the studied crop and prices of the studied and competing crops. Collected data were subjected to both descriptive and inferential statistics. The empirical evidence showed the production of groundnut to be affected by area risk and uncertainty- climate change consequence. Furthermore, the future trend of the crop cannot guarantee the food security of groundnut in the country as the annual yield contribution to the annual output will not yield desirable change in the annual output level. Therefore, it becomes imperative for policymakers to inject production and developmental finances into the sector as green alternative remains the best option to salvage the economy of the country which is staggering owing to dampening crude oil prices- a major source of revenue earning. Furthermore, groundnut is now a staple food in virtually all households' diets in the country as it serves as food, oil and condiments, confectionaries, snakes etc., thus a drain on the country foreign reserve owing to the need to strike a balance between demand and supply.

Keywords: Groundnut, Growth, Instability, Forecast, Nigeria

Introduction

In Nigeria, groundnut (Arachis hypogaea L.) used to be the most valuable export commodity from 1950s to 1970s as evidenced by the famous groundnut pyramid in Kano State. In West Africa, 51% of the total production comes from Nigeria, thus making it the largest producer in the sub-Saharan region. Nigeria total production contributions in Africa and the world at large are 39% and 10%, respectively. With an estimated annual 1.55 million mt, the country is the fourth largest producer in the world and the highest producer in Africa (USDA, 2020).

The country was primed to be the largest exporter of groundnut in Africa until in the late 1970s when it lost its position and the visible groundnut pyramid was wiped out due to combination of dry-spell, rosette epidemic, aflatoxin contamination, diseases, poor technology and weak co-ordination of government policies. These major setbacks have significantly affected the crop productivity, thus production and subsequently made the country to lose its share in the domestic, regional and international markets.
In the Northern part of Nigeria, the crop remains the major source of edible oil as well as livelihoods for the smallholder farmers. Nautiyal (1999) reported that in Nigeria, groundnut provides high quality cooking oil and is an important source of protein for both human and animal diets, and also provides much needed foreign exchange by exporting kernels and cake. As the population continues to surge in the world, the demand for edible oil in many developing countries such as Nigeria will also continue to grow. Groundnut will continue to be important in satisfying this growing demand because it is by far the most nutritive oil-seed in most of the developing countries.

In many West African countries, groundnut oil has traditionally been a significant dietary component. In addition, of recently, the use of groundnut meal is becoming more recognized not only as a dietary supplement for children on protein poor cereals-based diets but also as effective treatment for children with protein related malnutrition (Sadiq et al., 2017). Further, in the international market, there is a large trade boom in the groundnut confectionery.

Methodology

An annual data that spanned over the period of 1961 to 2017 and covered production, area, yield of the studied crop and prices of the studied and competing crops, sourced from the FAO database were used. For thorough investigation, the data were portioned based on the regime shifts which marked the nation’s economy viz. pre-Structural Adjustment Period (SAP) (1961-1984), SAP (1985-1999) and post-SAP (2000-2017). Furthermore, the collected data were analyzed with the aid of descriptive and inferential statistics. The objective i was addressed through descriptive statistics and growth model analysis, objective ii using the instability indexes (Sandeep et al., 2016; Boyal et al., 2015; Sadiq et al., 2020), Cuddy-Della Valle instability index (Cuddy and Valle, 1978), Coppock’s index (Coppock, 1962) and Hazell’s decomposition model (Hazell, 1982; Sadiq et al., 2020), objective iii using instantaneous change model and Hazell’s decomposition model, objective iv using the Nerlove’s response model (Sadiq et al., 2017; 2020, and objective v using the ARIMA model, using the methodologies described by Sadiq et al. (2020) with appropriate modifications.

Results and Discussion

Figure 1 illustrates the production trend of groundnut. A marked cyclical trend in groundnut production was observed during the pre-SAP (Structural Adjustment Programme) period with the production tides been high during the early period of the regime, which subsequently declined during the late period of the regime (Figure 2). Furthermore, a steep rise in the trend of the production was observed throughout the SAP period (Figure 3), which maintained a stable high production tide thereafter with a marginal upward and downward swing during post-SAP period (Figure 4). Production trend was driven by both changes in area and yield - mainly by yield despite evidence of area expansion during the early and late pre-SAP period, respectively. A pronounced influence of yield in driving the groundnut production annually persist through the SAP period despite expansion in the annual area cultivated under the reference crop.
Groundnut in Nigeria

Figure 1. Production trend of Groundnut (1961-2017)

Figure 2. Pre-SAP Production trend of Groundnut (1961-1984)

Figure 3. SAP Production trend of Groundnut (1985-1999)

Figure 4. Post-SAP Production trend of Groundnut (2000-2017)
Afterward, the joint influence of both area expansion and yield increase were responsible for the inclined-declined changes that marked groundnut production during the post-SAP period. Therefore, it can be inferred that the complete disappearance of the groundnut pyramid which visible occurred during the pre-SAP and early SAP regimes owed major to poor productivity of the crop in the studied area.

The results of the average annual change in the production of groundnut showed the average annual area to be marked by a slight decline from the pre-SAP to SAP periods and thereafter, steeply inclined by almost two-fold during the post-SAP period (Table 3). Conversely, the average annual yield was on the increase vis-à-vis the regime periods with the changes been arithmetical. Consequently, the average annual production exhibited a similar trend change with what was observed for the average annual yield. Therefore, these results justified the groundnut production trend observed graphically. Results of the growth pattern showed the annual area to be marked by a negative significant growth rate (-6.7%) during the pre-SAP era and thereafter, juxtaposed to a positive significant growth rate which transient through the SAP era (10.9%) to post-SAP era (2.8%). However, for the yield, it ebbed i.e. it was marked by a negative growth rate which transient throughout the regime shifts. For the production, the pre-SAP witnessed a negative significant annual growth rate which thereafter, juxtaposed into positive annual growth rate that transient the two consecutive succeeding policy regimes. The negative growth rate in all the production parameters during the pre-SAP period may owe to the shock of civil war which lasted for almost half of a decade in the country. Generally, for the overall period, the area, yield and production witnessed incremental significant changes in the annual growth rate with the influence of both area and yield been almost simultaneous (Table 1).

Therefore, it can be inferred that both area expansion and technology interchangeably, played a key influence in driving the production level of groundnut in the study area. Besides, the empirical evidence showed the status of the compound growth rate (CGR) for area to be deceleration-acceleration-deceleration vis-à-vis the regime shifts. If the yield level was doubled during the pre-SAP, SAP and post-SAP regimes, the yield status would have accelerated, and then stagnant and decelerated thereafter, respectively. Consequently, the CGR status of the production would have been a deceleration, acceleration and a stagnation vis-à-vis the policy regime periods if the production of the reference crop increased by two-fold.

Table 1. Growth pattern of groundnut production

| Variables | Pre-SAP | SAP | Post-SAP | Overall |
|-----------|---------|-----|---------|--------|
| Area (ha) | CGAR %  | 10.9*** | 2.8*** | 1.2*** |
| AA        | 1421750 | 1325413 | 2380848 | 1699271 |
| Status    | -5177.394***(D) | 6804.76***(A) | -2051.53***(D) | 2044.47***(A) |
| Yield (hg)| CGAR %  | -0.7**  | -0.8NS  | 1.00*** |
| AA        | 8524.33 | 11821.80 | 13348.61 | 10915.54 |
| Status    | 24.68**(A) | -5.930NS(S) | -4.671***(D) | -0.942***(D) |
| Production| CGAR %  | -7.4*** | 10.2*** | 2.3*** |
| AA        | 1193792 | 1510200 | 3119169 | 1885071 |
| Status    | -636.39***(D) | 10311.17***(A) | -5284.93NS(S) | 2047.12***(A) |

Source: Authors' computation, 2020; SAP = Structural Adjustment Programme; AA = Annual Average; A = Acceleration; D = Deceleration; S = Stagnation. *** significant at p=0.001; ** significant at p=0.05; * significant at 9.0.1; NS = Non-significant.

Sources of Change in the Production Level
The results of the instantaneous source of change in the average production vis-à-vis the regime shifts showed that the average annual production level during the pre-SAP to be driven by yield effect while the area effect predominates in driving the annual average production change during the SAP and post-SAP periods (Table 2). The area effect was the major driving force for incremental change in the average annual production level despite the pull-down effect of yield effect and interaction effect. Therefore, the effect of area in bringing about change in the average annual production level of the study crop predominates in the studied area.
Groundnut in Nigeria

Table 2. Sources of change in groundnut production (Intra-wise %)

| Source of change    | Pre-SAP      | SAP         | Post-SAP     | Overall   |
|---------------------|--------------|-------------|--------------|-----------|
| Area effect         | 10.49209     | 74.78194    | -232.032     | 317.0754  |
| Yield effect        | 46.82779     | 54.94869    | 323.398      | -82.2239  |
| Interaction effect  | 42.67321     | -29.7284    | 8.608195     | -134.829  |
| Total change        | 100          | 100         | 100          | 100       |

Source: Authors’ computation, 2020; SAP = Structural Adjustment Programme

Furthermore, the results of sources of change due to the economy structural change showed “change in mean yield” to be the driving force that made the average production level of SAP regime to be higher than that of the pre-SAP era. Contrarily, ‘change in mean area” predominates in making the average annual production level of post-SAP regime to be higher than that of SAP regime (Table 3). Therefore, it can be inferred that the change in the level of groundnut production in the studied area did not exhibit a unique pattern as area effect and yield effect interchange simultaneously.

Table 3. Sources of change in groundnut production (Inter-regime wise %)

| Source of change     | Pre-SAP to SAP | SAP to Post-SAP |
|----------------------|-----------------|-----------------|
| Area effect          | 148.25          | 12.42           |
| Yield effect         | -25.97          | 76.57           |
| Interaction effect   | -10.04          | 9.89            |
| Covariance effect    | -12.23          | 1.12            |
| Total change         | 100             | 100             |

Source: Authors’ computation, 2020; SAP = Structural Adjustment Programme

Magnitude and Sources of Instability

The evidence from the CV showed the magnitude of volatility in both the area and yield to be high and moderate respectively, during the pre-SAP era, thus the reason for the high precipitation of shock in the production. However, during the SAP period, the shock generated as a result of area expansion was high while the yield precipitated low instability. Contrarily, the magnitude of instability as revealed by the CV indices showed a simultaneous low instability in both the area and yield during the post-SAP regime. Therefore, high area instability and simultaneously low area-yield were what have triggered the high and low volatilities in the production of groundnut during the SAP and post-SAP regimes respectively.

Generally, the CV of the overall period showed the production instability to be high which owed to high fluctuation in area expansion (Table 4). Furthermore, in determining the exact direction of the production instability (CDII; Sadiq et al., 2020), it was observed that the production instability was moderate during the first structural change and low for the succeeding structural changes i.e. SAP and post-SAP regimes. The low instability effect of both area and yield dampened the fluctuation extent of the production during SAP and post-SAP regimes while the simultaneous moderate effect of both the area and yield was responsible for temperament instability noticed in the production of groundnut during the pre-SAP era. Contrarily, the area and yield instabilities were high and low respectively for the overall period with a consequential effect of high instability in the production level of groundnut in the studied area (Table 4).

The empirical evidence showed the effect of price volatility on the production level of groundnut to be high across the policy regime shifts as evident by the CII indexes which were above the peak threshold. Therefore, it can be inferred that the reason for the high instability in the production of groundnut owing to price fluctuation can be hedged between arbitrage and speculation effects based on market intelligence and information. Though, the empirical evidence using volatility models viz. GARCH model will prove the extent of the arbitrage and speculation effects in determining price volatility which is responsible for triggering the high production instability evidence in the studied crop. Further, for the overall period, the price fluctuation effect made the instability status of production to be high, thus the reason for high instability in area and yield (Table 4).
Table 4. Magnitude of instability in groundnut production

| Regimes     | Variables | CV    | CDII  | CII    |
|-------------|-----------|-------|-------|--------|
| Pre-SAP     | Area      | 46.913| 26.24614| 46.5353 |
|             | Yield     | 23.978| 23.65208| 50.26351|
|             | Production| 51.84 | 25.76401| 56.20232|
| SAP         | Area      | 51.598| 16.63986| 45.16818|
|             | Yield     | 18.178| 17.82927| 41.4844 |
|             | Production| 47.344| 11.69311| 48.53411|
| Post-SAP    | Area      | 15.385| 5.65281 | 59.27802|
|             | Yield     | 17.352| 11.70456| 39.62221|
|             | Production| 13.369| 13.32883| 59.98133|
| Overall     | Area      | 44.044| 40.9159 | 51.58349|
|             | Yield     | 27.594| 23.21835| 46.0573 |
|             | Production| 54.87 | 45.37985| 55.37053|

Source: Authors’ computation, 2020; Cuddy-Della Valle instability index (Cuddy and Valle, 1978); CII = Coppock's instability index (Coppock, 1962; Sadiq et al. 2020)

The empirical evidence showed "change in mean yield" to be the major risk that account for variation in the average annual production level between the pre-SAP and SAP regimes. Between the SAP and post-SAP regimes, fluctuation in the average annual production level was majorly driven by "change in area variance", while for the overall period, "change in area variance" which is a risk and "change in residual" which is an uncertainty predominates in causing variation in the annual average production level of groundnut in the country (Table 5).

Table 5. Sources of instability in groundnut production

| Source of variance                        | Pre-SAP to SAP | SAP to Post-SAP | Overall |
|-------------------------------------------|----------------|-----------------|---------|
| Change in mean yield                      | 132.29         | -31.82          | 28.35   |
| Change in mean area                       | -2.21          | 17.37           | 2.96    |
| Change in yield variance                  | -0.72          | 0.82            | 1.17    |
| Change in area variance                   | 32.65          | 141.80          | 75.75   |
| Interaction between changes in mean yield and mean area | -0.75          | 2.48            | -2.16   |
| Change in area yield covariance           | -54.25         | -24.24          | 1.14    |
| Interaction between changes in mean area and yield variance | 0.09           | 1.83            | -0.53   |
| Interaction between changes in mean yield and area variance | 30.15          | 38.99           | -73.32  |
| Interaction between changes in mean area and yield and change in area-yield covariance | -15.90         | -24.78          | -1.00   |
| Change in residual                        | -21.35         | -22.45          | 67.65   |
| Total change in variance of production    | 100            | 100             | 100     |

Source: Authors’ computation, 2020; SAP = Structural Adjustment Programme

Farmers’ Acreage Response
The Nerlovian’s response regression model (Sadiq et al., 2020) revealed that the linear functional form is the most suitable among the functional forms tried, given that it met the economic, statistical and econometric criteria (Table 6). Thus, the linear functional form of the multiple regression was chosen as the lead equation as the best fit for the specified equation. The diagnostic test results showed the residual to be normally distributed, no problem of heteroscedasticity, no serial correlation and no arch effect as indicated by their respective t-statistics which were not different from zero at 10% degree of freedom (Table 6). In addition, the empirical evidence showed the model specification to be adequate, the parameter estimates were stable i.e. did not drift and there is no structural break in the equation despite that the sample has different sub-population (regimes) as evident by their respective t-statistics, which were not different from zero at 10% degree of freedom (Table 6). Furthermore, exploration of the measure of goodness of fit to test the reliability of the results, the empirical evidence showed absence of spurious
correlation and spurious regression: the measure of goodness of fit (0.94) is less than the value of the Durbin-Watson statistic (2.22). With these ample evidences, there is a statistical sense in the least squares, thus the least squares are reliable for future prediction given that they are efficient and consistent (Table 6).

Table 6. Farmers' acreage response

| Variables | Parameters | t-stat  | Mean  | SRE | LRE  |
|-----------|------------|--------|-------|-----|------|
| Intercept | 364109 (233722) | 1.558⁴ | -     | -   | -    |
| GP_{t-1}  | -8.73866 (8.132)  | 1.075⁴ | 16982.43 | -0.93 | -0.736 |
| CP_{t-1}  | 5.29774 (5.310)   | 0.997⁴ | 24977.16 | 0.083 | 0.656 |
| SP_{t-1}  | 0.954002 (6.690)  | 0.142⁴ | 22030.71 | 0.013 | 0.104 |
| GPR_{t-1} | 27.8188 (13.705)  | 2.030** | 2305.37 | 0.040 | 0.318 |
| CPR_{t-1} | -10.6878 (5.663)  | 1.887*  | 5814.695 | -0.039 | -0.308 |
| SPR_{t-1} | 22.8058 (22.716)  | 1.004⁴ | 2626.06 | 0.038 | 0.297 |
| Y_{t-1}   | 33.047 (17.108)   | 1.932*  | 10701.02 | 0.222 | 1.753 |
| YR_{t-1}  | -82.243 (27.043)  | 3.041*** | 1131.703 | -0.058 | -0.461 |
| T_{t-1}   | -850.502 (6519.89) | 0.130⁴ | 24.5   | -0.013 | -0.103 |
| WI_{t-1}  | -476900 (163698)  | 2.913*** | 0.986241 | -0.295 | -2.332 |
| A_{t-3}   | 0.873504 (0.0746)  | 11.70*** | 1562182 | 0.856 | 6.765 |
| R²        | 0.93978           |        |        |     |      |
| F-stat    | 49.656 {4.86e-18} *** |        |        |     |      |
| Durbin-Watson | 2.223 {0.4691} NS  |        |        |     |      |
| Autocorrelation | 0.7332 {0.397} NS  |        |        |     |      |
| Arch effect | 0.8409 {0.3591} NS  |        |        |     |      |
| Heteroscedasticity | 11.295 {0.4189} NS  |        |        |     |      |
| Normality  | 0.3897 {0.8229} NS  |        |        |     |      |
| CUSUM test | 0.5284 {0.6006} NS  |        |        |     |      |
| RESET test | 1.5741 {0.2223} NS  |        |        |     |      |
|          | 0.18457 {0.9985} NS  |        |        |     |      |
|          | 0.24725 {0.2999} NS  |        |        |     |      |

Source: Authors’ computation, 2020; CUSUM = cumulative sum; RESET = Ramsey Regression Equation Specification Error; *** significant at p=0.001; ** significant at p=0.05; * significant at 9.0.1; NS Not-significant. Values in ( ), [ ] and { } are standard error, t-statistic and probability level respectively. SRE = short-run elastic; LRE = long-run elasticity; Refer to the text for the abbreviation of variables.

The measure of goodness of fit (R²) indicated 94% variation in the current acreage of groundnut in the studied area is been explained by the economic variables involved in the economy phenomenon of farmers’ acreage response while 6.02% represent the influence of the disturbed economic reality. Furthermore, the empirical evidence showed six exogenous information viz. lagged yield, weather index, lagged yield risk of groundnut, lagged price risk of groundnut, lagged price risk of cowpea and the lagged acreage to be the economic variables that significantly influenced farmers’ decision on current acreage allocation cultivated under groundnut as indicated by their respective least squares which were different from zero at 10% degree of freedom.

The positive significant impact of lagged yield in inducing expansion on the current extent cultivated under groundnut implied that improved groundnut varieties coupled with the recommended technological practices were adopted. Thus, the high productivity of the crop in the studied area stimulated expansion in the current area cultivated in the studied area. The negative significance of the weather index revealed that the food security of groundnut: a staple and cash crop duality feature, is been threatened by climate change - dry spell due to untimely rainfall cessation, thus affecting the current acreage allocated to groundnut in the studied area. It was observed that the farmers were risk-averse to failure- yield loss in order to avoid lost of equity given that the bulk of the crop is produced by farmers having tiny and uneconomic holdings. In addition, coupled with the tiny and uneconomic holdings, these farmers are resource-poor, and loss of equity capital can lead to loss of livelihood, thus causing a decline in the current acreage cultivated under groundnut. Besides, the farmers are risk averse to fluctuation (high) in the
price of cowpea as surge in the price of cowpea forced the farmers to shift to the cultivation of cowpea, thus affecting the current acreage cultivated under groundnut. However, the farmers had preference for price risk in the situation when the groundnut supply fall short of the demand, thus impacted positively on the current area cultivated under groundnut. Furthermore, the empirical evidence revealed that the crop is cultivated on small-scale basis and shifting to the production of alternative crops is capital intensive for these resource-poor farmers, thus the non-significant of the owned lagged price coefficient.

Further, it was observed that the farmers adjust slowly the current area cultivated under groundnut as evident by the adjustment coefficient which is 0.127. The short-run and long-run elasticities were -0.09 and -0.736 respectively, indicating the acreage responsiveness of the crop to price changes during the immediate succeeding period for the former while the later reflects the acreage responsiveness of the crop to price change if given sufficient time. Thus, it can be inferred that in the long-run, the impact of price policy instrument on groundnut production is insignificant. This finding is contrary to the finding of Jain et al. (2005) where the acreage responsive of groundnut to price changes in the long-run was high, thus, indicated that the price policy instrument impacted substantially on groundnut in the long-run. It is worthwhile to note that negative supply response is not an uncommon feature as revealed by previous studies (Jain et al., 2005; Sadiq et al., 2017; 2019; 2020). Evidence showed that the farmers are faced with high constraints viz. technological and institutional, as the time needed for price effect to adjust and materialize would be 22.15 years. This did not come as a surprise as the visible groundnut pyramids which disappeared for almost four decades is yet to re-surface in the studied area. Furthermore, the result showed that the investment on the infrastructure development, agricultural research and technologies had no impact on the crop as indicated by the non-significant of the time trend index at 10% degree of freedom.

**Production Forecast of Groundnut**

The ADF-GLS and KPSS unit root tests results showed the variables to be integrated of the same order I (1) (Sadiq et al., 2020), implying that they all became stationary after first difference (Table 9). This shows that the variables are Gaussian white noise. For the forecast, the ARIMA at different level showed ARIMA (1,1,1)(AIC) to be the best fit to forecast production, area and yield respectively, given that they have the lowest AIC values (Table 7).

| Items                     | Production | Area     | Yield    |
|---------------------------|------------|----------|----------|
| ADF-GLS test              | Level      | -1.475   | -1.256   | -2.3832  |
|                           | 1st Diff   | -4.280   | -4.3827  | -4.7783  |
| KPSS test                 | Level      | 1.8057   | 1.10244  | 1.40623  |
|                           | 1st Diff   | 0.1186   | 0.20196  | 0.07553  |
| ARIMA (1,1,1)(AIC)        |            | 1611.531 | 1554.32  | 1021.79  |
| ARIMA (1,1,0)(AIC)        |            | 1609.859 | 1552.67  | 1019.83  |
| ARIMA (0,1,1)(AIC)        |            | 1609.982 | 1552.68  | 1020.905 |
| Autocorrelation test 1st  |            | 2.543**  | 3.3125** | 0.7412** |
| Arch LM test              |            | 3.718**  | 0.4274** | 3.639**  |
| Normality test            |            | 4.633*   | 7.0877** | 0.07185** |

Source: Authors’ computation, 2020; ARIMA = Auto Regressive Integrated Moving Average ADF = augmented Dickey–Fuller; ADF-GLS and KPSS critical levels at p=0.05 are -3.03 and 0.462, respectively. Arch-LM = Autoregressive Conditional Heteroscedasticity-Lagrange Multiplier; *** significant at p=0.001; ** significant at p=0.05; * significant at 0.1; NS = Not-significant.

Furthermore, in determining the reliability of the ARIMAs for forecasting, evidence showed the Theil’s inequality coefficient (U) and the relative mean absolute prediction error (RMAPE) to be less than 1 and 5% respectively (Table 9). Thus, the chosen ARIMAs can be used for ex-ante projection with high projection validity and consistency as the predictive error associated with the estimated equations in tracking the actual data (ex-post prediction) are insignificant and low.
Table 8. One step ahead forecast of groundnut production

| Period | Production (hg) | Area (ha) | Yield (t) |
|--------|----------------|-----------|-----------|
|        | Actual         | Forecast  | Actual    | Forecast  | Actual  | Forecast  |
| 2013   | 2475430        | 318962.9  | 2732700   | 2685448  | 9055    | 12518.71  |
| 2014   | 3399158        | 2866764   | 2799773   | 2756826  | 12141   | 10656.65  |
| 2015   | 3467445        | 3026415   | 2801756   | 2823861  | 12376   | 10688.55  |
| 2016   | 3581800        | 3466149   | 2680000   | 2825419  | 13365   | 12265.4   |
| 2017   | 2420000        | 3560521   | 2820000   | 2702856  | 8582    | 12899.52  |

Source: Authors’ computation, 2020

Table 9. Validation of models

| Variable     | R²         | RMSE      | RMSPE     | MAPE       | RMAPE (%) | Theil’s U   |
|--------------|------------|-----------|-----------|------------|------------|-------------|
| Production (hg) | 0.996647  | 59868.42  | 136146.3 | -3.10369   | 0.861034   |
| Area (ha)    | 0.999463  | 86258.47  | 1486.50   | -0.10541   | 0.973885   |
| Yield (t)    | 0.999169  | 2231.63   | 534.83    | -3.24415   | 0.831902   |

Source: Authors’ computation, 2020; mean absolute prediction error (MAPE), relative mean square prediction error (RMSPE), relative mean absolute prediction error (RMAPE) (Paul, 2014)

The results of the one-step-ahead of the sample production forecast showed the tendency of cyclical trend with the trend ebbing in the years 2019 and 2021; and thereafter, a marginal rise in the production which will persist till the end of the forecast period (Table 10).

Table 10. Out of sample forecast of the variables

| Year | Production (hg) | Area (ha) | Yield (t) |
|------|----------------|-----------|-----------|
|      | Forecast       | LCL       | UCL       | Forecast | LCL | UCL  |
| 2018 | 2952264        | 2168159   | 3736370   | 2844563  | 2373087 | 3712370  |
| 2019 | 2749713        | 1848629   | 3650796   | 2868374  | 2199426 | 3537322  |
| 2020 | 2865895        | 1788005   | 3943785   | 2892179  | 2071989 | 3712370  |
| 2021 | 2843823        | 1643768   | 4038788   | 2915985  | 1968392 | 3863578  |
| 2022 | 2881720        | 1559421   | 4204019   | 2939790  | 1880001 | 3999580  |
| 2023 | 2893605        | 1464063   | 432147    | 2963596  | 1802401 | 4124791  |
| 2024 | 2916773        | 1385627   | 447919    | 2987402  | 1732972 | 4241831  |
| 2025 | 2935047        | 1309395   | 4560699   | 3011207  | 1670008 | 4352406  |
| 2026 | 2955444        | 1240172   | 4670716   | 3035013  | 1612327 | 4457699  |
| 2027 | 2974920        | 1174614   | 4775226   | 3058818  | 1559066 | 4558570  |
| 2028 | 2994795        | 1113240   | 4876350   | 3082624  | 1509577 | 4655670  |
| 2029 | 3014497        | 1055082   | 4973913   | 3106429  | 1463354 | 4749505  |
| 2030 | 3034275        | 999967    | 5068582   | 3130235  | 1419996 | 4840474  |

Source: Authors’ computation, 2020; LCL = lower confidence level; UCL = upper confidence level
The production trend will be driven by the marginal persisting rise in the area as the yield will be marginally fluctuating upward and downward. This showed that the agricultural tailored policies did not exert significant impact on the groundnut production in the country. Thus, there is a need for adequate intervention, viz. production finance to revive this sector as the crop in the recent times has become a staple food in virtually all households in the country. This showed that the food security of groundnut is under a serious threat, which if not tamed will continue to drain the foreign reserve of the country just like wheat which has made the country to be at the mercy of the USA, thus a serious draining on the country purse. Besides, a similar intervention aimed at boosting rice production viz. total ban on importation and the adequate provision of production and development finances-CBN Anchor borrower programme, should equally be extended to groundnut as it is now a necessity in Nigerian’s households’ food plate owing to its multi-dimensional purpose.

Conclusion and Recommendations

The performance of groundnut in the country was affected by poor investment on technology and infrastructure. Further, the effect of area predominates in bringing about change in the annual production level instead of yield. The decision of the farmers on acreage allocation was governed by both institutional and non-institutional factors. The empirical evidence showed area risk and uncertainty to be the factors that are responsible for variability in the annual average production level of groundnut in the studied area. There is need to adjust to climate smart agricultural practices to mitigate the consequence of climate change and low productivity. The future trend of the crop cannot guarantee food security of the crop in the studied area as the contribution of the annual yield will not give a desirable change in the annual output of groundnut. Therefore, in the light of the foregoing, the study recommends the need for the policymakers to support the sector with production and development finances as the crop played a very vital role in sustaining the economy of the nation from 1960s to late 80s and still stand a better chance to buffer the current dwindle economy.

References

Boyal, V.K., Pant, D.C. and Mehra, J. (2015). Growth, instability and acreage response function in production of cumin in Rajasthan. The Bioscan, 10(1): 359-362

Coppock, J.D. (1962). International Economic Instability. McGraw-Hill, New York, pp 523-525.

Cuddy, J.D.A. and Valle, P.A.D. (1978). Measuring the instability of time series data. Oxford Bulletin and Economic Statistics, 40: 53-78.

Hazell, P.B.R. (1982). Instability in Indian food grain production. Research Report 30, Washington, D.C., USA: International Food Policy Research Institute.

Jain, P.K., Singh, I.P. and Kumar, A. (2005). Risk in output growth of oilseeds in the Rajasthan state: A policy perspective. Agricultural Economics Research Review, 18(2): 115-134.

Nautiyal, P.C. (1999). Groundnut: Post harvest operation. National Research Centre for Groundnut, pp: 46. Retrieved from www.fao.org/fileadmin/user_upload/inpho/docs/Post_Harvest_Compendium_Groundnut.pdf.

Paul, R.K. (2014). Forecasting wholesale price of pigeon pea using long memory time-series models. Agricultural Economics Research Review, 27(2): 167-176.

Sadiq, M.S., Singh, I.P. and Ahmad, M.M. (2020). Sesame as a potential cash crop: an alternative source of foreign exchange earnings for Nigeria. Sri Lanka Journal of Food and Agriculture, 6(1): 7-21

Sadiq, M.S., Singh, I.P. and Karunakaran, N. (2017). Supply response of cereal crop farmers to price and non-price factors in Rajasthan state of Nigeria. Journal of Agricultural Economics and Rural Development, 3(2):203-210

Sadiq, M.S., Singh, I.P., Grema, I.J. and Yusuf, A.O. (2017). Modeling profit efficiency of small scale groundnut farms in Niger State, Nigeria: Stochastic Profit Frontier Approach. Journal of Agriculture and Agricultural Technology, Vol. 7(1):14-23

Sandeep, M.V., Thakare, S.S. and Ulemale, D.H. (2016). Decomposition analysis and acreage response of pigeon-pea in western Vidarbha. Indian Journal of Agricultural Research, 50(5): 461-465

Sence Agric (2020). Agriculture at glance. Retrieved from https://www.agriculturenigeria.com/production/groundnut

USDA (2020). Peanut production. Foreign Agricultural Service, United State Department of Agriculture.