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Supply Response and Elasticity of Selected Staple Food Crop in Nigeria: Evidence from FAO, 1995-2017

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Abstract: This study investigates the supply response and elasticity of selected staple food crop in Nigeria: evidence from FAO, 1995-2017. The study is based on secondary data source from Food and Agricultural Organization (FAO). The time series data was sourced from 1970-2015. Supply response in agriculture presents the agricultural output response to changes in agricultural price and all agricultural incentives, therefore, this study investigated the yield response of maize to price change for over 20 years. The highest production of maize was recorded in Kaduna, Niger and Taraba State of Nigeria while the lowest acreage cultivated to maize was found in Lagos and Bayelsa. The results shows that the relationship between the short run and long run elasticity for output response of maize is negatively inelastic. This shows that it is not price responsive.

Key words: Supply response, staple crop, elasticity, Nerlovian Model, FAO, food crop

INTRODUCTION

Despite the endowments of population of about 190 million people in Nigeria with 98.3 mln/ha and enormous natural resourced, Nigeria is still characterized by inequality of income distribution, poor health and education standards, high unemployment rate, high debt and relatively low agricultural productivity (Burren, 1998). The Nigerian post independence economy can be viewed in 3 distinct phases namely, the first phase from 1960-1973; second phase 1974-1982 and third phase 1983 present.

The first phase of the economy which were largely characterized by substantial expansion in infrastructure, public utilities and the construction sectors was supported by the agricultural sector (Tackie and Abhulimenn, 2002). Economic growth in the second phase was propelled by increasing oil export. Increases in oil price in 1973/74 and 1979/80 further precipice huge transfer of wealth to the country.

Due to the mismanagement of the resources in the second phase, the third phase witnessed serious economic deterioration, external debt crisis, financial fragility and rising inflation. Burren (1998) attributed the decline in economic growth to falling and unstable world oil price after 1981. The government was faced with the challenges of insufficient revenue from petroleum to pay the rising costs of imports, finance major developments and service external debt payments.

MATERIALS AND METHODS

Supply response in agriculture presents the agricultural output response to changes in agricultural price and all agricultural incentives. Supply response measures the degree to which level of production changes with response to different factors. Askari and Cummings (1977) suggested Nerlovian Model as the most appropriate model for crop supply response. Nerlovian Model is a dynamic model which states that output (quantity or acreage) is a function of expected price output adjustment and some exogenous variable. Thus, a typical Nerlovian Model as follows:

$$\begin{aligned} & A^{0} = C+a_{1}P_{1}^{e}+a_{2}Z_{t}+U_{t} \\ & p_{t-1}^{e}+1^{3}\left(p_{t}^{e}=p_{t-1}^{e}\right) \\ & A_{t}=A_{t-1}+\left(A_{t}^{0}=A_{t-1}\right) \end{aligned} \quad (1)$$

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Where:

A_t = The actual area to be cultivated at time t
$A^e t$ = The area desired to be cultivated at time t
p_t = The actual real producer price at time t
P^e_t = The expected real producer at time t
Z_t = Any other exogenous supply at time t

The model is restricted to annual crops and can't be use well for perennial crops like cocoa, rubber, oil palm, etc. Peterson (1979) argues against using time-series data in estimating long men elasticity because only short run year to year fluctuations are observed. The output response to annual fluctuations is likely to be small because farmer will respond strongly to the price changes only, if they are perceived to be permanent. Apart from identifying the correct output measurement, researchers much determine which price variable should be used, the choice of the deflator (consumer price index input price, other crops price, etc.) is essential in formulating price response Ajetomobi (2010) used autoregressive distributed lag and error correction models to analyze supply response, risk and intuitional change in Nigerian agriculture. He used tow model. He began with Nerlovian partial adjustment and expectation dynamic model and the risk model. Model 1 (the Nerlovian Model) this can be written as:

$$A(L)A_t = B(L)P_tC(L)RER_t + \sqrt{\frac{1}{m-1}\sum_{j-1}^{m}\bar{P}(P_tJ)_t^2} \text{ for output response}$$

$$A(L)A_t = B(L)P_tC(L)RER_t +_t^e \text{ for acreage response}$$

Model 2 (The risk model): This can be written as:

$$A(L)Q_t = B(L)P_t + C(L)RER + D(L)W_t + t^E$$

$$\text{for output response } A(L)Q_t = B(L)P_t + C(L)RER + D(L)W_t +_t^E \text{ for acreage response}$$

Where:

Q_t = Total production
A_t = Acreage
P_t = Own Price
RER_t = Real Exchange Rate
W_t = Price risk

A(L), B(L), C(L) and DCL) are lag operators of order 1-4 while $_t^E$ is the error term . Oluwande *et al.* assessed how responsive maize output is to price and non price factors and how sensitive fertilizer and labour demand are to prices and non-price factors using cross-sectional farm level data for 334 maize producing household in the high potential maize zone of Kenya. The study employed normalized restricted translog profit function to estimate maize supply and variable input demand elasticities which is written as:

$$\text{In}\rho^* = \alpha_0 + \sum_{i=1}^{2}\alpha_1 \text{InPj}^* + \tfrac{1}{2}\sum_{i=1}^{2}\sum_{j=1}^{2}\text{yijiNpJ}^*\text{inPi}^* + \sum_{i=1}^{2}\sum_{k=1}^{3}\delta\text{ikInPi}^*\text{InZk} + \sum_{k=i}^{3}\beta_k\text{InZ}_k + \tfrac{1}{2}\sum_{k=1}^{3}\sum_{h=1}^{3}\varpi\text{khInZkInZn} + D\mu$$

Where:

$\cdot^*$ = Restricted profit ., normalized by the output price (p) (ksh/kg)
Pi^* = Price of ith input (P_1) normalized by the output price (p) (ksh, kg)
I = 1, fertilizer price = 2, wage rate
Z = Quantity of fixed input k
K = 1 area render maize education level of the household head distance to motor able road .
., yij, .ik, ., U_{kh} = The parameters to be estimated
In = Natural logarithm

Abrar (2001) estimate supply response in the presence of technical inefficiency using the profit function. The profit function at the optimal output level is:

$$\pi(\tau_p, w) = \max p^l y^0 - \tau^{-1}C(y^0, w)$$

where, y denotes the optimal output levels Oladejo *et al.* analyzed the magnitude and the direction to which the level of transaction costs influence changes in maize supply in Iwo agricultural zone of Osun State, Nigeria using Cob-Douglas regression model is written as:

$$\text{Log } Q = b_0 + b_1 \log x_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + b_7 \log X_7 + b_8 \log X_8 + b_9 \log X_9$$

$$\text{While } b_1 > 0,\ b_2 > 0,\ b_3 < 0,\ b_4 < 0,\ b_5 < 0, b_6 < 0,\ b_7 < 0,\ b_8 < 0,\ b_9 < 0$$

Where:

Q = Quantity of maize supplied (kg)
X_1 = Area of land cultivated to maize (ha)
X_2 = Market price for maize (N)
X_3 = Harvest cost (N)
X_4 = Storage cost (N)
X_5 = Cost of transport (N)
X_6 = Assemblage cost (N)
X_7 = Bargaining cost (N)
X_8 = Agents fee (N)
X_9 = Transactions land rent (N)
b_0 = Constant
$b_1, ..., b_9$ = Coefficient values of independent variable
E = Error term

Lawrence (2007) used cointegration and error correction modeling approach to calculate the aggregate supply response to price incentives of maize. The model is represented in this form:

$$\Delta y_t = \alpha_0 - \alpha_1 \left(y_{t-1} - B_i Z_{t-1} \right) + \beta_0 \Delta Z_t + \Delta_D + \varepsilon_t$$

D is a dummy variable, α_0 is an estimated coefficient in the regression, is the difference operator it represents the aggregates maize output. Z is a vector of regressors and β, reflect the equilibrium effect of the individual Z regressors on Olubanjo *et al*. analyze the supply response of cocoa farmers in Nigeria using ECM approach which can be represented in this form:

$$\text{In } Q_t = a_0 + a_1 \text{In } p_t + a_2 \text{InRAN}_t + a_3 \text{InD}_t + a_4 \text{InExC}_t + a_5 \text{InH}_{At} + a_6 \text{UM} - a_7 \text{ecm}_{t-1} + \mu +$$

Where:

Q_t = Output of cocoa in year t (tons)
P_t = Price of cocoa in year (naira)
RAN = Average annual rainfall in yeart for 5 location (inches)
IND = Index of average world price (1985-100) in year
$E{\times}C_t$ = Exchange rate in year ($ to N)
H_{At} = Area harvested to coca in year (ha)
DUM = Dummy variable
Ecm = Error correction factor+

Secondary data was used for this research work. The data was obtained from food and agricultural organization statistics of the United State:

$$\text{Log } Y = \log b_0 + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + e$$

Where:

Y = Quantity of maize (tonnes)
X_1 = Yield (tonnes/ha)
X_2 = Acreage (ha)
X_3 = Price (naira)
X_4 = Rainfall (mm/Annum)
X_5 = Production (tones)
X_6 = Trend
e = error term

RESULTS AND DISCUSSION

The average mean of maize production in Nigeria is 141.026 ton. The production may be low due to insufficient investment in agricultural production pumped less money in agriculture compared to the industrial sector Government on the other hand does not play a good role in planning for the agricultural sector.

Their plan for agricultural sector has not been encouraging following the budgetary allocation for agriculture. This bad attitude towards a better planning to agriculture has led to primitive, subsistent and unproductive standard of agriculture in Nigeria compared to the American system and other countries. It was sometimes said that a single American farmer produces enough food for over one thousand non farmers with surplus to export.

An average farmer in Nigeria can hardly feed himself and his other non-farmers or exporting any surplus. The low production may also be said to be due to irrational, conservative, ignorant and superstitious resources allocations (farmers) who are unable to operate a viable farming system.

The maximum production of maize in Kaduna, Niger and Taraba State is high compared to the rest of the state while the minimum maize production is in state like FCT, Lagos as well as Bayelsa poor impact of irrigation may be attributed to low minimum maize production in those state while good impact of irrigation may be attributed to maximum and maize production in places like Kaduna, Niger and Taraba State Table 1.

Table 1: Descriptive statistics of maize production in Nigeria

States	Mean	SD	Min.	Max.
Abia	69.94500	14.890680	42.02	93.62
Adamawa	134.69420	37.471380	71.84	175.61
Akwa Ibom	53.87500	12.449030	37.10	70.00
Anambra	49.20000	10.259660	27.92	69.00
Bauchi	139.57170	30.648360	69.08	189.66
Bayelsa	2.36500	0.556540	1.67	3.27
Benue	139.18500	13.703650	117.84	165.63
Borno	419.17330	84.354940	343.01	553.25
Cross River	94.11750	11.818010	75.79	114.28
Delta	107.35250	31.719980	81.01	195.00
Ebonyi	40.47500	12.567270	22.11	63.09
Edo	77.62167	10.418380	57.90	88.50
Ekiti	91.78333	7.106344	86.87	113.30
Enugu	85.71250	11.857220	69.64	104.80
Gombe	199.88920	49.564360	156.73	313.11
Imo	162.60750	75.747840	62.30	372.41
Jigawa	5.61667	3.083647	2.46	13.16
Kaduna	844.85170	348.375600	60.52	1391.05
Kano	1395492.00000	37.925860	80.93	215.18
Katsina	170.24830	22.791470	140.12	206.49
Kebbi	28.54167	7.302983	17.00	39.10
Kogi	215.07000	43.461530	123.58	255.00
Kwara	85.79500	15.428830	61.71	113.11
Lagos	0.94250	0.483531	0.41	1.85
Nassarawa	105.19170	22.522790	80.32	145.46
Niger	403.36670	149.020500	299.50	823.50
Ogun	80.64083	11.141100	61.58	96.83
Ondo	168.69920	11.796300	144.22	189.16
Osun	72.18333	10.111990	55.01	87.28
Oyo	245.80080	33.516340	185.40	294.13
Plateau	338.35500	80.718280	196.07	473.90
Rivers	127.89670	29.255850	90.14	170.30
Sokoto	14.96917	1.713574	12.23	18.99
Taraba	240.56670	201.692000	46.75	544.34
Yobe	13.76250	5.592167	6.50	22.50
Zamfara	43.11250	9.747518	25.86	60.84
FCT	5.26000	1.940286	3.91	10.73

Table 2: Descriptive statistics of the maize acerage in Nigeria: 1995-2017

States	Mean	SD	Min.	Max.
Abia	43.121670	7.127319	34.64	57.97
Adamawa	115.094200	49.860960	36.58	156.27
Akwa Ibom	43.233300	11.232200	22.10	55.10
Anambra	22.892500	5.921812	12.42	35.88
Bauchi	95.824170	26.261430	52.23	146.35
Bayelsa	1.944167	0.453260	1.37	2.72
Benue	112.572500	21.801910	98.20	176.64
Borno	288.333300	56.658570	237.96	381.90
Cross River	53.063750	5.175158	43.95	63.08
Delta	57.894170	10.059150	44.58	78.49
Ebonyi	26.705000	5.140917	20.43	36.37
Edo	42.170000	4.817523	32.99	49.29
Ekiti	44.968330	3.046198	41.07	53.18
Enugu	49.020000	9.435646	37.50	66.76
Gombe	133.083300	33.236860	51.30	209.05
Imo	65.000000	5.436386	51.30	70.18
Jigawa	8.078333	4.492260	4.00	19.40
Kaduna	315.151700	41.318460	225.79	371.94
Kano	85.714170	26.691490	47.33	130.70
Katsina	167.605800	38.536390	98.98	248.61
Kebbi	22.658330	3.841036	15.50	31.50
Kogi	136.898300	11.609750	113.00	154.17
Kwara	65.012500	9.417065	52.18	86.15
Lagos	0.444167	0.170318	0.25	0.74
Nassarawa	59.164170	9.721417	42.96	74.34
Niger	317.460000	69.999480	189.56	40.16
Ogun	59.776670	9.303654	75.14	92.47
Ondo	84.083330	5.303654	75.14	92.47
Osun	44.035830	6.270652	33.56	55.23
Oyo	158.198300	21.428740	120.55	189.54
Plateau	169.754200	31.858591	131.45	236.93
Rivers	77.035830	15.524480	56.46	95.08
Sokoto	12.871670	3.382035	9.87	22.26
Taraba	117.851700	108.176400	23.41	265.00
Yobe	18.691670	4.598707	10.70	27.80
Zamfara	38.873330	8.401441	26.00	57.06
FCT	4.968333	1.093616	2.97	7.04

Table 2 shows the overall analysis of maize acreage. Expansion of land under maize cultivation has effect on total agricultural production increase. There is a general, understanding that the growth of maize could be accelerated significantly without bringing more land under cultivation but with the judicious use of the available portions of land under current cultivation exercise.

The low acreage in Nigeria may be due to land use decree promulgated in 1978 which now became land use act in 1982. Rights held by individuals, strangers, village heads have thus been taken over by the state. Use act sets up an upper limit to the amount of agricultural land that can hold.

The low acreage in Nigeria may be due to land use decree promulgated in 1978 which became land use act in 1982. Rights held by individuals, strangers, village heads have thus been taken over the by the state. The low acreage may also be due to the high price of land. When the price of land is high, small scales farmers who doesn't have much money will be limited by this factor and even this factor of high price land will affect the those that may have the intension of having large expose of land for the cultivation of maize.

Table 3: Shortrun and longrun elasticity for output response model

Variables	Shortrun	Longrun
Constant	1.0109810	09.43800
Lag dependent	0.8928855	8.33500
Price	-0.3405230	-3.17910
Rainfall	-0.1223948	-1.14260
Trend	0.0169525	0.15827

R^2 = 0.7974F = 429.13; Adjusted R^2 = 0.7956

Table 4: Shortrun and longrun elasticity for yield response

Variables	Shortrun	Longrun
Constant	0.3399519	-0.0734500
Lag dependent	5.6280640	-1.2160700
Price	0.8206350	-0.1773170
Rainfall	0.1156453	-0.0249900
Trend	0.0039089	-0.0008446

R^2 = 0.1554; F = 20.05; Adjusted R^2 = 0.1476

Table 5: Shortrun and longrun elasticity for acreage response

Variables	Shortrun	Longrun
Constant	1.2441080	11.1614
Lag dependent	0.8885346	7.9714
Price	-0.2030200	-1.8214
Rainfall	0.1788404	-1.6044
Trend	0.0125320	-0.11243

R^2 = 0.8048; F = 449.36; Adjusted R^2 = 0.8030

The low acreage may also be due to the soil type when a soil checked and inspected by the soil specialist, conclusion may separate the land that is best fit for maize cultivation and the one that is not good for the production. The maximum acreage for cultivation of maize was found in States like Katsina, Benue, Taraba, etc.

The minimum acreage for cultivation of maize was found in Lagos, Bayelsa that of Lagos and Bayelsa may be due to high price of land in the states while in states where we have maximum acreage for maize cultivation may be due to high price of land in the states while in states where we have maximum acreage for maize cultivation may be due to the high availability of land for agriculture use.

Table 3 shows the relationship between the short run and long run elasticity for output response for considering the price at the long run it is negatively inelastic. This shows that it is not price responsive. Table 4 shows the relationship between the short run and long run elasticity for yield response. At the long run, the price is negatively inelastic, hence, it is not price responsive.

Table 5 shows the relationship between the short run and long run elasticity for acreage response. At the long run, the price is also negatively inelastic, hence, it is not price responsive. Table 6 shows the relationship between maize supply and selected variables. The variables are yields, acreage, rainfall and price. Considering yield, acreage and rainfall, they have a positive relationship with the supply of maize meaning that an increase in yield,

Table 6: Relationship between maize supply and selected variables

Variables	Coefficient	t-values
Yield	0.3399519	7.52
Acreage	0.8885346	41.41
Rainfall	0.1156453	2.72
Price	-0.3465300	-0.28

acreage and rainfall will bring about an increase in the supply of maize and this is in line with the apriori expectation.

Considering the price it has a negative relationship with maize supply. This means that an increase in price will bring about a decrease in the supply of maize. This is not in line with apriori expectation. Hence, the null hypothesis is accepted which states that the supply of maize is not price responsive.

CONCLUSION

This study examine supply response of maize in Nigeria. A time series data on price, acreage, production and yield per hectare were considered. The average mean of maize production in Nigeria is 141.026 tons, the average mean acreage of maize is 85.3851 ha and the average mean yield in the country is 15775. 14 tons/ha. The regression analysis for long and short run elasticity was used to examine the equations at the aggregate crop levels. The result shows that maize is not price responsive this study mostly support the results that farmer's response to price is very low. One could not dismiss that effort to improve the supply of maize through price incentives is a futile exercise. Various discussion on supply response theme in the academic literature and clearly pointed out that turning attention to removing some of the physical constraints will go a long way in increasing the supply response.

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