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Hectrage Response of Some Selected Cereal Crops to Price and Non-Price Factors in Nigeria (1983-2008)

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Abstract
The Study aimed at estimating the hectrage response of maize and sorghum to changes in price and non- price factors in Nigeria between 1983 and 2008. Time series data in respect of weather index approximated by the national mean rainfall (millimeters), area harvested (hectares), producer price in local currency (Naira/ton), and the annual yield (Kg/hectare) of the selected cereal crops were obtained. Unit root tests, via Augmented Dickey Fuller (ADF) equation, were conducted on the data series to determine the stationary properties of hectrage, price, yield and mean rainfall. Estimation was carried out using the Heteroskedasticity and Autocorrelation Consistent Covariance Estimator. Results of maize response function showed that, own price and yield were significant at 10%, lagged hectrage was significant at 1%; while yield of sorghum was significant at 5%. On the other hand, results of sorghum response function showed that lagged hectrage was significant at 1%, while the yield of the crop, yield of maize and weather were significant at 5% level. The major trend in this study is that lagged dependent Variable(lagged hectrage) has been found to be a significant determinant of hectrage allocation in the cultivation of the crops studied; and yield, rather than price was more important in hectrage allocation decision of farmers in Nigeria. Efforts should be geared towards enhancing land management practices, expansion of cultivable land and accessibility to same by farmers to encourage cultivation of more land for increased crop productivity and achieving stable yields.
Keywords: Hectrage Response, Unit Root Test, Heteroskedasticity and Autocorrelation Consistent Covariance, Response Function.

1.0 Introduction

Agriculture has made a substantial contribution to the economic development of Nigeria especially in the sixties. As the mainstay of the economy, it employs 60% of Nigerians and used to be principal foreign exchange earner for the country. Major agricultural products include groundnuts, palm oil, cocoa, coconut, citrus, fruits, maize, millet, cassava, yams and sugar cane. Prior to exploration of oil in Nigeria in the seventies, agriculture contributed over 70% of the country's Gross Domestic Product (GDP) (Ashinze and Onwioduokit, 1996). One of the most daunting ramifications of the discovery of oil was the decline of agricultural sector. So tragic was this neglect that Nigeria, which in the 1960's grew 98% of its own food and was a net exporter, now, imports much of the same cash crops it was formerly famous for as the biggest exporter. Petroleum now plays a large role in the Nigerian economy, accounting for 40% of the GDP (Search.com, 2010). In recent years, the growth of the agricultural sector has been unable to keep pace with the growing demand for food due to increase in the rate of population growth. This has led to a wide gap between domestic production and consumption, thus, giving rise to increase in the level of importation of food and industrial raw materials.

Prior to 1986, strong appreciation of the Naira eroded the competitiveness of Nigeria's agricultural exports and reduced the cost of food imports due to unfavourable macroeconomic policies, resulting in a predictable sharp decline in the quantity and value of agricultural exports, accompanied by a surge in food imports especially rice (NTWG, 2009). Report in 1983 indicated that about $56.6 million and $213.4 million worth of rice and wheat respectively, were imported (Haruna, 1995). The Food and Agriculture Organization (FAO) also asserts that the level of Nigeria's self sufficiency in cereals has been falling resulting in rapid growth in the amounts of cereals imports, especially rice imports, which increased 130 percent in 2001, over the previous five year average (FAO, 2001). However, these short term measures could not solve the problem of declined agricultural production in the long-run.

In line with the aforementioned circumstance, the federal government formulated policies and programmes aimed at reviving the agricultural sector. The policies were pursued through various means, such as subsidy on prices of improved seeds, fertilizers and agro-chemicals and provision of low interest credit to small-scale farmers among others. In the mid seventies and early eighties some new varieties, basically arable crops were extensively tested under field trials and were found to be responsive towards high doses of fertilizer and irrigation, yielding a significant output than the traditional varieties in vogue. The evolution and distribution of these varieties occurred under the aegis of different programmes such as the Operation Feed the Nation (OFN), Green Revolution, National Accelerated Food Production Programme (NAFPP) and Integrated Agricultural

Development Programmes (ADPs) (Haruna, 2002). To complement these measures, more areas of land were cultivated for increased production of arable crops. These efforts led to tremendous increase in output (Nkonya *et al*, 2010).

In most of the sub-Saharan African countries, the prime role of the agricultural sector in the provision of adequate foodstuff is drastically declining over the years. Due to critical supply shortages, food prices have risen considerably over the years. In Nigeria, the problem had been aggravated by rising costs of farm inputs precipitated by the depreciation of the exchange rate, and the associated general increase in the costs of living and commodity prices due to the introduction of the Structural Adjustment Programme (SAP) in the country (Philip *et al*, 2008). As a result of policy distortions and the increasing liberalization of the economy, particularly the withdrawal of government subsidy on major agricultural inputs such as fertilizer, sustained and successful arable crop production in Nigeria was directly and vigorously challenged by constraints of low yield per hectare, lack of adequate maintenance of established irrigation infrastructural facilities and non availability of production inputs at affordable prices.

It is also a known fact that, the nature of farmers' responses revolves around the ecology and economics of agricultural production, both of which are usually influenced by future occurrence whose probability distribution cannot be determined empirically or otherwise in advance. Furthermore, the necessity for making subjective forecast places a limit on distance into the future for which farmers and policy makers can plan in a meaningful manner (Tahir, 2012). All these influence the extent of policy formulation; and underscore the need for research into the field of supply responsiveness of farmers especially in the developing countries.

But, economic theory suggests that prices are important determinants of economic behavior and rational farmers should sufficiently react to changes in prices of output (Narain, 1965). And according to Moraes (2006), the expected signs of the estimated coefficients of variables are derived from simple logic. An increase in a crop's own price is expected to have positive impact on the crops acreage, while increases in the price of land competing crops are expected to have a negative impact on the crop's acreage. Hence, it is generally assumed that farmers behave rationally and react to circumstances in a way that maximizes their utility in the context of opportunities, incentives and risks as perceived by them (Nayarana and Parikh, 1981).

However, it is the view that farmers in less developed countries are not responsive to changes in relative prices and/or they are less responsive than those in the developed countries (Narain, 1965). And Mytilli (2006) asserts that there are many arguments to support the notion that farmers in less developed countries do not respond to economic incentives like price and income. Krishna, (1962); Narain, (1965); Askari and Cummings, (1976); and Gulati and Kelly, (1999) further assert that non-price factors seem to dominate over price factors in farmers' decision problem. Reasons cited for poor response varied factors such as constraints on irrigation, infrastructure e.t.c to lack of complementary agricultural policies (Mytilli, 2006). The poor performance of the agricultural sector in Nigeria has been ascribed to the existence of these constraints (Phillip *et al*, 2008); leading to the supposed irrational economic behavior of farmers which suggests that farmers do not take into account prices and incomes while allocating their limited resources to various competing crops or enterprises.

Empirical determination of the relationships that exist between output, quantities, resource use and prices remain the central focus for researchers in agricultural development. In view of the overriding need to enhance the level of agricultural productivity, particularly of food grains, in the face of increasing population, declining agricultural output and the supposed poor response of farmers to economic incentives (price and non price factors) in developing countries such as Nigeria; the importance of determining empirically quantitative relationships that provide estimates of changes in output, hectrage and yield associated with input use and in prices and vice visa cannot therefore be overemphasized (Tahir, 2012).

Maize, sorghum, cowpea, groundnut, yam and cassava are some of the most important staple arable crops produced in Nigeria. Annual output of these crops has been observed to increase over the years, and hectrage under their production still have great potentials for expansion with resultant increase in output (Nkonya *et al*, 2010). Also, farmers are expected to respond positively to changes in price and other economic incentives in allocating their limited resources among competing crops. In view of these, an analysis of the hectrage response of selected arable crops in Nigeria was undertaken to verify such assertion, based on agricultural productivity and other economic parameters.

The main objective of the study therefore, is to examine the hectrage response of the selected arable crops i. e. maize and sorghum to price and non-price factors in Nigeria between 1983 and 2008.

2.0 Methodology

2.1 The Area of Study

Nigeria is located in West Africa and shares land borders with the Republic of Benin in the West, Chad and Cameroon in the East and Niger in the North. Its coast lies on the Gulf of Guinea part of the Atlantic Ocean in the South; along the coast of West Africa between latitude 4^0 and 14^0N and longitude 3^0 and 15^0E (Obasi, 2006). Nigeria is a physically and climatically diverse country. It encompasses three major ecological regions, a humid forest region, a sub-humid region and semi-arid region, with annual rainfall ranging from about 250mm in the Sahelian North to over 3000mm in the Southern Coastal areas. The natural vegetation varies from rain forest to savanna. The natural and physical climate diversity permits the growth of a wide variety of crops. There is also substantial inland water resource. According to the 2006 National Population Census, Nigeria is the most populous country in sub-Saharan Africa with a population of 140 million people (National Population Commission, 2006) growing at a fast pace of 3.2% per annum. The population is characterized by almost equal proportion of males and females, and rural-urban migration. Over 44% of the people are living below the poverty line, and 63% of the national population lives in rural areas. The life expectancy at birth was estimated at 51 years (UNICEF, 2010).

2.2 Scope of Study

The study covered the entire country and analyzed the hectrage response of the selected cereal crops from 1983 to 2008 (26 years). Data (1983-2008) for the identified variables were obtained from the Food and Agriculture Organization (FAO) statistical database (FAOSTAT), and the Nigerian Metreological Agency (NIMET). Data in respect of weather index approximated by the national mean rainfall (millimeters), area harvested (hectares), producer price in local currency (Naira/ton), and the annual yield (kg/hectare) of the selected cereal crops covering the period of study were obtained.

2.3 Method of Data Analysis

A Combination of the distributed lag and Nerlovian supply response models was employed. The resulting Nerlovian dynamic adjustment model (NEDAL) was used to determine the supply responsiveness of farmers i.e. hectrage allocation to supply shifters-lagged hectrage, price, yield and rainfall.

A major problem which arises in any economic time series analysis concerns the non stationarity of the variables. Regressions involving non-stationary variables may result in spurious estimates. Following Szeto (2001) who noted that there are three solutions to the problem of spurious regression thus; (1) determine the stationarity of the variables before estimating (2) add the lagged value of the dependent variable as an independent variable (3) the cointegration approach; two approaches were employed by conducting unit root test; including the lagged dependent variable as an independent variable and estimating the regression equation with the Heteroskedasticity and Autocorrelation Consistent Covariance Estimator (HAC consistent covariance) using Statistical Software, E views 4.0.

Determining the stationarity of the variables of study involved testing the unit root in the variables to identify the order of integration of each single time series. This entailed performing an Augemented Dickey Fuller (ADF) unit root test with and without deterministic trend using statistical software, E-views 4.0.

The procedure for the (ADF) test is as follows:

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \sum_{i-1}^{n} \beta_j \Delta Y_{t-1} + \ell_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\Delta Y_t = \alpha + \gamma t + \beta Y_{t-1} + \sum_{t-1}^{n} \beta_j \Delta Y_{t-1} + \ell_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where equations (1) and (2) above indicate ADF tests without trend and with trend, respectively. Thus, the ADF unit root test posits a null hypothesis ß=0 versus an alternative hypothesis ß<0 where the ADF statistics was compared with the Mackinnon criterion for rejecting null hypothesis.

The H_o is rejected if the ADF statistic is greater than the critical values in absolute term.

Heteroskedasticity and Autocorrelation Consistent Covariance method or the HAC consistent covariance was used to estimate the regression equations. The method consists of the White heteroskedasticity and the Newey-West HAC consistent covariance estimators with each allowing for ordinary least squares estimation.

The Newey-West HAC consistent covariances estimation method was adopted in this study due to its robustness and inclusiveness in addressing autocorrelation and heteroskedasticity issues. The method is consistent in the presence of both heteroskedasticity and autocorrelation of unknown form and is given by:

$$\sum NW = \frac{T}{T-K}\left(X^{/}X\right)^{-1} \hat{\pi}\left(X^{/}X\right)^{-1} \ldots\ldots\ldots\ldots\ldots (3)$$

Where

$$\hat{\pi} = \frac{T}{T-K}\left\{\sum_{t-1}^{T} U_t^2 x_t x_t^{/} + \sum_{v=1}^{q}\left[\left(1-\frac{v}{q-1}\right)\right]\sum_{t=v+1}^{T}\left(x_t u_t u_{t-v} x_{t-v^{/}} + x_{t-v} u_{t-v} u_t x_t^{/}\right)\ ]\right\}$$

and q, the truncation lag, is a parameter representing the number of autocorrelations used in evaluating the dynamics of the OLS residuals, Ut.

Nerlove's partial adjustment and adaptive expectation model (1958) assumes that the area farmers desire to cultivate is a function of the expected price and some other important variables. Nerlove claims that farmers' planting decision depends on the price they expect to receive when the crop is marketed. In turn, the actual price for the crop depends on the amount actually harvested as well as the current level of demand. Nerlove's model is basically characterized by both adaptive expectation and partial adjustment.

According to Patunru (1998) standard representation of the Nerlovian model is:

$$p_t^* = P_{t-1}^* + \beta\left(P_{t-1} - P_{t-1}^*\right) + U_t, 0 \le \beta \le 1 \qquad (4)$$

$$X_t = X_{t-1} + \gamma\left(X_t^* - X_{t-1}\right) + V_t, 0 \le \gamma \qquad (5)$$

u and v are random terms with zero expected values, X is quantity supplied.

Equation (4) resembles the adaptive expectation and says that the expected price P_t^* for the year is equal to the expected price last year, plus the difference between the actual and the expected price last year, multiplied by expectation coefficient β.

Equation (5), on the other hand resembles the adjustment process, inferring that the quantity supplied this year is the same as the quantity supplied last year plus the difference between the expected (or desired) supplies this year and the actual supply last year times the adjustment coefficient γ.

The coefficient γ represents level of technology or the speed of adjustment. Hence the farmer could not move to equilibrium instantaneously in the short run.

Furthermore, the supply response function is represented thus;

$$X_t^* = a + bp_t^* + cZ_t + W_t \qquad (6)$$

Where z is other exogenous factors and w is random term with zero expected value.

Allowing for continuing lags, equation (4) can be rewritten as:

$$P_t^* = \sum_{s=1}^{\alpha} \beta(1-\beta)^{s-1} . p_{t-1} \qquad (7)$$

Combining equations (6) and (7); we obtain:

$$X_t^* = a + b\sum_{s=1}^{\alpha} \beta(1-\beta)^{s-1} . P_{t-s} + CZ_t + W_t \qquad (8)$$

Plugging equation (8) into (5), the following equation implies both adaptive expectations and partial adjustment process.

$$X_i = a\gamma + b\gamma\sum_{s-1}^{\alpha} \beta(1-\beta)^{s-1} . P_{t-s} + C\gamma z_t + \gamma w_t + \gamma x_{t-1} + X_{t-1} + v_t \qquad (9)$$

Suppressing γ in the constant and error terms, we have:

$$X_t = a + b\gamma\sum_{s=1}^{\alpha} \beta(1-\beta)^{s-1} . P_{t-s} + C\gamma z_t + (1-\gamma)X_{t-1} + U_t \qquad (10)$$

For estimation purpose, equations (4), (6) and (5) can be substituted to get:

$$X_i = a\beta\gamma + b\beta\gamma P_{t-1} + [(1-\beta) + (1-\gamma)]X_{t-1} + [-(1-\beta)(1-\gamma)]$$
$$X_{t-2} + c\gamma z_t + [-c\gamma(1-\beta)]z_{t-1} + v_t - (1-\beta)v_{t-1} + \gamma w_t - \gamma(1-\beta)w_{t-1} + b\gamma u_t \qquad (11)$$

The reduced form:

$$X_i = \pi_1 + \pi_2 P_{t-1} + \pi_3 X_{t-1} + \pi_4 X_{t-2} + \pi_s z_t + \pi_6 z_{t-1} + e \qquad (12)$$

Where:

$\pi = a\beta\gamma$

$\pi_2 = b\beta\gamma$

$\pi_3 = (1-\beta) + (1-\gamma)$

$\pi_4 = -(1-\beta)(1-\gamma)$

$\pi_5 = c\gamma$

$\pi_6 = -c\gamma(1-\beta)$

$$e = v_t - (1-\beta)v_{t-1} + \gamma w_t - \gamma(1-\beta)w_{t-1} + b\gamma u_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(13)$$

Sheffrin, (1996) also asserts that the different assumptions of the basic Nerlove model concerning the formation of price expectation could dramatically alter the actual price dynamics in the market. If the price expectation is based on last year's price, there would be a potential for significant instability in prices and production. Moreover, in agriculture, which is subject to weather uncertainties and other socio-economic, environmental and technological changes, particularly in a developing country like Nigeria; a model which will accommodate additional variable explanatory factors in determining the supply response of farmers is more desirable. The Nerlovian Dynamic Adjustment lag model (NEDAL) appropriately meets this need, hence, adopted in this study.
NEDAL postulates that the actual hectrage under a crop in any period is adjusted in proportion to the difference between the desired hectrage in the long run equilibrium and the actual hectrage in the preceding year. Also, the expected price in any year can be expressed as a function of actual price last year and the expected price last year, while the expected price last year could be replaced by linear function of last year's hectrage. Thus, through this algebraic substitution, the final form of the adjustment model expresses hectrage in any year as function of previous year's actual price and previous year's hectrage thereby ignoring the effect of expectational lags in prices. This is in line with estimation equation as stated by Patunru (1998) in the reduced form of equation (12).The reduced form is a distributed lag model with the lagged dependent variable appearing as an independent variable.
As Cummings, (1975) and Holt, (1999) noted, supply response could be assumed to be equivalent to response in acreage under cultivation to changes in economic and non-economic factors. Moreover, Mythili, (2006) also asserts that area decision is totally under the control of farmers and using supply or output conceals some variations in area and yield if they move in opposite directions. Therefore hectrage was used as indicator of supply in this study.
This study tried to estimate the impact of variable factors on output vis-à-vis the area harvested. The variable factors considered include the lagged values of the dependent variable, the yield of investigated crop in the previous year(s), the yield of the competing crop in the previous year(s), the price of the investigated crop in the previous year(s), the price of the competing crop in the previous year(s) and the weather index approximated by the annual mean rainfall at a time "t". The use of lagged (previous years) price, yield and hectrage was based on the assumption that previous year(s) price, yield and hectrage allocated to the production of the selected crops exert pressures on farmers' subsequent hectrage allocation decisions in the production of the crops.
The general form of the model adopted in this study is:

$$Q_i = b_0 + b_1 A_{it-k} + b_2 y_{it-k} + b_3 y_{jct-k} + b_4 P_{it-k} + b_5 P_{jct-k} + b_6 W_{t-k} + U_t$$

Where

Q_i = Hectrage response of crop i

b_0 = intercept

$b_1 \ldots\ldots\ldots b_6$ = Distributed lag weights (coefficients of variables)

k = 1……… n years

A_{it-k} = Hectrage under crop i, lagged at 1…..n year(s)

y_{it-k} = Yield of crop i, lagged at 1…..n year(s)

y_{jct-k} = Yield of competing crop j, at 1…..n year(s) lagged.

P_{it-k} = Price of crop i, lagged at 1…..n year(s)

P_{jct-k} = Price of competing crop j, lagged at 1…..n year(s)

W_{t-k} = Amount of rainfall at one year lagged

U_t = Residual error

The general form of the model was applied for estimating values in respect of the crops selected for the study.

3.0 Results

3.1 Unit Root Test Result:

The result of the unit root tests obtained shows the order of integration and stationarity of hectrage, price, yield and mean rainfall series determined by the Augemented Dickey Fuller test. Table 1 shows the order of integration and the number of times the series were differenced. One of the variables (price of sorghum) was stationary at levels implying an integrated order of: I (0); four variables (hectrage of sorghum, yield of sorghum, yield of maize and price of maize) were stationary after the first difference: I (1); while the hectrage of maize was stationary after the second difference: I (2).

Table 1: Unit Root Tests

Variables	Augmented Dickey Fuller Test					
	Order of integration	Critical values 1%	5%	10%	ADF Statistics	P-Values
Δ^2AMAIZE	I(2)	-4.4415	-3.6330	-3.2535	-6.968734	0.000002
ΔASORGHUM	I(1)	-4.4167	-3.6219	-3.2474	-5.107619	0.000004
ΔYMAIZE	I(1)	-4.4167	-3.6219	-3.2474	- 3.992675	0.000376
ΔYSORGHUM	I(1)	-4.4167	-3.6219	-3.2474	-5.758837	0.000067
ΔPMAIZE	I(1)	-4.4167	-3.6219	-3.2474	-7.033009	0.000007
PSORGHUM	I(0)	-4.3942	-3.6118	-3.2418	-3.660903	0.009291
ΔWEATHER	I(1)	-4.4167	-3.6219	-3.2474	-5.215415	0.000007

1. Δ= Difference operator
2. I (d) No. of times of integration
3. Level= 1%, 5%, 10% level of significance

3.2 Maize Hectrage Response:

Regression result in respect of maize hectrage response is presented in Table 2.

Table 2: Least squares regression result for maize hectrage response

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.056373	0.174615	0.32284	0.751
DLOG(AMAIZE(-1,2))	-0.756162	0.146823	-5.150178	0.0001***
DLOG(YMAIZE(-2))	0.374587	0.19869	1.885281	0.0777*
DLOG(YSORGHUM(-2))	-0.655694	0.280742	-2.335579	0.0329**
DLOG(PMAIZE(-2))	0.144248	0.075531	1.909773	0.0743*
LOG(PSORGHUM(-1))	-0.008864	0.018269	-0.485197	0.6341
DLOG(WEATHER(-1))	-0.036477	0.05998	-0.608157	0.5516
R-squared	0.685764	F-statistic		5.819521
Adjusted R-squared	0.567925	Prob(F-statistic)		0.002226
Durbin-Watson stat	1.984005			

Dependent variable: LOG (AMAIZE) *Significant @ 10% level **Significant @ 5% level ***Significant @ 1% level

The regression result for maize hectrage response as shown in Table 2 indicates that the lagged dependent variable i.e. the lagged hectrage of maize is statistically significant at 1% level. The yield of sorghum which is the competing crop is statistically significant at 5% level. The yield and price of the investigating crop, maize, were also statistically significant at 10% level; thereby indicating that hectrage of the investigating crop maize, it's own price and yield as well as the lagged yield of the competing crop, sorghum, were important factors determining farmers' hectrage allocation decision in the production of maize.

The coefficient of determination (R^2) is 0.6858 thereby indicating goodness of fit of the regression function and the joint influence of the independent variables (in conjunction with the lagged hectrage) in explaining 68.58% variation in maize hectrage. The F-statistic which is the global test for the significance of the regression function is 5.820 with a corresponding Prob (F-statistics) of 0.002, which further attests to the overall goodness of fit of the regression function. It is also notable that Durbin-Watson statistic is approximately 2.0 thereby, indicating absence of serial correlation between the variables used in the study.

It is also noticeable that the coefficients of the price and yield of maize are very low while the coefficients of the yield of sorghum and lagged hectrage of maize are above average; thereby indicating that the yield of sorghum and the lagged hectrage of maize exert more pressure on farmers' hectrage allocation decision for the production of maize. Moreover, the negative coefficients of lagged hectrage of maize and yield of sorghum may be a reflection of stagnating or declining hectrage allocation to maize and decreasing yield of sorghum over the period of study.

3.3 Sorghum Hectrage Response:

Regression result in respect of sorghum hectrage response is presented in Table 3.

Table 3: Least squares regression result for sorghum hectrage response

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.027125	0.072328	-0.375026	0.7126
DLOG(ASORGHUM(-1))	-0.459513	0.145931	-3.14883	0.0062***
DLOG(YMAIZE(-2))	-0.413998	0.154622	-2.677477	0.0165**
DLOG(YSORGHUM(-2))	-0.326174	0.123274	-2.645919	0.0176**
DLOG(PMAIZE(-2))	-0.013503	0.029492	-0.457873	0.6532
LOG(PSORGHUM(-1))	0.00754	0.008249	0.914051	0.3743
DLOG(WEATHER(-1))	0.060043	0.02518	2.384528	0.0298**
R-squared	0.694781	F-statistic		6.070227
Adjusted R-squared	0.580324	Prob(F-statistic)		0.001803
Durbin-Watson stat	2.024293			

Dependent variable: LOG (ASORGHUM) **Significant@ 5% level ***Significant @ 1% level

Regression result for sorghum hectrage response as shown in Table 3 indicates that the lagged dependent variable i.e. lagged hectrage of sorghum was statistically significant at 1% level. Also, the yield of sorghum, yield of the competing crop, maize, and weather were statistically significant at 5% level; thereby indicating that lagged hectrage of sorghum, yield of sorghum, yield of maize and weather were important factors influencing farmers' hectrage allocation decision in the production of sorghum.

It was also observed that the coefficient of lagged hectrage of sorghum was higher than its own price and yield coefficients as well as the coefficients of price and yield of maize, and weather; thereby indicating that lagged hectrage exerts more pressure than price, yield and weather on farmers' hectrage allocation decision in the production of sorghum.

The R^2 and the adjusted R^2 values are good at 0.6948 and 0.5803 respectively; thereby indicating goodness of fit and the significance of the response function. The R^2 or the coefficient of determination indicates that the explanatory variables (in conjunction with the lagged hectrage) have a joint influence on the variation of hectrage of sorghum to the extent of approximately 69%.

4.0 Discussion

A major trend in this study is that lagged dependent variable has been found to be a significant determinant of hectrage allocation in the cultivation of the crops of study. The trend is reflected by the estimates of the coefficients of lagged hectrage of the crops which were statistically significant at 1% and 10% levels, thereby indicating that lagged hectrage was an important factor influencing farmers' hectrage allocation decisions in the production of the selected crops of study. The coefficients of the lagged hectrage of maize and the yield of sorghum were higher than the coefficients of price of maize, thereby indicating that lagged hectrage and yield exert more pressure on farmers' hectrage allocation decision for the production of maize. Moreover, the negative coefficients of lagged hectrage of maize and yield of sorghum may be a reflection of stagnating or declining hectrage allocation to maize and decreasing yield of sorghum over the period of study. Also, the coefficient of lagged dependent variable (hectrage of sorghum) was higher than the coefficients of its own price and yield and the coefficients of price and yield of maize and weather thereby indicating that lagged hectrage exerts more pressure than other factors on farmers' hectrage allocation decision in the production of sorghum. This is consistent with findings of Chadhaury, (1986) who found lagged hectrage to be important factor determining acreage allocation to the cultivation of crops. Kumar and Roy, (1985)., Ahmed, (1986) and Mahmood *et al,* (2007) have also noted that although area is expected to vary positively with expected yield, it could either rise or fall with changes in rainfall, depending upon whether or not there is a normal rainfall or flood or drought. Moreover, relative rather than absolute prices and irrigation could be better account for acreage response.

The trend of hectrage allocation decisions in respect of the production of cereal crops also indicates that yield rather than price; exert more pressure on farmers' hectrage allocation decision given that coefficients of yield were consistently higher than the coefficients of price in respect of the selected cereal crops. This may be attributable to the subsistence nature of farming in Nigeria, where the primary objective of farming households is to maximize yield for consumption; an effort towards ensuring food security. Apart from the fact that enough quantity could be produced beyond family consumption, availability of surplus is a status symbol for most farming households in developing economies such as Nigeria. This is consistent with previous studies in Nigeria, which indicate that price alone may not be an adequate incentive for inducing farmers' response except it is accompanied with other factors such as access to irrigation, technology, cultivable land and minimal risk among other factors (Olubode-Awosola *et al*, 2006 and Ogazi, 2009). The small holding and subsistence orientation of the Nigerian farming system coupled with lack of stable pricing regime and market imperfections may be the basis for which farmers' responsiveness to yield (for consumption) rather than to price, is higher. After all, it is usually the surplus rather than total output that is marketed. It is therefore obvious that the more the yield obtained, notwithstanding the price level, the more hectrage would be allocated to production of the crops.

Philip, *et al,* (2008) have also noted that Nigeria's agricultural system is characterized by a number of sector wide constraints to increasing agricultural productivity; which include poor agricultural pricing policies, low fertilizer use, low access to agricultural credit, land tenure insecurity, land degradation, poverty and gender issues, low and unstable investment in agricultural research and poor market access and marketing efficiency. These constraints, to a large extent may be accountable for the partial responsiveness of farmers in Nigeria to price and non-price factors in their hectrage allocation to the production of crops of study or specifically to each of the explanatory variables of study as hypothesized.

5.0 Conclusion and Recommendations

The study tried to estimate the hectrage response of maize and sorghum to price and non-price factors in Nigeria between 1983 and 2008 and found that Nigerian farmers do not respond fully to changes in economic incentives in their resource allocation decisions.

In view of the findings of the study that lagged dependent variable (lagged hectrage) had significant influence on hectrage allocation, efforts should be geared towards expansion of cultivable land and enhancing land management practices and accessibility to same by farmers through formulation and implementation of policies on land reforms. This will encourage farmers to cultivate more land for increased crop productivity. Government should endeavour to create a National Land Development Agency with a view to propel vigorous implementation of policies on land reforms.

Efforts should also be geared towards ensuring policies which encourage farmers to achieve stable yields in line findings of the study that yield rather than price was more important factor that determined farmers' hectrage allocation decision to the production of the crops studied. Attention should also be directed at removing some of the physical infrastructure constraints to agricultural performance, improvement in the output and input market infrastructure, expansion of irrigation and ensuring pricing and marketing policies which centre on enhancing crop productivity, farm income and food security and empowering farmers to make decisions about their own crops and livelihoods.

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The variables used in this study and their definitions are as follows:

Variable Name	**Definition**
AMaize	Area harvested of Maize (hectares)
ASorghum	Area harvested of Sorghum (hectares)
PMaize	Producer price of Maize (Naira/ton)
PSorghum	Producer price of Sorghum (Naira/ton)
YMaize	Yield of maize (kg/hectare)
YSorghum	Yield of Sorghum (kg/hectare)
Weather	Weather index approximated by mean annual Rainfall (Millimeters)

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