ACREAGE RESPONSE OF SOYBEANS TO PRICE IN NIGERIA

OREFI ABU, [1]* AKANDE RUFAI OLAIDE[1] & VICTORIA ADA ODU OKWOCHE[2]

[1]Department of Agricultural Economics, University of Agriculture, Makurdi, P.M.B 2373, Benue State, **NIGERIA**
[2]Department of Agricultural Extension and Communication, University of Agriculture, Makurdi, P.M.B 2373, Benue State, **NIGERIA**
* Corresponding Author's Email: orefi@yahoo.com

ABSTRACT

The decision with regards to allocation of area to any crop by farmers among other things depends on the prices of the individual crop. The extent to which farmers respond to economic incentives is thus crucial to policy makers. This study was aimed at estimating the acreage response of soybean to changes in price in Nigeria from 1976 to 2012. Time series data in respect of soybean area harvested (hectares) and producer price of soybean in local currency (Naira/tonne) were obtained. Augmented Dickey Fuller (ADF) test and, the Johansen co integration technique were employed to test for the stationarity of the variables and the long-run relationship between variables respectively. Result indicates the presence of one co integrating long run equilibrium relationship between the variables. The Vector Error Correction Model (VECM) estimates showed that soybean price had a negative influence on the area harvested. Suggesting that a decrease in soybean price will result in reduction in area cultivated, leading to a decrease in profit and a decrease in profit gives disincentive to farmers to produce more. Therefore, positive price policy would undoubtedly encourage farmers to bring more area under soybean crop to boost the production of soybean in Nigeria.

Keywords: Acreage response, ADF, VECM, Soybean, Nigeria.

INTRODUCTION

Agriculture is the principal source of food and livelihood in Nigeria, making it a critical component of programs that seek to reduce poverty and attain food security in Nigeria (Philip *et al*., 2008). As a result, raising agricultural productivity is an important policy goal for concerned governments and development agencies. According to Molua (2010), expanding cultivated area is a feasible option for increasing production. However, understanding how producers make decisions to allocate land among crops and how decisions about land use are affected by changes in prices and their instability is essential for predicting the supply of staple crops and, consequently, evaluating the global food supply situation (*Haile at al*, 2013). Responsiveness of farmers to economic incentives such as price could influence contribution of agriculture to the economy (Mushtaq & Dawson, 2002). This could be attributed to crucial roles played by agricultural prices in achieving efficient allocation of production resources (Niamatullah and Zaman, (2009).

Price is generally the channel through which economic policies are expected to affect agricultural variables such as output, supply and export and income (Phillips and Abalu, 1987; Dercon, 1993). According to Narain (1965), economic theory suggests that prices are significant determinants of economic behavior and normal farmers should adequately react to changes in prices of output. In a viable economic system, prices of commodities give signals

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to the producers concerning the type and quantity of commodity to be produced in a particular place at a particular time (Reddy *et al*, 2009). Thus, price relationships have a significant influence on decisions regarding the type and quantity of agricultural production activity. Farmers are generally believed to be responsive to producer prices (Ezekiel *et al*., 2007). Producers are more anxious about low prices, which may threaten their living standards as well as their longer term capability when income is too low to provide for the farm family or for the needs of the farm. The prices of most farm commodities do not stay constant throughout the season; they follow some regular seasonal patterns. Seasonal prices are at their lowest at harvest and their pinnacle a few weeks to the new harvest usually for storable products such as cereals and leguminous grains (Olukosi *et al*., 2007). It is generally believed that farmers have enough power to determine the physical process of agricultural production, implying that the decisions on what to produce, how to produce and which inputs to use are in the hands of the farmers and the farmers take the prices as decision-making factor (Bor and Bayaner, 2009). Thus, rational producers are expected to increase the use of inputs in response to crop price increases, suggesting that producers base their decisions on the expected crop prices (Bor and Bayaner, 2009).

Earlier studies (Bewley et al. 1987; Coyle, 1993; Barten & Vanlot, 1996) have examined how prices affect crops area allotment decisions. According to Weersink et al. (2009) own and competing crop prices are the essential variables in explaining acreage response. An increase in a crop's own price is expected to have positive impact on the crops acreage (Tahir, 2014). Consequently, it is by and large assumed that farmers behave rationally and react to circumstances in a way that make best use of their utility in the context of opportunities, incentives and risks as perceived by them (Nayarana and Parikh, 1981). On the other hand, Narain (1965) is of the view that farmers in less developed countries are not receptive to changes in relative prices and/or they are less responsive than those in the developed countries. Reasons given for this lack of response to price by farmers are factors such as poor irrigation facility, poor infrastructure and the absence of complementary agricultural policies (Mytilli, 2006).

Soybean (*Glycine Max L*) is a leguminous vegetable of the pea family that grows in the tropical, subtropical and temperate climates (IITA, 2014). It has been described as a "miracle bean" or a "golden bean" because it is an inexpensive, protein-rich grain. Soybean has an average protein content of 40 per cent, richer in protein than any of the common vegetable or animal food sources found in Nigeria (Dugje *et al.,* 2009). It contains 30 per cent carbohydrate and excellent amount of dietary fibre, vitamins and minerals, the seeds also contain about 20 per cent oil on a dry matter basis, and this is 85 per cent unsaturated and cholesterol-free (Dugje *et al*., 2009; IITA, 2014). Soybean can also improve soil fertility through nitrogen fixation, allowing a longer duration of ground cover in the cropping sequence, and providing useful crop residues for animal feed (Sanginga *et al.,* 1999). Over the years, IITA has made substantial efforts to improve the productivity of the crop by developing high yielding, early maturing varieties capable of nodulating in association with local rhizobia, and possessing other good agronomic traits (IITA, 1994). Improved soybean varieties released in Nigeria include TGx 849-313D, TGx 1019-2EN, TGx 1019-2EB, TGx g1447-2E, TGx 536- 02D, TGx 306-036C, TGx 1485-1ED, and TGx 1440-1E (IITA, 1994). The crop can be effectively cultivated in many states in Nigeria using low agricultural input.

Given that production judgments of farmers are dependent on a variety of policies of government, among which price policy is one of the most important. It is expected that farmers would allocate their limited land resources to that crop enterprise which the price tends to be encouraging. This is quite rational as the allocation of land to a better-priced crop would bring more profits to farmers. Supply response has become an essential research agenda connected with agricultural growth in developing countries. This is because the issue of agricultural supply response is a very important one as it has an impact on growth, poverty, and environment (Mamingi, 1997). A significant number of studies (Nosheen and Igbal, 2008; Khan and Zaman, 2010; Ali, Altaf and Farroq, 2014) have analyzed agricultural supply response to price and non-price factors among a wide range of crops over the years. Acreage response to price and possibly non-price incentives is of substantial significance for developing correct policy and planning development programmes for the agricultural sector of any economy in general and Nigeria in particular. The response of the area under crops to the changes in the prices of the crops concerned is very essential to understanding the behavior of the farmers.

In view of the importance of soybean to the economy and its incredible potential to improve the nutritional standing and wellbeing of the smallholder resource-poor farmers who accounts for over 90 per cent of the food produced in Nigeria, it pertinent to empirically determine the response of soybean "the golden crop" to price incentive. It is in line with this that this study examined the acreage response of soybean to price in Nigeria.

DATA AND METHODOLOGY

Data sources

The data used for this study are from Food and Agriculture Organization (FAO) Publication. The time span covered in this study was 1976-2012. Time series data in respect of soybean area harvested (hectares) and producer price of soybean in local currency (Naira/tonne), represented by *SBAH* and *PPSB* respectively were obtained.

Methodology

This study aimed at determining acreage response of soybean to producer price in Nigeria. The use of time series data for analysis demands the investigation of presence of unit root in the data. This is to ensure that the variables used in the regressions are not subject to spurious regression. For this reason, unit root test was carried on the variables. The Johansen co-integration test and vector error correction model (VECM) were also employed to determine the long-run relationship between variables and the response of soybean to producer price. Also Granger causality test was conducted to measures the ability of past values of one variable to predict the current values of other variable. The estimation procedure takes the following forms:

Unit Root Test

The initial step in carrying out a time series analysis is to test for stationarity of the variables, in this case, soybean area harvested (SBAH) and producer price of soybean (PPSB) series. The Augmented Dickey-fuller (ADF) test was used to check for unit root for the variables used for this study. A series is said to be stationary if the means and variances stay constant over time. It is denoted as I(0), meaning integrated of order zero. Non stationary stochastic series have changing mean or time varying variance. All the variables used in this study were first tested for stationarity. The rationale was to overcome the problems of spurious regression. A stationary series tends to always return to its mean value and variations around this mean value. A variable that is non-stationary is said to be integrated of order *d*, written as

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I(d), if it must be differenced *d* times to be made stationary. In the same way, a variable that has to be differenced once to become stationary is believed to be *I(1)* i.e., integrated of order 1. According to Gujarati (2003), the Augmented Dickey Fuller (ADF) test entails running a regression of the form:

$$\Delta Z_t = \beta_1 + \beta_2 t + \delta Z_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Z_{t-i} + \varepsilon_t \tag{1}$$

Where Δ = the change operator; Z_t = variable series (SBAH and *PPSB* being investigated for stationarity); Z_{t-1}= Past values of variables; $\Delta Z_{t-1} = (Z_{t-1} - Z_{t-2}), \Delta Z_{t-2} = (Z_{t-2} - Z_{t-3})$, e.t.c; t = time variable and ε_t is the white noise error. The null hypothesis that δ = 0 means existence of a unit root in Z_t or that the time series is non-stationary. The decision rule is that if the computed ADF statistics is greater than the critical at the specified level of significance, then the hull hypothesis of unit root is accepted otherwise it is rejected. In other words, if the value of the ADF statistics is less than the critical values, it is concluded that Z_t is stationary i.e Z_t ~ I(0). When a series is found to be non-stationary, it is first-differenced (i.e the series ΔZ_t = Z_t - Z_t-1 is obtained and the ADF test is repeated on the first-differenced series. If the null hypothesis of the ADF test can be rejected for the first-differenced series, it is concluded that Z_t ~ I(1).

Cointegration Test

The rationale for carrying out cointegration is to identify or find out whether there is long-run equilibrium relationship between variables. When two or more data series have a long-run equilibrium relationship, it means that they move together closely, they will not separate from each other in the long run and are co integrated. An impulse will only make them to be apart from each other in the short run. However, in the long run, they will automatically resume equilibrium. The most commonly used methods for co integration test are the Engle-Granger two step test (Engle and Granger, 1987) and the Johansen Maximum Likelihood procedure (Johansen and Juselius, 1990). This study adopts Johansen Maximum Likelihood procedure because it allows for all feasible co integration relationship and the number of co integrating vectors to be verified practically. The starting point for Johansen co integration test is the vector auto regression (VAR) of order *p* given by: $Z_t + \phi + A_1 Z_{t-1} + ... + A_p Z_{t-p} + \varepsilon_t$. This VAR can be re-written as:

$$\Delta Z_t = \phi + \sum_{i=1}^{n} \Gamma_i \Delta Z_{t-1} + \Pi Z_{t-1} + \varepsilon_t \tag{2}$$

Where, $\Pi = \sum_{i=1}^{p} A_i - I, \Gamma_i = -\sum_{j=i+1}^{p} A_j$ and Z_t (*SBAH and PPSB*) is a (n x 1) vector of all the non-stationary *l(1)* variables in the study, ϕ is a (n x 1) vector of parameters (intercepts), ε_t is an kx1 vector of innovations or random shocks. Γ_i and Π are (n x n) matrices of parameters, were Γ_i is a (n x 1) vector of coefficients of lagged Z_t variables. The Π is a *(n x 1)* is a long-run impact matrix which is product of two *(n x 1)* matrices. If the coefficient matrix Π has reduced rank *r<n*, subsequently there exist (*n x r)* matrices *α* and *β* each one with rank *r* such that Π = *αβ′* and *β′Zt* is stationary. The *r* is the number of co integrating relationships, the elements of *α* is known as the adjustment parameters in the vector error correction model and each column of *β* is a cointegrating vector. It can be revealed that for a

known *r*, the maximum likelihood estimator of β defines the combination of $Zt-1$ that yields the *r* largest canonical correlations of ΔZt with $Zt-1$ after correcting for lagged differences and deterministic variables once present. Johansen (1995) suggested two different likelihood ratio tests, the trace test which tests the null hypothesis of *r* co integrating vectors against the alternative hypothesis of *k* co integrating vectors and maximum eigenvalue test, which tests the null hypothesis of *r* co integrating vectors against the alternative hypothesis of $r + 1$ co integrating vectors.

Vector Error Correction model (VECM)

An error correction model was employed to model the causal influence among the non stationary variables with evidence of long-run relationship. The vector error correction model is useful for the evaluation of a short term adjustment which adjusts towards the long run equilibrium in each time period. If the variables are found to be co integrated, a vector error correction model (VECM) is estimated because a co integrating relationship deals only with long-run relationship without considering the short-run dynamics. Thus, if the series SBAH and PPSB are found to be *I(1)* and co integrated, then the ECM model is represented by the following equations:

$$\Delta \ln SBAH_t = \varphi_1 + \sum_{i=1}^{n} \beta_{1i} \Delta \ln SBAH_{t-1} + \sum_{i=1}^{n} \sigma_{1i} \Delta \ln PPSB_{t-1} + \alpha ECT_{t-1} + \varepsilon_t \tag{3}$$

$$\Delta \ln PPSB_t = \varphi_3 + \sum_{i=1}^{n} \beta_{3i} \Delta \ln SBAH_{t=1} + \sum_{i=1}^{n} \sigma_{3i} \Delta \ln PPSB_{t-1} + \alpha ECT_{t-1} + \varepsilon_t \tag{4}$$

Where *lnSBAH* is logarithm of soybean area harvested in year t (ha), *lnPPSB* is the logarithm of producer price for soybean (naira/tonne), *ECT* is the error correction term, Δ is the difference operator and ε_t is the error term which takes care of other variables that could have influence on soybean area harvested but not specified in the model and while *n* is the optimal lag length orders of the variables.

Granger Causality Test

Granger causality measures the ability of past values of one variable to cause the current values of another variable. According to granger (1969) causality, if a series X_1 "granger causes" a series X_2, then the past values of X_1 should contain information that helps predict X_2 above and beyond the information contained in the past values of X_2 alone. Granger causality test is an essential analysis given that it highlights the existence of causation and it can be unidirectional or bidirectional (Gogoi, 2014). To implement the granger causality test, the following regression model was specified:

$$\ln SBAH_t = \alpha_1 + \sum_{i=1}^{p} \phi_{11i} \ln SBAH_{t-1} + \sum_{i=1}^{p} \phi_{12i} \ln PPSB_{t-1} + \mu_{1t} \tag{5}$$

$$\ln PPSB_t = \alpha_2 + \sum_{i-1}^{p} \phi_{21i} \ln SBAH_{t-1} + \sum_{i-1}^{p} \phi_{22i} \ln PPSB_{t-1} + \mu_{2t} \tag{6}$$

Where *p* is the lagged observations incorporated in the model which is determined using the lag length criteria such as Akaike Information Criteria (AIC) and the Schwartz Information Criteria (SIC) amongst others, the matrix ϕ contains the coefficients of the model, μ_1 and μ_2 are residual errors for each time series.

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RESULTS AND DISCUSSION

Augmented Dickey Fuller Unit Root Test

Augmented Dickey-Fuller (ADF) stationarity test was carried out on the logarithmic form of the variables (*ln SBAH* and *ln PPSB*). Table 1 shows the result of the ADF test for levels as well as for first difference of the variables. The results show that test at level failed to reject the null hypothesis of non-stationary of all the variables examined. This means that all the variables are non-stationary at levels. However, after first difference, the null hypothesis is accepted. This shows that all the variables used are integrated of order one [i.e *l(1)*].

Table 1: Augmented Dickey-Fuller Unit Root Test of Variables

Variable	Level				First difference			
	ADF	1%	5%	10%	ADF	1%	5%	10%
$\ln SBAH$	-2.237	-3.628	-2.946	-2.612	-5.422	-3.639	-2.951	-2.614
$\ln PPSB$	-2.305	-3.646	-2.954	-2.616	-6.744	-3.645	-2.954	-2.616

Critical values of ADF tests are based on p-values; Lag length was based automatic on Schwartz Information Criteria (SIC).
Source: Author's calculation

Co integration Test Result

Since, most of the variables follow order one [I(1)] the next step was to test if there exists a long run relationship (co integration) among the variables. The Johansen co integration rank test results are presented in Table 2. Both the trace statistic and eigenvalue statistic in the Table 2 show that there is a unique long run relationship among the variables because in both cases the test shows at most one co integrating equation at 5 percent level of significance. Thus, the Johansen co integration test confirms the existence of a unique long run relationship among the variables. Consequently, co integration test results as shown in Table 2, indicates that the dependent variable soybean area harvested is co integrated with producer price of soybean, as such the test statistics strongly reject the null hypothesis of zero co integrating vectors in favour of the alternative hypothesis that there is at least one co integrating vectors. Therefore, the results in Table 2 confirm that the producer price is an important determinant soybean area harvested in Nigeria.

Table 2: Cointegration Test

Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.325	13.201	12.321	0.035
At most 1	0.032	0.999	4.129	0.368

Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.325	12.202	11.225	0.034
At most 1	0.032	0.999	4.129	0.368

Trace test and Max-eigenvalue test indicates 1 cointegrating equation(s) at the 0.05 level; * denotes rejection of the hypothesis at the 0.05 level; **MacKinnon-Haug-Michelis (1999) p-values
Source: Author's calculation

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Vector Error Correction Estimates

The presence of a co integrating relationship between the dependent and independent variable as indicated by the Johansen co integration test required investigating the short-term relationship between the variables in the co integrating equation by estimating the error correction model. The results of the vector error correction estimates as shown in table 3 contain long-term estimates, short-term estimates and diagnostic statistics. The long-term estimates show that producer price of soybean (PPSB) is negatively and significantly related to soybean area harvested (SBAH) in the long run. Parameter estimates of the long-run shows that soybean price has a significant influence on soybean area harvested at 1 per cent with a negative coefficient of 2.83, suggesting that a one per cent reduction in price will result in a 2.83 per cent reduction in area harvested in the long-run. The observed short- and long-term relationships between producer price of soybean (PPSB) and soybean area harvested (SBAH) can be attributed to poor pricing policy, ineffective marketing system, among others in Nigeria.

The error correction coefficient (-0.299) of the model had the expected negative sign and was significant at the 1 per cent probability level, confirming the existence of a long-term relationship between soybean area harvested (SBAH) and producer price of soybean (PPSB). The error correction coefficient indicates a feedback of about 30 per cent of the previous year's disequilibrium from the long-term values of the independent variable. Soybean area harvested (SBAH) and price of soybean (PPSB) are in conformity with a priori expectation in the long run. This implies that a reduction in the producer price of soybean (PPSB) would likely reduce soybean area harvested (SBAH). The R square value of 0.75 suggests that 75 per cent of the variation in soybean area harvested was due to the influence of the explanatory variable (producer price of soybean) that was incorporated into the model. The remaining 25 per cent of the variations in soybean area harvested (SBAH) can be accredited to other variables or factors not included in the model. The F-statistic value was significant at the 1 per cent probability level, signifying the combined significance of the explanatory variable of the model.

Table 3: Vector Error Correction Estimates

Variables	coefficients	Standard Error	t-statistic
Long run			
Constant	30.461		
$\ln SBAH$ (-1)	1.000		
$\ln PPSB$ (-1)	-2.833	0.531	-5.338***
@TREND(76)	-0.129	0.0214	-6.039***
Short run			
CointEq1	-0.299	0.094	-3.194***
$\Delta(\ln SBAH$ (-1))	-0.005	0.176	-0.026
Δ ($\ln SBAH$ (-2))	0.192	0.128	1.497
Δ ($\ln SBAH$ (-3))	0.816	0.141	5.789***
Δ ($\ln SBAH$ (-4))	0.096	0.179	0.538
Δ ($\ln PPSB$ (-1))	-0.619	0.244	-2.535**
Δ ($\ln PPSB$ (-2))	-0.798	0.243	-3.287***
Δ ($\ln PPSB$ (-3))	-0.104	0.218	-0.479
Δ ($\ln PPSB$ (-4))	-0.841	0.253	-3.326***
Constant	0.026	0.064	0.402
Diagnostic Statistics			
R-squared	0.754	Log likelihood	11.849
Adj. R-squared	0.654	Akaike AIC	-0.116
Sum sq. resids	0.893	Schwarz SC	0.342
S.E. equation	0.202	Mean dependent	0.194
F-statistic	7.515	S.D. dependent	0.343

*** and ** denotes significance at 1% and 5% levels respectively.
Source: Author's calculation

Granger Causality Test

The Granger causality test was used to detect the nature and direction of influence or causality between two variables. From the Granger results (Table 4), the null hypothesis that producer price of soybean (*lnPPSB*) does not Granger cause soybean area harvested (*lnSBAH*) is rejected. This is because computed F- statistic value is significant at 5 per cent probability level. Thus the results show that producer price of soybean (*lnPPSB*) granger causes soybean area harvested (*lnSBAH*) in Nigeria. On the contrary, we accept the null hypothesis that *lnSBAH* does not Granger cause lnPPSB. Therefore, unidirectional causality exists between *lnPPSB* and *lnSBAH* with the direction running from *lnPPSB* to *lnSBAH*.

Table 4: Pairwise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.
$\ln PPSB$ does not Granger Cause $\ln SBAH$	33	3.495	0.022
$\ln SBAH$ does not Granger Cause $\ln PPSB$		0.568	0.688

Source: Author's calculation

CONCLUSION

Given the relative value of soybean to the economy and it's potential to improve the nutritional status and well being of smallholder resource poor farmers, this study examined the acreage response of soybean to price in Nigeria by analyzing time series data from 1976 to 2012. This study employed the Augmented Dickey-fuller (ADF) test, Johansen cointegration test, vector error correction model and Granger causality test. The cointegration test showed that there is unique long-run relationship between soybean acreage and producer price. Consequently, there is no tendency for the two variables to drift wide apart in the long run. Based on the findings from this study, price has negative and significant effect with the area allocation to soybean crop. This implies that if the expected producer price of soybean decreased the area allocation to soybean will also decrease. This study has been able to establish that producer price is negatively and significantly related to soybean area harvested in Nigeria both in the long run and in the short run. Suggestive of the fact that a decrease in output prices will result in reduction in cultivated land, leading to a decrease in profit and a decrease in profit gives disincentive to farmers to produce more. Consequently, positive price policy would surely encourage the farmers to bring more area under soybean crop to enhance the production of soybean in Nigeria. The Granger causality test showed that a unidirectional causality exists between producer price and soybean area with the direction running from price to soybean area.

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