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RICE FARMERS' SUPPLY RESPONSE TO PRICE CHANGES IN NORTH EAST AND NORTH WEST ZONES OF NIGERIA

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ABSTRACT This paper analysed the supply response of rice farmers in the North East and the North West zones of Nigeria. The objective is to understand rice farmers' behaviour toward price changes. Secondary data from the Agricultural Performance Survey report from 1999-2018 was used. The data was analysed using the Nerlovian model. The paper revealed that the elasticity of the lagged price in the yield, production and area models was 0.4262, 1.243 and 1.272 respectively and they are all significant. Lagged area coefficient was significant and estimated at 0.7710. The results, therefore, showed that rice farmers are responsive to price changes and they normally respond to the change by expanding more land for rice cultivation. Although, the speed of land adjustment was found to be very low (0.23), signifying that there are great technological and institutional constraints preventing rice farmers from realizing the desired long-run equilibrium acreage level. The paper finally recommends that trade policies, such as rice import ban, should be implemented with caution since farmers' speed of adjustment is slow; and that strategies which will ensure increase in productivity should be implemented instead of relying on land expansion only to increase the volume of production.

Keywords: Nerlovian Model, North-east, North-west, Rice, Supply Response,

INTRODUCTION

Supply response is one of the issues that receive attention in agricultural development economics because the responsiveness of farmers to changes in price and other non-price incentives determines the extent to which agriculture contributes to the economic growth of the nation. One of the feasible options through which farmers, in less developed countries, increase their level of production is through land expansion. And the decision to expand the area is, in turn, determined by the price of the crop to be cultivated. A rational farmer responds to crop price changes by adjusting the land area in which the crop is planted. Thus, he reacts to an increase in price by increasing the area. Therefore, understanding how farmers make a decision to allocate land among crops and how decisions about land use are affected by changes in prices is essential for predicting the supply of staple crops (Haile *et al*., 2013).

Generally, price is a channel through which economic policies are expected to affect agriculture output (Dercon, 1993). Farmers take price as a decision-making factor on what and how to produce, and which inputs to use in the production process. Meaning that the price of commodities gives signals to producers concerning the type and quantity of the commodity to be produced in a particular place at a particular time (Reddy *et al*., 2009).

Currently, the Government has placed a total ban on rice importation in order to, among other reasons, protect local producers and encourage them to increase the level of production so as to meet the local demand for the commodity and thus, addressed food insecurity challenges bedevilling the country. Consequently, Nigerian have been witnessing an increase in rice prices day-in-day-out. But the pertinent question to ask is about the behavior of the Nigerian farmers toward changes in price. Do Nigerian rice farmers increase their production when the price of the commodity increases? Unless they respond positively to changes in price, any attempt by the government to ban importation may not yield the desired result. Therefore, the objective of this study is to determine rice farmers' supply response in the North East and the North West zones of Nigeria, to ascertain how their responses to price changes are. This will enable policy-makers to formulate appropriate policies on rice production vis-à-vis importation.

However, this study differs from the previous ones, e.g (Olubode-Awosola*et al*., 2006; Rahji*et al*., 2008;

Rahji andAdewumi, 2008; Ajetomobi, 2010; Akanni andOkeowo, 2011; Ayinde, Bessler, and Oni, 2014; Utuk, 2014), in that the previous studies used aggregate data in their analysis. And scholars have pointed out that analyzing supply response on aggregate level ignores regional specific characteristics (Paltasingh and Goyari, 2013) because supply-response estimates display curiously large variation across crops, regions and time (Diebold and Lamb, 1996). Therefore, this study narrowed the data and focused on the Northern-East and the North-West regions of Nigeria so as to capture supply responses that are more peculiar to the regions.

METHODOLOGY

The North-East and the North West zones cover 280,410km^{2}and 216,065km^2 respectively of the Nigeria's land area (909,890km^2). Rainfall amount in both regions is relatively low, erratic, and characterized by spatial and temporal variability (Abdulkadir, Usman and Shaba, 2015). The major crops grown in the region include, but are not limited to, maize and rice.

The study used secondary data collected from the Agricultural Performance Survey Reports prepared by the National Agricultural Extension and Research Liaison Services (NAERLS) and Federal Dept. of Agricultural Extension (FDAE). Data collected includes rice price, area devoted to rice production, yield per hectare of rice, total rice production, quantity of imported rice, and amount of rainfall from each state.

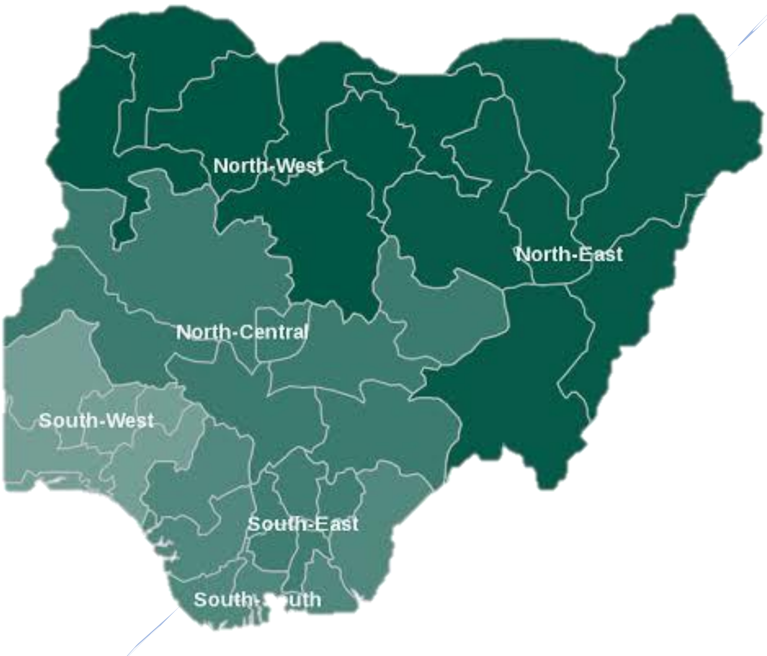

Figure 1 Map of Nigeria showing the study area: Northeast and Northwest

Nerlovian model was used to analyze the data. The model consists of three equations as specified by Askari and Cummings, (1977) in Leaver, (2004).

$$A^*_t = \alpha_0 + \alpha_1 P^*_t + \alpha_2 Z_t + u_t \quad \ldots(1)$$

$$P^*_t = P^*_{t-1} + \beta (P_{t-1} - P^*_{t-1}) \quad \ldots(2)$$

$$A_t = A_{t-1} + \gamma (A^*_t - A_{t-1}) \quad \ldots(3)$$

Where: A_t = actual area cultivated at time t,; A^*_t = desired area at time t,; P_t = actual price at time t,; P^*_t = expected price at time t,; Z_t = other observed, exogenous factors affecting supply at time t; and β and γ are termed the expectation and adjustment coefficients respectively.

The above Nerlovian model cannot be estimated due to its incorporation of the expected area and expected price which is inestimable. To tackle this problem, the two variables must be eliminated through rigorous mathematical process in order to come up with the estimated or "reduced form" of the equations. The reduced form of the Nerlovian equation is expressed thus:

$$A_t = b_0 + b_1P_{t-1} + b_2A_{t-1} + b_3A_{t-2} + b_4Z_t + b_5Z_{t-1} + E_t \ldots\ldots\ldots\ldots (4)$$

Where: A_t, P_{t-1}, A_{t-1} and Z_t are as defined above.

Following Khan (2010), the empirical model for this study is specified as follows:

$$A_t = \alpha + \beta_1P_{t-1} + \beta_2R_t + \beta_3IM_t + \beta_4 A_{t-1} + E_t \ldots\ldots\ldots\ldots (5)$$

By applying logarithm on both sides of equation it becomes:

$$Log A_t = Log\alpha + \beta_1LogP_{t-1} + \beta_2LogR_t + \beta_3LogIM_t + \beta_4LogA_{t-1} + LogE_t \ldots\ldots (6)$$

Where; A_t = Actual area (ha) devoted to rice in year t; P_{t-1} = Lagged farm gate price of rice in year t-1; R_t = Rainfall (in millimeters) in year t; IM_t= Quantity (tons) of rice imported in year t; A_{t-1}= Lagged area devoted to rice in year t-1; α and $\beta_1 - \beta_4$= Parameters to be estimated; and E_t = Error term in year t.

Since a lot of debates exist in literature concerning the most appropriate variable that should be used as a response variable in the Nerlovian model where some scholars suggest "yield" others suggest "output" and some suggest "area", this study uses all the three variables in separate models. Thus, three models were analyzed and the best among them is chosen and used to draw conclusions.

RESULTS AND DISCUSSION

Yield Response Model

Table 1 shows that all variables have plausible signs except lagged yield which has a negative sign, but statistically not significant. Likewise, import and rainfall variables were not significant. The only significant variable is the lagged price with a coefficient of 0.4262. This signifies that an increase in the last year's price will motivate rice farmers to increase their purchase of high-quality input such as fertilizers, herbicides and the use of tractors and thereby lead to an increase in yield per hectare. It should, however, be noted that since the model's goodness of fit is very low($R2$ = 32.73%) and the F-statistics is not significant (Table 1), the research will further consider another model to study rice farmers' behavior toward changes in price and non-price factors in the North East and the North West regions of Nigeria.

Table 1: Rice Farmers' Response in terms of Yield Per Hectare

Variable	Coefficient	Standard error	T	p-value
C	1.151059	1.690114	0.681054	0.5069
LNLAGYIELD	-0.020437	0.122800	-0.166426	0.8702
LNLAGPRICE	0.426174**	0.190883	2.232640	0.0424
LNIMPO	-0.176295	0.100477	-1.754586	0.1012
LNRAIN	0.180217	0.282718	0.637445	0.5341
R-squared	0.327283			

Adj R-squared	0.135079			
F-statistic	1.702785			

Source: Eviews 7.1 output using data obtained from APS, NAERLS and NIMET Note: all variables are in log form, ** significant at 5%.

Output Response Model

Diagnostic tests reveal that estimates of the production model are plausible. The goodness of fit ($R2 = 0.9311$) suggests that about 93% of the variation in the dependent variable (output) is explained by the regression model (Table 2). Another good thing about the model is that the F-statistic is highly significant which proved that the independent variables jointly explained the changes in the dependent variable. Since the equation of the model includes lagged values of the dependent variable, Durbin Watson statistics cannot be used to check for autocorrelation, rather Durbin h statistics is one of the most appropriate tools to be used in that situation. The computed value of Durbin h is 0.8255 and is less than the critical value at 5%, hence the null hypothesis of no autocorrelation cannot be rejected. Similarly, there is no serial correlation, no functional misspecification, residuals are normally distributed and homoscedastic. Therefore the model is reliable for interpretation.

The result from Table 2 shows that all the variables in the production response model have the expected signs except import variable which has positive sign even though not statistically significant. The rainfall variable also turns out to be insignificant in explaining the changes in the quantity of rice produced, though has a correct sign (positive). This is contrary to what is documented in the literature: that rainfall is one of the most important and significant factors that determines rice production in Nigeria and many countries in Africa.

Lagged production, as shown in Table 2, is highly significant ($p < 0.01$). This indicates that the current year's supply increases with the increase in the previous year's supply. Since the coefficient of lagged production is 0.6430, implies that a 1% increase in last year's production will cause the current year's production to increase by 64%.

Table 2: Rice Farmers' Response in Terms of Total Production

Variable	Coefficient	Standard error	T	p-value
C	-3.2017	3.3898	-0.9445	0.3609
LNLAGPRICE	1.2430*	0.6008	2.0691	0.0575
LNLAGPROD	0.6431***	0.1639	3.9244	0.0015
LNIMPO	0.0065	0.1874	0.0348	0.9727
LNRAIN	0.2616	0.5360	0.4880	0.6331
R-squared	0.9312			
Adj R-squared	0.9115			
F-statistic	47.3462			

Source: Eview's output using data obtained from APS, NAERLS and NIMET

Note: all variables are in log form, ***, **, *, significant at 1%, 5%, and 10% respectively

Furthermore, Table 2 shows that lagged price is significant at 10% with a coefficient of 1.2430, an indication of high responsiveness of the current year's production to the previous year's price. When rice farmers received a high price for their commodity this years, for example, it would serve as an inducement for them to increase their level of production next year.

Acreage Response Model

Table 3 depicts the estimation results of rice farmers supply response taking acreage as the dependent variable. This estimation seems reasonable because all signs of the explanatory variables appear to be following apriori. Also, the R square value of 0.9186 suggests that 91.86% of the variation in rice area harvested was due to the influence of the explanatory variables that were incorporated into the model. The remaining 25 percent of the variations in rice area harvested can be attributed to other variables or factors not included in the model. The F-statistic value was significant at the 1% probability level, implying the combined significance of the model's explanatory variables. Moreover, diagnostics tests of the model proved the absence of autocorrelation and heteroscadasticity. It also shows that the residuals were normally distributed and the model is stable. Meaning that the model is well specified as indicated by the Ramsey RESET test probability values of 0.9247 which led to non-rejection of the null hypothesis of no misspecification in the model.

Based on the above results, the acreage response model seems to be better than the previous two models (yield and production models). Therefore, this study summarizes its findings based on acreage response model.

Table 3 shows that the lagged price variable is positive and significant at the 10% level with a coefficient of 1.2716. Suggesting that the previous year's price has direct effect on the current year's acreage expansion. Farmers tend to increase the land size for rice cultivation when they expect an increase in producer price at the harvesting period. Therefore, price expectation plays a vital role in decision making during the planting period. According to the result presented in Table 3, lagged price elasticity is greater than one (1.27), which means an increase in the price of the commodity would yield more than proportionate increase in area cultivated for rice in the study area.

Table 3: Rice Farmers' Response in Terms of Acreage

Variable	Coefficient	Standard error	T	p-value
C	-3.972	2.6818	-1.4810	0.1607
LNLAGACREAGE	0.7710***	0.1512	5.0994	0.0002
LNLAGPRICE	1.2716*	0.6115	2.0794	0.0564
LNRAIN	0.3855	0.4320	0.8925	0.3872
LNIMPO	-0.1555	0.1878	-0.8281	0.4215
R-squared	0.9186	Adj R-square	0.8953	

Source: Eview's output using data obtained from APS, NAERLS and NIMET

Note: all variables are in log form, ***, **, *, significant at 1%, 5%, and 10% respectively

Specifically, in empirical terms, a 1% increase in rice price in the previous year will lead to an expansion of land by 1.27% for rice production in the current year. Virtually, rice farmers in the study area respond to an increase in price by clearing more land for rice cultivation. This is the result of the short-run estimation of price elasticity. However, in the long run, price elasticity concerning acreage was estimated at 5.55 (Table 3). Clearly, it shows that long-run elasticity is higher than the short run elasticity implying that rice farmers tend to equilibrium in the long run. That is to simply say they will respond to price changes more in the long run. This result is similar to that of Orefi, *et al*., (2017) who conducted a study on acreage response of soybeans to the price in Nigeria and established that a decrease in soybean price will result in a reduction in area cultivated, leading to a decrease in profit. Consequently, a decrease in profit gives a disincentive to farmers to produce less.

Furthermore, Table 3 shows that the lagged acreage variable is highly significant (p <0.01) and positive. Empirically, a 1% increase in area cultivated last year could trigger an increase in land expansion by 0.8% in the subsequent year, all things being equal. It could be said that when farmers realize substantial incentives in terms of meeting their goals, they will additionally increase the land area for cultivation. Though, the speed of adjustment, as depicted by the coefficient of adjustment in Table 3 is low. Precisely, the rate of adjustment is 1 - 0.771, which is equal to 0.23. It can be inferred from this value (0.23) that adjustment speed and magnitude of change in planned acreage toward the desired acreage is very slow since, according to Olayemi (2001), if adjustment coefficient ≥ 0.05, the adjustment speed is said to be big and if it is < 0.05, the speed of adjustment is said to be small. Since the adjustment coefficient is relatively smaller (0.23), it means there are greater technological and institutional constraints that prevent rice farmers from realizing the desired long-run equilibrium acreage level.

Scholars have advanced reasons why farmers, especially in developing countries, do not respond so quickly by expanding land for cultivation even if there is a change in price or other incentives. Some of the reasons for the low response include techno-economic and socio-institutional factors (Anthony, 2016). These factors are simply referred to as 5 "in's": input (irrigation, fertilizers), innovation (use of high yielding varieties – research), information (through extension agents and other means), infrastructure (roads, transports), and institutional changes (land ownership, credit facilities).

The findings reported above align with the results obtained by Khan, (2010) who studied Production and Acreage Response of wheat in the Northwest Frontier Province, Pakistan, and Conteh*et al*. (2014) who studied rice supply response in Tanzania. They both reported a positive and significant influence of lagged prices and low adjustment coefficients.

Table 4: Estimate of Price Elasticities

Variable	Adjustment coefficient (δ)	Short run	Long run
Lnprod	0.357	1.243	3.482
Lnarea	0.229	1.272	5.555
Lnyield	0.980	0.426	0.435

Source: Researcher's computation. Note that: Long run supply elasticities concerning lagged price depicted in Table 4 were obtained by dividing the corresponding short-run elasticities with the coefficient of adjustment δ. The coefficient of adjustment is in turn calculated by subtracting the coefficient of the lagged dependent variable from one (Shoko, 2014).

The result in Table 4 indicates that the variable of import has a negative sign as expected, albeit not statistically significant. It means that the quantity of rice imports exerts a negative effect on rice farmers' supply response. The larger the volume of import of rice the more the farmers feel reluctant to produce locally since foreign rice competes significantly with the domestic rice. Local farmers tend to reduce production by allocating the land for other crops or shun rice farming completely for other lucrative jobs. Therefore, the reason why governments impose various policies to curtail rice importation is, among other reasons, to help local farmers boost their production and make Nigeria self-reliant.

The above-stated result is similar to the findings reported by Akanni and Okeowo (2011). In their analysis of aggregate output supply response of selected food grains in Nigeria, they reported that the rice importation variable had a negative signs and statistically insignificant. They further stressed that experience has shown that the era of the rice ban in Nigeria boosted domestic production tremendously.

Still, Table 4 shows the rainfall variable has a positive signs but not statistically significant. It can be inferred from this that the amount of rainfall does not significantly determine farmer's decisions on land allocation for rice production in the study area. Surprisingly, this finding is in contrast to most of the supply response studies (Khan, 2010; Akanni andOkeowo, 2011; Ayinde, *et al*., 2014; Anthony, 2016; Ayinde, *et al*., 2017) which reported a significant effect of rainfall variable on supply response for various crops. The reason for the non-significance of the rainfall variable in this study could be attributed to the fact that land allocated to rice production through the irrigation system is quite substantial in the study area.

Conclusion and Recommendations

Rice farmers in the study areas are responsive to price changes. They typically respond to price increase by expanding land area cultivated to rice. Their response is comparatively more pronounced in the long-run than in the short-run. Also, the speed of acreage adjustment is relatively slow.

It is therefore recommended that price incentives in form of input subsidies should be offered to farmers so as to increase their income level which in turn will encourage them to produce more. In addition, trade policy measures, such as rice import ban, should be implemented with caution since farmers' rate of adjustment is relatively slow.

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