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Seeking an Alternative Modality to the Management of Nigeria's Fertilizer Subsidy Scheme-an Empirical Approach to the Case Study of Ondo State, Nigeria (1976-1996)

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Abstract: The fertilizer subsidy programme was instituted as a way of making inorganic fertilizers readily available to Nigerian farmers at affordable prices in order to boost food production in the country. Not too long after the scheme took off, farmers started complaining bitterly that they did not receive their supplies of the substance at the time of need and in sufficient quantities. This study was consequently embarked upon to determine; *inter alia*, if the farmers' complaints about the subsidy scheme were founded and if so, to design alternative ways of administering the programme so that the lofty goals for which it was established could be realised. Primary and secondary data were collected on the relevant variables to the study. Primary data were collected from the farmers on, among other things, whether they received the fertilizers in sufficient quantities and at the time of need. These data were descriptively analysed. Secondary data were collected from NAFCON, AISC, ADP, FPDD (now FFD). Secondary data were collected. These data were on the quantities of fertilizers produced by NAFCON, the input usage of NAFCON, quantities of fertilizers supplied to Ondo State, quantities of fertilizers demanded (adopted) by farmers in Ondo State, the income of farmers in Ondo State and the prices of fertilizers. These data were inferentially analysed. Evidence from the descriptive analyses showed that farmers in Ondo State did not receive their supplies of fertilizers in sufficient quantities and at the time of need. However, evidence showed that for most years of the study period, the supply of fertilizers on the average surpassed adoption (demand). From the inferential analyses, econometric evidence showed that a subsidy introduced into NAFCON'S production process would lead to increased output of fertilizers. An increased output would induce fertilizer prices to fall in Ondo State. Econometric evidence also showed that with reduced prices, the quantities of fertilizers that would be available to the farmers for adoption would be relatively unchanged. This is because of the inelastic nature of the farmers' adoption or demand schedule. It is therefore the recommendations of this study that the adoption of fertilizers must continue to be subsidised, but the method of introducing the subsidy must change. The distribution logistics as it exists presently must be absolutely scrapped. The vast bureaucratic network through which fertilizers are distributed to the farmers must be totally by-passed. In its place, a system of distribution that is market-based must be instituted. The institution of a market-based distribution system can only be realised when the subsidy is introduced at the plant level which would translate into increased output of fertilizers. An increased output of fertilizers would cause fertilizer prices to fall in Ondo State where farmers could purchase fertilizers at reduced rates without having to deal with public-sector channels. In order for the quantities of the fertilizers available to the farmers to increase, more producers must be subsidised to participate in the industry so that the farmers' inelastic demand schedule could be made more elastic. Also, the producers benefiting from the subsidy must be made to submit themselves to government's regulatory framework in terms of internal management (productivity, due process in purchases etc.) and quality control.

Key words: Alternative modality, mannegement, fertilizer subsidy, scheme, Nigeria

INTRODUCTION

Consequent upon a sharp decline in the rate of growth of food and fibre production especially in the late 1960s and early 1970s (Idachaba, 1984) successive Federal Governments in Nigeria, since the early 1970s, have instituted some agricultural programmes with a view to solving this problem. The Agricultural Development Project (ADP) was established in 1975 as an input distribution and delivery system, which ensured that

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farmers did not have to travel more than 5-15 km to purchase needed farm inputs (Idachaba, 1984). Because of the importance of fertilizer amongst other inputs, it has occupied a prominent place in the national agricultural policy (Evbuomwan, 1991).

The Green Revolution Programme was introduced in 1979, with the main pre-occupation, being the procurement and distribution of fertilizers through agents whose methods of carrying out their role led to their being named emergency contractors (Famoriyo, 1996). In 1988, the National Fertilizer Company of Nigeria (NAFCON) was founded by the Federal Government. Other fertilizer granulating and blending firms have since been established in the country. Purchases of inorganic fertilizers such as Compound Fertilizer (NPK), Urea Fertilizer and Single Superphosphate Fertilizer (SSP) by the Federal Government from these companies were used to supplement foreign procurement which were distributed to farmers all over the Federation at heavily subsidised rates.

However, no sooner had all the above been done than the farmers started complaining persistently that not enough of the subsidised commodity was received by them during the crucial planting periods. Also, the consumers' situation has not improved because the proportion of their disposable incomes expended on foods has continued to increase over the years. It is therefore the objectives of this study to evaluate the fertilizer subsidy programme and identify the inefficiencies in the administration of the programme in Ondo State, Nigeria from 1976 to 1996, to analyse the supply and demand patterns of fertilizers in Ondo State during the study period and to design market intervention aimed at removing likely inefficiencies in the present administration of the scheme. The study concludes by making recommendations.

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Subsidy as a policy instrument has been used by governments worldwide to pursue different sectoral objectives. This review therefore would not be limited to subsidy as it affects production in the fertilizer industry alone but would also review production subsidies in other areas such as industrial subsidy and cotton production subsidy.

In India for instance, the government instituted a policy of input price subsidisation in the fertilizer industry and then removed it during the era of deregulation and liberalisation. Schumacher and Sathaye (1999) investigated the relationship between input usage, productivity and growth in the value of output in India's fertilizer industry during the subsidisation years (1973-1991) and the liberalisation years (1991-1993). During the subsidisation years, the difference between the retention price (mainly based on production cost) and the ceiling on the prices of fertilizers sold to the farmers was the level of input subsidisation to the fertilizer industry. The study used cross state and national time series data. Kendrick and translog cost function (variants of production functions) approach were adopted. Also adopted was Solow approach which assumed a neo-classical Cobb-Douglas specification of production function with constant returns to scale, perfect competition in the market and factors being rewarded their marginal products.

Specifying the growth value of output as the dependent variable and labour, capital, energy and material inputs as the independent variables, Schumacher and Sathaye (1999) submitted that on the average, total input usage, total productivity and value of output growth annually were 9.81, 3.60 and 13.41%, respectively during the subsidisation years. They also found that input usage, total productivity and value of output annually were-2.18,-8.44 and-10.62%, respectively during the liberalisation years. The findings of the study concerning the subsidising years seemed to confirm the submission of Lingard (2002) that subsidies will increase the use of variable production inputs. Disagreeing with these submissions, Zalla and Saad (1998) in their study on fertilizer production and marketing in Egypt found that following the elimination of subsidies (in 1992), the domestic production of nitrogenous fertilizers increased by 3.6% per year, while the production of phosphate grew by just over 1%.

When discussing the issue of fertilizer production subsidy around the world, two eras stand out: The era of monopoly in production, purchase and distribution of fertilizers in the 1970s and the very early 1980s and the era of deregulation and liberalisation which started in the mid 1980s. Considering the era of monopoly, subsidisation to producers of fertilizers can be of two types: Direct payment based on the per unit of fertilizers produced or input price support. The latter has been widely adopted by governments albeit with varying degree of modifications.

Subsidies to fertilizer producers have been used to stimulate domestic fertilizer production to ensure adequate and timely supply, save foreign exchange, and promote economic development especially in countries with high energy cost or dependence on imported raw materials. Nitrogen production has been subsidised in India, Bangladesh, Indonesia, Mexico, and Egypt whereas phosphate production has been subsidised in India, Indonesia, China, Morocco and Pakistan (IFDC, 2003b). For different studies on Phillipines, India and Egypt (David and Balisacan, 1981; Ranade and Kapur, 2001). In these countries, the production subsidies work thus: The production costs (which usually consists of the cost of feedstock, energy etc) are first calculated. This is referred to as the retention price. The ceiling price at which fertilizers are sold to the farmers is then subtracted from the retention price. The difference is the per unit input price subsidy paid to the producers in the fertilizer industry.

The financing of this level of subsidisation usually requires a huge budgetary outlay. For the developed world, financing subsidy schemes does not pose much problems. For instance in 1998, net transfers to agriculture in OECD countries amounted to $ 362 billion, approximately three quarters of which were in forms of producer supports (Robin *et al.*, 2003). But for many developing countries with many developmental needs, such outlays had adverse impact on national, state and local government budgets. For example, in Nigeria, between 1991 and 1992, the fertilizer subsidy cost, as a percentage of the national budget, ranged from 16.8% in 1991 to a high of 42.7% in 1992 (IFDC, 2005; Nagy and Edun, 2002). Most of these developing nations rely on the contributions of donor nations to finance their agricultural outlays. So at the prodding of the donors, these countries since the mid 1980s, sought to deregulate and liberalise their fertilizer sectors. Existing literature on the best framework to adopt for an efficient fertilizer procurement and distribution tend to emphasise the need to reduce transaction costs (supply side approach) involved in fertilizer distribution (IFDC, 2003a; IFDC, 2003b; Nagy and Edun, 2002; Debrah, 2002). Models in these studies used simple linear supply and demand equations in which supply and demand were the endogenous variables and price was the only exogenous variable. The studies suggested that an embrace of a supply-side, market friendly fertilizer distribution framework would induce the Shifting of the Supply Curve to the Right (SSCR) so that at equilibrium, the unit price of fertilizer would fall and the quantity of fertilizer supplied would rise.

The factors that engender a market friendly fertilizer distribution system and hence a reduction in the transaction cost of fertilizer distribution according to the studies are: The creation of a conducive macro policy, declaration and adherence to consistent input marketing policy, building human capital for market development, improving access to finance, developing and implementing regulatory frameworks, promoting market transparency through market information systems, promoting technology transfer activities and strengthening research capacity for promoting the private seed industry.

Gadzey *et al.* (2000) in trying to examine the effectiveness of industrial subsidies on manufacturing output in state of Alabama, USA used panel data across 20 counties in the state from 1970 to 1999 in the pooled regression. The independent variables were county subsidies, population density and the usage bill. The dependent variable was industrial output. The empirical results showed that subsidies have a positive effect on county output. Specifically, the coefficient of the subsidies variable indicated an impact of $ 6.61 per $ 1000 of grant.

Studies have also been carried out that showed, *inter alia*, the effect of subsidy on output or production. In the fall of 2002 Brazil brought a complaint about US cotton subsidies to the dispute settlement panel of the WTO. Brazil claimed that US support for cotton granted in the period 1999-2002 exceeded that level allowed under WTO agreements and therefore caused the world price of cotton to fall. Sumner (2003) used econometric model adapted from and largely based on the key supply and demand elasticities from the well-known and respected Food and Agricultural Policy Research Institute (FAPRI) to examine by simulation the export and world price effects of removing the 6 major US subsidies supporting US production and export of Upland cotton.

The simulation model used made some assumptions on the elasticities on the variables. These variables are the expected price yield, marketing loan benefits yield, production flexibility contract payment, direct payments, market loss assistance payments, counter-cyclical payments, crop insurance subsidy and cost per acre were specified in the supply equation (proxied by expected revenue because it is expected that subsidies that increase the expected net revenue per acre planted would naturally increase the quantity supplied). The variables that entered into the demand equation are price minus domestic step 2 payment, price minus export step-2 payment and export credit. Based on the assumption made on the supply and demand elasticities, the baseline figures were derived for US cotton production, US exports, US mill use of cotton, US average price and world price when the subsidies were assumed to be in place. A policy scenario which assumed that the subsidies were removed was thereafter simulated.

Sumner (2003) submitted that removing the subsidies simultaneously would cause a fall in US exports on the average by almost 43%, would cause the US market price on the average to rise by 15.2% and would cause the world price of Upland cotton to rise on the average by about 11.6%.

Poonyth *et al*. (2004) assuming different elasticities in the computation of the baseline figures, used essentially the same variables in their supply and demand equations. The baseline figures derived were subjected to the Agricultural Trade Policy Simulation Model (ATPSM). They simulated a policy scenario that assumed the removal of cotton subsidies would reduce world price cotton between 3.1 and 4.8%. They also estimated that cotton output in non-subsidising countries would reduce by 2%. Output was also estimated to decrease by 15% in the United States and by 32% in the EU Countries.

Shepherd (2004) used Vector Autoregression (VAR) model in which the following variables were modeled as the endogenous variables: Nominal world price of cotton, total world consumption of cotton, change in the level of total world stocks of cotton. The model then specified the lagged values of the preceding variables and subsidies as the exogenous variables. Shepherd (2004) found that the world production of cotton responded to a subsidy shock. He however found that the response of price to subsidy shock was not as robust as reported in the studies of Goreux (2004); Sumner (2003) and Poonyth *et al*. (2004).

MATERIALS AND METHODS

The study area is Ondo State, Nigeria. Ondo state consists of eighteen Local Government Areas. Ilaje and Eseodo Local Government Areas were excluded from the study because they are in the main riverine areas where food crop farming is not known to be largely practised, therefore, fertilizers are not adopted in these areas. The remaining 16 Local Government Areas constituted the study area. However, owing to financial constraints, the sample was chosen from twelve Local Government Areas. These Local Government Areas were divided into three different climatic zones into which state could be divided i.e., the Southern zone, the Central zone and the Northern zone. The Southern zone which comprised the following Local Government Areas-Irele, Okitipupa, Odigbo and Ondo West Local Government Areas; the Central zone which comprised the following Local Government Areas-Akure-South, Akure-North, Idanre and Ile-Oluji/Okeigbo Local Government Areas and the Northern zone which comprised the following Local Government Areas-Akoko Northwest, Akoko Southwest, Akoko Northeast and Akoko Southeast.

The target groups were from these Local Government Areas. The target groups were the farmers who have adopted fertilizers during the study period, governmental agencies within the state such as Agricultural Development Project (ADP), Agricultural Input Supply Company (AISC), governmental agencies outside the state such as the National Fertilizer Company of Nigeria (NAFCON)[2] and the Fertilizer Procurement and Distribution Department (FPDD) now the Federal Fertilizer Department (FFD). All these agencies have valuable information which are pertinent to the study in their archives.

Samples were drawn from the twelve Local Government Areas in the three zones. Primary data were collected with the use of questionnaires administered on the target groups. A total number of eight hundred and sixteen questionnaires were sent out for administration on the farmers in the twelve Local Government Areas i.e., 68 questionnaires were sent to each Local Government Area. Farmers who have adopted fertilizers during the study period were randomly selected and questions concerning whether they received their fertilizers in sufficient quantities and at the time of need, fertilizer usage and point of collection of fertilizers were asked by Enumerators. Purposive sampling was utilised to collect secondary data from the governmental agencies by the researchers. Data on the quantities of fertilizers received in Ondo state were collected from AISC and ADP. Data on the quantities of fertilizers sent to Ondo state were collected from FPDD now FDD. Data on the income of farmers and the quantities of fertilizers consumed in Ondo state were collected from ADP. Data on the quantities of fertilizers produced and the prices of inputs used in the production process were collected from NAFCON.

[2] NAFCON stopped production of fertilizers in 1999 and is now acquired by NOTORE (a chemical company) under the Nigerian Government's policy of privatization of State Owned Enterprises (SOEs). NOTORE is yet to start production of fertilizers.

Secondary data on the prices of fertilizers were collected from the Report of the Fertilizer Inventorisation Study Team. Indexes were constructed on NAFCON's fertilizer production, NAFCON's input (equipment, replacement parts, labour, materials) usage without subsidy, NAFCON's input usage with subsidy. The indexes were expressed in quarterly figures. The prices of fertilizers and the prices of the inputs in the base year i.e., 1976 were used as weights. According to Shao (1976) when the weight is the number of the base year (that is, $w = q_0$ or $w = p_0$), the index is called Laspeyres index.

The data collected on the farmers from the questionnaires were descriptively analysed. The indexes constructed on NAFCON's production of fertilizers, NAFCON's input usage with or without subsidy were fitted into Ordinary Least Squares (OLS) regression models and econometrically analysed. The data collected on the quantities of fertilizers produced without subsidy and supplied to Ondo state by NAFCON, the quantities of fertilizers produced with subsidy and supplied to Ondo state by NAFCON, the prices and quantity demanded of fertilizers in Ondo state were fitted into Two-Stage Least Squares (TLS) regression models and econometrically analysed.

$$\text{Log}\frac{\sum Q_n P_o}{\sum Q_o P_o} = \partial + \theta\ \text{Log}\left[\frac{\sum q_n p_o}{\sum q_o p_o}\right] + U_i \qquad (1)$$

Where:

$$\text{Log}\frac{\sum Q_n P_o}{\sum Q_o P_o}$$

Weighted quantity index of fertilizers produced by NAFCON.

∂ = Intercept term.
θ = Estimator of weighted index of input usage by NAFCON without subsidy variable.

$$\frac{\sum q_n p_o}{\sum q_o p_o}$$

Weighted index of input usage by NAFCON without subsidy variable (inputs are labour, equipment replacement parts, materials)
U_i = Stochastic disturbance term.

$$\text{Log}\frac{\sum Q_n P_o}{\sum Q_o P_o} = \partial + \theta\ \text{Log}\left[\frac{\sum q_n P_o(1+s)}{\sum q_o p_o}\right] + U_i \qquad (2)$$

$$\Rightarrow \text{Log}\frac{\sum Q_n P_o}{\sum Q_o P_o} = \partial + \theta\ \ \text{Log}\left[\frac{\sum q_n P_o}{\sum q_o p_o}\right] + \lambda\text{Log}\left[\frac{\sum_s q_n P_o}{\sum q_o p_o}\right] + U_i \qquad (3)$$

Where:

$$\text{Log}\frac{\sum Q_n P_o}{\sum Q_o P_o}$$

Weighted index of fertilizers produced by NAFCON.
∂ = Intercept term.
θ = Estimator or coefficient of weighted inputs without subsidy.

$$\text{Log}\frac{\sum q_n P_o(1+s)}{\sum q_o p_o} \Rightarrow 1)\text{Log}\frac{\sum q_n P_o}{\sum q_o p_o}$$

Index of input usage without subsidy and

$$2)\text{Log}\frac{\sum_s q_n P_o}{\sum q_o p_o}$$

Index of input usage induced by subsidy

$$Q_{fso}\ \beta_o + \beta_1 P_m + U_{1t} \qquad (4a)$$

$$Q_{fdo}\ \alpha_o + \alpha_1\ \alpha_1 P_m + U_{2t} \qquad (4b)$$

$$(\beta_o, \beta_1, \alpha_0) > 0 \text{ and } \alpha_1 < 0$$

Where:

Q_{fso} = Quantity of fertilizers shipped to Ondo state and assumed produced without subsidy
β_0 = Intercept term of supply equation.
β_1 = Estimator.
P_m = Price of fertilizer in supply and demand equations.
Ut_1 = Stochastic disturbance term.
Q_{fdo} = Quantity of fertilizers used (adopted) by farmers in Ondo State.
α_0 = Intercept term of demand equation.
α_1 = Estimator of average price of fertilizers in demand equation.
U_{2t} = Stochastic disturbance term.

The equations in model (C_i) are dependent in that any disturbance caused by U_{1t} such as strikes, tariffs, exchange rate fluctuations etc would affect P_m in both equations. Likewise, a disturbance caused by U_{2t} like increase in income of farmers, increase in hectares of land cultivated by farmers etc would affect P_m in both equations. Consequently, P_m should be regarded as an endogenous variable just like Q_{fso} and Q_{fsd} in this system of structural equations. According to Gujarati (1978), a regression of Q on P_m would violate an important assumption of the classical linear regression model, namely, the assumption of no correlation between the explanatory variable(s) and the disturbance term. In his view, if this is ignored, the least-squares estimators are not only biased but also inconsistent; that is, as the sample size increases indefinitely, estimators do not converge to their true (population) values (Gujarati, 1978). As a way out of this, two new variables, P_{m-1} (lagged one value of the average price of fertilizers) and I (the average income of farmers) were introduced into the structural linear supply and demand functions, respectively. Model (C_i) then becomes:

$$Q_{fso} = \beta_o + \beta_1 P_m + \beta_2 P_{m-1} + U_{1t} \quad (5a)$$

$$Q_{fdo} = \alpha_o\ \alpha_1 P_m + \alpha_2\ I + U_{2t} \quad (5b)$$

From this new system of equations, reduced form equations could be derived in which Q and P_m (endogenous) variables are expressed in terms of pre-determined (exogenous) variables I and P_{m-1}

$$P_m = \prod_0 + \prod_1 P_{m-1} + \prod_2 I + V_t \quad (6)$$

$$Q = \prod_3 + \prod_4 P_{m-1} + \prod_5 I\ W_t \quad (7)$$

Where:

$$\Pi_0 = \frac{a_0 - \beta_0}{\beta_1 - a_1} \quad (8)$$

$$\Pi_1 = \frac{a_2}{\beta_1 - a_1} \quad (9)$$

$$\Pi_2 = \frac{-\beta_2}{\beta_1 - a_1} \quad (10)$$

$$V_t = \frac{U_{2t} - U_{1t}}{\beta_1 - a_1} \quad (11)$$

$$\Pi_3 = \frac{a_0\beta_1 - a_1\beta_0}{\beta_1 - a_1} \quad (12)$$

$$\Pi_4 = \frac{a_1 a_2}{\beta_1 - a_1} \quad (13)$$

$$\Pi_5 = \frac{-a_1\beta_2}{\beta_1 - a_1} \quad (14)$$

$$W_t = \frac{a_1 U_{2t} - a_t U_{1t}}{\beta_1 - a_1} \quad (15)$$

From the six reduced-form equations (**Π_0, Π_1, Π_2, Π_3 Π_4** and **Π_5**), six structural coefficients or estimators (β_0, β_1, β_2, α_0, α_1 and α_2) can be indirectly estimated. For a detailed derivation of the reduced-form equations and relevant coefficients, see Appendix (A).

$$Q_{fsso} = s\beta_0\ \beta_1 P_m + U_{1t} \quad (16a)$$

$$Q_{fdo} = \alpha_0\ \alpha_1 P_m + U_{2t} \quad (16b)$$

Note that factor s is attached to the intercept term which is expected to cause the supply curve (Q_{fsso}) to shift to the right to intersect a stationary demand curve (Q_{fdo}). Assumption here is that the fertilizers shipped to Ondo State is produced with a subsidy.

Again, because the system of equations in (D_i) are dependent which may lead to biased and inconsistent estimators, the lagged value of average price of fertilizers (P_{m-1}) and average income of farmers (I) are introduced. Model (D_i) becomes:

$$(D_{ii})\ Q_{fsso} = s\beta_0\ \beta_1 P_m\ \beta_2 P_{m-1} + U_{1t} \quad (17a)$$

$$Q_{fdo} = \alpha_0\ \alpha_1 P_m\ \alpha_2 I + U_{2t} \quad (17b)$$

From this, reduced form equations are derived in which Q and P_m (endogenous) variables are expressed in terms of pre-determined (exogenous) variables I and P_{m-1}.

$$P_m = \prod_0 + \prod_1 P_{m-1} + \prod_2 I + V_t \quad (18)$$

$$Q = \prod_3 + \prod_4 P_{m-1} + \prod_5 I + W_t \quad (19)$$

Where:

$$\Pi_0 = \frac{a_0 - \beta_0}{\beta_1 - a_1} \quad (20)$$

$$\Pi_1 = \frac{a_2}{\beta_1 - a_1} \quad (21)$$

$$\Pi_2 = \frac{-\beta_2}{\beta_1 - a_1} \quad (22)$$

$$V_t = \frac{U_{2t} - U_{1t}}{\beta_1 - a_1} \quad (23)$$

$$\Pi_3 = \frac{a_0\beta_1 - a_1 s\beta_0}{\beta_1 - a_1} \quad (24)$$

$$\Pi_4 = \frac{a_1 a_2}{\beta_1 - a_1} \quad (25)$$

$$\Pi_5 = \frac{-a_1\beta_2}{\beta_1 - a_1} \quad (26)$$

$$W_t = \frac{a_1 U_{2t} - a_1 U_{1t}}{\beta_1 - a_1} \quad (27)$$

From the six reduced form equations, ((Π_0, Π_1, Π_2, Π_3 Π_4 and Π_5) six estimators (β_0, β_1, β_2, α_0, α_1 and α_2) can be indirectly estimated. For a detailed derivation of the reduced-form equations and relevant coefficients, see Appendix (A).

APPENDIX A

A. Derivation of the Reduced-form Equations and Parameters of Equations (4a) and (4b) in Model (C_i).
Supply and Demand Equations are:

$$Q_{fs} = \beta_0 + \beta_1 P_m + U_{1t} \quad (1a)$$

$$Q_{fd} = \alpha_0 + \alpha_1 P_m + U_{2t} \quad (1b)$$

$$(\beta_0, \beta_1, \alpha_0 > 0 \text{ and } \alpha_1 < 0)$$

Adding variables P_{m-1} and I to the supply and demand equations, respectively:

$$Q_{fs} = \beta_0 + \beta_1 P_m \; \beta_2 P_{m-1} + U_{1t} \quad (2a)$$

$$Q_{fs} = \alpha_0 + \alpha_1 P_m \; \alpha_2 I + U_{2t} \quad (2b)$$

$$(\beta_2, \alpha_2 > 0 \text{ and } (Q_{fs} = Q_{fd} = Q)$$

Solving for P:

$$\beta_1 P_m - a_1 P_m = a_o - \beta_o + a_2 I - \beta_2 P_{m-1} + U_{2t} - U_{1t} \quad (3)$$

$$P_m (\beta_1 - a_1) = a_o - \beta_o + a_2 I - \beta_2 P_{m-1} + U_{2t} - U_{1t} \quad (4)$$

$$P_m = \frac{a_0 - \beta_0}{\beta_1 - a_1} + \frac{a_2}{\beta_1 - a_1} I - \frac{\beta_2}{\beta_1 - a_1} P_{m-1} + \frac{U_{2t} - U_{1t}}{\beta_1 - a_1} \quad (5)$$

$$P_m = \prod_0, \prod_1 I + \prod_2 P_{m-1} + V_t \quad (6)$$

Where:

$$\Pi_0 = \frac{a_0 - \beta_0}{\beta_1 - a_1} \quad (7)$$

$$\Pi_1 = \frac{a_2}{\beta_1 - a_1} \quad (8)$$

$$\Pi_2 = \frac{-\beta_2}{\beta_1 - a_1} \quad (9)$$

$$V_t = \frac{U_{2t} - U_{1t}}{\beta_1 - a_1} \quad (10)$$

Substituting P into the demand equation or equation (2b):

$$Q_{fd} = a_0 + a_1 \left[\frac{[a_0 - \beta_0] + [a_2] - [\beta_2] + [U_{2t} - U_{1t}]}{\beta_1 - a_1} \right] \quad (11)$$

$$Q_{fd} = \frac{[a_0\beta_1 - a_1\beta_0] + [a_1 a_2] - [a_1\beta_2] + [a_1 U_{2t} - a_1 U_{1t}]}{\beta_1 - a_1} \quad (12)$$

$$Q_{fd} = \prod_3 + \prod_4 I + \prod_5 P_{-1} + W_1 \quad (13)$$

Where:

$$\Pi_3 = \frac{a_0\beta_1 - a_1\beta_0}{\beta_1 - a_1} \quad (14)$$

$$\Pi_4 = \frac{a_1 a_2}{\beta_1 - a_1} \quad (15)$$

$$\Pi_5 = \frac{-a_1\beta_2}{\beta_1 - a_1} \quad (16)$$

$$W_t = \frac{a_1 U_{2t} - a_t U_{1t}}{\beta_1 - a_1} \quad (17)$$

Using Eq. (7), (8), (9), (14), (15) and (16), the unique values of β_0, β_1, β_2, α_0, α_1, and α_2 can be derived:

$$\beta_0 = \alpha_0 - \prod_0 (\beta_1 - \alpha_1) \quad (18)$$

$$\beta_1 = \frac{a_2 + \Pi_1 a_1}{\Pi_1} \quad (19)$$

$$\beta_2 = -\prod_2 (\beta_1 - \alpha_1) \quad (20)$$

$$a_0 = \frac{\Pi_3(\beta_1 - a_1) + a_1\beta_0}{\beta_1} \quad (21)$$

$$a_1 = \frac{\Pi_5 \beta_1}{\Pi_5 - \beta_2} \quad (22)$$

$$a_2 = \frac{\Pi_4(\beta_1 - a_1)}{a_1} \quad (23)$$

Derivation of the reduced-form equations and parameters of Eq. (16a) and (16b) in model (D_i).

After adding variables P_{-1} and I to the supply and demand equations and also adding factors S to the supply Eq. (1a) and (1b) become:

$$Q_{fss} = {}_s\beta_0 + \beta_1 P_m + \beta_2 P_{m-1} + U_{1t} \quad (24)$$

$$Q_{fd} = a_o + a_1 P_m + a_2 I + U_{2t} \quad (25)$$

Solving for P_m:

$$\beta_1 P_m - a_1 P_m = a_o - {}_s\beta_o + a_2 I - \beta_2 P_{m-1} + U_{2t} - U_{1t} \quad (26)$$

$$P_m = \frac{a_0 - s\beta_0}{\beta_1 - a_1} + \frac{a_2}{\beta_1 - a_1} I - \frac{\beta_2}{\beta_1 - a_1} P_{m-1} + \frac{U_{2t} - U_{1t}}{\beta_1 - a_1} \quad (27)$$

$$P_m = \Pi_0 + \Pi_1 I + \Pi_2 P_{m-1} + V_t \quad (28)$$

Where:

$$\Pi_0 = \frac{a_0 - s\beta_0}{\beta_1 - a_1} \quad (29)$$

$$\Pi_1 = \frac{a_2}{\beta_1 - a_1} \quad (30)$$

$$\Pi_2 = \frac{-\beta_2}{\beta_1 - a_1} \quad (31)$$

$$V_t = \frac{U_{2t} - U_{1t}}{\beta_1 - a_1} \quad (32)$$

Substituting P_m into the demand equation or Eq. (2b):

$$Q_{fd} = a_0 + a_1 \left[\frac{[a_0 - s\beta_0] + [a_2] - [\beta_2] + [U_{2t} - U_{1t}]}{\beta_1 - a_1} \right] \quad (33)$$

$$Q_{fd} = \frac{[a_0\beta_1 - a_1 s\beta_0] + [a_1 a_2] - [a_1\beta_2] + [a_1 U_{2t} - a_1 U_{1t}]}{\beta_1 - a_1} \quad (34)$$

$$Q = \Pi_3 + \Pi_4 I + \Pi_5 P_{m-1} + W_t \quad (35)$$

Where:

$$\Pi_3 = \frac{a_0\beta_1 - a_1 s\beta_0}{\beta_1 - a_1} \quad (36)$$

$$\Pi_4 = \frac{a_1 a_2}{\beta_1 - a_1} \quad (37)$$

$$\Pi_5 = \frac{-a_1\beta_2}{\beta_1 - a_1} \quad (38)$$

$$W_t = \frac{a_1 U_{2t} - a_t U_{1t}}{\beta_1 - a_1} \quad (39)$$

Using equations (29), (30), (31), (36), (37) and (38), the unique values of ${}_s\beta_0$, β_1, β_2, $\alpha_0\alpha_1$ and α_2 can be derived:

$$s\beta_0 = sa_o - \Pi_0 s(\beta_1 - a_1) \quad (40)$$

$$\beta_1 = \frac{a_2 + \Pi_1 a_1}{\Pi_1} \quad (41)$$

$$\beta_2 = -\Pi_2(\beta_1 - a_1) \quad (42)$$

$$a_0 = \frac{\Pi_3(\beta_1 - a_1) + a_1\beta_0}{\beta_1} \quad (43)$$

$$a_1 = \frac{\Pi_5\beta_1}{\Pi_5 - \beta_2} \quad (44)$$

$$a_2 = \frac{\Pi_4(\beta_1 - a_1)}{a_1} \quad (45)$$

RESULTS

The empirical findings section consists of two sub-sections: Descriptive statistics findings and inferential statistics findings.

Descriptive statistics results: Out of the 816 questionnaires sent out through the enumerators, 596 of them were completed. Five hundred and ninty six was therefore the sample size. Two hundred and twenty two of the questionnaires were returned by the Enumerators uncompleted. The reason being that in the course of the interview between the Enumerators and some respondents, the Enumerators discovered that such respondents could not be included in the study because they did not use fertilizers during the study period. The mean value of the response rate in the three zones was 73%. The questionnaire taken to Agricultural Input Supply Company (AISC), Akure, National Fertilizer Company of Nigeria (NAFCON), Fertilizer Procurement and Distribution Department (FPDD) Abuja now Federal Fertilizer Department (FFD), Abuja and ADP, Akure by the researchers were completed and promptly returned to the researchers. So, the response rate of these organisations was 100%.

Fertilizer usage among the 596 farmers interviewed in the zones was 100%. About 77.89% of the farmers interviewed reported receiving their fertilizers through the ADP outposts. About 17.01% of the farmers received their fertilizers through AISC while about 5.10% reported receiving their fertilizers through ADP headquarters. One of the key issues addressed by the questionnaires was the issue of the availability of fertilizers to farmers. About 72.33% of the farmers reported not receiving their fertilizers in sufficient quantities in the three zones, while 27.67% of the farmers reported receiving their fertilizers in sufficient quantities. Sixty six percent of the farmers in the three zones reported not receiving their fertilizers at the time of need while 34% reported receiving their fertilizers at the time of need.

Table 1 shows that the excess of supply of fertilizers over demand or consumption was on the average about 1715 metric tonnes per year while the excess of demand over supply was on the average about 585 metric tonnes annually.

Inferential statistics results: This sub-section presents the regression results of NAFCON's output of fertilizers without subsidy, the effect of subsidy on NAFCON's output of fertilizers with subsidy, the effect of NAFCON'S fertilizer output without subsidy on the quantity and price

Table 1: Fertilizer supply, consumption (Demand) and average subsidy price of fertilizers in Ondo State (1976-1996)

(I) Year	(ii) Quantity of fertilizers supplied (000 metric tonnes)	(iii) Quantity of fertilizers consumed (000 metric tonnes)	(iv) GAP (surplus/deficit) (000 metric tonnes)	(v) Price per 50 kg bag of Fertilizers (₦)
1976	902	596	306	2
1977	1043	750	293	2
1978	1205	950	255	2
1979	1393	1022	370	2
1980	1610	1174	436	2.50
1981	1861	2748	-887	2.50
1982	2149	2900	-751	2.50
1983	2484	3100	-616	2.50
1984	2871	3300	-429	6
1985	3318	3561	-243	9
1986	3835	3750	85	10
1987	4432	3950	482	10
1988	5122	4200	922	10
1989	5920	4400	1520	15
1990	6842	4600	2242	20
1991	7908	4800	3108	40
1992	9140	5100	4040	40
1993	5880	5300	580	80
1994	6811	5500	1311	150
1995	10000	5800	4200	155
1996	13285	6000	7285	160

Sources: Column (ii)-FPDD and AISC Data Files; Column (iii) -ADP Data Files; Column (iv) -Computed by author; Column (v) -Ayoola, G.B., Chude V.O. and Abdulsalam, A.H. (2002). Towards A Fertilizer Regulatory and Quality Assurance System for Nigeria: An Inventorisation of the Fertilizer Sector, Federal Fertilizer Department (FFD), Federal ministry of agriculture and rural development, Abuja, p. xxiv of table of content

Table 2: Ordinary least squares and two-stage least squares regression results

Models	Dependent variables	Constants	Independent variables: $\text{Log}\left[\frac{\sum q_n P_o}{\sum q_o p_o}\right]$	$\text{Log}\left[\frac{\sum s q_n P_o}{\sum q_o p_o}\right]$	Log P_m	N
A	$\text{Log}\left[\frac{\sum Q_n P_o}{\sum Q_o p_o}\right]$		1.720*			40
			(40.459)	5.043*		40
B	$\text{Log}\left[\frac{\sum Q_n P_o}{\sum Q_o p_o}\right]$		0.674*	(26.284)		
			(35.015)			
C_{ii}	Log Q_{fso}	5.894*			0.377*	21
		(9.137)			(4.218)	
	Log Q_{fdo}	7.337*			0.152*	21
		(5.294)			(9.245)	
		Equilibrium value:			Equilibrium value:	
		Q = 8.312			P_m = 6.413	
D_{ii}	Log Q_{fsso}	5.766*			0.400*	21
		(13.154)			(6.376)	
	Log Q_{fdo}	7.337*			0.152*	21
		(5.294)			(9.245)	
		Equilibrium value:			Equilibrium value:	
		Q = 8.300			P_m = 6.335	

* Significant at 5% level; t ratios in parentheses; (iii)Computed by authors

of fertilizers in Ondo State, the effect of NAFCON's output of fertilizers with subsidy on the quantity and price of fertilizers in Ondo State.

The choice of double log functional form in all the regression models in Table 2 over all other functional forms were premised on the fact that double log functional forms yielded better estimates. All the regression models were treated for first order positive serial autocorrelation with the use of Cochrane-Orcutt iteration procedure.

Models (A) and (B) are OLS regressions to show the effect of subsidy introduced at the plant level in form of input price support on the production of fertilizers by NAFCON. First, in model (A), the index of production of fertilizers by NAFCON was regressed on input index without subsidy. Second, in model (B), the index of production of fertilizers by NAFCON was regressed on input index without subsidy and index of input usage induced by the introduction of a subsidy. The subsidy rate was a 50% across-the-board input price support. The justification for this was that this was the subsidy rate granted on fertilizer subsidy by the Federal Government of Nigeria during the period of observation of NAFCON's production process.

The models in Table 2 were generally well behaved in terms of the values of their R^2, D.W statistics and t ratios. The estimator attached to the independent variable in model (A) shows that a 1% increase in the usage of inputs without subsidy caused output of fertilizers by NAFCON to increase by about 1.72%. However, there are 2 estimators in model (B). They are: The estimator attached to input usage without subsidy independent variable and the estimator attached to input usage induced by subsidy independent variable. The estimator attached to input usage without subsidy independent variable shows that a 1% increase in the usage of inputs without subsidy caused output of fertilizer by NAFCON to increase by about 0.674% while the estimator attached to input usage induced by subsidy independent variable would cause output of fertilizer to increase by about 5.043% if it increases by 1%.

Model (C_{ii}) is a two-stage least squares regression of quantity of fertilizers supplied to Ondo State without subsidy and quantity adopted (demanded) of fertilizers in Ondo State on the price of fertilizers in Ondo State. It must be noted that the value of the intercept term in the supply equation is 5.894. When the two equation are set equal to each other, the value of P_m is 6.413 and the value of Q is 8.312.

Model (D_{ii}) is also a two stage least squares regression of quantity of fertilizers supplied to Ondo State with subsidy and quantity adopted (demanded) of fertilizers in Ondo State on the price of fertilizers in Ondo State. It must be noted that the value of the intercept term in the supply equation decreased to 5.766 due to the fact that the variable Q_{fso} was multiplied by a scalar (s = 5.043%) which was what the empirical result in model (B) suggested i.e., the supply curve in model (A) was to shift to the right due to the input price support (subsidy). The demand equation remains the same and when the two equations are set equal to each other, P_m is 6.335 and Q is 8.300.

The empirical results show that due to the introduction of a subsidy into the production process of NAFCON, more fertilizers are produced which caused the market supply curve of fertilizers in Ondo State to shift to the right causing the price of fertilizers at equilibrium in Ondo State to reduce while the quantity of fertilizers remains relatively unchanged.

DISCUSSION

From the findings from this study, it has been shown that the majority of the farmers in Ondo State who used fertilizers did not get the subsidised substance in sufficient quantities and at the time of need. This was so despite the fact that evidence shows that the supply of fertilizers consistently surpassed adoption (demand) during the study period.

Figure 1 shows that except for about 5 years of the study period i.e., from 1981 to 1985, supply of fertilizers constantly surpassed adoption (demand). The reason may be due to the fact that in 1979, the Green Revolution Programme was introduced. Under this programme, farmers were encouraged to adopt fertilizers and this probably spurred an increase in the adoption of fertilizers by farmers in Ondo State in the several years that immediately followed the introduction of the programme.

The excess of supply over demand during the study period, especially from 1986 was probably due to two reasons. First, with the introduction of SAP in 1986, the Federal Government of Nigeria reduced the subsidy rates of fertilizers. This, coupled with the fact that there was a substantial leakage in the fertilizer subsidy scheme may have depressed fertilizer consumption (adoption) by the farmers. Second, during the study period, there was some effort on the part of the Federal Government of Nigeria to increase domestic fertilizer production. Hence, the National Fertilizer Company of Nigeria (NAFCON) was founded in 1988. The ensuing increase in domestic production may have widened the supply/demand gap.
Findings from this study have also shown that instead of allowing the farmers to enjoy subsidy when they take

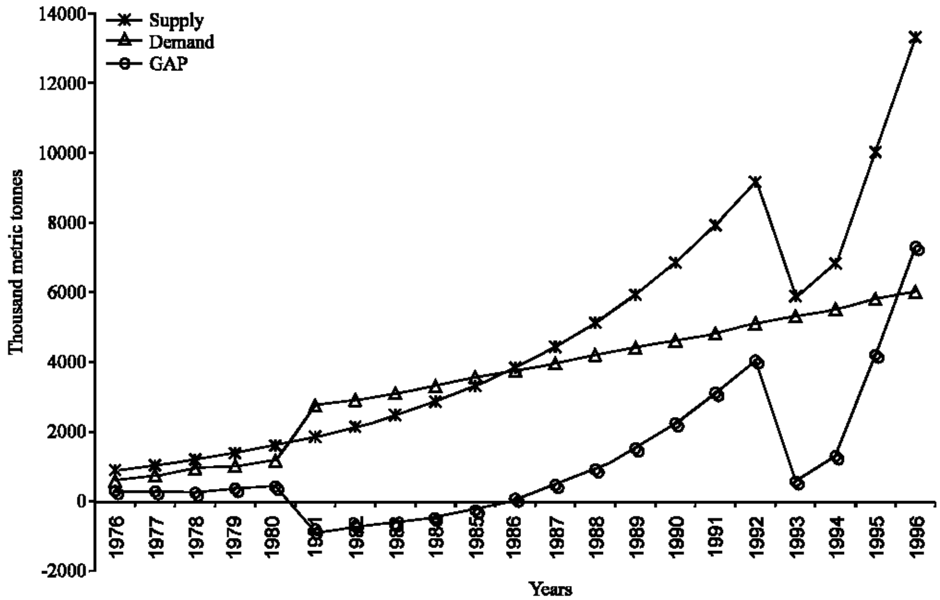

Fig. 1: Trend in fertilizers supply, adoption (demand) and supply/adoption (demand) gap in ondo state (1976 - 1996)

delivery of the subsidised substance at the ADP/AISC, the subsidy can be introduced at the plant level i.e., by subsidising NAFCON's production of fertilizers. This will cause the supply curve of fertilizers to shift to the right due to the increased output induced by the subsidy. This will cause the market price of fertilizers to reduce in Ondo State while the quantities of fertilizers available in the market in Ondo State remain relatively unchanged as shown in Table 2. A calculation of the price elasticity of demand of fertilizers from the beginning to the end of the study period in Table 1 showed a coefficient of elasticity of 0.011 which was close to zero.

CONCLUDING REMARKS

From the findings of this study, it can be concluded that during the study period, farmers in Ondo State adopted subsidised fertilizers. The fertilizers were distributed to the farmers through a long web of bureaucratic network. This network unwittingly encouraged the leakage or diversion of the fertilizers. This leakage or diversion prevented the fertilizers from getting to the farmers at the time of need and insufficient quantities. These violated the principle of inclusion i.e., the subsidy was not specific or not well targeted causing the intended beneficiaries to be excluded.

When the issue of an alternative way of administering the programme was considered, it was discovered that introducing the subsidy via the production process of NAFCON would engender increased output of fertilizers (NPK and Urea). The increased output would cause the prices of the fertilizers to decrease in Ondo State. However, the quantities of fertilizers adopted would remain relatively unchanged because of the inelastic nature of the farmers' adoption or demand schedule for fertilizers in Ondo State.

POLICY RECOMMENDATIONS

Based on the conclusions, the following are recommended: The fertilizer prices in Nigeria should continue to be subsidised, but the modality of targeting must change such that the intended beneficiaries are not excluded.

The distribution logistics as it exists presently must be scrapped. The vast bureaucratic network through which fertilizers are distributed to the farmers must be totally by-passed. In its place, a system of distribution that is market-based must be instituted. This can be realised when the subsidy is introduced at the plant level. This will lead to increased output of fertilizer by NAFCON. A positive economic externality derivable from this is that fertilizers would be made available to farmers in Ondo State at reduced prices. However, the quantities of fertilizers available due to this reduction may not change because of the inelastic nature of farmers' fertilizers adoption or demand schedule in Ondo State. In order to make the schedule less inelastic, it is recommended that the Federal Government of Nigeria adopts a policy of an across-the-board subsidisation of all fertilizer producing firms. This would encourage entrepreneurs to venture into fertilizer production thereby causing many firms of varying sizes to compete in the fertilizer industry i.e., creation of an industry that is monopolistically competitive. In return, all benefiting firms must submit themselves to the regulatory framework of the government in terms of internal management (productivity, due process in purchases etc) and quality control.

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