

PMMA Network Session Paper

Do Government Fertiliser Subsidies Benefit Rural Poor Farmers in Nigeria? Making Sense out of Existing Data

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A Research Proposal

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Abstract of Research Proposal

The central question addressed by the study is: do government fertilizer subsidies benefit rural poor farmers in Nigeria? Related questions include: what is the distributional profile or benefit incidence of the fertilizer subsidy in terms of targeting performance? And what is the impact of the fertilizer subsidy on the poor farmers in terms of output, productivity and incomes? The study theoretically argues that while subsidy may be necessary to keep fertilizer prices low and affordable by poor farmers, it is not sufficient to significantly push up poor farmers' fertilizer demand and utilization, productivity and incomes. Moreover, it is hypothesized that in the Nigerian case, fertilizer subsidy does not effectively target the rural poor farmers; rather, richer farmers tend to receive disproportionately large share of benefits from the fertilizer subsidy. It is also hypothesized that fertilizer subsidy has differential impacts on men and women farmers. The study is based on organizing, collating and analysing secondary data scattered in several government publications, statistical reports, farm and household survey reports and agricultural sector reviews. Data analysis is in two phases. Phase 1 is explorative and descriptive, using simple statistics and techniques. Phase 2 involves a systematic combination of analytical and modeling approaches and techniques. They include the Gini Ratio techniques, the Subsidy Incidence Model, the Fertilizer Demand Model and Conditional Outcomes Model.

RESEARCH QUESTIONS

Central Research Question

The central research question is: are fertiliser subsidies benefiting rural poor farmers in Nigeria?

Principal Research Questions

There are two principal dimensions of the central research question. Firstly, what is the distributional profile or benefit incidence in terms of targeting performance of fertiliser subsidy in Nigeria? Secondly, what is the impact of the fertiliser subsidy on the poor farmers in terms of output, productivity and incomes?

Contextual Research Questions

1. Which farmer category does Nigerian fertiliser subsidy policy aim to benefit? What are the forms of intended benefits and against which benchmarks and indicators are they measured?
2. How has fertiliser subsidy performed against intended or expected benchmarks/indicators of results and outcomes? What explains the performance?
3. Do the fertiliser subsidies target rural poor farmers in a deliberate identifiable manner? Is the targeting gender sensitive? How effective is the targeting?
4. To what extent is the transmission of the benefits of fertiliser subsidy (through the channels of lower fertiliser prices, lower production costs, higher gross margins (incomes) and greater consumption/welfare) borne out by the existing data?

CENTRAL ARGUMENT or HYPOTHESIS

While subsidy may be theoretically necessary to keep fertiliser prices low and affordable for poor farmers, subsidy is not sufficient to increase poor farmers' fertiliser demand/utilisation, productivity and incomes in the Nigerian setting.

THE CONCEPTUAL FRAMEWORK OF THE STUDY

The causal relationships, transmission mechanisms and underlying factors defining the poverty and distributional impact of fertiliser subsidy policy in Nigeria is depicted by the conceptual schema, given below.

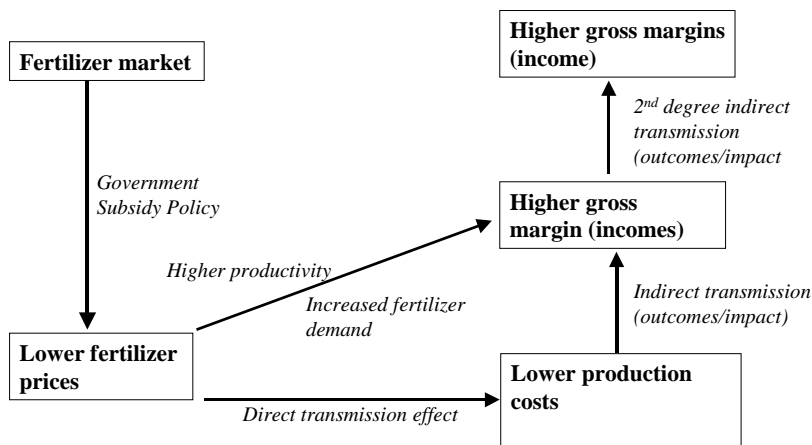


Fig. 1. Data analytic conceptual frame illustrating transmission of benefits of government fertilizer subsidy

In concept, fertiliser subsidy programmes in Nigeria aim at making fertilizer prices affordable to poor smallholder farmers in order to ensure increased agricultural outputs, productivity and incomes as well as maintaining food supply to the teeming populations (food security). Farmers actually enjoy the fertiliser subsidy if and only if they buy the fertiliser at the government recommended subsidy-based retail prices. Anticipated primary effects of fertiliser subsidy include lowered unit cost of fertiliser (and perhaps lowered costs of farm production), increased fertiliser demand/utilisation. In a similar vein, the expected secondary effects include increased crop outputs, productivity and incomes, and by implication, poverty alleviation.

OBJECTIVES

The objectives of the study are to:

1. Review the design and conduct of fertilizer subsidies by Nigerian federal and state governments
2. Examine the effects of the subsidy programmes on the fertilizer market (demand and prices)

3. Trace the influence of fertilizer subsidies on outputs, productivity and incomes of poor farmers
4. Establish the benefit incidence of fertilizer subsidies among rural poor smallholder farmers
5. Identify lessons for fertilizer subsidy policy in Nigeria and elsewhere

SCIENTIFIC CONTRIBUTION OF THE RESEARCH

Public subsidies on agricultural inputs in Nigeria are usually justified on several theoretical arguments: to capture positive market externalities of fertilizer use by the bulk of the farming population, correct market failures in agricultural inputs sub-sector, protect agriculture as a critical economic sector, promote equity, target poverty through accelerated agricultural productivity/incomes and reap economies of scale. But, in practice, fertilizer subsidy programmes in Nigeria have continued to generate confusing signals to farmers and other agriculture-sector stakeholders due mainly to the high instability and inconsistency of government strategy since the past two decades. Corresponding to the debate on the fertilizer subsidy question, several studies have focused on the Nigerian scenario to provide sound bases for fertilizer policy reforms. Most existing research concentrate on institutional and macro-policy issues and aspects (distribution, production, marketing). Relatively, less attention goes to the impact of the subsidy on rural poor smallholder farmers. Targeting effectiveness and impact of fertilizer subsidy on poor rural farmers remain largely under-researched. Yet, these knowledge and insights are critical for clarifying options for the country's agricultural input subsidy policies. So, in addition to providing timely policy-relevant empirical scrutiny of fertilizer subsidy in Nigeria, this research would generate methodological insights for studying the micro-level impact of macro-policy agricultural subsidies.

In Nigeria and other Sub-Saharan African countries, agricultural subsidies remain the object of continuing academic and policy debate. The impact of macroeconomic policies on poverty (household or micro-level indicators) can take place through various transmission channels – prices, consumption, income and employment. Given the theoretical ambiguity of the effect of economy-wide policy (in this case, fertilizer subsidy) on poverty through these macro-micro transmission channels, more advanced empirical studies will promote better understanding of the effects of policy on the poor (that is, behavioural responses to policy). But, despite the great controversy surrounding the relevance and impact of fertilizer subsidies on fertilizer access, pricing and hence farmer production and productivity, very little research exists in SSA on the possible links between fertilizer subsidies and poverty. This is mainly because of the difficulty of measuring certain policy variables and isolating effect of a specific policy from the effects of other different simultaneous policies. This study therefore derives justification not only in terms of its critical and urgent policy relevance of the findings to the Nigerian economy, but also has significant potentials to enrich the scientific and methodological insights and experiences in studying the micro-level effects of macro-policy instruments.

POLICY RELEVANCE

The National Agricultural Policy provides for selective application of subsidies on farm inputs, farm equipments and facilities and farm services to reduce cost of agricultural production. But over the years, the fertilizer subsidy policy has come under severe and often contradictory pressures from diverse sources including poor fiscal position, perceived low effectiveness of fertilizer subsidies, domestic political forces/lobbies, imperatives of private sector role, international donor agencies and multilateral institutions. The consequence of these has been frequent changes in the fertilizer subsidy policy. This highly volatile and inconsistent fertilizer subsidy policies in Nigeria underscores the policy relevance of this study.

Nigerian Fertilizer Subsidy Policy: Retrospect and Outlook

An overview of the Nigeria's fertilizer subsidy policy landscape since the 1970s reveals the important roles for sound research in informing policy decisions. The history of fertilizer subsidy policy in Nigeria falls under seven distinguishable regime periods. Before 1976, state governments did fertilizer procurement and distribution as well as set the subsidy level; the level of subsidy ranged between 25-50% of landed cost of fertilizer. Between 1976-1979, the Federal Government centralized fertilizer procurement and distribution, and set the subsidy level. The subsidy level rose to 75-85%, depending on states. Between 1980-1983, the policy reverted to decentralized procurement, and federal and state governments bore equal share of the 75% subsidy. During the 1984-1985 period, the Federal Government again centralized procurement and the subsidy levels were 38% in 1985, 25% in 1988 and 28% in 1986. Between 1986-1998, the Federal Government decentralized procurement, deregulated and privatized marketing of fertilizer by 1997. The subsidy level ranged 70-80%, with the Federal Government withdrawing from the subsidy programme in 1997-98. In 1999, the Federal Government re-introduced fertilizer subsidy level of 25% but abolished subsidy in 2000 (Okoye, 2003). Presently, the Federal Government policy provides for a subsidy level of 25% under the Fertiliser Market Stabilisation Programme. State Governments are also implementing various fertilizer subsidy levels for their farmers to augment the Federal Government's subsidy levels. Besides, tariffs were another instrument used by the government to influence supply and demand for fertilizer. The reduction of import tariff on fertilizers from 10% in 1996 to 5% in 1997 and 0% in 2000 contributed to reducing the rate of decline in fertilizer consumption. However, total fertilizer use declined from about 461,000 metric tons in 1993-94 to mere 173,000 metric tons in 1999-2000, a decline of about 63%.

Nigeria's fertilizer subsidy policy landscape bears a grim, inconclusive and unsustainable outlook that calls for additional research to clarify causal relationships and underlying factors. Nominal fertilizer subsidy levels were 82%, 74%, 86%, 77% and 65% in 1990, 1991, 1992 and 1993 respectively. For the years 1994, 1995, 1996, 1997 and 1998, the nominal fertilizer subsidy levels were 65%, 87%, 74%, -0% and 0% respectively. During 1999-2003, the level remained at 25%, except in 2000 when it was 0%. Between 1990-96, fertilizer subsidy expenditures consistently exceeded total capital expenditure on

agriculture. It was 725%, 600%, 400% and 397% of total capital expenditures on agriculture in 1992, 1995, 1991 and 1993 respectively (Okoye, 2003). Fertilizer subsidy therefore pressured government budgetary resources and stifled requisite investments in agricultural infrastructures and institutions. Despite the huge budgetary expenditures on fertilizer subsidies, farmer access to fertilizer remains high as prices also remain high; total fertilizer use declined, averaging -6.5% between 1989/90-1999/2001; total fertilizer use as a percent of potential demand averaged a mere 7.3% in the same period. Despite application of subsidy, nominal prices of fertilizer (for 50kg bag) rose from 50 in 1990 to ₦875 in 1996, ₦1200 in 1997, ₦1500 in 1999 and ₦1800 in 2000, with considerable price variability within states. For example, in 2000, fertilizer price reached ₦2000 per 50kg bag much above the official subsidy (retail) price of ₦900 per 50kg bag. In 2001, subsidized fertilizer was about 59% of total fertilizer supply and about 69% of total fertilizer sold, underscoring that considerable share of total fertilizer supplies is not captured by the fertilizer subsidy. Current fertilizer use levels in Nigeria (9.4kg/ha) are much below Africa's average (21kg/ha) and the global average (100kg/ha). There is a marked regional disparity in fertilizer use in the country. The Northern Nigeria account for up to 70% of total annual consumption of fertilizer in the country, the southern Nigeria has mere 30%. Some of the factors responsible include large cultivated land area in the Northern region, planting of high value crops and the granting of higher fertilizer subsidies by state governments in the region.

In recent years, especially since the return to democratic governance in Nigeria in 1999, government subsidy programmes have come under increased scrutiny and the debate has intensified regarding the bases, applications, impact and sustainability of subsidy policies in the country. The high level of policy inconsistencies, ambiguities and instabilities that characterize governments' attitude reveals the unsettling and volatile nature of fertilizer subsidy issue in the country as portrayed by the cycle of subsidization, de-subsidisation and re-subsidisation. Where government practiced fertilizer subsidy, it justifies it on the need to offset discriminatory economic policies that shift the domestic terms of trade against agriculture, induce risk-averse farmers to use the profit-maximizing level of fertilizers; reduce the risks associated with learning and adopting new technologies; offset the high distribution costs due to inadequate provision of public goods (e.g., road network); encourage fertilizer distribution to remote areas; encourage balanced nutrient use in line with the agronomic requirements of different crops and ecological zones; redistribute income to the rural poor farmers in order to improve their socio-economic welfare; cushion the effect of liberalization and currency devaluation on the agricultural sector. On the other hand, when it is withdrawn, government gives counterintuitive reasons. It has enriched unintended beneficiaries and constituted a drain on government treasury. It distorts the market mechanism and stifles private sector initiatives in agricultural input market development.

Amidst the uncertainty surrounding the bases, application, impact and sustainability of Nigeria's fertilizer subsidy policies, government continues to pursue the subsidy option without sound empirical insights on its ramifications for the rural poor smallholder farmers who produce more than 70% of the nation's agricultural output. In spite of the continued application of fertilizer subsidy policies, total fertilizer use declined, averaging -6.5% between 1989/90 and 1999/2001. Besides, total fertilizer use is far below the

potential and economic demand. The contradictory signals on Nigeria's fertilizer policies underscore the need for sound and focused analysis to generate scientific evidence and produce valid and reliable insights clarifying the subsidy impact on rural poor smallholder farmers, who are the intended primary beneficiaries of the subsidy policies. If fertilizer subsidy is targeted improperly and disproportionately benefiting the non-poor rural farmers, it will be imperative that subsidies be reformed and re-tooled to become more socially beneficial. Whichever the case, sound research is imperative for reaching any valid conclusions.

METHODOLOGY

Critical Methodological Issues, Trends and Challenges

In recent years, the literature on the poverty and distributional impact of economic policy has developed in tandem with the growing focus on poverty reduction as a central development yardstick. The resultant demand for more poverty and distributional analysis is pressing. Whether reforms concern fiscal, monetary, exchange rate, public expenditures, market liberalisation, public enterprises, there is groundswell of need to figure out the likely aggregate effect of these policies and also their effect on various social groups and impact at the individual or household level. No doubt, knowledge has improved on the methodological and conceptual issues and challenges in analysing the impact of growth, public policy, social spending and targeted interventions on poverty and inequality. Yet, methods to evaluate the poverty and distributional impact of economic policies are faced with a big challenge. Relevant questions in our context include: who benefits from government fertiliser subsidies? What is the average versus marginal benefit incidence? Who are the target groups? How much impact do subsidies have on poverty? (Duclos, 2002). But, decision processes in Nigeria do not seem to be underlined by systematic poverty impact evaluations that reveal how individuals and households are affected (ex ante or ex post) by policies and change in policies (Eboh, 2003). The situation is not very different in other SSA countries. Poverty and distributional evaluation techniques have not been widely used because of several factors, including not being easily accessible and lack of relevant data and institutional infrastructure.

Bourguignon and Pereira da Silva (2003) provides a compendium of techniques currently available to evaluate the impact of economic policies on poverty and income distribution. The compendium rallies the techniques around the common thread of *incidence analysis* showing that this basic microeconomic evaluation tool can be used in different ways and in particular to evaluate a wider range of macroeconomic policies with some potential impact on poverty. Key features and trends of methods for evaluating poverty and distributional impact of economic policies are elaborated in Bourguignon and Pereira da Silva (2003). Because poverty is essentially an individual phenomenon, poverty impact evaluation methods should necessarily operate at the micro level. Identifying who are the poor people in a population in order to gauge the poverty impact of particular policy requires using household or individual level data. Hence, poverty incidence analysis must necessarily proceed first at the micro level –to identify who gains or loses because of a

specific policy or policy change. Poverty evaluation requires incidence analysis to rank gainers and losers of a policy/policy change against initial individual welfare levels or poverty status. Using one technique alone gives a very partial picture of the poverty impact of a particular policy. In order to have a less partial view, various techniques may be used at the same time or indirect methods can be devised. Likewise, where complex set of policies is subjected to poverty impact evaluation, simultaneous use of various techniques is often necessary. In cases where the dimensions of household's economic and social environment are taken into account, evaluation of macro policies goes beyond simple incidence analysis. Serious gaps exist in the set of poverty evaluation techniques that are presently available. The relevance of incidence analysis, notwithstanding, improvement of existing tools is required to deal with certain areas of policy reforms. One of the big methodological challenges is building links between micro phenomena taking place at the household level and macro modelling. Some tools exist to handle micro-macro policy issues, but they are imperfect and unsatisfactory for particular applications (Bourguignon and Pereira da Silva, 2003). Generally, the unifying link between macro policies and distribution of economic welfare is the systematic reliance on microeconomic data sets, essentially household surveys of various types.

Poverty and distributional impact evaluation of economic policies may be *ex ante* and/or *ex post*. *Ex ante* evaluation involves quantitative techniques that try to predict the various effects of policies including those on distribution and poverty. *Ex post* approaches compare individuals or households before and after some policy changes or households involved in some specific program with households not involved in this program (Bourguignon and Pereira da Silva, 2003). *Ex post* evaluation serves to check whether actual effects were those expected and possibly to reform them. The difference between *ex ante* and *ex post* approaches is more significant when possibly complex behavioural responses are taken into account. There is also the question of average versus marginal poverty incidence of policies. Average poverty incidence (for example the percent of the poorest segment that benefits in a programme) does not show the marginal effect of expanding or contracting the programme, changing a policy or altering particular public spending. Hence, *average incidence* and *marginal incidence* analyses are often combined in the poverty and distributional impact evaluation of economic policies.

Poverty incidence analysis focuses on immediate or direct impact of a policy on households and individuals, with possible modifying influence of behavioural responses and market mechanisms, that is, indirect or second round of effects. Regardless of whether indirect effects are significant or not, second round of effects may be difficult to study at the same level of disaggregation as direct effects. Evaluation techniques relying on the incidence framework at a micro level are therefore best suited to policies with identifiable direct impact on households, like reforms in the tax system or in the composition of public spending, including transfers in cash or kind (such as subsidies). But, where the indirect or second round of effects of previous policies that arise from the behavioural responses of micro agents through market mechanisms are sizable, they affect household welfare by modifying the price system and returns to productive assets. For macroeconomic policies that have little direct impact on households, like financial sector and monetary policy reforms, the indirect effects become important for poverty

incidence analysis. Accordingly, the distributional incidence analysis of the changes taking place at the aggregate level, mostly through prices, factor returns and labour market conditions, become imperative.

A critical methodological issue bearing on the nature of poverty impact (whether direct or indirect impact) is the selective application of accounting vis-à-vis behavioural approaches. The simple incidence analysis exemplifies the accounting approach – who receives what from the government or public spending? Accounting approaches ignore possible behavioural responses by agents that may critically alter how much is or what is received from the government. This is because accounting approaches focus on first round of effects and disregard second round of effects due to behavioural responses. In contrast, behavioural approaches in poverty impact evaluation of policies take into account behavioural responses. Taking into account behavioural responses is important for poverty incidence analysis, since they may compound, mitigate or reverse first round of effects revealed by accounting approaches. Integrating behavioural responses into the analysis is however constrained by difficulty in identifying them and their determinants.

Access to and use of fertiliser tend to have a gender dimension, reflecting elements of traditional gender roles in agriculture. While women constitute over 60 percent of the agricultural producers in the country, they have less than commensurate access to productive resources and inputs, including fertiliser. Gender roles and power relations therefore have a critical influence on fertiliser access and use, just as fertiliser subsidy tends to impact differently on gender categories. Analysis of the gender impacts of fertiliser subsidy is therefore necessary to take into account the socio-cultural underpinnings of men's and women's access to fertiliser. Hence, the data sets will be explored for gender incidence in fertiliser demand, prices and benefits from subsidy. The questions on gender impacts of fertiliser subsidy include: what effect has gender differences in power and economic relations on men's and women's access to (or benefits from) fertiliser subsidy? To what extent has fertiliser subsidy reinforced or ameliorated gender differences in fertiliser demand? How does differential gender access to fertiliser subsidy affect farm productivity and incomes? How is benefit incidence of fertiliser subsidy distributed across men and women farmers?

Literature reveals that every poverty and distributional impact study faces methodological choices at the outset. The mix of techniques would eventually depend on the perspective adopted for poverty evaluation, the data at hand, economic modelling capacity, the nature of the policy and the way and manner of implementation.

Study Approach

The study is based on the rigorous analysis of existing data in relation to the research objectives. The approach is to collate, organise and make sense out of the existing secondary data on trends of fertilizer subsidies, prices and demand in Nigeria. Descriptive materials on fertiliser subsidy administration would be utilised. Secondary data from the various sources will be organised into a systematic data structure to serve the purposes of the research objectives.

Types and Sources of Data

The study will engage both macro- and micro-level data in a mutually reinforcing and complementary manner. The study shall combine time series, cross-sectional and panel data, to make sense out of them in a coherent manner. Time series macro-level data will be sought with regard to the parameters, viz. annual fertilizer subsidy share of agricultural sector budget at the federal and state government levels, annual size of fertilizer subsidy at the federal and state government levels, nominal vis-à-vis real effective fertilizer subsidies, annual total fertilizer consumption in the country and disaggregated by states, annual average prices of fertilizer (national level and state level), annual fertilizer retail prices (government official recommended rates under the subsidy programmes), annual total quantities of fertilizer captured by subsidies, annual productivity indices for the various crops, annual fertilizer utilisation across crops, states and regions. Secondary data will come from Fertiliser Procurement Department of the Federal Ministry of Agriculture, Departments/Units responsible for fertilizer matters at the state government level. Other sources include the DAIMINA (Developing Agri-Inputs Markets in Nigeria) project – an on-going initiative by the International Fertiliser Development Centre Office in Abuja, the Federal Ministry of Agriculture with support from the United States Agency for International Development. Additional information will come from the Federal Government's Project Coordinating Unit (a organ of the Federal Ministry of Agriculture charged with the collation and reporting of agricultural data from the State's Agricultural Development Programmes throughout the country), the Federal Office of Statistics (the central statistical agency responsible for data collection, analysis and reporting on sectoral issues including agriculture).

On the other hand, micro-level data will be obtained on: fertilizer consumption or purchases, actual fertilizer retail (purchase) prices, sources of fertilizer, participation in and access to fertilizer markets, farmers' costs, outputs, productivity and incomes and socio-economic characteristics of farmers. Farming household-level data shall come from the Federal Office of Statistics and the State-level Agricultural Development Programmes. The State-level Agricultural Development Programmes have Research and Planning Departments that gather statewide data on farm inputs, outputs, prices and incomes.

The Federal Office of Statistics conducts *rural agricultural sample surveys* (RASS) to collect farm, farmer and household level data on inputs use, costs, outputs, productivity, incomes and prices. The RASS as well as the National Consumer Survey (NCS)/National Consumer Expenditure Survey (NCES) derive from the framework of the National Integrated Survey of Households (NIHS) – a 2-stage design with Enumeration Areas (EAs) as first stage and households within EAs as second stage units. Data from the NCS/NCES data in 1980, 1985, 1992 and 1996 were analysed to construct poverty profile for Nigeria over the 16-year period – 1980-1996. The Nigerian Living Standard Survey (NLSS) commenced in September 2003 to widen the scope of the NCES. It includes information on farm and household level agricultural resource allocation, input use, market purchases of inputs and sales of farm produce, farm cost and farm income.

Data from these various sources shall be scrutinised and synthesized to form data structures amenable to inferential analysis and modelling in line with the objectives of the study.

DATA ANALYSIS AND MODELLING

FIRST STAGE

The first stage involves the use of explorative and descriptive statistics and techniques, including means, percentages/ratios and standard deviations. Descriptive statistics shall be computed for the pooled sample of households, and then for sub-samples formed on the bases of, among others, region, community attributes, income and social characteristics (e.g. gender, education, household size, etc.). Cross tabulation of the average amount of fertiliser purchased at the official subsidy price by deciles of households shall be constructed, based on raw micro-data from the Federal Office of Statistics. The deciles will rank all households in the sample using income per capita. This cross tabulation will show on a provisional basis, whether or not the subsidies are well targeted to the poor farming households. It shall reveal – what percentage of farmers in each income bracket enjoys the fertiliser subsidy. In addition, there shall be a cross tabulation of the average amount of total fertilizer utilised across deciles of farming households constructed based on income per capita.

SECOND STAGE

The second stage involves analytical and modelling methods and techniques to assess the distributional profile or benefit incidence of fertiliser subsidy and the impact of fertiliser subsidy on household or farmer outcomes. The analytical techniques and models to be used in this stage include:

1. The Gini Ratio Technique (GRT)
2. The Subsidy Incidence Model: Impact Evaluation of Subsidy by Propensity Score Matching (PSM)
3. The Fertiliser Demand Model (FDM)
4. The Conditional Outcomes Model (COM)

The *Gini* Ratio Technique

Gini ratio technique shall be used to find inequalities in the distribution of benefit-incidence of fertilizer subsidy across the socio-economic strata of rural smallholder farmers, as follows:

$$Gini = 1 - \frac{1}{N} \sum_{i=1}^N (y_i + y_{i-1}).$$

$$Gini = 1 - \sum_{i=1}^N (x_i - x_{i-1})(y_i + y_{i-1}).$$

Overall inequality of benefit incidence is related to the percentage of each stratum of farmers buying fertilizer at not more than the official retail price and the share of each

stratum of farmers in total money value of fertilizer subsidy (for farmer level analysis), the percentage of farmers in each community buying fertilizer at not more than the official subsidy retail price and the share of each community in total money value fertilizer subsidy (for community level analysis). Subsidy enjoyed by the farmer in price terms is the difference between government subsidy official retail price of fertilizer and the hypothetical (presumed) price without government subsidy. The benefit is measured in terms of the relative share of total fertiliser purchases that is obtained at no more than the official recommended retail price for that year.

Group-level distribution indicator

The value of total government subsidy enjoyed by group i (on number of farmer basis) is given as follows:

$$Gi = \sum_{i=1}^n \frac{X_i}{X_n} F_i$$

where Gi = benefit incidence for farmer group i, Xi = number of farmers in group i buying fertilizer at not more than the official recommended subsidy price of fertilizer, Xn = total number of farmers in group i, Fi = money value of subsidy based on total units of fertilizer bought by farmers in group i at not more than the official subsidy retail price. By Gi, we shall assess if the subsidy is reaching the poorest segments of farmers and to what extent.

Farmer- or household-level distribution indicator

On the other hand, the value of total government subsidy enjoyed by individuals (in terms of units of fertilizer bought at no more than that official recommended retail price) is:

$$Hi = \sum_{i=1}^n \frac{F_i}{F_n} S_i$$

Where Hi = benefit incidence for person i, Fi = number of units of fertilizer bought by person i at not more than official subsidy retail price; Fn = total number of units of fertilizer bought by person i; Si = money value of subsidy based on the total units of fertilizer bought at not more than the official subsidy retail price.

The Subsidy Incidence Model: Impact Evaluation of Subsidy by Propensity Score Matching (PSM)

This model predicts the probability of a household enjoying fertiliser subsidy. A household is said to enjoy fertiliser subsidy if and only if it buys fertiliser at not more than the government recommended price for the given year or period. To assess the distributional impact of subsidy, we need to measure the “cost savings” to farmers who buy fertiliser at the recommended official retail price (subsidised farmers) conditional on pre-subsidy costs, where the cost savings is the difference between production costs *with* the subsidy and that *without* it. This conditional impact estimate is the subsidy incidence (as adapted from the “benefit incidence” concept).

The *with* situation can be observed but the *without* situation is fundamentally unobserved, since both are mutually exclusive events. The *without* situation is the *counterfactual* or missing data – the comparison or control group. To know what impact fertilizer subsidy has, we need to know what would have happened without the subsidy. The cost saving and increased fertiliser demand attributable to the subsidy is the difference between the actual fertiliser costs and demand for farmers who have access to subsidised fertiliser and the costs and demand for those same farmers if the subsidy had not existed. An easy procedure is to merely calculate averages of saved costs and fertiliser demand separately for farmers who have access to subsidised fertiliser (subsidised farmers) and comparing them with averages of saved costs and fertiliser demand for farmers who do not have access to subsidised fertiliser (non-subsidised farmers). This method uses non-subsidised farmers as the comparison group for inferring what the schooling would be of the subsidised farmers if the subsidy had not existed.

However, this technique has flaws because it erroneously presupposes that non-subsidised farmers rightly reveal fertiliser costs and demand without the subsidy. Hence, this method is inherently biased as shown below. Let P_i denote the subsidy status of the i th farmer. This can take two possible values, namely $P_i=1$ when the farmer enjoys subsidy and $P_i=0$ when he does not. When the i th farmer does not enjoy subsidy, his level of cost saving or fertiliser demand is C_{oi} which stands for farmer i 's cost saving/fertiliser demand C when $P = 0$. When the farmer does enjoy subsidy, his cost saving/fertiliser demand is C_{li} . The expected cost saving/fertiliser demand due to subsidy for a farmer that does in fact enjoy subsidy is

$$G = [E (C_{li} - C_{oi} / P_i = 1)].$$

This is the conditional mean impact, conditional on a farmer enjoying fertiliser subsidy. In the evaluation literature,

$E (C_{li} - C_{oi} / P_i = 1)$ is the treatment effect or the average treatment effect on the treated;

the impact of the fertiliser subsidy is

$$E (C_{li} / P_i = 1) - E (C_{oi} / P_i = 1).$$

What the comparison between averages of cost savings/fertiliser demand between subsidised and non-subsidised farmers does is to produce a biased estimate (difference in means of cost savings/fertiliser demand) given as:

$$D = [E (C_{li} / P_i = 1) - E (C_{oi} / P_i = 0)].$$

The estimate has a bias if there is a difference in outcome values (cost savings/fertiliser demand) between subsidised and non-subsidised farmers without the intervention, as is often the case. Bias may be due to differences in observable characteristics or differences in un-observables or both.

Since a simple identity links D and G, namely $D = G + B$, the term B is the bias in the estimate and it is given by

$$B = [E(C_{oi} / P_i = 1) - E(C_{oi} / P_i = 0)].$$

This bias is the expected difference in cost savings/fertiliser demand without subsidy between farmers who did in fact enjoy subsidy and those who did not. We could correct for this bias if we know $E(C_{oi} / P_i = 1)$. But, we cannot get even the sample estimate of this because it is unobservable, we cannot observe what the cost savings/fertiliser demand would have been for farmers who actually enjoyed subsidy had they not enjoyed subsidy. This is missing data – the counterfactual mean.

Drawing on the impact evaluation literature, there are several methods of getting rid of this bias, that is, assessing the counterfactual or forming a better comparison group – the one that will give an unbiased estimate of fertiliser subsidy's impact. This involves comparing outcome indicators (cost savings/fertiliser demand) conditional on observed characteristics. A comparison group simulates the counterfactual or missing data – what cost savings/fertiliser demand by the subsidised farmers would have been without the subsidy. The main methods for designing a comparison group include randomisation, matching, double difference and instrumental variables (Ravallion, 2001). If we find a sample of non-subsidised farmers with the same values of observed characteristics (household and other characteristics) X as the non-subsidized farmers, and if the outcome indicator is independent of subsidy given X, then this comparison group will give an unbiased estimate of fertiliser subsidy's impact. This is sometimes called 'conditional independence' and it is the underlying assumption made by all comparison group methods.

Reflexive comparisons can be done by juxtaposing baseline pre-subsidy data and post-subsidy data on the same individuals, but this can be deceptive. Another technique is to identify potential farmers for subsidy and after applying the intervention on random sample of them, data is then collected on the post-intervention sample - the randomisation technique. Means of outcome indicators are then compared, pre- and post-intervention. Another method is to use propensity score matching following Rosenbaum and Rubin (1983, 1985), Dehejia and Wahba (1998, 1999) and Heckmann and Robb (1985), Heckman et al (1997, 1998), Jalan and Ravallion, (2002), Ravallion (2001).

The basic principle in matching methods is to use as a control for each subsidised farmer a non-subsidised farmer with the same observed characteristics. The aim of matching is to find the closest comparison group from a sample of non-subsidised farmers to the sample of subsidised farmers; closest in terms of observable characteristics. Let X be the vector of observed characteristics. Ideally, one would match a subsidised farmer with a non-subsidised farmer using the entire dimension of X, i.e. a match is only declared if there are two farmers, one in each of the two samples, for whom the value of X is identical, but this procedure is cumbersome, inefficient and impractical. The problem is simplified by using the propensity score matching method. Instead of aiming to ensure that the matched control for each participant has exactly the same value of X, we can get

the same result by matching on the probability of enjoying fertiliser subsidy, given X . This means matching conditional on $P(X)$ alone rather than on X , where $P(X) = \text{Prob}(D=1/X)$ is the probability of enjoying fertiliser subsidy conditional on X , the propensity score of X . If D_i 's are independent over all I and cost savings/fertiliser demand (outcome) is independent of subsidy given X , then outcomes (cost savings/fertiliser demand) are also independent of subsidy given $P(X)$, just as they would be if subsidy were assigned randomly. Hence, a potentially high dimensional matching problem is reduced to a single dimensional problem. We can estimate the probability using the predicted value of P given X from a regression. This is called the "propensity score". The propensity score is calculated for each observation in the subsidised and comparison samples using standard discrete choice parametric or semi-parametric models. Logit regression models are the appropriate estimation method to use. Using the logit regression, the binary outcomes takes the value one if the farmer enjoyed fertiliser subsidy and zero otherwise. Two groups are identified: those farmers that enjoy fertiliser subsidy ($D_i = 1$ for farmer i) and those that do not ($D_i = 0$). The treated group (subsidised farmers) are matched to households without (control group) on the basis of the propensity score:

$$P(X) = \text{Prob}(D_i = 1/X) \quad (0 < P(X) < 1)$$

where X is a vector of pre-subsidy control variables. The regressors comprise a wide range of community and household's social, economic, infrastructure and demographic characteristics and state dummy variables. Regressing P on X gives us the predicted value of P for each possible value of X , which we then estimate for the whole sample. That is:

$$P_i = f(X_i) \text{ 's) where } P_i \text{ and } X_i \text{ 's are as earlier defined.}$$

Thus, the logit probability model is stated as:

$$\log(P_i / 1-P_i) = \alpha + \beta X_i$$

For each subsidised farmer, we then find the non-subsidised farmer with the closest value of this predicted probability. The difference in cost savings or fertiliser demand is then the estimated gain from the fertiliser subsidy for the subsidised farmer. We then take the mean of all those differences to estimate the impact or we take the means for different income groups. The mean impact estimator of the fertiliser subsidy is given by:

$$G = \frac{\sum_{j=1}^P (Y_{j1} - \sum_{i=1}^{NS} W_{ij} Y_{ij0})}{P}$$

where Y_{ji} is the cost saving/fertiliser demand by subsidised farmer j , Y_{ij0} is the cost saving/fertiliser demand of the i th non-subsidised farmer matched to the i th subsidised farmer, P is the total number of subsidised farmers, NP is the total number of non-subsidised farmers and the W_{ij} 's are the weights applied in calculating the average income of the matched non-participants.

The Logit Regression Model is appropriate because it assumes that the error term in the equation has a logistic distribution and estimates the parameters consistent with that assumption by maximum likelihood methods. Propensity Score Matching (PSM) then uses the estimated $P(X)$'s or a monotone function of it to select comparison subjects. Exact matching on $P(X)$ implies that the resulting matched control and treated subjects have the same distribution of the covariates. PSM therefore eliminates bias in estimated treatment effects due to observable heterogeneity.

The Fertiliser Demand Model (FDM)

This model answers the question about whether fertiliser subsidy has significantly affected fertiliser demand/utilisation among poor farming households. It is about the primary effects/outcomes of fertiliser subsidy. The fertiliser subsidy programme aims to provide benefits (transfers) to farmers in the form of affordable fertiliser prices. By this concept, the purchase price of fertiliser would be lower than what it should have been without government paying a portion of the price through public subsidy arrangements. Assessing the impact of the subsidy on poverty is important to determine if the subsidy makes any difference for poor farming households – that is, whether poor farming households are benefiting from the subsidy and by how much?

Two biases often affect programme impact (and thus fertiliser subsidy impact) analysis: bias from heterogeneity at the community level and that from the household or individual level. Pitt and Khandor (1998) adopted a quasi-experimental approach to control for both types of biases, using cross sectional data. Panel data may provide opportunities for better estimation of subsidy impact for the following reasons. Results based on cross sectional data may not be very robust as impacts may depend on the methods used. Fixed effects estimation with panel data is less dependent on the exclusion criteria used in cross sectional analysis. Cross sectional analysis provides only short-term effects. When farming households are observed in more than one year, we can write the reduced form fertiliser demand by i th household in j th village in period t as:

$$F_{ijt} = X_{ij}\beta_{cf} + \eta_{ij}^c + \mu_j^c + \varepsilon_{ijt}$$

where F_{ijt} is fertiliser demand by i th household in j th village in period t , X is a vector of household and community characteristics, β is a vector of unknown parameters to be estimated, η is an unmeasured determinant of the fertiliser demand that is time invariant and fixed within a household, μ is an unmeasured determinant of the fertiliser demand that is time invariant and fixed within a community, and ε is a non-systematic error.

The Conditional Outcomes Model (COM)

This model concerns the potential secondary effects of fertiliser subsidy. It answers the questions concerning whether fertiliser subsidy has translated into increased crop outputs and productivity and incomes for the poor farming households. The conditional demand

for outcomes such as land productivity/farm incomes (Y_{ij}) conditional on the level of fertiliser demand or utilisation (F_{ij}) is given by:

$$Y_{ijt} = X_{ijt}\beta + F_{ijt}\delta + \eta_{ij}^y + \mu_j^y + \varepsilon_{ijt}^y$$

Where δ is the effect of fertiliser. The aim here is to estimate the impact of fertiliser on outcomes of particular interest such as household per capita income, land productivity, etc. with cross sectional data (where $t=1$), endogeneity arises as a result of the possible correlation among μ_j^c and μ_j^y and among ε_{ij}^c and ε_{ij}^y (Pitt and Khandker, 1998). Where panel data is unavailable ($t = 1$), household-level fixed-effect method cannot be used to resolve household subsidy endogeneity. A 2-stage instrumental variable (IV) method can be used to resolve the household endogeneity problem. With the availability of panel data, ($t > 1$), household-level fixed effect method can be used and 2-stage identification restriction is not needed. This is simply done by differencing out the unobserved community and household attributes, where are the sources of correlation between the fertiliser demand and household outcome equations. Differencing the Y_{ijt} equation at two points of time yields the following outcome equation:

$$\Delta Y_{ij} = \Delta X_{ij}\beta + \Delta F_{ij}\delta + \Delta \varepsilon_{ij}^y$$

Consistent estimates of the fertiliser effect δ can be obtained from the above equation using a household fixed-effects method without recourse to instrumental variable estimation, such as the one used in the quasi-experimental survey design, under the assumption that the error terms of the fertiliser demand and outcome equations are uncorrelated.

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PRIOR TRAINING AND EXPERIENCE OF TEAM MEMBERS IN THE ISSUES AND TECHNIQUES INVOLVED

The Team Leader has considerable experiences on the theoretical/conceptual, methodological and empirical dimensions of agriculture sector interface with poverty as well as regarding poverty analysis, measurement and monitoring. These experiences have been gained through training, practice and empirical research. In 1999-2001, the Team Leader conducted a study on *Informal Sector Dynamics and Potentialities for Poverty Alleviation in Nigeria*, under the auspices of the Council for the Development of Social and Economic Research in Africa's Grants for Advanced Field Research Programme.

During February-March 2003, the Team Leader participated in Study on the *Empirical Assessment of the USAID Nigeria - supported Agricultural Programmes and Projects in Nigeria*. The practical exposure and analytical insights were highly enriching. During June-July 2003, the Team Leader solely undertook the *Assessment of the Nigeria Agriculture Sector Performance and Competitiveness*, under the auspices of the World Bank Country Office in Nigeria. This study significantly impacted upon the Team Leader some new understandings of the critical issues, opportunities, options and constraints in maximizing agriculture sector's role in poverty alleviation, sustainable economic growth and development. The Team Leader is also carrying out a study on the *Nigerian Poverty Reduction Strategy Paper (PRSP) process* as an input into an Africa-wide Learning and Information Sharing Programme on the PRSPs, under the auspices of the United Nations Economic Commission for Africa, Addis Ababa.

EXPECTED CAPACITY BUILDING FOR RESEARCHERS AND THEIR INSTITUTIONS

The second and third members of the research team are Doctoral Degree candidates in the Department of Agricultural Economics, University of Nigeria, Nsukka. One of them is male and the other is female. While the male member is beginning to research on the impact of forest conservation and forest management on rural poverty, the female member is doing a research focusing on the impact of irrigated farming on rural livelihoods. Participation in the PEP Network is timely and relevant to the current researches of both student team members. Both team members would benefit in terms of intellectual exposure to scientific expertise on poverty monitoring, measurement and analysis that will be provided by participation in the Poverty and Economic Policy Research Network. Both young and student team members will gain analytical insights, research techniques and skills and methodological capabilities through this research. They would thereafter become able to do poverty impact research independently and creditably.

ANY ETHICAL, SOCIAL, GENDER OR ENVIRONMENTAL ISSUES OR RISKS WHICH SHOULD BE NOTED

This research takes into consideration the potential for gender differences in access to resources, farm inputs (including fertilizer) markets, institutions and technologies in rural smallholder agriculture. Hence, the gender dimensions of the applications, impact and sustainability of fertilizer subsidy programmes is an integral component of the objective of this research. Poverty and agricultural economy have gender dimensions as evidenced in past macro and micro-level studies and reports on Nigerian agriculture and poverty profile. This research and data collection and management system is designed to reflect perspectives (views, concerns and understandings) of different gender on fertilizer subsidy and the data collection process integrates triangulation principles (triangulation of methods, sources and analysis) in order to provide a fuller and real-life picture of the differential gender impacts of fertilizer subsidies on the poor smallholder farmers.

LIST OF PAST, CURRENT OR PENDING PROJECTS IN RELATED AREAS INVOLVING TEAM MEMBERS (NAME OF INSTITUTION, TITLE OF PROJECT, LIST OF TEAM MEMBERS INVOLVED)

The Team Leader is currently the Project Coordinator of the newly constituted National Working Team on the Agriculture Sector Strategies for Poverty Reduction in Nigeria, with possible funding from Council for the Development of Social and Economic Research in Africa (CODESRIA), Dakar. This Working Group is housed in the African Institute for Applied Economics, Enugu, and has 10 members including academics, policy officials and development practitioners. The Team Leader has also been involved in the World Bank Institute's train-the-trainers workshop on Advanced Impact Evaluation of Poverty-Related Programmes held in Addis Ababa, June 9-12, 2003. The Team Leader is currently coordinating the Poverty, Income Distribution and Labour Market Research Programme of the African Institute for Applied Economics, Enugu, Nigeria.