GUIDING INVESTMENTS IN SUSTAINABLE AGRICULTURAL INTENSIFICATION IN AFRICA (GISAIA)

Fertilizer subsidies and private market participation: The case of Kano

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Synopsis:
This brief presents empirical results of a study conducted to explore the effect of a fertilizer voucher program on farmer participation in the private fertilizer market in Kano State, Nigeria.

Key findings

- Receiving subsidized fertilizer through a voucher redeemable at private dealers' shops increased the **probability and extent of participation** in the private fertilizer market by smallholder farmers.
- The voucher program developed links between rural farmers and input suppliers.
- The temporary use of voucher programs could strengthen weak links between input dealers and farmers.

Policy Implications

- To develop sustainable private input markets, input subsidy programs that subsidize input suppliers rather than purely subsidize farmers could also be effective in increasing farmer access to and use of inorganic fertilizer.
- Better infrastructure in distant and less accessible areas could ensure that the private sector can profitably meet the demand of rural famers.

Research question: What is the effect of input vouchers on private market participation in Nigeria?

Most empirical studies on input vouchers and private input markets have focused on contexts where input vouchers are received by relatively well-off farmers and fertilizer use is relatively low (Mason and Jayne, 2013; Ricker-Gilbert et al., 2011). This study focuses on a context (Kano state in Nigeria) where fertilizer use is relatively common with a mean of about 165 kg per hectare in the 2010 Nigerian Living Standards Measurements Survey-Integrated Survey on Agriculture (LSMS-ISA).

Consequently, this study explores if the use of fertilizer subsidies increases or decreases smallholder participation in the private market under this scenario. The study makes two key contributions to the existing literature. The first contribution is its ability to capture the effect of a subsidy program that appears to have reached a broad set of farmers including the relatively poorer households. Second, distinct from most of the relevant literature on this topic, this study recognizes that rather than a situation where two parallel distribution channels are used for an input (as was the case in Xu et al., 2009; Mason and Jayne, 2013), this study explores a case where both the subsidized and commercial fertilizer were being distributed by the private sector. Consequently, the private sector as a whole is not necessarily expected to be negatively affected under such an arrangement.

This study does not explore the effect of the voucher program on the entire private fertilizer market but focuses on identifying if the program had any effect on farmers' participation in the private fertilizer market and possible explanations for this.

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The Nigerian context

The fertilizer market in Nigeria

Nigeria is the most populous country in Africa (about 158 million people) and the largest economy since the rebasing of its GDP data in 2014. Nigeria alone accounts for almost 25% of all fertilizer consumption in Sub-Saharan Africa (SSA) in 2008/2009 (IFDC, 2009). Given its size, the regional fertilizer market in West Africa is significantly affected by what goes on in Nigeria. The potential effects of national policies geared to increase farmer use of fertilizer often extend beyond Nigeria's border. Consequently, understanding the effects of input vouchers on the private fertilizer market in a country such as Nigeria is critical for any strategic effort to improve the sustained use of inputs in SSA.

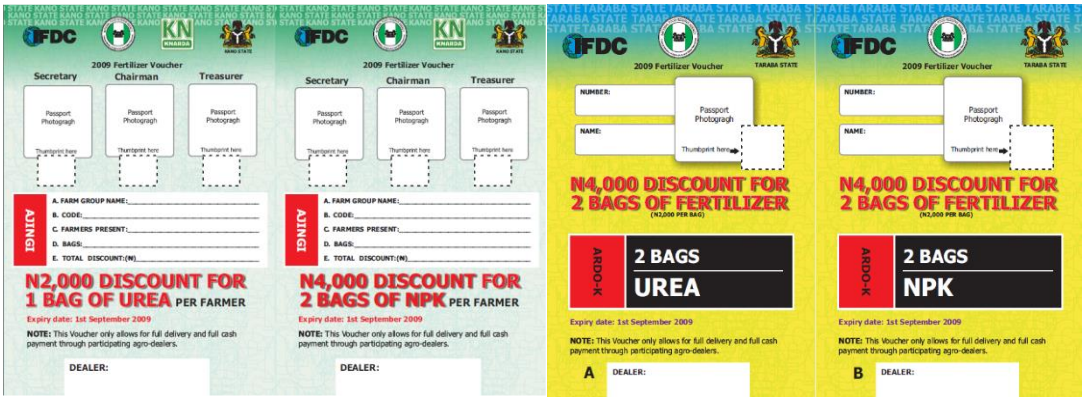
The 2009 voucher program in Kano State, Nigeria

Studies have shown that policy inconsistency, diversion of fertilizer from farmers, late access to fertilizer; high prices and poor fertilizer quality are major constraints to fertilizer use in Nigeria (Banful et al., 2010; Liverpool-Tasie et al., 2010). The use of vouchers in Nigeria was proffered as a potential solution to the shortcomings of subsidized fertilizer, which was largely distributed by the government. The 2009 voucher program was piloted in two Nigerian states: Kano and Taraba. Kano, located in North-Western Nigeria, is the most populous Nigerian state with over 9.4 million residents (NPC, 2006). The primary activities in Kano are commerce and agriculture and the poverty rate in Kano is**)** over 75% (NBS, 2009). Fertilizer use in Kano is not new and according to the 2010 LSMS-ISA data, fertilizer use in Kano State is significantly higher than many other Nigerian states.

(source, IFDC)

The 2009 voucher program in Kano was a collaborative effort between the government (Federal and State), the private sector suppliers and dealers, and the International Center for Soil Fertility and Development (IFDC). The program (designed to deliver subsidized fertilizer to small holder farmers across the 44 local government areas [LGAs] of Kano) was meant to model smart subsidies that allow for targeting of rural smallholder farmers and develop a private sector supply and distribution channel (IFDC, 2010). The value of the voucher was a ₦2000 discount per bag on two bags of nitrogen phosphorous potassium (NPK 15:15:15) and one bag of urea (46% nitrogen). Farmers were required to pay the difference between the market price and the ₦2000 discount per bag. Participants in the 2009 voucher program in Kano were required to be members of a farmer group.

Each participating farmer group received a single voucher that entitled each of its members to the ₦2000 discount per bag on three bags of fertilizer. Anecdotal evidence drawn from complaints on the field indicated that individuals got different quantities than the three bags they had been promised. Liverpool-Tasie et al. (2010) show that the friends or relatives of the farm group president received more bags of fertilizer than those without such relationships. This study capitalizes on this characteristic of the program in its identification strategy.



The analysis: Estimating the effect of the voucher program on farmers' participation in the private market

To estimate the degree to which subsidized fertilizer affect farmers' participation in the private commercial fertilizer marker, the paper used a Double Hurdle (DH) model (to account for the corner solution nature of fertilizer demand since many households apply zero kilograms of fertilizer) and a control function approach to address the endogeneity of the quantity of subsidized fertilizer received by farmers (*See box for details*).

Brief overview of the data

The data used in this paper comes from a survey of 640 households in Kano (North West Nigeria). Interviewed households were selected from 10 randomly selected LGAs; administrative units constituting the third tier of the administrative structure in Nigeria. Households were randomly selected from the randomly selected local governments in Kano. The survey respondents were largely household heads, their spouses, and other adult household members. Respondents were interviewed about their participation in various farm groups and other com-munity associations, their leadership positions in their farm group and local communities, their farming practices (input use, sources, and prices), and about their participation in the 2009 voucher program. Household demographic information was also collected. Because more than one household member could have participated in the voucher program, standard errors are clustered at the household level in all estimations.

Table 1 demonstrates that participation in the private fertilizer market differs significantly across respondents who participated in the voucher program and those who did not. The quantity of fertilizer purchased in the private market was significantly higher among those who participated in the voucher program than those who did not. However, there was substantial participation in the private market irrespective of the program, as about 70% of respondents who did not participate in the voucher pro-gram still purchased fertilizer from the private market.

Table 1
Private sector participation by participation status in the 2009 voucher program

	Nonparticipants	Voucher program participant
Purchased fertilizer from the private market (1/0)	0.720 (0.449)	0.937* (0.243)
Number of 50 kg bags of nonsubsidized fertilizer (bags) purchased	3.009 (4.177)	5.004* (7.683)
Received subsidized fertilizer	0.387 (0.488)	1.000* (0.00)
Number of 50 kg bags of subsidized fertilizer received (bags)	1.224 (3.581)	3.699* (5.962)

Note: The means are statistically significantly different at 5% or less.

Box 1: The challenge in estimating the effect of subsidized fertilizer on commercial fertilizer demand

To estimate the degree to which subsidized fertilizer affects farmers' participation in the private commercial fertilizer market, the basic model can be specified as follows:

$$QFert_{pi} = X_i\beta + \delta QFert_{si} + u_i$$

Where $QFert_{pi}$ refers to the quantity of fertilizer purchased by farmer i from the private market in 2009. X_i is a vector of controls that affect private sector fertilizer demand. It includes household demographic information, socioeconomic characteristics, and variables to capture access to credit and transactions cost. It also includes the price of fertilizer as well as the price of output crops on which fertilizer is applied. $QFert_{si}$ refers to the quantity of subsidized fertilizer that farmer $i$received in 2009. u_i is a farmer-specific error term and β and δ are parameters to be estimated. Our primary interest is in estimating the parameter δ which indicates the presence and extent to which access to subsidized fertilizer affects farmers' participation in the private fertilizer market.

Two key problems in estimating the effect of subsidized fertilizer on commercial fertilizer demand are the endogeneity of the quantity of subsidized fertilizer received and the corner solution nature of input demand (Ricker-Gilbert et al., 2011). When the decision not to use inputs is an optimal choice (where use is not profitable at prevailing market prices as in Coady (1995), a zero observation for the quantity of an input used reflects an optimal choice rather than an unobserved one. This precludes the use of ordinary least squares (OLS) estimations as the constraint of $y \geq 0$ automatically implies that we do not have constant marginal effects and$E(Y|X, Y > 0) \neq \beta X$. It also precludes Heckman et al. (1999) type selection models designed for inci-dental truncation where the zeros are unobserved values. Like Ricker-Gilbert et al. (2011), this paper uses a double-hurdle (DH) approach which allows the process that determines the decision to participate in the private market to be different from that which determines the extent of participation. Variables like distance may affect the decision to participate but distance need not play a significant role in the quantity of inputs purchased. However, it is possible that even after the decision to participate has been made, individuals further away from the market (and with sufficient capital) might prefer to buy more (to minimize the average cost of inputs) than a farmer who is closer to the market.

Following Imbens and Wooldridge (2007) and Wooldridge (2008), we estimate a first-stage regression of the quantity of subsidized fertilizer received by a farmer $QFert_{si}$ using a Tobit model. Then the generalized residuals are included in the second stage estimations (Wooldridge, 2008). For the second stage estimations, a DH model is used. The DH model used in the second stage estimations follows Cameron and Trivedi (2009). The first step is the decision to purchase fertilizer from the private market or not while the second step is the decision about the quantity of fertilizer to purchase from the private market once the decision to participate has been made. The DH model relaxes the assumption that the zeros and the positive values come from the same data generating process. Consequently, the first part uses the full sample while the second part only uses the positive observations. For the first hurdle, we estimate a probit model for the entire sample and for the second stage we estimate a truncated regression. In both hurdles, the generalized residuals are included as covariates.

Identification when using the control function approach requires an instrument, which is appropriately excluded from our primary equation. This paper uses a variable that captures if the respondent was a relative of the farm group leader, secretary, or treasurer as an instrument for the quantity of subsidized fertilizer that a farmer received. While being related to the farm group leadership would affect the quantity of fertilizer received by a farmer, being related to the group leadership is not likely to be correlated with unobserved characteristics that are likely to drive commercial fertilizer demand such as farmer ability. Therefore, this study assumes that upon controlling for other characteristics that could be correlated with a households relationship to the farm group leadership in the demand for commercial fertilizer, the variable satisfies the exclusion restriction of not being correlated with the error term of the equation above and is considered an appropriate instrument. Being related to the farm group leadership is consequently excluded from our estimation of the basic model.

In all second stage estimations, P-values are estimated via bootstrapping at 500 repetitions (except where otherwise stated) to account for the fact that the generalized residual came from a first-stage regression estimation. With a cross-sectional data set, we are not able to completely rule out the effect of time-invariant characteristics (like farmer ability), which could simultaneously be correlated with their ability to secure subsidized fertilizer, while also affecting their demand for fertilizer in the private market. However, in addition to the instrumental variable approach adopted, additional controls to capture possible variation across farmers are included in the estimations and a falsification test is conducted to further demonstrate that it is unlikely that there is some unobservable variable correlated with relationship to the leadership that also causes market purchases of fertilizer. District dummies are included in all estimations to capture time-invariant (or slowly changing) geographic factors that are likely to affect input demand. These include soil characteristics, weather, and infrastructural development.

The findings

Receiving subsidized fertilizer through a voucher redeemable at private dealers stimulates participation in the private fertilizer market

Generally, the results for Kano appear to reveal that it is possible for a fertilizer subsidy program to increase farmer participation in the private sector. Once the decision to participate had been made, every bag of subsidized fertilizer increased the quantity of fertilizer purchased from the private market by 0.256 of a bag, which is about 12.9 kg. Findings also demonstrate that under certain circumstances, e.g., where input dealers' links to farmer are weak, there could be significant gains from the temporary use of voucher programs to strengthen such links.

Factors affecting the quantity of subsidized fertilizer respondents received

The results reveal that whether the recipient was in a farm group that purchased fertilizer together was highly correlated with the quantity of subsidized bags received. Wealth and education variables do not appear to be a significant determinant of the number of bags recipients received but being married and the local government where farmers lived were. In addition, being a relative of one of the farm group leaders increased the number of bags received by about 1.6.

Main drivers of private fertilizer market participation

The results reveal that an additional bag of subsidized fertilizer increased the probability of participating in the private commercial market by 0.09. Though statistically significant, this effect is quite small. This is not surprising given the large fraction of participants in the private market generally and thus the limited variation in the private market participation variable. By nature of the programs' implementation, suppliers were required to establish presence in all the LGAs at certain periods to distribute the subsidized fertilizer as determined by the program. In addition to just making the product available in areas where input suppliers might have been previously absent, it also could have significantly reduced the transactions and transportation costs associated with procuring fertilizer.

As expected, fertilizer price is negatively associated with participation in the private market while access to credit is positively correlated. Farmers with more livestock and more education are also more likely to participate in the private market while households who rent rather than own their land are less likely to participate in the private market. Renting in land likely captures a wealth effect.

The extent of participation in the private market

The DH model results provide evidence that access to subsidies is positively correlated with the extent of farmer participation in the private sector. Once the decision to participate in the private fertilizer market has been made, the quantity of subsidized fertilizer received is significantly positively correlated with the quantity of fertilizer purchased in the private market. From the DH model, we can infer that for every 50 kg of subsidized fertilizer received, an additional 12.9 kg was added to the average quantity of fertilizer purchased in the private market. They appear to indicate that the importance of fertilizer use is not unknown to farmers in Kano. Rather, farmers tend not to have access to the product.

Though participation in the private fertilizer market in Kano was generally high in 2009, anecdotal evidence indicates that this was not the norm and not the case in previous years. Furthermore, additional information from the implementing agency (IFDC) indicates that input suppliers in Kano sold quantities larger than the amount sold through the voucher program. Other factors that affect the extent of participation in the private market are distance, landownership status, livestock ownership, and land area which is not unusual.

The way forward

This study attests that the voucher program played a significant role in the positive effect of subsidized fertilizer on private market fertilizer purchases. Going forward, it is important to gather additional information from other actors in the fertilizer supply chain to better understand the effect of these programs on private market development. One approach could be an analysis of the agro-input dealers, as was done by Krausova and Banful (2010) for Ghana.

Policy agenda

The study has important messages for policy:

- There is **less likely to be distortionary effects** of fertilizer subsidies where fertilizer subsidy programs involve the private sector and ensure that many farmers (including the poor) receive a significant amount of fertilizer to warrant participation but not enough to satisfy their demand.
- Where private fertilizer market links are weak, there could be **significant gains from the temporary use of voucher programs** to strengthen links between input suppliers and farmers.
- It is important that **governments fulfill their role to provide the necessary infrastructure** to minimize transaction costs associated with reaching some remote locations. This will help ensure that the private sector can still profitably meet the demand of rural farmers after the exit of a government or development organization led program.
- **Input subsidy programs have the potential to develop sustainable private input markets.** This can be done through input subsidy programs which subsidize input suppliers in a way that encourages the development of private markets rather than purely subsidizing farmers.
- **Increased attention has to be paid to the targeting mechanism**. This will ensure that elite capture of the process is minimized as the program becomes better understood in the rural areas.

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