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Assessment of the 2009 fertilizer voucher program in Kano and Taraba, Nigeria

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International Food Policy Research Institute

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Abstract

This study analyzes the application of an input voucher program implemented in 2009 in two Nigerian states, Kano and Taraba. Using primary data collected from 1000 households, we explore the effect of the voucher program on the quantity and quality of fertilizer received, the timeliness of receipt, and the price paid by respondents. The findings indicate that program participants in both states were more formally educated than non participants, purchased fertilizer in groups, and had previously used subsidized fertilizer. Voucher program participants in our sample were more likely to receive subsidized fertilizer and in fact received 2.5 (Kano) and 3.5 (Taraba) more bags of subsidized fertilizer than non participants. They paid less than the market price but higher than was paid for subsidized fertilizer from other sources outside the program. Program participants in Taraba received their fertilizer late, and were more likely to be unsatisfied regarding unwanted substances found in their subsidized fertilizer. In Kano, there was no significant correlation found among participants in the study and the likelihood that they would either receive their fertilizer late, be unhappy about the quantity of the fertilizer received, or angry about the presence of unwanted substances in their fertilizer.

Introduction

Government distribution of subsidized fertilizer in Nigeria is often characterized by cumbersome and expensive administrative processes as well as diversion of the product from the proclaimed beneficiaries. A new fertilizer subsidy approach was introduced, which involved the use of vouchers to be used to simultaneously target subsidies, develop demand in private markets as well as encourage relationships between agricultural input dealers and financial institutions (Gregory 2006; Minot and Benson 2009). Agricultural input vouchers are increasingly being employed to address problems of low agricultural productivity and food security by increasing the timely access to inputs. Malawi has used input vouchers in its nationwide fertilizer and seed subsidy programs since 1999. Input vouchers have also been used in Afghanistan in 2001, Mozambique in 2002, Zambia in 2003, Tanzania in 2008 and Ghana in 2008 and 2009 (Longley et al 2003; Longley et al 2007; Gregory 2006; Minot and Benson, 2009; IFDC 2010). In Nigeria, the use of vouchers to provide federal and state government subsidized fertilizer was piloted in several states in 2004 and again from 2008 to 2010. Through provision of guaranteed demand and assured profit margins to small input dealers, fertilizer voucher programs are expected to accelerate development of private-sector fertilizer retail markets (Gregory 2006). Such programs also provide an opportunity for farmers and input suppliers to be trained on the efficient and profitable use of fertilizer. Via readily implementable exit strategies such as reducing the value of a voucher over time or converting it to a crop production credit that is repaid at harvest, input vouchers can be used in establishing sustainable subsidy programs over the long-term.

This paper analyzes various aspects of the 2009 input voucher program that was implemented in the states of Kano (in north-central Nigeria) and Taraba (on the eastern boarder of the country) by the federal government of Nigeria, the respective state governments and the International Center for Soil Fertility and Agricultural Development (IFDC). Under the system of government procurement and distribution of subsidized fertilizer, there were persistent problems of late delivery and the diversion of fertilizer from the intended beneficiaries (Nagy and Edun 2002). The voucher program was expected to improve the targeting of the subsidy and through provision of guaranteed markets and capacity development trainings, support the private fertilizer retail sector. This study uses primary information collected from 1000 households in Kano and Taraba to explore the impact of the voucher program on the quantity and quality of fertilizer received; the timeliness of receipt of fertilizer and the price paid for the product. The analysis explores the difference between voucher program participants and non-participants in these variables. It also studies differences between voucher recipients in Kano and Taraba as there was a difference in the implementation modalities of the voucher program in the two states.

The paper is organized as follows: Section 2 summarizes the history of fertilizer subsidies and distribution in Nigeria, while section 3 describes the 2009 fertilizer voucher program in Kano and Taraba. The data and methodology used are discussed in section 4 and a description of the voucher program participants is presented in Section 5. Regression results are presented in section 6, followed by a discussion of the respondents' perceptions of the voucher program. Section 7 summarizes the key findings of this study and concludes.

Background of Fertilizer Subsidies and Distribution in Nigeria

Prior to 1976, state governments in Nigeria procured fertilizer independently and distributed the fertilizer through sales agents and an extension system. Key problems of this era included interstate leakages to take advantage of price differences, congested ports and consequently, high demurrage charges, limited control over fertilizer type, quality, packaging and poor subsidy administration and control (Nagy and Edun 2002). The period between 1976 and 1986 saw the

procurement and distribution of fertilizer as a centralized, federal government activity executed through the Fertilizer Procurement Distribution Division (FPDD). FPDD procured fertilizer from the international markets and from the Federal Super-phosphate Fertilizer Company Ltd. (FSFC) in Kaduna. The Federal government paid for transportation and distribution costs to depots in the states. States then distributed the fertilizer through farm service centers. Key problems here included excessive costs for fertilizer storage combined with transit losses occurring due to theft or poor storage facilities. Fertilizer was often delivered late, if it was delivered at all. (Nagy and Edun 2002).

Between 1987 and 1991, the physical transport of fertilizer from the port and FSFC was the responsibility of the states. Though the federal government reimbursed transport costs, states that could not afford it left their allocations at the port causing the federal government to incur demurrage and warehousing costs. This system was changed in 1992 when FPDD was given responsibility to distribute imported fertilizer only while National Fertilizer Company of Nigeria (NAFCON)[1] distributed locally produced fertilizer. Though this initiative was said to have reduced the cost of the system, other major problems like the non-delivery of fertilizer, handling, and storage and transit losses still persisted. In 1994, the federal government experimented with distributing 80 percent of the fertilizer through local governments and 20 percent through the state governments. This was implemented for one year and then abandoned. The federal government stopped importing fertilizer directly in 1995 and switched to a tender system in which contracts for importation were awarded to private importers. NAFCON and blending plants were the agencies distributing locally produced fertilizer (Nagy and Edun 2002).

In 1997, Nigeria adopted a complete liberalization of the fertilizer sector. Subsidies were abolished and the import tariff reduced from 10 to 5 percent. This initiative was largely ineffective, partly because the private sector did not have the capacity to take over the administration of the process. Fertilizer use declined sharply and the federal government reintroduced a fertilizer subsidy of 25 percent in May 1999. The subsidy was discontinued again in August 2000. In 2001, the federal government again resumed fertilizer procurement and subsidy.

Inconsistencies in fertilizer policies and the dual fertilizer market have prevented the private sector in Nigeria from actively participating in the subsector in the post 1997 period. Problems with fertilizer quality, interstate leakages due to price differences, and timeliness of fertilizer distribution persisted. Government tenders for fertilizer were invariably late, so also was federal government's payments to fertilizer distributors and the remittances from the states to the federal government.

2009 fertilizer Voucher Program in Kano and Taraba

In 2004, the International Center for Soil Fertility and Development (IFDC) piloted an alternate delivery system for subsidized fertilizer utilizing fertilizer vouchers in Kano and Bauchi states and in the Federal Capital Territory (FCT). A second pilot was done in Kano and Bauchi states in 2008. In 2009, a voucher program that was a collaborative effort between the government (Federal and state), the private sector suppliers and dealers and FDC was instituted in Kano and Taraba. It was designed to deliver subsidized fertilizer to 140,000 and 76,000 small holder farmers in Kano and Taraba, respectively. These pilot programs were designed to address fertilizer distribution challenges and, as such, did not involve or accompany any substantial

[1] NAFCON is now called Notore Chemical Industries Limited. Following NAFCONs decline and consequent closure in 1999, it assets were purchased by Notre as part of Bureau of Public Enterprises (BPE) privatization of hitherto public enterprises in 2005.

policy change. Three fertilizer suppliers[2] and over 150 private sector agro dealers participated in the program. Participating farmers were provided with vouchers, which were redeemable at agricultural input dealers certified by the program implementers within their local government of residence. The subsidy value of the voucher was a N2000 discount per bag on two bags of triple 15 Nitrogen Phosphorous Potassium (NPK 15:15:15) and one bag of Urea (46 percent Nitrogen(N) content) in Kano, and on two bags each of NPK 15:15:15 and Urea (46 percent N) in Taraba. Farmers were required to pay the difference between the market price and the N2000 discount per bag. According to the Nigeria Agri Markets Information Service (NAMIS), fertilizer prices in central markets in Kano and Taraba were about N3000 and N3600 respectively for a 50Kg bag of NPK 15:15:15 and N3, 200 and N3, 650 respectively for a 50Kg bag of Urea[3]. Thus the voucher value was between 55-60 percent of the NPK market price and 50-55percent of the Urea market price in the two states.

The amount of fertilizer eligible for the N2000 per bag discount was 16,200 metric tons (MT) in Taraba and 21,000 MT in Kano. The total subsidy provided by the Federal and state governments amounted to about N966 million and N522 million respectively[4]. The Federal government paid its portion of the N2000 subsidy per bag directly to each supplier based on the amount of each product it had been asked to provide[5]. This meant that vouchers were allocated to match the volume of product requested by states from the Federal government through suppliers with specific dealers in the various local government areas (LGAs), limiting farmer's choice on their source of the product. In most cases, there was a different certified agricultural input dealer for NPK and for Urea, increasing the transaction costs associated with redeeming the vouchers.

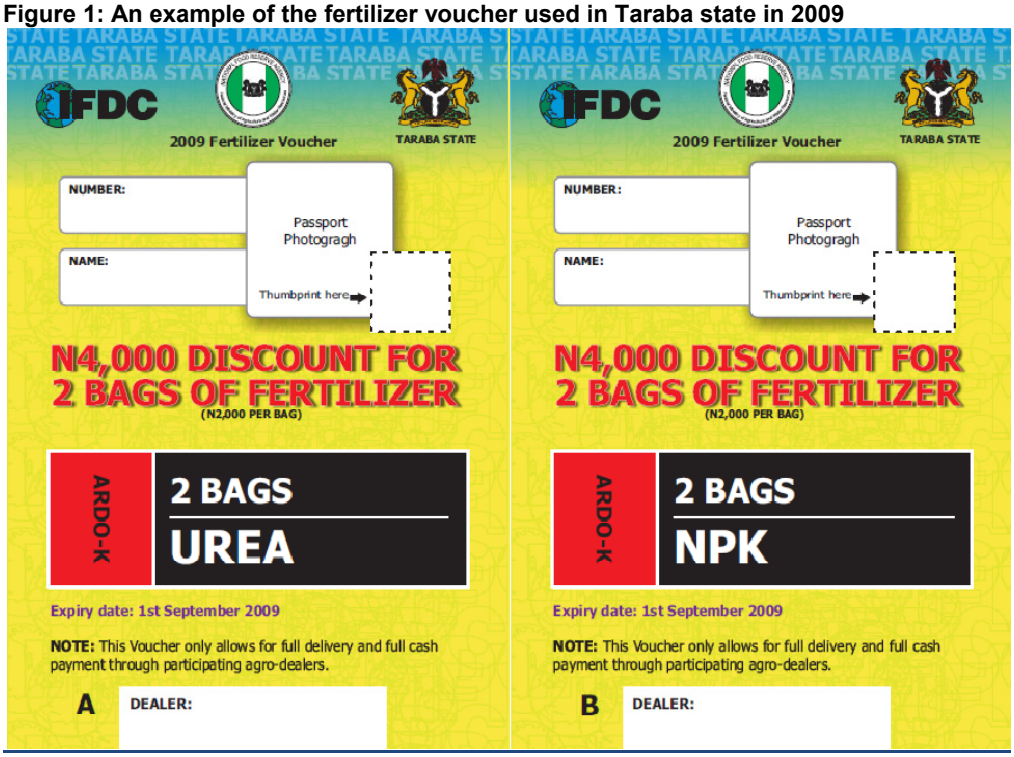
Due to state level peculiarities, there were slight difference in the ways in which the programs were administered in the two states. In Kano, there is a long history of farmers organizing into small farmer groups, but such groups are rare in Taraba. In both states, voucher recipients were required to be members of an organized group but, the recipient in Kano had to be a member of a small farmer group, while in Taraba, the recipient could be a member of any organized group, not necessarily a farmer group. In Kano, a farmer group received a single voucher that entitled its members to a N2000 discount on three bags of fertilizer per member. In Taraba, each individual member of the organized group received a voucher and could purchase four bags of fertilizer at the discounted rate.

The redeemed vouchers were taken by the agricultural input dealers to the fertilizer wholesalers/importers who gather the vouchers and submit them to the (voucher program) Project Implementation Team (PIT) which consisted of the fertilizer wholesaler/importers, IFDC, the state Agriculture Development Project (ADP), and the State Representatives. The team would then check and verify vouchers against the appropriate lists. Once the PIT confirmed the value of the reconciled vouchers for each fertilizer wholesaler/importer, that value would be credited to their various accounts (IFDC 2010).

[2] The three suppliers are the three companies that produced or imported the fertilizer used in the program. They were Notore Chemicals Industry, Golden Fertilizer and TAK Fertilizer.
[3] Prices for August 2009 were used since this was around the time that a lot of fertilizer distribution for the voucher program occurred. Prices in January and June were within a N5 band difference indicating that prices in August are satisfactory to represent fertilizer price in both states.
[4] This amounts to $6.5 million and $3.5 million at the rate US$1.00 US$1.00=N150.00
[5] Under the voucher program, the portion of the N2000 that was equivalent to 25 percent of the cost price for fertilizer was borne by the Federal government and the balance was provided by the states.

In Taraba, the operational procedure by which farmers received vouchers was as follows. Farmers from selected organized groups gathered at a voucher distribution center on a prearranged day. Each farmer was required to bring three passport photographs. The leader of the group would vouch for the identity of each of the groups' members as a farmer. Each farmer was given a paper voucher divided into two sections as shown in Figure 1 below. A passport photograph was affixed to each section.

Figure 1: An example of the fertilizer voucher used in Taraba state in 2009

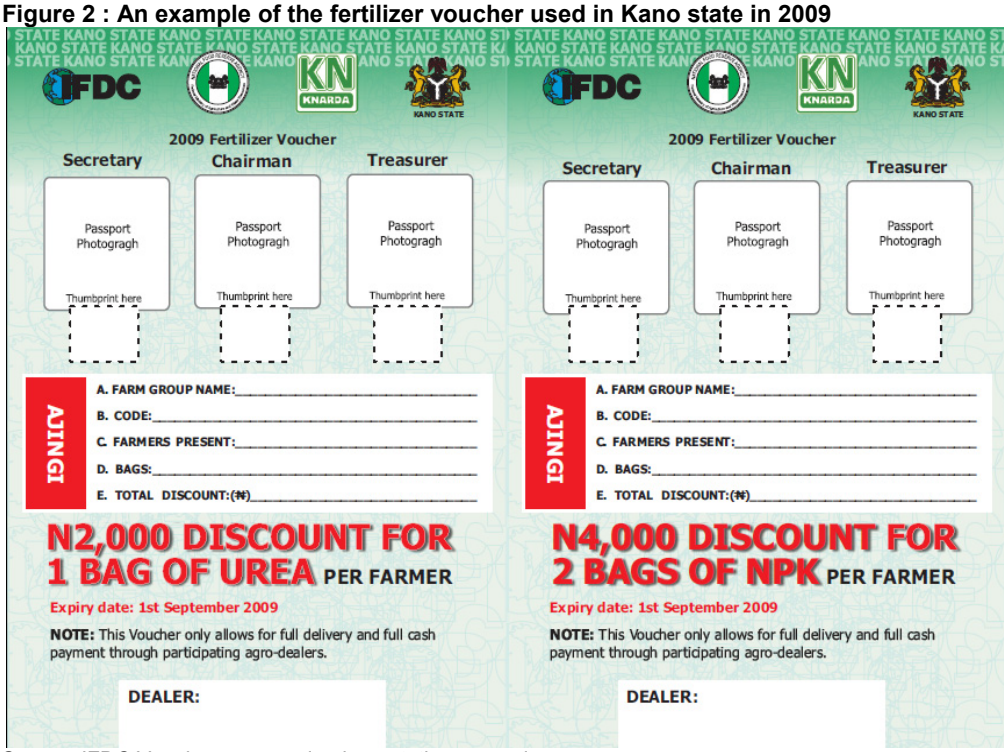


Source: IFDC Voucher program implementation manual

The third copy of the farmer's photograph was affixed to a roster to be given to the specific agricultural input dealer at which the farmer could use the voucher. Farmers were made to thumb sign in each of the sections of the voucher in the space indicated in Figure 1. Upon filling necessary documents, farmers were given the vouchers. A farmer and his or her assigned agricultural input dealer then arranged a day on which the farmer could purchase and pick up the 4 bags of fertilizer.

In Kano, farmer groups were required to bring their certificate of registration to verify their group's authenticity. Due to the long history of farmers with farm groups in Kano, a single voucher was issued to the entire farmer group and the subsidized fertilizer for all members of the group had to be purchased as a group. Figure 2 shows an image of an example of a voucher used in the program in Kano. In Kano, rather than having individual photos of farmers on the voucher as was the case in Taraba, photos of the farm group representatives (i.e. Secretary, Chairman and Treasurer) were placed in the relevant slots shown in Figure 2. Individual members of the group also had to provide one single passport photo to the farm group executive to be presented at the voucher distribution day but the members of the group were not required to be present for the groups' voucher to be provided to the group leadership.

Figure 2 : An example of the fertilizer voucher used in Kano state in 2009



Source: IFDC Voucher program implementation manual

In Kano, each farmer listed on the membership roster of a participating farmer group was required to contribute N6, 000 each as a sign of the group's commitment to fully utilize the voucher. This requirement was a measure to limit the demand for participating in the voucher program in Kano as there was initially much higher demand than could be serviced by the total amount of fertilizer available under the program - farmers had to tie up their money early in the implementation of the voucher program and bear the risk of not receiving fertilizer they had committed the funds to purchase in order to be eligible to participate in the program. Each voucher in Kano entitled a farmer group to receive fertilizer bags, numbering 3 times the number of farmer group members – the number of farm group members was indicated by the total deposit supplied by the farmer group divided by N6000.

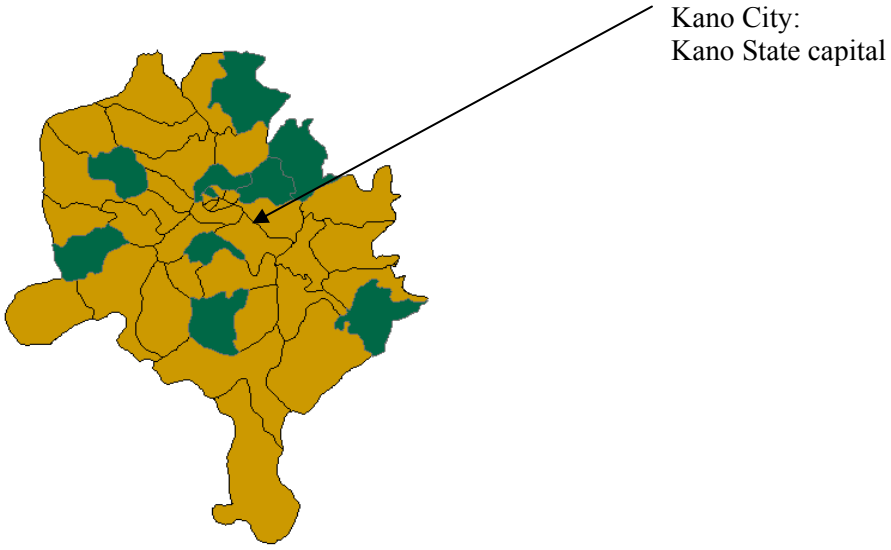
In both Kano and Taraba, the three fertilizer wholesalers/importers were to ensure fertilizer availability through designated agricultural input dealers. Specifically, they were to ensure fertilizer supplied to agro-dealers met proposed redemption allocations and timeframes (not more than 30 days from a specified date in each state) and to pay their contracted distributors a 5 percent gross margin for the agro-input dealers. In Kano, the state government was also responsible for ensuring the quality of fertilizers at supplier, agro-dealer and farmer levels. The government reserved the right to reject any substandard product discovered at any level.

Data and Methodology

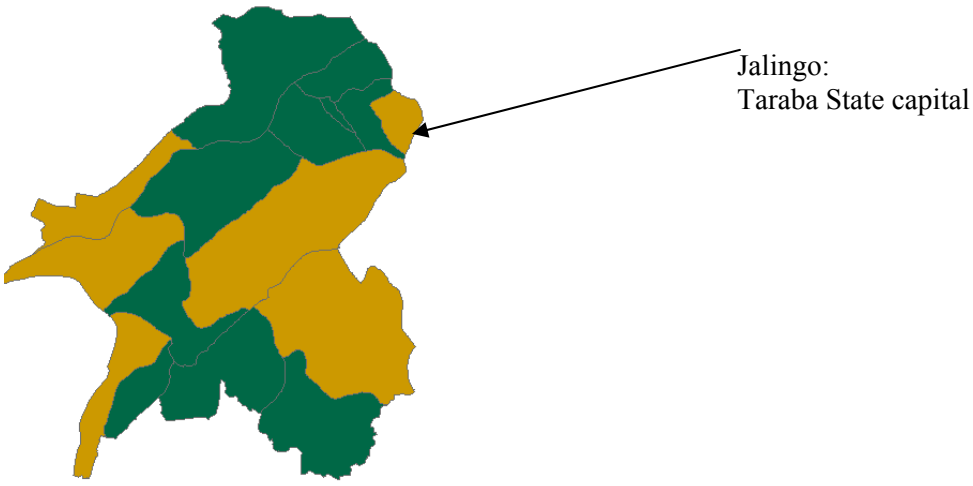
The National Bureau of Statistics (NBS) of Nigeria reports that in 2005 there were about 1,320,000 households in Kano and 447,000 households in Taraba (NBS 2008). The data used in this voucher study comes from a survey of 640 households in Kano and 360 households in

Taraba. While the basis of selecting this number of households from each state is detailed in appendix 1, this number exceeds the minimum sample size required to determine statistical differences between participants and non participants in the voucher program with 95 percent confidence. See appendix 1 for complete details on this procedure. In each state, the interviewed households were selected from 10 randomly selected Local Government Areas (LGAs) with administrative units under each state constituting the third tier of the administrative structure in Nigeria. As shown in Figure 3, the 10 selected LGAs in each state represented potential LGA variation, which could affect the level of exposures farmers had to the voucher program as well as other cultural, infrastructural or administrative differences that affect farmer access to fertilizer apart from the program.

Figure 3: Surveyed Local Government areas (LGA's) in Kano and Taraba



Source: Generated by authors
Note: Surveyed LGAs are highlighted



Generated by authors
Note: Surveyed LGAs are highlighted

In Taraba, due to the unavailability of a complete list of villages in each local government, we could not conduct a standard random sampling of villages in each selected local government and thus adopted the following approach: We obtained a list of farmers who had participated in the voucher program from the IFDC Nigeria office in Abuja. For the 10 randomly selected LGAs, we compiled a list of villages in which there was at least one voucher program participant. From this list, we randomly selected two to three villages per LGA. The field staffs administering the surveys were instructed to interview five households, randomly selected from each of these villages resulting in 10-15 of the minimum of 25 households per LGA minimum to be surveyed. Field staff were also instructed to visit two to three additional villages in close proximity to these assigned villages and to interview five households in each if and only if the village head or local leaders consulted had no knowledge about the voucher program. This strategy was adopted to provide a set of control villages within an LGA which were at least in location, similar to the villages in the LGA which contained voucher program participants.

Unlike Taraba, there was no comprehensive list of the voucher program participants in Kano and so the following strategy was employed to select survey respondents: A list of villages in Kano was compiled based on information supplied by LGAs and the Kano Agricultural Development Agency. Eighty villages were then randomly selected from this list. The field staff in Kano interviewed in pairs, with each pair interviewing eight households in about eight villages[6]. Households within each village were randomly selected but with due consideration that at least one out of the four households interviewed participated in the voucher program. In both states, enumerators were trained extensively in randomly selecting households in a village and how to be mindful in considering the entire village in their selection of those households to interview. Survey coordinators paid surprise field visits to some enumerators to ensure that training instructions were adhered to. Table 1 shows the distribution of surveyed households across the selected LGAs in each state.

Table 1: Distribution of survey households across local government areas in Kano and Taraba

Kano		Taraba	
Local Government Area	**Number of households surveyed**	**Local Government Area**	**Number of households surveyed**
Bagwai	64	Sardauna	55
Takai	64	Gassol	59
Dambatta	60	Ussa	25
Dala	82	Kurmi	25
Karaye	37	Ardo Kola	25
Ungoggo	91	Jalingo	36
Gezawa	83	Donga	35
Gabasawa	60	Karim Lamido	50
Rano	49	Lau	25
Kura	50	Yorro	25
Total	**640**		**360**

Source: Generated from the fertilizer voucher program evaluation survey

[6] Eight households in eight villages gives us about 64 households per pair. With 10 pairs of field staff, this gives us our 640 households in Kano state.

The survey respondents were primarily household heads, their spouses, other adult household members and for a few questions, children and youth in the household. Respondents were interviewed about their participation in various farm groups and other associations, their leadership positions in their 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.

Table 2: Distribution of survey respondents by relation to the household head

	Kano		Taraba	
	Voucher program participant	**Voucher program non participant**	**Voucher program participant**	**Voucher program non participant**
Household head	0.32	0.29	0.33	0.34
Spouse	0.44	0.41	0.39	0.45
Other household member	0.24	0.30	0.28	0.21

Source: Generated from the fertilizer voucher program evaluation survey

As shown in Table 2 respondents in the survey are almost equally distributed between household heads, their spouses and other household members (children, in-laws, grandparents and other non family members resident in the household).

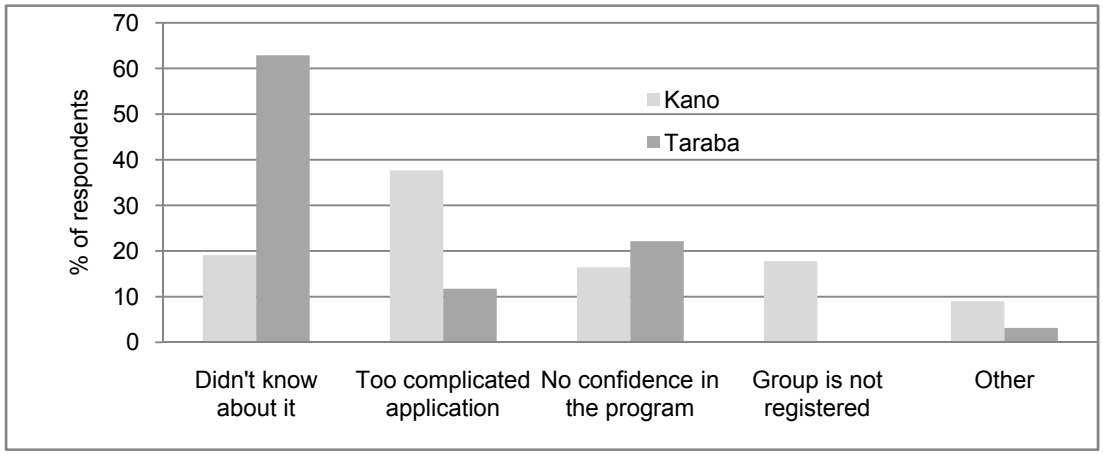
Basic Characteristics of Survey Respondents: Voucher Program Participants versus Non Participants

Voucher program participation

About 60 percent of the survey respondents in both states were in farmers' groups that received a voucher in 2009. In Kano, ninety percent of farmers whose group received a voucher (about 75 percent of respondents who constitute over 90 percent of those who actually received a voucher) actually redeemed the voucher; i.e. they received some subsidized fertilizer through the program. In Taraba, 65 percent of respondents indicated that they had attempted to participate in the voucher program. Forty percent of the survey respondents received a voucher and 83 percent of these farmers actually redeemed the voucher. For this study, respondents are only considered to have participated in the voucher program if they redeemed their voucher[7]. For the 25 percent of survey respondents in Kano who did not attempt to participate in the voucher program, the main reason provided was the complicated participation process. The main reason given by the 35 percent of respondents in Taraba who did not attempt to participate in the voucher program was limited awareness about the program. Figure 4 shows that lack of confidence and a complicated participation process were the next two most important reasons.

[7] Though no specific question in the survey addressed why received vouchers were not redeemed, field staff indicated that some farmers claimed not to have taken any of the subsidized fertilizer in cases where rather than the 3 bags that been promised via the program, they were given a few kilograms of the product.

Figure 4: Reasons for not participating in the 2009 fertilizer voucher program



Source: Generated by authors with data from the fertilizer voucher program evaluation survey
Kano: Number of observations=609; Taraba: Number of observations= 257

Demographics of Households

The typical households in both states were quite similar with little variation across voucher program participants and non-participants. Households were on average headed by a middle aged male of about 45 years. Ninety six percent of household heads in Kano and 92 percent in Taraba were married.

Table 3: Education levels across voucher program participants

	Entire Sample (%)		Kano (%)		Taraba (%)	
	Kano	Taraba	Participant	Non Participant	Participant	Non Participant
No education	2	16	1	1	16	14
Some secondary education	19	29	24	12	29	32
Higher education	10	23	11	9	33	20
Number of observations	3,936	1,737	2,003	1,004	468	969

Source: Generated by authors with data from the fertilizer voucher program evaluation survey

As shown in Table 3, education varied by state and whether a respondent participated in the voucher program. Participation in Islamic education was more prominent in Kano (48%) than Taraba (12%). However, while a larger fraction of household heads in Taraba had not received any formal education compared to Kano, more respondents in Taraba had attained higher levels of education (secondary or tertiary). A larger fraction of voucher program participants had received secondary or post secondary education than non-participants in Kano. In Taraba, more program participants had received some formal tertiary education. See table A.1 for complete summary statistics.

Occupation and Wealth of Respondents

The primary occupation of household heads in both states irrespective of whether they participated in the voucher program was farming. It accounted for the primary activity of about 70% of household heads. The next most significant occupation in both states was a civil servant or/ nongovernmental organization (NGO) worker. Herding was also a significant occupation in the Kano sample, accounting for the primary activity of almost 10% of household heads in that state.

Wealth and participation in the voucher program were correlated in both Kano and Taraba. The average land size in both states was about 3.5 hectares with voucher program participants having larger land holdings than non-participants (See table 4) Wealth was also captured by a household asset and livestock index. The asset index was based on the presence of cell phones, televisions, radios, bicycles and motorcycles. It was generated as the sum of a series of dummy variables (1/0) indicating the presence of any of these items in the household, ranging from 0 to 5. The livestock index is the household tropical livestock unit (TLU) value[8]. While participants in the voucher program had significantly more livestock than non participants in both states, there was no statistically significant difference in the average household asset index across the two groups in both states.

Level of agricultural intensification and previous experience with subsidized fertilizer between 2008 and 2009

About 23 percent of respondents in Kano used irrigation on their farms and this did not vary with voucher program participation status. However, in Taraba, voucher program participants were more likely to use irrigation than non participants. In both states, voucher program participants were significantly more likely to use improved seeds than non participants.

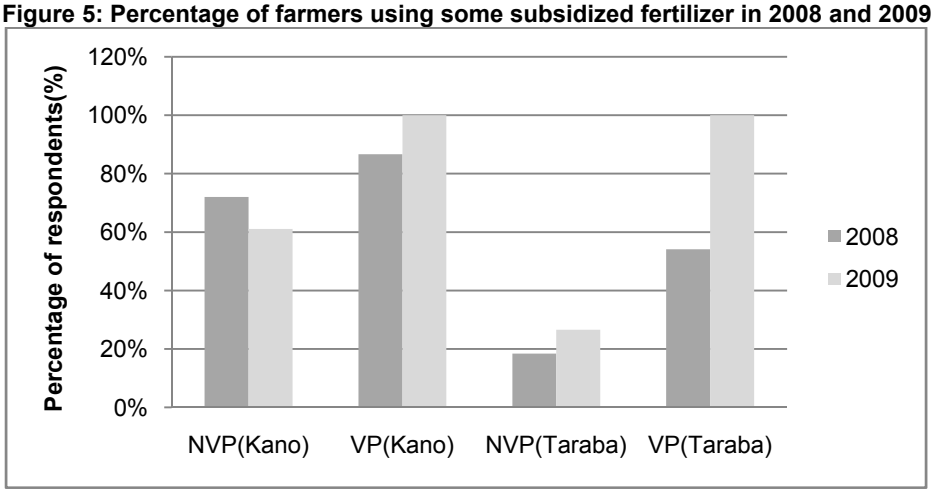
Participants in the voucher program in Kano and Taraba were more likely to have received subsidized fertilizer in the past[9]. Access to subsidized fertilizer in Taraba, and in particular for voucher program participants increased between 2008 and 2009. The percentage of voucher program participants in Kano who used subsidized fertilizer increased by about 14 percentage points between 2008 and 2009 (from 86 percent to 100 percent), while it decreased by about 16 percentage points for non participants (from 72 percent to 61 percent).

While there was a slight increase in the percentage of non voucher program participants who used subsidized fertilizer from another source other than the voucher program (from 18 percent to 26 percent) in Taraba, the increase (about 34 percentage points) was much larger among participants. The smaller increase in percentage of respondents using subsidized fertilizer in Kano reflects the strong presence of government support for fertilizer in that state.

[8] Tropical livestock unit (TLU) is a common unit used to describe livestock numbers of various types as a single figure that expresses the total amount of livestock a household owns, taking into account the weight and size of each animal. See http://www.fao.org/ag/againfo/programmes/en/lead/toolbox/Mixed1/TLU.htm from the Food and Agricultural Organization (FAO) for more information.

[9] This was generated from information on whether farmers in both states had used subsidized fertilizer in the previous year; 2008. In Kano, farmers were also asked if they had participated in the previous voucher programs that had occurred in their state in 2004 and 2008.

Figure 5: Percentage of farmers using some subsidized fertilizer in 2008 and 2009



Source: Generated by authors with data from the fertilizer voucher program evaluation survey
Note: NVP means 2009 voucher program non participants and VP means voucher program participants

Kano state procured about 32,00010 metric tons of fertilizer through the Federal Market Stabilization Program (FMSP) in 2008 and provided an additional 44 percent subsidy to fertilizer over and beyond the 25 percent subsidy given by the Federal government (Banful et al, 2010). Furthermore, the state has had previous experience with voucher programs in 2004 and 2008.

Community and political connectedness of households

Membership in a farmer group in Kano or some organized group in Taraba was required for participation in the 2009 voucher program. This was strongly enforced in Kano where over 95 percent of respondents were in a farm group. Enforcement was lower in Taraba where only about 80 percent of program participants were in some organized group. However, despite the perception that farm groups were few or nonexistent in Taraba, 60 percent of program participants in Taraba were in farm groups. Farmer groups' being a source of agricultural inputs was unanimously important to survey respondents, but particularly to program participants. Voucher program participants tended to have purchased some agricultural inputs as a group.

The majority of survey respondents, both participants and non-participants alike in Kano and Taraba did not, on average hold leadership positions in their communities. In Kano the percentage of program participants who had close ties to the president of their farm group is not significantly different from non-participants. In Taraba, fewer program participants had close links with the farmer group president than non-participants. While participation in rotating savings and credit association (a sign of local connectedness and access to credit) was more evident amongst program participants than non-participants in Taraba, it was not different in Kano.

To statistically confirm significant factors associated with voucher program participation, we empirically estimate the effect of household characteristics on the probability of participating in the program. Details of this analysis are in Appendix A.2 and the results largely confirm the summary statistics described above and summarized in table 4. Participants in the voucher program in Kano were mainly farmers who had used subsidized fertilizer in the past; respondents who were formally educated, were members in a farmer group that purchased

[10] This was the fourth largest procurement by any of the 36 states in Nigeria in 2008.

fertilizer together in 2009 and belonged to households with larger livestock holdings. Respondents who participated in the 2009 voucher program were also more likely to be female. This may reflect the fact that many households were polygamous with several spouses. Eighty-eight percent of spouses whose husbands participated in the program also participated. For Taraba, participants were also more formally educated and more likely to have received subsidized fertilizer in the past. Results indicate that the likelihood of respondents participating in the voucher program depended on the local government they resided in.

Table 4: Summary Statistics

	Kano	Taraba	Kano Voucher participant	Taraba Voucher participant
Ever participated in an agriculture related training (1/0)	0.228	0.114	0.338	0.145
	(0.420)	(0.318)	(0.475)	(0.354)
			* (+)	(+)
Member of a rotating savings and credit arrangement (1/0)	0.161	0.263	0.020	0.564
	(0.368)	(0.441)	(0.140)	(0.498)
			* (-)	(+)
Member of at least one farm group (1/0)	0.797	0.349	1.000	0.436
	(0.403)	(0.477)	0.000	(0.498)
			* (+)	* (+)
Received subsidized fertilizer in the past (1/0)	0.368	0.198	0.430	0.564
	(0.482)	(0.399)	(0.497)	(0.498)
			* (+)	* (+)
Used irrigation in 2009 (1/0)	0.160	0.042	0.219	0.137
	(0.367)	(0.201)	(0.415)	(0.345)
			* (+)	* (+)
Used improved seed in 2009 (1/0)	0.551	0.154	0.612	0.222
	(0.497)	(0.361)	(0.488)	(0.442)
			* (+)	* (+)
Member of a group that purchased fertilizer together in 2009 (1/0)	0.385	0.078	0.444	0.427
	(0.487)	(0.268)	(0.498)	(0.497)
			(+)	* +
Number of 50kg bags of NPK fertilizer received (bags)	1.311	0.449	2.103	1.376
	(2.393)	(1.659)	(3.387)	(3.873)
			* (+)	* (+)
Number of 50Kg bags of Urea fertilizer received (bags)	0.631	0.394	1.604	2.738
	(1.775)	(1.078)	(3.926)	(5.891)
			* (+)	* (+)
Received subsidized fertilizer in 2009 (1/0)	0.769	0.549	0.887	0.437
	(0.422)	(0.498)	(0.317)	(0.497)
			* (+)	* (+)
Number of 50Kg bags of all fertilizer received (bags)	1.942	0.843	3.007	3.282
	(3.821)	(2.405)	(2.171)	(1.496)
			* (+)	* (+)
Received fertilizer late in 2009 (1/0)	0.381	0.114	0.219	0.436
	(0.486)	(0.318)	(0.415)	(0.498)
			* (+)	* (+)
Received fertilizer late in 2008 (1/0)	0.396	0.247	0.484	0.645
	(0.489)	(0.432)	(0.499)	(0.479)
			* (+)	* (+)

	Kano	Taraba	Kano Voucher participant	Taraba Voucher participant
Price paid for NPK in 2009	2267.08 (1541.6)	4019.022 (938.978)	1568.148 (966.889) * (-)	3354.167 (678.908) * (-)
Price paid for Urea in 2009	2182.58 (1467.6)	3737.967 (1311.211)	1083.721 (333.206) * (-)	2441.026 (185.651) * (-)
Deviation in number of months fertilizer was received relative to ideal month (May)	2.546 (1.693)	2.184 (1.297)	2.451 (0.779) * (+)	2.581 (0.734) * (+)
Respondent had non full fertilizer bags in 2009 (1/0)	0.029 (0.169)	0.014 (0.116)	0.093 (0.291) * (+)	0.047 (0.211) * (+)
Respondent had non full fertilizer bags in 2008 (1/0)	0.029 (0.169)	0.014 (0.116)	0.053 (0.224) * (+)	0.043 (0.203) * (+)
Respondent had unwanted substances in their nonsubsidized fertilizer in 2009 (1/0)	0.019 (0.136)	0.036 (0.187)	0.083 (0.275) * (+)	0.128 (0.335) * (+)
Respondent had unwanted substances in their subsidized fertilizer in 2009 (1/0)	0.065 (0.247)	0.005 (0.068)	0.094 (0.292) (+)	0.073 (0.231) * +
Participated in the 2009 voucher program (1/0)	0.119 (0.324)	0.100 (0.301)	1.000 0.000 * (+)	1.000 0.000 * (+)
Age (years)	33.572 (14.848)	34.925 (12.769)	24.868 (8.766) * (-)	31.222 (11.975) * (-)
Male (1/0)	0.586 (0.493)	0.419 (0.494)	0.656 (0.477) (+)	0.137 (0.345) (-)
Household head has been formally educated (1/0)	0.479 (0.500)	0.648 (0.478)	0.498 (0.500) * (+)	0.749 (0.434) * (+)
Land Area in 2009 (hectares)	3.491 (6.764)	3.424 (3.584)	4.233 (1.071) * (+)	4.212 (1.979) * (+)
Farming is the respondents primary occupation (1/0)	0.333 (0.471)	0.424 (0.494)	0.338 (0.475) (+)	0.017 (0.130) * (-)
Respondent is closely associated to the president of their farm group (1/0)	0.847 (0.361)	0.849 (0.358)	0.787 (0.479) (-)	0.591 (0.492) * (-)
Respondent holds a position in their village (1/0)	0.002 (0.049)	0.062 (0.241)	0.720 (0.259) (+)	0.100 (0.301) (+)
Household asset index	2.125 (2.312)	1.576 (1.479)	3.907 (3.837)	1.145 (0.985)

	Kano	Taraba	Kano Voucher participant	Taraba Voucher participant
			(-)	+
Household total livestock asset	6.859	9.710	7.610	26.286
	(20.195)	(114.420)	(23.100)	(204.100)
			* (+)	* (+)
Respondent rents land (1/0)	0.104	0.120	0.109	0.123
	(0.306)	(0.325)	(0.311)	(0.323)
			(+)	(-)
Respondent is the household head (1/0)	0.308	0.337	0.318	0.330
	(0.462)	(0.473)	(0.466)	(0.471)
			(+)	(-)
Respondent is the spouse of the household head (1/0)	0.429	0.431	0.438	0.394
	(0.495)	(0.495)	(0.496)	(0.490)
			(+)	(-)
Respondent is another household member other than the head or spouse of the head	0.263	0.232	0.243	0.275
	(0.440)	(0.423)	(0.429)	(0.448)
			* (-)	* (+)

Source: Generated by authors with data from the fertilizer voucher program evaluation survey
Note: Standard deviation and the sign of mean differences are in parenthesis.
* denotes significant differences in means of voucher program participants and non participants at a significant level of 10 percent or less .

Regression Analysis

The voucher program was intended to improve on the traditional fertilizer distribution system characterized by numerous leakages and the late delivery of poor quality fertilizers to farmers at often close to the market price(Nagy and Edun 2002; IFDC 2010). Thus, we would expect an improved system to reduce fertilizer leakages and increase the *quantity* of subsidized fertilizer that farmers had access to. We would also expect to see *better quality* fertilizer being distributed to program participants *on time* and at a *price* significantly lower than the market price. Consequently, this section empirically tests if the voucher program improved these four outcomes for participants: quantity, quality, timeliness and price of fertilizer. The effects of program participation, household characteristics and location on each of the four outcomes are explored using linear and non linear models of multivariate analysis where the outcome variables are continuous and binary, respectively.

While voucher allocation to farmers or farmer groups was not random, information available on the implementation of the program does not provide any particular criterion besides group membership that was used to target farmers for the program. If farmers self select into the voucher program and some unmeasured farmer specific variables affect both participation in the voucher program and the outcome variables of interest, then a regression specification which only controls for whether the farmer redeemed a voucher, cannot distinguish which of the factors actually causes voucher recipients to enjoy better outcomes. Due to the fact that not all farmers had equal probability of being given a voucher, a regression specification that estimates the impact of having access to a voucher on the outcomes of interest, will suffer from an omitted variable bias if the regressors included do not capture all the factors that influenced a farmer's ability to participate in the voucher program. Given the significant data constraints we face, instead of estimating the causal effects of having a voucher on outcomes, we opt to explore various hypotheses relating participation in the voucher program and each of the four outcome variables we consider; quantity, quality, timeliness and price. These hypotheses, allow an

exploratory analysis of how utilizing a voucher is correlated with the various outcomes without determining the exact mechanism by which such respondents gained these benefits.

In the best case scenario, where we have successfully captured all the factors that influenced a farmer's access to a voucher, a statistically significant coefficient on voucher program participation in our models of the four outcome variables provides evidence of a causal effect between voucher usage and improved farmers' outcomes. However, even if there is an omitted variable that is related to whether or not a farmer received a voucher and also related to the four desirable outcomes, the models are still useful; a statistically significant coefficient on having a voucher shows that a farmer with a voucher had a higher probability of getting the desired outcome than non-participants.

Getting Subsidized Fertilizer and Amount of Subsidized Fertilizer Received

Besides the private fertilizer market, the voucher program is one of several sources of subsidized fertilizer for farmers. Particularly in Kano, but also in Taraba, several subsidy programs existed concurrently, with other programs typically utilizing the traditional fertilizer distribution system**.** We would expect that, after controlling for other factors that might affect farmers' access to and demand for subsidized fertilizer, the number of bags of subsidized fertilizer used and the probability that program participants use subsidized fertilizer would be greater than that of their counterparts who did not participate in the program.

Thus we test the following hypotheses:

1. Ho: Having access to a voucher increased the number of bags of subsidized fertilizer that farmers received.
2. Ha: Having access to a voucher did not increase the number of bags of subsidized fertilizer that farmers received.

1. Ho: Having access to a voucher increased a farmer's probability of receiving subsidized fertilizer.
2. Ha: Having access to a voucher did not increase a farmer's probability of receiving subsidized fertilizer.

To test these hypotheses, we estimate the model:

$$Y = \alpha + \beta_v VOUCHER + \beta_z Z_i + \beta_{LLGA} i + \varepsilon_i \qquad \text{Equation 1}$$

where the dependent variable is a dummy variable, set to 1 if the farmer received subsidized fertilizer in 2009, or the number of 50kg bags[11] of subsidized NPK solution and Urea that a farmer received in 2009[12]. VOUCHER is a dummy variable equal to one if farmer i participated in the voucher program and **Z** refers to a vector of household characteristics and other variables expected to affect the quantity of fertilizer that a farmer would use. Specifically, **Z** consists of the respondents age, whether they were formally educated, whether they have close links to the president of their farmer group (largely friends or relatives), if they held leadership positions in

[11] Note that this is not a dummy variable but a count of the number of subsidized 50kg bags of fertilizer respondents reported as having received

[12] Given that for some farmers the quantity of subsidized fertilizer received is that from different sources, we distinguish between quantity of bags received and the probability of receiving subsidized fertilizer to see if participating in the program was strongly associated with the likelihood of receiving subsidized fertilizer. We also use these two measures of quantity to distinguish between factors that affect access to farmer groups and those that explain intergroup dynamics and access.

the village, land ownership and other proxies of wealth like livestock and non livestock assets. Among the variables in Z is the "membership of a respondent in at least one farmer group and/or whether a farmer's farm group procured fertilizer together in 2009" which are our best proxies for the factor which lead the farmer to be selected for participation. Z also includes

Participants in the program in Kano and Taraba also on average received respectively over 2.5 and 3.5 bags more than non-participants. The quantity of fertilizer offered to program participants was 3 bags in Kano and 4 bags in Taraba. The fact that the quantity of subsidized fertilizer is less than the program intended might reflect that farmers in the program did not, on average, get the promised number of bags[13]. It could also be due to the fact that other sources of subsidized fertilizer were prevalent in both states such that, the difference between these two groups of respondents would not be equal to the exact (total) amount of subsidized fertilizer supposedly available under the voucher program. In Kano, farmers were significantly less likely to receive subsidized fertilizer than non-farmers. In Taraba also, participating farmers received fewer bags of fertilizer than program participants who were not farmers. This indicates that individuals other than farmers had preferential access to subsidized fertilizer in both states.

In Kano, respondents closely linked to the president of their farm group received more bags of subsidized fertilizer than those without such links. This indicates differential access to subsidized fertilizer within farmer groups. Similarly, farmers with larger land were more likely to receive subsidized fertilizer. Respondents who rented the land they farmed on received more bags of subsidized fertilizer than those who owned land. Given limited availability of land and high land rent costs, renting land might actually be more prevalent among richer farmers. Household heads were less likely to receive subsidized fertilizer compared to other family members. This suggests that once a household head was a program participant, several other members of the same household were also indicated as members of an organized group and therefore also eligible to receive fertilizer. The data confirms this interpretation as about 95 percent of other family members in households where the head participated in the voucher program also participated in the program.

In Taraba, older farmers were more likely to receive subsidized fertilizer and after accounting for program participation, respondents who held leadership position in their villages were less likely to receive subsidized fertilizer than those who did not hold positions. Since estimation is at the individual level, this might be due to the fact that village leaders were less involved in agriculture (e.g. if they are elders or chiefs) and thus less likely to participate in the program. The local government area in which an individual was located is a significant determinant of the probability of receiving subsidized fertilizer and the quantity of bags received.

[13] Discussion with the program implementers indicated that many farmer groups reported having fewer members than in reality in Kano. Thus while distribution of fertilizer was made on the estimation of 3 farmer per group, if farmer group sizes were double the number reported (to participate) and the received fertilizer was distributed equally, this would immediately reduce the number of received bags by 2.

Table 5: Voucher program participation and the quantity of subsidized fertilizer received

	Probit Models (Probability of receiving subsidized fertilizer)		**Fixed effects Model** (Number of bags)	
	Kano	Taraba	Kano	Taraba
Participated in Voucher program (1/0)	0.764***	7.170***	2.568***	3.556***
	(0.24)	(0.62)	(0.81)	(0.87)
Member of a group that purchased fertilizer together in 2009 (1/0)	0.25	0.42	0.930*	-0.007
	(0.22)	(0.39)	(0.54)	(0.51)
Used improved seed in 2009 (1/0)	-0.345	-0.009	1.123	-0.493
	(0.25)	(0.01)	(0.82)	(0.44)
Age (years)	0.0154*	0.529*	-0.0004	-0.006
	(0.01)	(0.28)	(0.03)	(0.01)
Male (1/0)	0.34	0.152	-0.424	0.105
	(0.28)	(0.18)	(0.65)	(0.41)
Household head has been formally educated (1/0)	0.152	0.008	-0.164	-0.798
	(0.19)	(0.02)	(0.37)	(0.75)
Land Area in 2009 (hectares)	-0.006	-0.25	-0.013	0.318
	(0.02)	(0.17)	(0.03)	(0.27)
Farming is the respondents primary occupation (1/0)	-0.292*	0.0441	-0.131	-0.652*
	(0.17)	(0.31)	(0.51)	(0.35)
Respondent is closely associated to the president of their farm group (1/0)	0.0293	-0.076	1.247*	-0.618
	(0.27)	(0.26)	(0.69)	(0.38)
Respondent holds a position in their village (1/0)	0.135	-0.231**	-0.514	0.235
	(0.26)	(0.11)	(0.37)	(1.03)
Household asset index	-0.170***	0.005	-0.03	0.056
	(0.05)	(0.01)	(0.11)	(0.15)
Household total livestock asset	0.007	-0.555	-0.004	-0.003
	0.00	(0.47)	(0.01)	0.00
Respondent rents land (1/0)	0.508	0.33	1.817*	-0.344
	(0.34)	(0.40)	(1.07)	(0.48)
Respondent is the household head (1/0)	-0.609**	0.44	0.0497	0.884
	(0.27)	(0.28)	(1.05)	(0.63)
Respondent is the spouse of the household head (1/0)	-0.191	-0.609	-0.557	-0.156
	(0.25)	(0.37)	(0.63)	(0.37)
Constant	5.114***	-0.747	0.04	0.765
	(0.48)	(0.51)	(2.15)	(0.60)
LGA Dummies	YES	YES	YES	YES
Number of observations	1021	739	1389	739
R-squared (Pseudo r squared)	(0.396)	(0.571)	0.146	0.1731
Adjusted R-squared			0.131	0.145

Note: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are shown in parentheses. Each regression includes a full set of local government area dummies to capture location specific effects. 1/0 refers to dummy variables with 1 for affirmative responses and zero, otherwise.

Price Paid by voucher program participants

Under the inefficient traditional delivery system, farmers typically are forced to pay higher than the announced subsidized prices for fertilizer (Nagy and Edun, 2002). Subsidized fertilizer often leaks to the private market and the price farmers pay is sometimes almost identical to the market price (IFDC 2010). We expect a more efficient distribution system, such as that of the, voucher program, to minimize leakages. Consequently, the price paid by program participants should be significantly lower than the market price.

Thus to estimate the correlation of the voucher program participation with the price paid for NPK and Urea, we estimate the following model[14]:

$$P_{rice}Fert_i = \alpha + \beta_v VOUCHER + \beta_z Z_i + \beta_L LGA_i + \varepsilon_i \qquad \text{Equation 2}$$

where the dependent variable ($\mathbf{P_{rice}Fert_i}$) refers to the price paid for NPK and for Urea fertilizers, respectively , and Z is the vector of controls as discussed for estimating equation 1, with an additional dummy variable to capture the effect of timing of fertilizer purchase on price. All regressions are local government fixed effects estimations.

We explore the effect of participating in the voucher program on prices from two fronts. On one front, we consider that there are multiple sources of subsidized fertilizer (particularly in Kano) and on another front we consider that farmers typically are forced to pay higher than the announced subsidized prices. Thus we compare the price difference between subsidized fertilizer obtained via the voucher program and subsidized fertilizer obtained from all other sources. For this analysis, our sample only includes farmers who purchased subsidized fertilizer from multiple sources. Next we consider the fact that the price farmers often pay is almost identical to the market price (IFDC 2010). Thus we compare if there is any significant difference between the price paid by respondents who participated in the voucher program and those who purchased directly from the market. For this analysis, our sample includes all respondents who purchased fertilizer; the price paid by voucher recipients for their subsidized fertilizer is compared to the price paid for fertilizer from the market by non-participating farmers who purchased fertilizer. Estimation results are shown in table 5 and 6 below.

For the sample of respondents in Kano who received subsidized fertilizer, we find that farmers who participated in the voucher program paid significantly higher prices for NPK fertilizer than non-participating farmers who had access to subsidized NPK from other sources. Discussions with program implementers as well as field staff indicate that some of the alternative sources of subsidized fertilizer in Kano offered fertilizer to farmers at fixed and very low prices. There was one scheme in 2009 where fertilizer was provided by some local governments at a flat rate of N1000 for a bag of NPK. These might explain these findings. Farmers in Kano paid lower prices for all fertilizers and respondents who purchased fertilizer early also paid lower prices for NPK.

When comparing all respondents (and not just those who bought subsidized fertilizer through multiple programs) we find that farmers who participated in the voucher program paid significantly lower prices for both NPK and Urea compared to those who purchased at market prices only. Farmers who purchased fertilizer as a group tended to pay a lower price for NPK than those who did not. Farmers who purchased fertilizer early also tended to pay lower prices.

[14] The price data available does not distinguish between different types of NPK fertilizer (NPK20:10:10 or NPK 15:15:15 etc)

Given that we consider all months earlier than July to be early, this could be driven by farmers who have storage capacity or are less cash constrained and thus able to procure at a low price when general demand is low. Amongst all respondents, household heads and individuals from wealthier households paid higher prices on average for urea. This likely reflects the increased participation of these individuals in purchasing fertilizer from private market. Geographic location remains an important factor in explaining fertilizer prices in both states, reflecting different levels of infrastructure, local policies and availability of alternative sources of subsidized fertilizer besides the voucher program.

Table 6: Voucher program participation and fertilizer price paid in Kano

Price in Naira	Sample of only respondents who used subsidized fertilizer		All respondents using fertilizer	
	Price of NPK (Fixed Effects)	Price of Urea (Fixed Effects)	Price of NPK (Fixed Effects)	Price of Urea (Fixed Effects)
Participated in Voucher program (1/0)	201.2***	129	-453.2***	-353.7**
	(71.59)	(107.60)	(142.70)	(158.30)
Member of a group that purchased fertilizer together in 2009 (1/0)	-44.59	-143.4	-422.3***	-353.4*
	(86.90)	(149.70)	(142.80)	(188.80)
Received/Purchased fertilizer on time (1/0)	-346.3***	-229.4	-416.3**	-423.4**
	(90.17)	(162.10)	(188.50)	(205.30)
Age (years)	2.614	0.877	1.249	-3.571
	(1.93)	(3.20)	(3.87)	(4.74)
Male (1/0)	-16.85	-102.4	-77.66	-162.9
	(66.26)	(90.91)	(102.10)	(143.90)
Household head has been formally educated (1/0)	60.1	96.15	73.55	65.09
	(50.96)	(80.30)	(91.39)	(101.40)
Land Area in 2009 (hectares)	-1.446	-4.688	5.079	-4.015
	(1.79)	(3.45)	(6.09)	(4.24)
Farming is the respondents primary occupation (1/0)	-127.8**	-145.0**	-37.38	-139.2
	(52.82)	(69.77)	(97.62)	(143.40)
Respondent is closely associated to the president of their farm group (1/0)	-24.37	-45	-56.86	-60.54
	(43.93)	(60.89)	(82.48)	(114.00)
Respondent holds a position in their village (1/0)	18.85	7.617	-84.04	-115.9
	(47.20)	(50.66)	(79.41)	(100.90)
Household asset index	-2.877	-6.469	32.8	116.9***
	(17.95)	(24.59)	(33.22)	(38.27)
Household total livestock asset	0.246	-0.738	0.479	-3.412
	(0.75)	(1.02)	(2.54)	(2.24)
Respondent rents land (1/0)	116.5	11.98	95.02	-105.9
	(79.49)	(105.30)	(140.30)	(152.40)
Respondent is household head (1/0)	-49.07	53.52	52.63	292.5*
	(81.14)	(113.10)	(134.90)	(168.30)
Respondent is the spouse of the household head (1/0)	-93.26	-73.84	-7.959	-32.32
	(84.03)	(137.10)	(113.20)	(148.90)

Price in Naira	Sample of only respondents who used subsidized fertilizer		All respondents using fertilizer	
	Price of NPK (Fixed Effects)	Price of Urea (Fixed Effects)	Price of NPK (Fixed Effects)	Price of Urea (Fixed Effects)
Constant	1261***	1326***	1871***	3341***
	(134.80)	(185.00)	(266.10)	(720.50)
LGA dummies	YES	YES	YES	YES
Number of observations	989	809	1232	1001
R squared	0.77	0.53	0.56	0.38
Adjusted R-squared	0.764	0.511	0.550	0.364

Note: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are shown in parentheses. Each regression includes a full set of local government area dummies to capture location specific effects. 1/0 refers to dummy variables with 1 for affirmative responses and zero, otherwise.

For our sample of respondents who purchased subsidized fertilizer in Taraba, where prices were significantly different, they were lower for voucher program participants. We also find evidence that wealthier and better connected farmers received cheaper fertilizer than their less privileged counterparts who received subsidized fertilizer. The prices individuals paid were all decreasing in their land holdings, livestock holdings, non-livestock assets and links to the president of the farmer group.

Among all respondents, we find that those who participated in the voucher program paid significantly lower prices than those who purchased from the market for both NPK and Urea. Respondents who were primarily farmers and those with larger landholdings and livestock paid lower prices for fertilizer. In contrast to the situation in Kano, respondents in Taraba who purchased fertilizer on time tended to pay higher prices. The local government where respondents resided is significantly associated with the price they pay for their fertilizer products in both states; again reflecting different local policies and levels of fertilizer subsidy and access.

Table 7: Voucher program participation and fertilizer price paid in Taraba

Price in Naira	Sample of only respondents who used subsidized fertilizer		All respondents using fertilizer	
	Price of NPK (Fixed Effects)	Price of Urea (Fixed Effects)	Price of NPK (Fixed Effects)	Price of Urea (Fixed Effects)
Participated in Voucher program (1/0)	3.756	-241.7**	-854.2***	-1016***
	(133.60)	(109.90)	(191.40)	(180.50)
Member of a group that purchased fertilizer together in 2009 (1/0)	-234.3	32.4	-19.26	-170.9
	(218.00)	(58.93)	(195.30)	(163.20)
Received/purchased fertilizer on time (1/0)	244.2	120.9	-83.83	520.1***
	(150.50)	(75.16)	(197.40)	(173.70)
Age (years)	7.008*	-1.109	4.582	-0.776
	(4.04)	(1.87)	(5.32)	(5.16)
Male (1/0)	-143.6	-112	-215.5	-88.24
	(112.40)	(67.69)	(163.20)	(137.30)
Household head has been formally educated (1/0)	112.7	53.87	-33.55	-27.84

Price in Naira	Sample of only respondents who used subsidized fertilizer		All respondents using fertilizer	
	Price of NPK (Fixed Effects)	Price of Urea (Fixed Effects)	Price of NPK (Fixed Effects)	Price of Urea (Fixed Effects)
	(128.90)	(53.05)	(134.10)	(127.70)
Land Area in 2009 (hectares)	-30.79*	12.7	7.979	27.85
	(16.49)	(13.13)	(23.58)	(18.56)
Farming is the respondents primary occupation (1/0)	-144.8	-19.12	-247.4*	241.5**
	(108.00)	(52.29)	(135.90)	(108.90)
Respondent is closely associated to the president of their farm group (1/0)	-323.2*	81.8	-176.7	205.4
	(164.10)	(57.93)	(176.30)	(128.80)
Respondent holds a position in their village (1/0)	43.52	200.2**	-58.77	-56.43
	(101.60)	(96.15)	(172.20)	(150.20)
Household asset index	-92.08*	-15.45	-34.03	172.0**
	(50.98)	(28.33)	(87.71)	(77.52)
Household total livestock asset	-0.0277	-15.16**	-1.477***	-28.55**
	(0.14)	(6.04)	(0.36)	(12.32)
Respondent rents land (1/0)	117	-13.46	-113.8	-14.72
	(139.80)	(85.20)	(159.00)	(198.30)
Respondent is household head (1/0)	28.42	55.09	170.70	(25.89)
	(170.10)	(64.31)	(177.70)	(181.30)
Respondent is the spouse of the household head (1/0)	(123.20)	(112.60)	81.17	(28.08)
	(126.80)	(77.42)	(168.50)	(168.80)
Constant	2600***	2985***	4869***	4144***
	(351.90)	(200.10)	(323.70)	(350.00)
LGA Dummies	YES	YES	YES	YES
Number of observations	137	244	374	348
R squared	0.78	0.55	0.44	0.57
Adjusted R-squared	0.731	0.497	0.405	0.536

Note: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are shown in parentheses. Each regression includes a full set of local government area dummies to capture location specific effects. 1/0 refers to dummy variables with 1 for affirmative responses and zero, otherwise.

Timing of Receipt of Fertilizer

The delivery of subsidized fertilizer is persistently late (Banful & Olayide 2010). Consequently, we explore if farmers who participated in the voucher program tended to receive fertilizer closer to the ideal time it was needed. We recognize that the time a farmer received his fertilizer could be linked to the price he pays. We expect the majority of this effect to be accounted for by the voucher program participation variable as it is the major factor distinguishing the potential price paid for fertilizer from the market price. However, besides the program, better connected or

wealthier farmers could have access to fertilizer on time, at lower of higher prices, depending on the local situation[15]. We attempt to control for such price differences faced by households using household characteristics that indicate wealth, better connections and education to address this issue. To determine the correlation between voucher participation and the timeliness of receipt of fertilizer, we estimate equation 3

$$TDev_i = \alpha + \boldsymbol{\beta_v VOUCHER + \beta_z Z_i + \beta_L LGA_i + \varepsilon_i} \qquad \textbf{Equation 3}$$

where $\mathbf{TDev_i}$ is the absolute deviation in terms of number of months from the ideal month in which the farmer received subsidized fertilizer, Z remains as defined in the previous sections with local government dummies included to account for differential location effects on the timing of fertilizer receipt. In both Kano and Taraba, discussions with farmers indicated that in 2009, the onset of rains began towards the end of April with demand being highest between April and June. Thus we use May (month 5) as the optimal month.

The constant (α in equation 3), shown in Table 8 reveals that fertilizer was generally procured by respondents in both states later than May. This indicates that fertilizer availability, at the optimal time was a general problem across both states[16]. We find that respondents who participated in the voucher program in Kano were significantly more likely to have received their fertilizer later than non participants. In Taraba, those who held leadership positions in their village were more likely to have received their fertilizer earlier. Apart from participating in the voucher program, the most important factor associated with the time respondents received their fertilizer in 2009 was the local government they lived in. This is particularly important given the limited effect of household characteristics, generally and the positive and significant intercept term[17]. Results indicate that the timely availability of the product is beyond farmer control. State and local factors such as policies and infrastructure appear to be the key determinants of timely availability of fertilizer. Consequently strategies to address the general availability of fertilizer are necessary to increase farmer timely access to fertilizer and probably the effectiveness of the voucher program, since its execution depends on the availability of the product purchased by states.

[15] Better educated, connected and or wealthier farmers may be able to purchase fertilizer when cheap (e.g. after the peak season of fertilizer demand in the previous year) and store or may have access to opportunities and liquidity to purchase the product in bulk or at central markets at lower prices. On the other hand, they are also more able to pay any premium for scarce but available fertilizer at the time fertilizer is needed.

[16] This can also be seen by the values of the deviation in number of months fertilizer was received relative to ideal month (May) shown in table 4

[17] Given the statistical power of our model (as shown by the R-squared and Adjusted R-squared) as well as the fact that our explanatory variables are the typical household characteristics associated with demand for and access to inputs, we believe that the insignificance of most household characteristics (which have been significant in other models) alongside strong significance of the intercept term is driven by factors beyond farmer control and not model misspecification

Table 8: Voucher program participation and the timing of fertilizer receipt in 2009

Deviation in months	Kano Fixed Effects	Taraba Fixed Effects
Participated in Voucher program (1/0)	0.452**	0.387
	(0.20)	(0.33)
Member of a group that purchased fertilizer together in 2009 (1/0)	0.171	0.226
	(0.25)	(0.23)
Used improved seed in 2009 (1/0)	0.00861	-0.282
	(0.19)	(0.24)
Age (years)	-0.00356	-0.00739
	(0.01)	(0.01)
Male (1/0)	0.205	0.0238
	(0.17)	(0.16)
Household head has been formally educated (1/0)	-0.119	-0.237
	(0.11)	(0.18)
Land Area in 2009 (hectares)	0.0208	-0.0169
	(0.01)	(0.02)
Farming is the respondents primary occupation (1/0)	-0.163	0.31
	(0.15)	(0.23)
Respondent is closely associated to the president of their farm group (1/0)	-0.107	-0.0138
	(0.15)	(0.20)
Respondent holds a position in their village (1/0)	-0.0633	-0.584**
	(0.18)	(0.28)
Household asset index	0.0224	0.245*
	(0.05)	(0.14)
Household total livestock asset	0.00115	-0.015
	(0.00)	(0.03)
Respondent rents land (1/0)	0.185	0.192
	(0.17)	(0.22)
Respondent is household head (1/0)	0.0696	0.129
	(0.19)	-0.22
Respondent is the spouse of the household head (1/0)	0.0773	0.0622
	(0.21)	-0.22
Constant	3.678***	2.227***
	(0.44)	-0.614
LGA Dummies	YES	YES
Number of observations	1064	299
R squared	0.41	0.47
Adjusted R-squared	0.395	0.424

Note: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are shown in parentheses. Each regression includes a full set of local government area dummies to capture location specific effects. 1/0 refers to dummy variables with 1 for affirmative responses and zero, otherwise.

Problems with Fertilizer

Another commonly cited issue with subsidized fertilizer is that it is adulterated or underweight (Chude , 2006; Ayoola et al, 2002). A voucher program, particularly the 2009 program which only worked with 3 suppliers (such that substandard products could more easily be traced back to the supplier) could improve the fertilizer delivery along these dimensions. We thus expect fewer complaints from program participants about fertilizer received being short weighted or filled with foreign substances. We estimate three forms of equation 4

$$P(ProbFert_i = 1) = \alpha + \beta_v VOUCHER + \beta_z Z_i + \beta_L LGA_i + \varepsilon_i \qquad \textbf{Equation 4}$$

The dependent variable is a dummy variable equal to 1 if the respondent did not have a full bag of fertilizer, if they reported having unwanted substances (like hay or grass) in their subsidized fertilizer, or if they reported having unwanted substances in their unsubsidized fertilizer in 2009.

Tables 8 and 9 present the results for Kano and Taraba respectively. We do not find evidence that respondents in Kano who participated in the voucher program were less likely to report problems with fertilizer bags that were not full or had unwanted substances and this cut across both subsidized and private market products. On average respondents did not complain about fertilizer quality problems. Respondents who were primarily farmers were less likely to report fertilizer problems generally. Those who purchased fertilizer in groups were more likely to complain about having bags of fertilizer that were below the specified weight while older respondents and those who had close ties to their farm group president were significantly more likely to complain about unwanted substances in their subsidized fertilizer though this did not carry across to non-subsidized fertilizers. More affluent respondents with larger landholdings as well as livestock and non-livestock assets were less likely to have quality complaints. Finally we find here as in all previous cases, that location matters. Not finding that voucher program participants complained significantly more or less than non-participants indicates that other local factors besides level of participation in the voucher program affect the level of fertilizer dilution in the sample local governments.

Table 9: Voucher program participation and fertilizer problem complaints in Kano

Respondent reports problem with fertilizer (1/0)	Kano: Non Full bags	Kano: Unwanted substances in subsidized fertilizer	Kano: Unwanted substances in Non Subsidized fertilizer
Participated in Voucher program (1/0)	0.0166	0.281	0.0701
	(0.24)	(0.23)	(0.29)
Member of a group that purchased fertilizer together in 2009 (1/0)	1.403***	0.503*	0.306
	(0.29)	(0.28)	(0.30)
Used improved seed in 2009 (1/0)	0.327	0.334	-0.202
	(0.28)	(0.28)	(0.27)
Age (years)	0.00855	0.0187**	0.00782
	(0.01)	(0.01)	(0.01)
Male (1/0)	0.137	0.313	0.256
	(0.17)	(0.22)	(0.23)
Household head has been formally educated (1/0)	0.0738	-0.0335	-0.343
	(0.23)	(0.23)	(0.23)
Land Area in 2009 (hectares)	-0.130*	-0.0693**	0.0169
	(0.07)	(0.03)	(0.02)
Farming is the respondents primary occupation (1/0)	-0.561***	-0.473**	-0.540***
	(0.19)	(0.20)	(0.21)
Respondent is closely associated to the president of their farm group (1/0)	0.327	1.116***	0.382
	(0.29)	(0.37)	(0.29)
Respondent holds a position in their village (1/0)	0.061	-0.17	-0.0856
	(0.26)	(0.27)	(0.25)
Household asset index	-0.198**	-0.262*	-0.0721
	(0.09)	(0.14)	(0.10)
Household total livestock asset	-0.0163	-0.0259	-0.0170***
	(0.01)	(0.02)	(0.01)
Respondent rents land (1/0)	0.0318	0.458	0.346
	(0.29)	(0.38)	(0.34)
Respondent is household head (1/0)	-0.235	-0.675**	-0.471
	(0.31)	(0.34)	(0.37)
Respondent is the spouse of the household head (1/0)	-0.119	-0.31	-0.372
	(0.26)	(0.25)	(0.27)
LGA Dummies	YES	YES	YES
Constant	-2.255***	-7.249***	-1.316*
	(0.72)	(0.68)	(0.68)
Number of observations	1130	943	931
Pseudo R- squared	0.3053	0.2906	0.234

Note: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are shown in parentheses. Each regression includes a full set of local government area dummies to capture location specific effects. 1/0 refers to dummy variables with 1 for affirmative responses and zero, otherwise.

In Taraba, we find that respondents who participated in the voucher program were significantly more likely to report having received bags of fertilizer with less than the specified weight than non participants and were also significantly more likely to report the presence of unwanted substances in their subsidized fertilizer.

The factors associated with the probability of receiving underweight bags were different from those affecting the probability of having unwanted substances in subsidized fertilizer and those for problems with unsubsidized fertilizer. Respondents with local leadership positions and those who farmed on rented land were less likely to report underweight bags while formally educated respondents were more likely to complain. While respondents who used improved seed were less likely to report underweight bags, they were more likely to complain about unwanted substances in unsubsidized fertilizer. Respondents who were primarily farmers and leaders in their communities were less likely to complain about un- subsidized fertilizer while male respondents were more likely to complain about unwanted substances in both subsidized and unsubsidized fertilizer. However, while formally educated respondents were less likely to complain about unwanted substances in subsidized fertilizer, they were more likely to complain about the same issue with unsubsidized fertilizer. Again local government differences exist though these complaints are largely consistent across the types of fertilizer complaints.

Table 10: Voucher program participation and complaints about fertilizer in Taraba

Respondent reports problem with fertilizer (1/0)	Taraba: Non Full bags	Taraba: Unwanted substances in subsidized fertilizer	Taraba: Unwanted substances in Non Subsidized fertilizer
Participated in Voucher program (1/0)	0.870***	1.214***	0.209
	(0.33)	(0.41)	(0.31)
Member of a group that purchased fertilizer together in 2009 (1/0)	-0.0313	-0.335	-0.202
	(0.43)	(0.56)	(0.41)
Used improved seed in 2009 (1/0)	-0.931*	0.259	0.805**
	(0.52)	(0.51)	(0.37)
Age (years)	0.0165	-0.0152	0.0167
	(0.01)	(0.02)	(0.01)
Male (1/0)	0.0173	0.551*	0.626*
	(0.50)	(0.28)	(0.36)
Household head has been formally educated (1/0)	0.909***	-0.735**	0.749**
	(0.35)	(0.34)	(0.30)
Land Area in 2009 (hectares)	-0.0672	0.0461	0.071
	(0.04)	(0.04)	(0.04)
Farming is the respondents primary occupation (1/0)	-0.581	-0.343	-0.575**
	(0.40)	(0.37)	(0.23)
Respondent is closely associated to the president of their farm group (1/0)	0.371	0.218	0.441
	(0.51)	(0.57)	(0.33)
Respondent holds a position in their village (1/0)	-0.746*	-0.00883	-1.322***

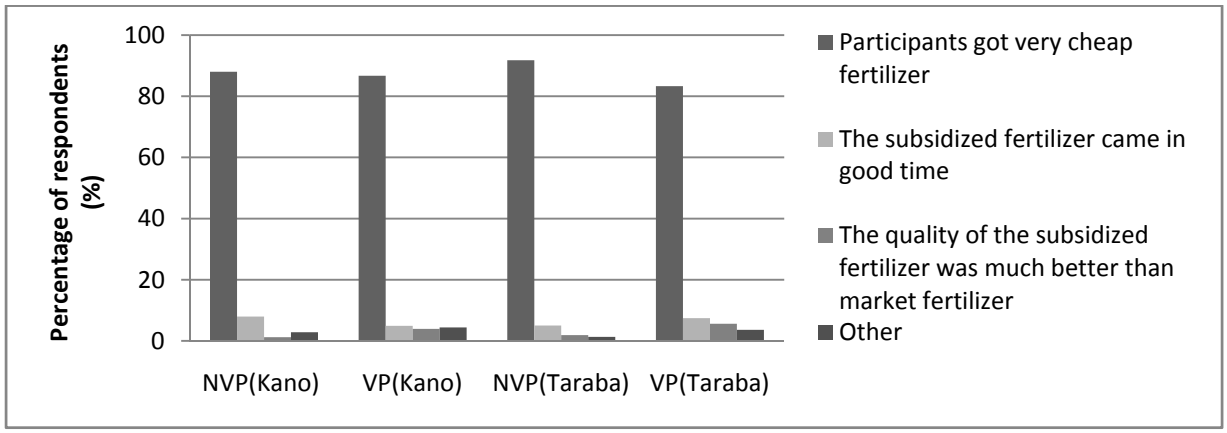
Respondent reports problem with fertilizer (1/0)	Taraba: Non Full bags	Taraba: Unwanted substances in subsidized fertilizer	Taraba: Unwanted substances in Non Subsidized fertilizer
	(0.41)	(0.29)	(0.31)
Household asset index	0.0419	0.033	-0.118
	(0.20)	(0.26)	(0.17)
Household total livestock asset	0.00762	0.165	-0.0145
	(0.04)	(0.13)	(0.03)
Respondent rents land (1/0)	-4.576***	-3.925***	0.252
	(0.70)	(0.47)	(0.37)
Respondent is household head (1/0)	0.247	0.285	-0.0123
	(0.44)	(0.44)	(0.38)
Respondent is the spouse of the household head (1/0)	0.796	0.453	0.791*
	(0.55)	(0.34)	(0.43)
LGA Dummies	YES	YES	YES
Constant	-9.085***	-10.23***	-3.827***
	(1.24)	(2.47)	(0.65)
Number of observations	739	368	628
Pseudo R -squared	0.4244	0.3335	0.3858

Note: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are shown in parentheses. Each regression includes a full set of local government area dummies to capture location specific effects. 1/0 refers to dummy variables with 1 for affirmative responses and zero, otherwise.7. 0

Respondent perceptions of the Fertilizer voucher program

Respondents in both states generally indicated a positive attitude towards the 2009 voucher program and similar schemes. Ninety percent and 98 percent of voucher program participants in Kano and Taraba respectively indicated that if the program were available next year, they would participate. Similarly, 85% and 90% of non-participants indicated interest in participating in such a program. The overwhelming reason for intending future participation among respondents was the cheaper price of the fertilizer. Issues of timeliness and quality were less significant with less than 10% of respondents in any category mentioning any of these as the reason to participate in the program. These responses are in line with the findings from the regression analysis where the largest evidence of program effect was seen with the lower prices relative to market prices and the quantity of subsidized fertilizer received.

Figure 6: Reasons for wanting to participate in future voucher program

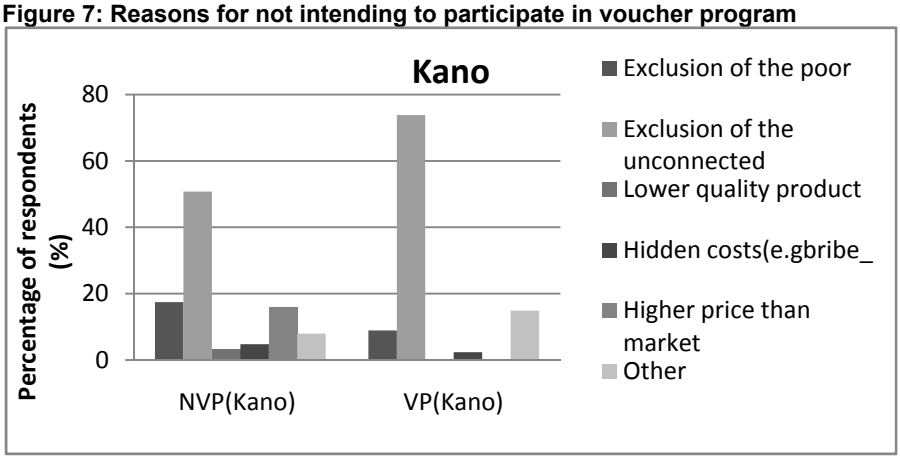


Source: Generated by authors with data from the fertilizer voucher program evaluation survey
Note: NVP means non voucher program participants and VP means voucher program participants

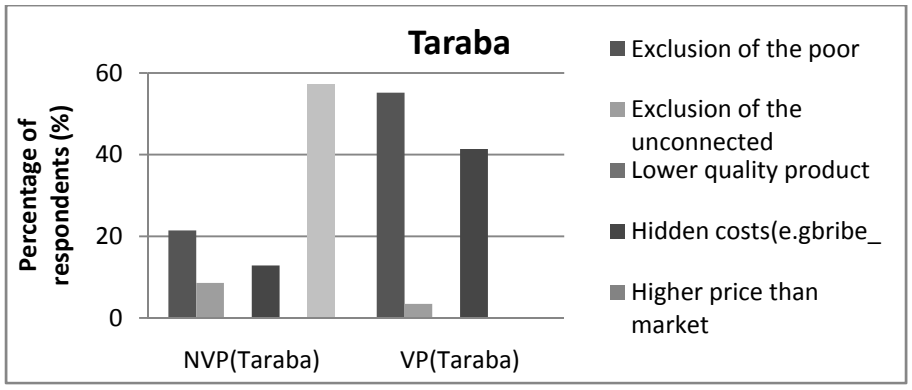
For respondents who indicated they would not participate in the future voucher program, the major reason in Kano was the fact that only those who were well connected were able to participate in the program. The ajority of these respondents were either not farmers or felt that the program was neither fair nor well organized.

In Taraba, financial limitations as well as the prevalence of other hidden costs like bribes tended to be the more prevalent reasons provided. The “other” category was the most prevalent reason for not intending to participate, particularly among non-participants in Taraba. This high number is driven by large number of respondents who are not farmers. Other important reasons cited were the respondents’ opinion that participation would be a waste of time and the desire not to be deceived by the promises of such programs.

Figure 7: Reasons for not intending to participate in voucher program



Source: Generated by authors with data from the fertilizer voucher program evaluation survey
Note: NVP means non voucher program participants and VP means voucher program participants
N= 231



Source: Generated by authors with data from the fertilizer voucher program evaluation survey
Note: NVP means non voucher program participants and VP means voucher program participants
N=99

Conclusions

This study analyzed an input voucher program in Kano and Taraba in 2009. In Kano, wealth and education were distinguishing factors associated with participation. This indicates that the poorest and most uneducated farmers might have been excluded either due to cumbersome program requirements or limited resources. While wealth did not distinguish participants from nonparticipants in Taraba, the characteristics of program participants indicates that less educated were somewhat excluded from the program. Program participants in both Kano and Taraba were more likely to have previously had access to subsidized fertilizer. However, participating in the program significantly increased the likelihood of receiving fertilizer, even after controlling for previous access to subsidized fertilizer. Furthermore, program participation increased the quantity of subsidized fertilizer received compared to non-participants. Program participants paid higher prices for subsidized fertilizer received through the program compared to their counterparts who received subsidized fertilizer from other sources outside the program. However, they paid significantly lower prices compared to those who purchased directly from the market.

On average, participating in the voucher program did not improve the timeliness of fertilizer receipt; rather where significant, it increased the likelihood that the product was received late. Timeliness of fertilizer availability appears to be beyond farmer control. What determines the timeliness of fertilizer availability are state and local government policies and infrastructure. This implies that the efficiency of programs like the voucher program may be improved by interventions to ensure that the products are purchased in a timely manner (largely imported) and efficiently distributed to states and local governments. Similarly, participating in the voucher program did not provide farmers with better quality fertilizer; again where significant, program participants were more likely to complain about fertilizer quality problems than non-participants.

Overall, there was a positive attitude of respondents toward the program. Though respondents opined that the implementation process could be improved to ensure better targeting with wider participation, they considered the program to be a useful avenue to increase farmer access to affordable fertilizer. The majority of the issues that participants had about the program in both states were the complicated and burdensome participation process as well as its exclusion of the poor and unconnected.

References

Ayoola, G B, V. O. Chude and A. A. Abdulsalaam (2002).Toward a Fertilizer Regulatory Policy For Nigeria: An Inventorization Of The Fertilizer Sector

Banful, A. B, and O. Olayide. 2010. Perspectives of varied stakeholders in Nigeria on the federal and state fertilizer subsidy programs. NSSP.

Chude, V. 2006. Fertilizer situation in Nigeria. Paper presented by Alhaji Bello Sule, Director Fertilizer Department, to the Program Advisory Committee on Agriculture and Food Security on 6 September, 2006. Abuja, Nigeria

Gregory, I. (2006). The Role of Input Vouchers in Pro-Poor Growth. Selected Sections from a Background Paper Prepared for the African Fertilizer Summit June 9-13, 2006 Abuja, Nigeria.

IFDC 2010. Project Implementation Manual (PIM) For 2009 Fertilizer Voucher Programme in Kano and Taraba States

IFPRI, 2008. A Policy Analysis Matrix (PAM) for Rice, Maize and Cassava Production System in Nigeria- a Supplemental Survey Dataset

KNARDA monitoring and evaluation department, 2010

Longley, C., R. Kachule, M. Madola, I. Maposse, B. Araujo, T. Kalinda and H. Sikwibele. 2003. Agricultural Input vouchers: Synthesis of Research Findings from Malawi. Mozambique and Zambia, FANRPAN.

Magnani Robert, 1997. Sampling Guide. Food and Nutrition Technical Assistance (FANTA) publication, December 1997.

Maiangwa, M.G, Ogungbile, , A.O., Olukosi, J.O. and Atala, T.K(2007). Adoption of Chemical Fertilizer for Land Management in the North-West Zone of Nigeria Tropical Agricultural Research and Extension, Vol 10 (2007)

Minot, N. and T. Benson. 2009. Fertilizer Subsidies in Africa – Are Vouchers the Answers? IFPRI Policy Brief Issue 60.

Nagy, J. G. and O. Edun. 2002. Assessment of Nigerian government of policy and suggested alternative market friendly policies. Confidential draft, September 26, 2002. International Fertilizer Development Center. http://www.usaid.gov/ng/downloads/reforms/assessmentoffertilizerpolicy.pdf. Accessed May 10, 2010

NBS (National Bureau of Statistics). 2008. Social statistics in Nigeria, 2005. Abuja, Nigeria.

Wooldridge, J.M., 2002 . Econometric analysis of cross section and panel data. Cambridge: MIT Press

Appendix 1

A.1.Sample selection

The domain for this analysis is smallholders in Kano and Taraba States; the subpopulations for which we want survey estimates of the outcome of participation in the voucher program. We randomly selected 10 local government areas each in both states. To ensure a level of generalization, we confirmed that the 10 LGAs selected represented potential LGA variation such as proximity to state capitals (Kano city and Jalingo), population and accessibility in terms of road availability and quality as can be seen in figures 1 and 2.

Our **measurement** units are the households and household members surveyed in both states. The key variables of interest that were used to determine the minimum sample size necessary for our analysis are quantity of subsidized fertilizer used as well as price of fertilizer purchased. We used the formula given in the sampling guide provided by the Food and Nutrition Technical Assistance (FANTA) for calculating the minimum necessary sample size. Our calculations were done to ensure with 95% confidence that estimated differences between program participants and non-participants (or participants over time) are not purely by chance and to have 80% confidence that an actual change or difference will be detected (power of the test) (Magnani, 1997).

Data on fertilizer consumption by states was not readily available. Thus our minimum sample size requirements were estimated using approximations from available data as follows: For quantity of fertilizer used, Banful et al, 2009 reveal that the average quantity of fertilizer that farmers in Kano and Taraba states would possess if subsidized fertilizer were equally distributed across households would be 97kg and 117kg respectively. However, Nagy and Edun (2002) estimate that only about 30 percent of subsidized fertilizer reaches small farmers at the subsidized price. Thus we can estimate that farmers in Kano and Taraba on average receive about 29.1kg and 35.1kg each of subsidized fertilizer through the traditional distribution mechanism. The goal of the voucher program was to increase the quantity of subsidized fertilizers farmers received through the use of vouchers rather than the previous government controlled distribution mechanism. Participating farmers in Kano and Taraba should have received 3 bags (150kg) and 4 bags (200kg) respectively. Using these figures, we can estimate that the sample size needed to identify the changes due to the program required samples of between 30 and 35 households on the quantity of subsidized fertilizer used in each state using the following FANTA formula:

$$n = D\left[\left(Z_\alpha + Z_\beta\right)^2 * (sd_1^2 + sd_2^2)/(X_2 - X_1)^2\right]$$

Where:

n = required minimum sample size per survey round or comparison group

D = design effect for cluster surveys indicating the factor by which the sample size for acluster sample would have to be increased in order to produce survey estimates with the sameprecision as a simple random sample (We use the default value of 2 as suggested by Magnani, 1997.

X_1 = the estimated level of fertilizer a household has access to prior to the program

X_2 = the expected level of subsidized fertilizers households have access to after participation[18]
sd_1 and sd_2 = expected standard deviations for the indicators for the comparison groups being compared

Zα = the z-score corresponding to the degree of confidence with which it is desired to be able to conclude that an observed change of size (X2 – X1) would not have occurred by chance (statistical significance), and

Zβ = the z-score corresponding to the degree of confidence with which it is desired to be certain of detecting a change of size (X2 – X1) if one actually occurred (statistical power).

NOTE: For the standard deviation, we used estimates on the ratio of mean to standard deviation of fertilizer use from a subsample of largely cereal producing households in another northern state, Kaduna in 2008 (IFPRI, 2008). The mean to standard deviation ratio was 1.07. This ratio was applied to our mean quantity of subsidized fertilizer before and after the voucher program to get the associated standard deviations. Even if there was no diversion of subsidized fertilizer in both states, applying the same formula indicates that we need between 170 and 250 respondents in Taraba and Kano respectively.

For further confirmation, the minimum sample calculation was also conducted using secondary data from other studies. A 2007 study cites 41kg/ha as the average fertilizer used for Kano state (Maiangwa et al, 2007). With average land size in Kano of about 1.9 ha (KNARDA monitoring and evaluation department, 2010), this amounts to about 78kg per household. Using the same standard deviation as above, we estimated the new minimum size necessary to satisfactorily capture a change in quantity of fertilizer used from 78 kg per household to about 150 kg (the three subsidized bags to be available through the program). It is estimated that a sample size of 118 is necessary.

For price of fertilizer, we used the August 2009 price of Urea (as that was the date at which between 80% and 90% of the vouchers had been distributed in Taraba and Kano respectively). The price of Urea at Dawanau market in Kano was about N3200 per 50 kg bag (N64/kg)[19]. The vouchers were individually worth a total value of N 2,000/50 kg bag. Thus, the benefit of receiving the voucher should translate to a N2000 difference in the price of Urea. Using this in the above formula to calculate the minimum sample size with standard deviation calculated again using the ratio of the mean to standard deviation of prices paid by farmers in Kaduna, we estimate that the minimum sample size would be about 80 households in Kano. Recognizing that farmers in more remote rural areas are likely to pay higher prices for their fertilizer, we simulated the price estimates and found that even if Urea prices were 50% higher in the rural areas (N4500 per bag), the minimum sample size would be about 210 [20].

Solely based on population, our sample should be composed of 80% of households in Kano and 20% in Taraba. However, to ensure adequate number of full respondents per state, the population difference of our 1000 households between the two states is reflected by a 640/360

[18] Thus the quantity (X2 - X1) is the size of the magnitude of change or program effect
[19] This data was collected from the Nigeria Agri Market Information Service (NAMIS) price bulletin.
[20] Data on urea prices in Taraba were not available from the NAMIS but the estimation of minimum sample size conducted with the price in the neighboring state, Adamawa at N73/Kg at Jimeta yielded about 110 as a minimum sample size which is less than our conservative estimate with higher farm gate prices for fertilizer. Calculations were also done with NPK and due to the larger difference between the mean and standard deviation of NPK prices; the required sample size was consistently smaller than that required for Urea. Thus we proceeded with the more demanding requirement.

split which reflects the state proportions within the total voucher program target group and is greater than the minimum desired sample size based on the most demanding sample size requirements based on earlier discussed calculations. Consequently, we surveyed 1000 households; 640 in Kano and 360 in Taraba and the respondents are largely household heads, their spouses, other adult household members and for a few questions, children and youth in the household.

Determinants of Participation in the Voucher Program

There are numerous factors likely to have affected the participation of farmers in the voucher program. For example, farmers who use improved seeds which are more responsive to fertilizer use and also require additional input cost investment (making complementary inputs likely to increase returns attractive) may be more likely to be interested in obtaining fertilizer. Poor farmers who are cash constrained but interested in using fertilizer may be more willing to participate in a voucher program despite the cumbersome process involved. In some cases, non-poor and better connected farmers might be able to meet the program requirements or have privileged access to participation. Using a linear probability model, we explore the relationship between various factors and a respondent's participation in the voucher program. We estimate the following:

$$Y = \alpha + \beta_1 Z + \beta_2 LGA + \varepsilon_i \qquad \text{Equation A.1}$$

where Y is a dummy variable indicating whether the respondent participated in the voucher program or not and Z is a vector of controls to capture factors we consider likely to affect the demand for or access to participating in the voucher program. Z includes household demographic variables like education and age of the household head; respondent membership in farm and community groups, leadership in the local community and relation to the household head. It also includes proxies for wealth like land, livestock and non-livestock assets. LGA dummy variables were used to capture location or culture specific effects. This is an exploratory regression model to determine if certain factors are correlated with program participation and to determine the direction in which each factor influences participation.

The results of equation A.1 are shown in Table A1.

We found that participants in the voucher program in Kano were largely farmers who had used subsidized fertilizer in the past, respondents who were in farmer groups that purchased fertilizer together in 2009 and belonged to households with larger livestock holdings. Male respondents, those practicing irrigation and respondents who were not farmers and members of ROSCAs tended to be less likely to participate in the voucher program in this state. This indicates that the participants in Kano were more likely to be farmers as was intentioned by the program. The fact that they are more likely to be female may reflect the fact that many households were polygamous with several spouses. Eighty-eight percent of spouses whose husbands participated in the program also participated. The limited participation by membership in a rotating savings and credit association might reflect the fact that individuals who join such groups might be more involved in small scale non farming activities such as petty trading and thus really may not be farmers and interested in the voucher program. If membership in ROSCAs is an indication of social capital, this result might be reflecting that such farmers are either too time constrained to meet the program requirements or have alternative guaranteed sources of subsidized fertilizer and thus are less interested in the program[21]. It appears limited

[21] We do not find evidence of more involvement of respondents who are not farmers in ROSCAs thus the second explanation might be more probable.

funds for investment might render irrigation and fertilizer as substitutes for credit constrained farmers. Alternatively, if wealthier and busier farmers tend to practice irrigation, then they may be less willing to fulfill the cumbersome requirements of the voucher program. For Taraba, we find that current participants were also more formally educated and more likely to have received subsidized fertilizer in the past. The LGA dummies were largely significant in both states indicating that the likelihood of respondents participating in the voucher program depended on the local government they resided in.

Table A1: Determinants of participation in the voucher program

Respondent participated in the 2009 fertilizer voucher program (1/0)	**Kano**	**Taraba**
Ever participated in a training organized by an extension agent or other organization (1/0)	0.001	-0.023
	(0.041)	(0.067)
Membership in a rotating savings and credit (1/0)	-0.124**	0.005
	(0.060)	(0.057)
Membership in at least one farm group (1/0)		0.509*
		(0.270)
Received subsidized fertilizer in the past (1/0)	0.100*	0.456***
	(0.054)	(0.093)
Used irrigation in 2009 (1/0)	-0.115*	-0.046
	(0.066)	(0.100)
Used improved seed in 2009 (1/0)	0.077	0.018
	(0.055)	(0.069)
Member of a group that purchased fertilizer together in 2009 (1/0)	0.477***	0.188*
	(0.064)	(0.098)
Age of household head (years)	0.001	0.003
	(0.002)	(0.003)
Male respondent (1/0)	-0.103*	-0.183**
	(0.054)	(0.090)
Household head has been formally educated (1/0)	0.078**	0.108*
	(0.038)	(0.062)
Land Area in 2009 (hectares)	0.002	0.012
	(0.002)	(0.009)
Farming is not the respondents primary occupation (1/0)	-0.086**	0.062
	(0.044)	(0.048)
Respondent is closely associated to the president of their farm group (1/0)	0.027	0.058
	(0.049)	(0.070)
Respondent holds a position in their village (1/0)	0.033	0.063
	(0.049)	(0.069)
Household asset index	0.001	0.035
	(0.017)	(0.033)
Household total livestock units	0.002**	0.010
	(0.001)	(0.008)
Respondent owns land (1/0)	0.019	-0.020
	(0.066)	(0.057)
Respondent is the household head (1/0)	-0.018	-0.027
	(0.058)	(0.110)
Respondent is the household head's spouse (1/0)	-0.036	-0.148
	(0.054)	(0.100)
Constant	-0.379**	-0.752*
	(0.155)	(0.393)
LGA dummies	YES	YES
Number of observations	1051	357
Pseudo R-squared	0.407	0.464

Note: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are shown in parentheses. Each regression includes a full set of local government area dummies to capture location specific effects. 1/0 refers to dummy variables with 1 for affirmative responses and zero, otherwise.

Table A.2: Distribution of respondents by Local Government Area

Local Government Area (LGA)	KANO	TARABA
Bagwai (1/0)	0.055	-
Takai (1/0)	0.040	-
Dambatta (1/0)	0.094	-
Dala (1/0)	0.053	-
Karaye (1/0)	0.092	-
Ungoggo (1/0)	0.146	-
Gezawa (1/0)	0.224	-
Gabasawa (1/0)	0.001	-
Rano (1/0)	0.215	-
Kura (1/0)	0.079	-
Sardauna (1/0)	-	0.162
Gassol (1/0)	-	0.242
Ussa (1/0)	-	0.124
Kurmi (1/0)	-	0.015
Ardo Kola (1/0)	-	0.031
Jalingo (1/0)	-	0.053
Donga (1/0)	-	0.099
Karim Lamido (1/0)	-	0.145
Lau (1/0)	-	0.043
Yorro (1/0)	-	0.085

Source: Generated by authors with data from the fertilizer voucher program evaluation survey