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TARGETING OF SUBSIDIZED FERTILIZER UNDER KENYA'S NATIONAL ACCELERATED AGRICULTURAL INPUT ACCESS PROGRAM (NAAIAP)

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Megan Sheahan, John Olwande, Lilian Kirimi, and T.S. Jayne[1]

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Tegemeo Institute of Agricultural Policy and Development
P.O Box 20498, 00200, Nairobi, Kenya
Tel: +254 20 2717818/76; Fax: +254 20 2717819
E-mail: Egerton@tegemeo.org

[1] Sheahan is a Research Support Specialist at Cornell University. Olwande is a Research Fellow at Tegemeo Institute, Egerton University, and is currently a PhD student at Michigan State University. Kirimi is a Senior Research Fellow at Tegemeo Institute, Egerton University. Jayne is professor of International Development at Michigan State University.

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Kindaruma Lane, off Ngong Road
P.O. Box 20498, 00200, Nairobi, Kenya
Tel: +254 20 2717818/76; Fax: +254 20 2717819
E-mail: egerton@tegemeo.org
URL: http://www.tegemeo.org

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Abstract

A new wave of "market smart" modern input subsidy schemes has emerged in sub-Saharan Africa over the past decade with the promise of increasing input use and grain yields while building or complementing private sector efforts. We study the extent to which geographic and household level targeting under Kenya's National Accelerated Agricultural Input Access Program (NAAIAP) has remained true to its "market smart" objectives using household level panel data from before and during the initial years of program implementation (2007-2010). Using a sample of households that plausibly received the NAAIAP voucher, we find that the average socio-economic status of a division and the wealth level of individual households within those divisions are strong predictors of subsidy received, suggesting that "resource poor" farmers were targeted as suggested in the program guidelines. However, we find that a large portion of the targeted households used commercial fertilizer before the start of the program and often in high amounts, implying that vouchers were not necessarily distributed to households who lacked the financial capacity to purchase fertilizer on commercial terms.

***Key words**: fertilizer, subsidy, vouchers, market smart, targeting, Kenya*

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Acronyms

DFID	Department for International Development
FAO	Food and Agriculture Organization of the United Nations
MoA	Ministry of Agriculture
MSU	Michigan State University
NAAIAP	National Accelerated Agricultural Inputs Access Program
NCPB	National Cereals and Produce Board
SSA	Sub-Saharan Africa
USAID	United States Agency for International Development

1. Introduction

The past decade has been characterized by a renewed interest in subsidizing modern inputs for African smallholder farmers as a strategy for fostering a Green Revolution in the region (Denning *et al.* 2009). In response to goals proposed at the 2006 African Fertilizer Summit (African Union 2006), at least ten African countries introduced or revived programs that provide inorganic fertilizer and sometimes hybrid maize seeds to farmers at subsidized prices, often at a considerable fiscal burden for the governments (Jayne and Rashid 2013). Recalling criticism of universal subsidy programs from the pre-liberalization era, most of these programs have been designed to target a sub-set of households that meet certain pre-determined and country-specific criteria. Generally, the subsidies are intended to target resource-poor farmers who lack the capacity to purchase inputs at prevailing commercial prices. In some countries, targeting is done in two stages: (i) at some geographic-level, whereby the selection of districts and villages within districts is based on a range of considerations, including agro-ecological potential, crops grown, and overall poverty levels; and (ii) at the household-level in which beneficiaries within the village are selected by the community or community leaders (Pan and Christiaensen 2012). By targeting geographic areas where the agro-ecological potential is suitable for beneficial crop response to fertilizer application, the governments are helping to raise fertilizer use where it is likely to be profitable once farmers graduate from the subsidy program. Also by targeting farmers who do not already purchase commercial fertilizer, these programs would presumably not disrupt existing commercial fertilizer and seed demand. Furthermore, these targeted subsidies aim to directly improve the livelihoods of resource-poor households.

A precondition for achieving the goals of any subsidy program is proper targeting of geographic areas and beneficiaries. However, a growing body of evidence suggests that targeting in many of these programs, particularly at the household level, has been unsatisfactory despite rebranding subsidies as "market smart" (Ricker-Gilbert Jayne, Shively 2013). Mason and Ricker-Gilbert (2013) show that households with more land were more likely to receive fertilizer subsidies in Zambia and Malawi. Other evidence from Malawi shows that poorer and female-headed households were less likely to receive fertilizer subsidies compared to their richer and male-headed neighbors (Holden and Lunduka 2010). In Tanzania, Pan and Christiaensen (2012) studied the effects of the decentralized process of community-based selection of beneficiaries and found that local elites still captured a vast

majority of the benefits of the fertilizer subsidies. In Ghana, Banful (2011) showed that political characteristics were statistically significant determinants of the number of vouchers a district received, signaling an attempt of the incumbent national government to "buy votes" through the use of government subsidy transfers. Similarly, Mason, Jayne, and Myers (2012) estimated a reduced form model of fertilizer subsidy recipients in Zambia and also found that political variables at the constituency level were positive significant determinants of the amount of subsidized fertilizer acquired by individual households.

Despite a sizeable body of literature showing imperfect household-level targeting, some positive evidence has emerged. For example, Liverpool-Tasie, Banful, and Olaniyan (2010) assessed the pilot fertilizer subsidy program in two states in Nigeria and found that wealth was not a significant factor that determined the number of bags of subsidized fertilizer farmers received and, where there were any statistically significant differences, recipients were actually poorer in terms of assets. While targeting based on poverty was not the objective of the Nigeria program, the insignificance of wealth in the targeting process may reflect the fact that the set of farmers that received subsidized fertilizer included a good portion of the poor which reduces the likelihood of the subsidy program having a distortionary effect on the private market (Liverpool-Tasie 2014).

While studies on targeting exist in some SSA countries where fertilizer subsidies have resumed, there is limited evidence to date from countries where vouchers are the mode of targeting. Distribution of vouchers or coupons to recipients who can then redeem them for inputs at private accredited retail stores has been a central feature of "market smart" subsidy programs. One such program is the National Accelerated Agricultural Input Access Program (NAAIAP), introduced by the Government of Kenya in 2007 to raise the productivity of resource poor farmers. To our knowledge, the only empirical evaluations of the NAAIAP to date have been internal to the funding agencies (Ministry of Agriculture 2010, 2011), specific to the impact on and capacity of the agro-dealers (Odame and Muange 2010), or are restricted to qualitative analysis on a small sub-sample of beneficiaries (Kiratu, Ngigi, Mshenga 2014). Moreover, most of the aforementioned studies from other countries focus on household level targeting and do not necessarily consider the geographic level targeting decisions made when subsidy programs are not nation-wide.

This study fills these gaps by assessing overall program targeting, both at the geographic (division) and household levels, using four waves of nationwide panel household survey data collected between 2000 and 2010, which includes years before and during the program implementation period. While the NAAIAP is not as large as the subsidy programs in countries like Malawi and Zambia, Kenya provides a unique environment in which to study government fertilizer subsidies given the strong influence of the private sector and remarkable growth in commercial fertilizer use over the years (Ariga and Jayne 2009). Not only has the private sector been instrumental in bolstering the fertilizer supply chain, but recent evidence also shows that, on average, households are applying fertilizer in quantities that appear to approach optimal levels given the conditions on farmers' fields (Sheahan, Black, Jayne 2013). This study sheds light on how well the NAAIAP has reached its stated targeting goals and contributed to increased use of fertilizer.

2. The National Accelerated Agricultural Input Access Program (NAAIAP)

Following pledges made at the African Fertilizer Summit in 2006, a proposal was developed in 2006 by the Ministry of Agriculture in Kenya for a three-year KSH 36 billion ($525 million) input subsidy program aimed at reaching 2.5 million smallholder farmers (Government of Kenya 2006). The NAAIAP was envisioned to address the problem of food insecurity and poverty among resource poor farmers with the stated objectives of improving access to and the affordability of key inputs for smallholders with less than one hectare of land. Fertilizer and improved maize seed were to be provided in a Kilimo Plus "starter kit" through a voucher redeemable at accredited local stockists/agro-dealers with the intention of building the capacity of stockists and a better functioning fertilizer network concurrently. To that end, the Kilimo Plus program was also designed to support stockists through an accreditation process. Targeted farmers would receive the Kilimo Plus "starter kit" for two agricultural seasons before graduating to the Kilimo Biashara package where farmers would pay for inputs at the market price but receive subsidized credit from local financial institutions. It was envisioned that this two-step program would enable households to slowly build up their capacity to engage with the commercial fertilizer market and complementary financial services. Between the input subsidy and associated training provided by government extension services, the total cost per farmer of the originally proposed program was estimated at $211 (Government of Kenya 2006).

Donors, however, were not keen on supporting the efforts given perceptions that the program was too large, too expensive, and scaled up too quickly without the capacity necessary to do so. In the absence of donor support, the Government of Kenya was able to pay for only a portion of the first year (2007/08) of the program (KES 250 million, about $3 million), meaning that the originally intended project saw substantial downward revision (Ministry of Agriculture 2010). Even with donor financing support starting in the second implementation year and World Bank funding arriving in 2010/11 (Ministry of Agriculture 2011), the support provided to individual farmers was downscaled. In its current form, the NAAIAP provides beneficiaries with a one-time fully subsidized input package (50 kg bag of basal fertilizer, 50 kg bag of top dressing fertilizer, and 10 kg of improved maize seed), enough for one acre of maize, via input vouchers redeemable at local stockists participating in the program. By October 2011, the program had reached an estimated 615,000 against the originally targeted 2.5 million resource poor farmers (25 percent) across the country with a total budgetary

allocation estimated at KES 4,120 million (Ministry of Agriculture 2011), roughly $50 million.

Program districts were selected on the basis of (i) suitability for maize, sorghum, and/or millet production; (ii) the high incidence of poverty; and (iii) lack of similar programs. Within the chosen districts, the program used a participatory approach in the selection of beneficiary farmers, conducted through community committees composed of various stakeholders. These stakeholder forums form the basic implementation units of the program and were created to ensure fairness in the selection of beneficiaries and participating input dealers (Ministry of Agriculture 2011). NAAIAP documents from the initial years of the program state that preference should be given to (i) subsistence farmers without the capacity to purchase commercial inputs, (ii) farmers with small landholdings but a sufficient amount to produce maize; (iii) women and child headed households and other vulnerable members of the society; and (iv) those who had not received similar support in the past (Ministry of Agriculture 2008). Internal evaluation reports suggest that targeting at the community level had been hurried and perhaps compromised by the delayed receipt of instructions and quotas from higher levels of program implementation (Ministry of Agriculture 2011).

3. Data and Sample Considerations

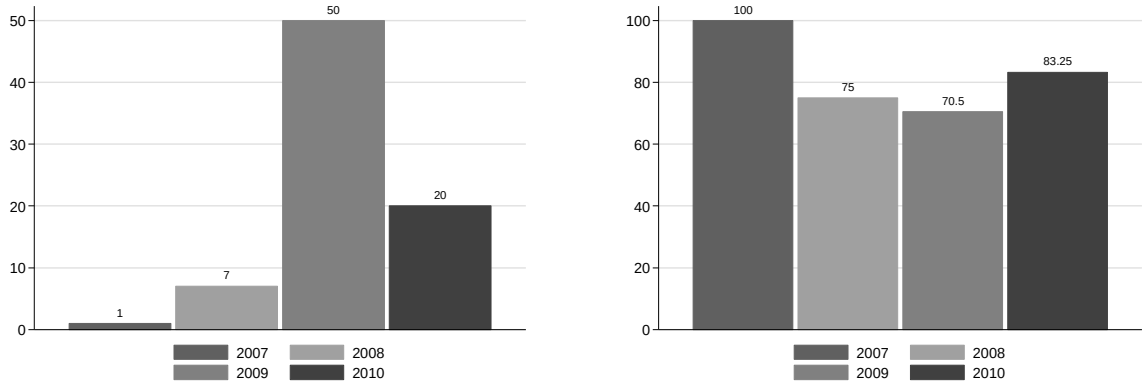
Data for this study comes from the Tegemeo Agricultural Policy Research and Analysis (TAPRA) project collected by Tegemeo Institute of Agricultural Policy and Development, Egerton University in collaboration with Michigan State University with support from the United States Agency for International Development (USAID). Rural household surveys were conducted across 24 administrative districts (as defined in 1997), 39 divisions, and 120 villages using structured questionnaires with a heavy emphasis on agricultural production (see Argwings-Kodhek *et al.* 1998 for details). The first round of data collection occurred in 1997 with follow up surveys of the same households in 2000, 2004, 2007, and 2010, a timespan covering thirteen years. Households were asked in 2010 about their participation in government fertilizer subsidy programs in any of the years since 2007, which allows us to define households as either NAAIAP recipients or non-recipients in the initial years of the program. We use the data spanning 2000-2007 to describe trends and patterns in selected observable attributes of these two groups prior to the start of the NAAIAP program. For econometric estimation, we use the cross section of data available in 2007, which acts as a suitable "pre-intervention" baseline to characterize the initial conditions of households before accruing any possible benefits under NAAIAP.

Between the years 2007-2010, the NAAIAP was not the only fertilizer subsidy program implemented by the government of Kenya. A separate fertilizer subsidy program existed where the government sold inorganic fertilizer to farmers through the National Cereals and Produce Board (NCPB) at prices lower than commercial ones.[2] In general, the NCPB program sought to temporarily alleviate the burden of high fertilizer prices in the post-2007 period for farmers that generally used and purchased fertilizer. As a result, the targeting criteria, objectives, and the package of fertilizer offered to farmers at subsidized prices were supposedly different from those under the NAAIAP. Despite these differences, enumerators implementing the 2010 survey reported that respondents often knew they received a government fertilizer subsidy but in some cases were unable to identify the exact program. Because we have reason to believe that some households may have misidentified the program providing fertilizer to them, we use additional reported information on (1) whether or not the subsidy received was full or partial and (2) the total kilograms of fertilizer provided under the program to help us identify and validate which households credibly received fertilizer under

[2] For details on this program, see Mather and Jayne (2011) and Peter and Rotich (2013).

NAAIAP. Specifically, householders were categorized as NAAIAP recipients if they received a full subsidy of 100 kilograms or less of fertilizer (the NAAIAP package included one 50 kilogram bag of basal and one 50 kilogram bag of top dressing fertilizer).[3]

Figure 1: Number of NAAIAP recipient households and average NAAIAP fertilizer subsidy received by year (as observed in 2010)



Notes: These figures were determined after cleaning the 2010 data per the discussion in Section 3. The sample size for the leftmost figure is 1,146. Quantities of subsidized fertilizer obtained by recipient households are included in the rightmost figure with the sample of 78 households.

The left side of Figure 1 shows the number of households in our cleaned data set that plausibly received the NAAIAP subsidy by program year. With such low number of observations, indicative of the downscaled program referred to in Section 2, we chose to study the overall targeting of the program over any of these observed four years. Furthermore, because of the nature of our cleaning, we observe very little variation in the total amount of fertilizer received (right side of Figure 1). Of the 78 households who received NAAIAP, 50 percent received 100 kilograms of subsidized fertilizer, 42 percent received 50 kilograms of subsidized fertilizer, and the remaining 8 percent (equivalent to 6 households) received some other value (25, 40, or 75 kilograms). We, therefore, restrict our analysis to the binary targeting decision.

[3] Through this cleaning process, 61 respondents who claimed to receive NAAIAP are verified as credible recipients, 24 respondents who claimed to receive NAAIAP are reclassified as NCPB recipients (and non-NAAIAP recipients), and 17 households who claimed to receive the NCBP subsidy are reclassified as NAAIAP recipients. The 1,044 households who said they did not receive a government subsidy remain classified as non-NAAIAP recipients.

Table 1: Number of divisions and households that received NAAIAP subsidies in any year between 2007 and 2010

	Division-level			Household-level		
District	**Non-Recipient**	**Recipient**	**Total**	**Non-Recipient**	**Recipient**	**Total**
Kilifi	1	0	1	50	0	50
Kwale	2	0	2	24	0	24
Taita Taveta	1	0	1	9	0	9
Kitui	1	0	1	15	0	15
Machakos	1	0	1	20	0	20
Makueni	0	1	1	37	33	70
Meru	1	0	1	79	0	79
Mwingi	1	0	1	27	0	27
Kisii	0	1	1	76	1	77
Kisumu	3	0	3	86	0	86
Bungoma	1	2	3	70	5	75
Kakamega	1	2	3	121	2	123
Vihiga	1	0	1	51	0	51
Muranga	0	3	3	58	8	66
Nyeri	1	1	2	83	13	96
Bomet	1	0	1	34	0	34
Nakuru	2	1	3	84	2	86
Narok	1	0	1	21	0	21
Trans Nzoia	1	1	2	44	6	50
Uasin Gishu	0	2	2	79	8	87
Total	**20**	**14**	**34**	**1,068**	**78**	**1,146**

Note: The districts are as defined in 1997. The numbers were compiled after cleaning the 2010 data per the discussion in the text. While included in the survey sample, Laikipia and Siaya districts are excluded from this table and our analysis because they were not included in the NAAIAP in any year in the period 2007-2010, as per government documents. We observe NAAIAP recipients at the household level. The division level columns show the number of divisions within districts where we observe in our sample at least one household receiving NAAIAP.

Table 1 shows the distribution of divisions and households where we observe NAAIAP recipients across all districts in our sample. Using district-level information from the Ministry of Agriculture in Kenya, the only districts in our dataset which were not targeted by NAAIAP in one of these four years were Siaya and Laikipia, which we drop from our analysis. Out of our truncated sample, 78 of 1,146 households received NAAIAP in any year between the 2007 and 2010 cropping years. Moreover, because we are also interested in geographic targeting, we include the number of divisions within districts where we observe at least one household receiving NAAIAP in our data. We choose the division, one geographic level smaller than the district, as our geographic level of analysis because the district-level provides too few degrees of freedom and limited variation. Of the 34 divisions in the 20 districts included in our sample, 14 have at least one NAAIAP recipient household during the requisite timeframe.

4. Hypothesis and Methodology

The first hypothesis we are interested to test is whether the NAAIAP program was truly implemented as a "market smart" subsidy. As described by Morris *et al.* (2007), smart subsidy programs should not undermine the private sector and related commercial demand. If NAAIAP was designed and implemented to complement and bolster private sector investment, then we would not observe households receiving the subsidy who have purchased reasonably high levels of commercial fertilizer in the past. Because we observe household input decisions before the start of the NAAIAP, we can test whether the program remained true to this targeting criterion. Evidence from the combined NAAIAP and the simultaneously occurring NCPB subsidy program in Kenya shows massive amounts of "crowding out" of commercial fertilizer purchases (Jayne *et al*. 2013), which suggests that targeting based on past fertilizer purchase decisions and abilities may have been sub-optimal.

While we would not expect that NAAIAP recipients frequently purchased commercial fertilizer in the past, we would expect there to be a functioning fertilizer market nearby since the program operates through vouchers redeemable from private and accredited agro-dealers. In Kenya, the private agro-dealer shops tend to be established in major rural market centers and areas easily accessible from major urban markets. The agro-dealer network also tends to be dense in areas with high demand for farm inputs like fertilizer. Therefore, because of both program design and as a proxy for where fertilizer markets already exist, we expect that a household's proximity to fertilizer agro-dealers and roads would raise the chance of the household being targeted. Also, we expect that a household in a village where commercial fertilizer use was more widespread before the start of the program would have a higher chance of being targeted because high incidence of commercial fertilizer use by others signals perceived profitability and accessibility by neighboring farming households.

Secondly, because the program was designed to specifically target "resource poor" farmers, we expect that less wealthy households in our sample were more likely to be NAAIAP recipients. Moreover, we expect land size to be a factor, as one of the selection rules was that a household has access to one acre (0.4 hectares) of land to dedicate to maize production. We, therefore, expect that households with extremely small farms were less likely to be targeted, since they would not meet the criteria. At the same time, we expect that those households with relatively large farms were not targeted since landholdings are often an indicator of

wealth. Women farmers were explicitly identified as intended beneficiaries in program descriptions, so we hypothesize that female-headed households are more likely to receive NAAIAP vouchers. Other socio-economic household characteristics such as education of head, household size, and death (a shock) in a household are expected to be factors in explaining targeting.

We test these hypotheses through both descriptive and regression analysis methods. While descriptive statistics provides a useful picture, regression analysis allows us to uncover relationships between characteristics of households and geographic areas and their inclusion in the program while holding all other observed characteristics constant. The most appropriate econometric model for this analysis entails specifying a binary dependent variable, which takes a value of one if a household or geographic area received NAAIAP and zero otherwise. There are a range of models that can be employed to study binary dependent variables, among them the linear probability model (LPM), probit model, and logit model. Given the shortcomings of the LPM model (Wooldridge 2009), we estimate non-linear probit models of the following form:

$$P(y = 1|x) = G(\beta_0 + \beta_i x_i)$$

where P is the probability of receiving the NAAIAP subsidy, which is dependent on a full set of explanatory variables x_i. In order for the predicted probability to fall between zero and one, the function G assumes a standard normal distribution. Probit models are estimated using maximum likelihood estimation (MLE). Given the non-linearity of probit models, we transform the coefficients into their linear equivalents using partial effects for easier interpretation.

5. Division Level Targeting Analysis

This section explores the geographic targeting of the subsidy program, where the unit of analysis is the division. Of the 34 divisions included in our data set, we observe 14 where at least one household received a NAAIAP subsidy (see Table 1). Our aim is to identify the factors correlated with NAAIAP distribution in a given division.

Table 2: Mean, standard deviation, and t-test results of variables in division-level targeting model

	Division without NAAIAP recipients (n=20)	Divisions with NAAIAP recipients (n=14)	significance
Median total household asset wealth (1000 KSH)	172 (117)	154 (63)	
Median household net income (1000 KSH)	132 (56)	137 (51)	
Percent of people in division who claim to be "worse off" than others (0-1)	0.12 (0.08)	0.11 (0.07)	
Median household land ownership (hectares)	2.2 (1.8)	1.4 (0.6)	*
Median household adult equivalents	5.4 (1.9)	4.8 (1.0)	
Median education level of household head (years)	5.9 (2.3)	7.1 (1.1)	**
Percent of households headed by female (0-1)	0.27 (0.15)	0.21 (0.08)	
Percent of households with mortality between 2004-2007	0.08 (0.05)	0.06 (0.04)	
Median distance to the nearest fertilizer dealer (km)	5.7 (8.5)	2.0 (1.7)	*
Median distance to the nearest tarmac road (km)	12.5 (13.1)	4.7 (4.1)	**
Percent of hhs in village using fertilizer in 2007 (0-1)	0.54 (0.43)	0.96 (0.06)	***

Note: NAAIAP subsidy recipients observed in the 2010 data. All other "baseline" variables observed in the 2007 data. The "significance" column refers to the results of t-tests used to determine statistically significant differences between recipient and non-recipient divisions. *** $p<0.01$ ($t>2.750$), ** $p<0.05$ ($t>2.042$), * $p<0.1$ ($t>1.697$).

Using our household level data, we create division-level median values for important observable characteristics of households and their operating environment that we expect influenced targeting. Table 2 includes summary statistics for these variables, split by whether or not the division had a NAAIAP-receiving household. T-tests are performed to determine where the means are significantly different. From this, we find that divisions with NAAIAP recipients had more educated household heads, smaller farms, were more accessible to tarmac roads and fertilizer dealers, and resided in villages where a larger percent of the population purchased commercial fertilizer in 2007.

Table 3: Marginal effects estimation results for NAAIAP fertilizer subsidy program geographical (division-level) targeting

Dependent variable = 1 if division had at least one NAAIAP recipient between 2007 and 2010; 0 otherwise	(1)	(2)	(3)
Median total household asset wealth (KSH 1000)	-0.00321**		
	(0.00136)		
Median household net income (KSH 1000)		-0.00356*	
		(0.00206)	
Portion of households that consider themselves "worse off"			0.521
			(1.059)
Median household land holdings (hectares)	0.127	0.00238	-0.0743
	(0.109)	(0.0664)	(0.0591)
Median household size (adult equivalents)	-0.0497	-0.0105	0.0153
	(0.0656)	(0.0549)	(0.0539)
Median education level of household head (years)	0.0202	0.0620	0.0237
	(0.0471)	(0.0506)	(0.0527)
Portion of households with female heads	-1.490*	-1.890*	-0.859
	(0.864)	(1.032)	(0.981)
Portion of households with mortality between 2004-07	-0.653	-1.424	0.493
	(2.094)	(1.902)	(2.221)
Portion of households using commercial fertilizer in 2007	0.983*	0.384	0.675
	(0.520)	(0.506)	(0.537)
Median distance to nearest fertilizer dealer (km)	-0.0560	-0.0151	-0.0174
	(0.0482)	(0.0432)	(0.0465)
Median distance to nearest tarmac road (km)	-0.0432**	-0.0273*	-0.0288*
	(0.0168)	(0.0143)	(0.0175)
No. of divisions	34	34	34

Note: Marginal effects are from a probit model. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

After estimating a probit model with the same set of correlates, we present the marginal effect estimates of factors expected to be associated with division level targeting in Table 3 under three different specifications with varying welfare measures (i.e., asset wealth, net income, and subjective welfare). All else equal, an increase in median household asset value and net income at the division level reduced the probability that a division was targeted by about 0.3 percent, suggesting that geographical targeting of the subsidy considered relative poverty trends. The included subjective welfare measure, where households reported whether or not they were "worse off" than their neighbors, did not produce the same effects. Increased proportions of women headed households in a division reduced the likelihood of the division being targeted in two of the three specifications, implying that areas with more women headed households were not more likely to be targeted. Other household socio-economic variables were not significant in the division targeting model.

Proximity to a tarmac road, perhaps a proxy for the density of road networks and connectivity in a division, increased the likelihood that a division would receive NAAIAP across all model

specifications. This suggests that the subsidy was targeted to geographical areas with better access to markets and perhaps more accessible to those individuals implementing the program. Further, more widespread use of fertilizer in a division raised its probability of being targeted in only one model specification, a weak indication that targeting favored areas where fertilizer use was less risky and possibly had higher returns. It also suggests that the subsidy was targeted to areas where awareness of fertilizer use among smallholders was relatively higher.

Given a growing body of literature showing potential political motivations behind subsidy targeting in other countries (e.g., Banful 2011; Lunduka, Ricker-Gilbert, Fisher 2013; Mason, Jayne, van de Walle 2013), we would ideally include a range of voting variables from the 2007 general elections that help us to test these same claims in the Kenyan context. The Kenyan election of 2007, however, was disputed, resulting in widespread violence, and official figures on disaggregated voting trends are not trusted. Furthermore, even when incorporating a set of potentially faulty voting variables into the model, we find virtually no relationship between NAAIAP targeting and 2007 election outcomes.[4] Beyond quantitative findings, anecdotal evidence from those familiar with the program suggests that if NAAIAP targeting were to have political undertones, then it would be more likely at the local level.

[4] We obtained data at the constituency level voting patterns for the 2007 presidential election from the Electoral Commission of Kenya. Bearing in mind the contested nature of the election casts doubt on the credibility of the included election results, we ran seven different models with permutations of three constructed voting variables—(i) the portion of households who voted for the winning presidential candidate, (ii) a dummy variable for whether or not the majority of households voted for the winning presidential candidate, and (iii) if somewhere between 30 and 70 percent of votes voted for the winning presidential candidate—and found only one model where a voting variable was significant at the 10 percent level. For more details, consult the authors.

6. Household Level Targeting Analysis

Our next aim is to understand how the NAAIAP targeted households within recipient divisions. Using panel data with a relatively long time horizon, we are able to trace the history of household commercial fertilizer use. Fertilizer purchase behavior of NAAIAP recipients and non-recipients between 2000 and 2007 (before NAAIAP) is highlighted in Tables 4 and 5. Table 4 shows that over 90 percent of NAAIAP recipient households purchased commercial fertilizer in any survey year prior to the start of the program, as compared to about 70 percent of non-recipients. This suggests poor targeting by the program since participant households were engaging in the commercial fertilizer market without assistance from the NAAIAP or other government program. However, we note that NAAIAP is ostensibly a program aimed at distributing fertilizer for application on maize and, later, other staple crops. It may be the case that these households were principally applying this fertilizer to cash or other non-staple crops.

Table 4: Percent of households that used commercial fertilizer and median amount applied across cultivated land (2000, 2004, 2007)

		2000	2004	2007
% of hh that used commercial fertilizer	Non-NAAIAP	73	75	78
	NAAIAP	97	91	96
Median total application (kg)	Non-NAAIAP	130	125	128
	NAAIAP	100	95	100
Median application rate (kg/ha)	Non-NAAIAP	99	90	99
	NAAIAP	91	79	75

Notes: Median application amounts are unconditional (include zeros).

Table 5 further illuminates temporal variation in commercial fertilizer purchases across survey years. If it was the case that a household only was able to purchase fertilizer in one survey year but not others given prohibitively high prices relative to household wealth or negative household shocks, then we might observe that inconsistent purchasers of fertilizer were more likely to receive NAAIAP. However, we find the opposite. Over 85 percent of NAAIAP recipients in our data consistently purchased fertilizer in 2000, 2004, and 2007. Only one percent of NAAIAP recipients did not purchase fertilizer in any one of the survey years before the program began. These results suggest that NAAIAP recipients were already and consistently purchasing fertilizer, meaning they likely had the means to support their own fertilizer consumption without the subsidy.

Table 5: Percent of households by commercial fertilizer use history prior to NAAIAP (2000, 2004, 2007)

	Non-NAAIAP	NAAIAP	Overall
Consistent users	66	86	68
Never users	16	1	15
Inconsistent users	17	13	17

Note: "Consistent users" are households that used fertilizer in all three survey years (2000, 2004, and 2007); "Never users" are households that did not use fertilizer in any of the three survey years; and "Inconsistent users" are households that used fertilizer in at least one but not all of three survey years.

Given a fairly low percentage of households receiving NAAIAP, we use two different samples for the remainder of our household-level analysis. In the first, we include all households in the districts covered by our sample where the Ministry of Agriculture (MoA) supposedly targeted NAAIAP as described in Table 1. In the second, we limit our sample to divisions where we find at least one NAAIAP-recipient household in our sample. The idea behind creating this sub-sample is that NAAIAP was likely not operating throughout entire districts, especially in early years of implementation, but only targeted areas within those districts. Without information on the targeting decisions by the MoA below the district level, we can use the incidence of NAAIAP household observations to more reliably focus on areas within districts where NAAIAP was present. Because we only find 14 divisions with NAAIAP households out of the total 34, this second method reduces the sample size to 538 households in the sub-sample analysis (including 460 non-NAAIAP recipients).

In Table 6, we stratify the sample into three groups (recipients, non-recipients across all NAAIAP districts, and non-recipients in the same divisions where NAAIAP recipients are observed) based on the two samples in order to investigate differences in their observed characteristics prior to the start of NAAIAP implementation and subsidy receipt. Using the full sample across all districts where NAAIAP was implemented, NAAIAP recipients were more likely to have less land, have more educated adult household members, be located closer to fertilizer markets and tarmac roads, and were much more likely to have purchased commercial fertilizer consistently in the past. NAAIAP recipients are also statistically significantly more likely to have purchased commercial fertilizer in previous survey years. Results are slightly different when restricting our sample to only those divisions where we observe at least one NAAIAP recipient household. In this second sample, NAAIAP recipients were found in villages with lower percentages of households using commercial fertilizer in previous years. Moreover, recipients tended to run out of own grain production earlier than non-recipients in the same divisions, an indicator of lower welfare status.

Table 6: Differences in means of key variables among NAAIAP and non-NAAIAP recipients

Variable	Details	NAAIAP recipients (n=78)	Non-NAAIAP recipients			
			In districts where NAAIAP was implemented (n=1,068)	sig	In divisions with at least one NAAIAP recipient (n=460)	sig
Assets	Self-reported value of household assets (KSH 1000)	273 (572)	290 (447)		273 (572)	
Income	Self-reported net income from all sources (KSH 1000)	189 (202)	190 (197)		184 (171)	
Subjective welfare	1=respondent claims that household is worse off than surrounding neighbors; 0=otherwise	0.09 (0.29)	0.13 (0.33)		0.13 (0.33)	
Land	Household land holdings (hectares)	1.7 (1.7)	2.5 (3.8)	***	2.3 (3.6)	**
Adult equivalents	Number of household members in adult equivalents	5.1 (2.4)	5.1 (2.6)		5.1 (2.4)	
Dependency ratio	Household dependency ratio	0.85 (0.79)	0.75 (0.73)		0.72 (0.72)	
Education of adults in household	Average years of schooling of adults in household	7.7 (2.4)	7.2 (3.0)	*	7.6 (7.3)	
Education of household head	Education of household head (years)	6.8 (3.9)	6.3 (4.5)		6.8 (4.4)	
Marital status of household head	1=married, 0=otherwise	0.74 (0.44)	0.74 (0.44)		0.77 (0.42)	
Gender of household head	1=female, 0=otherwise	0.23 (0.42)	0.23 (0.42)		0.19 (0.40)	
Mortality	1= Mortality in household between 2004-2007, 0=otherwise	0.08 (0.27)	0.06 (0.24)		0.05 (0.21)	
Fertilizer market	Distance to nearest fertilizer dealer (km)	2.1 (1.6)	3.5 (5.0)	***	2.4 (2.5)	
Tarmac road	Distance to nearest tarmac road (km)	5.4 (3.4)	7.4 (7.2)	***	6.4 (5.8)	**
Village fertilizer use	Proportion of households in village that purchased fertilizer in 2007 (0-1)	0.92 (0.10)	0.78 (0.32)	***	0.95 (0.08)	**
Binary household fertilizer use	1=household did not use fertilizer in 2000, 2004, or 2007, 0=otherwise	0.02 (0.11)	0.16 (0.37)	***	0.02 (0.12)	
Intensity of household fertilizer use	Fertilizer application rate across all fields (kg/ha)	161 (23)	151 (6)		177 (9)	
Production sold	Percent of total value of crop production sold by household	47 (26)	46 (28)		51 (26)	
Consumption from own production	Number of months in calendar year that household relies on production for consumption	9.8 (2.4)	9.7 (3.1)		10.8 (2.1)	***

Note: NAAIAP subsidy recipients observed in the 2010 data. All other "baseline" variables observed in the 2007 data (unless otherwise specified). Standard deviation in parentheses. The "sig" columns refer to the results of t-tests used to determine statistically significant differences between recipient and non-recipient households across the two different samples. The grayed columns represent variables that do not appear in the regression analysis in Table 7. *** $p<0.01$ ($t>2.750$), ** $p<0.05$ ($t>2.042$), * $p<0.1$ ($t>1.697$).

For each of the two samples, we estimate probit models with the variables described in Table 6 under three different fixed effects specifications for comparison. Because we observe a number of provinces, districts, and divisions with no subsidy recipients, the sample size changes between the three models that include all NAAIAP-included districts (per

government documents) because those binary variables become perfectly collinear predictors of non-recipients. The marginal effects of the probit model regressions across all model specifications and samples are shown in Table 7 for comparison.

Table 7: Marginal effects estimation results for NAAIAP fertilizer subsidy program household-level targeting

Dependent variable = 1 if household was a NAAIAP recipient between 2007 and 2010; 0 otherwise	In districts where NAAIAP was implemented (n=1,146)			In divisions with at least one NAAIAP recipient (n=538)		
Asset quintile 1 (lowest)	omitted	omitted	omitted	omitted	omitted	omitted
Asset quintile 2	-0.00116	-0.0193	-0.0393	-0.0165	-0.0145	-0.0161
	(0.0254)	(0.0391)	(0.0359)	(0.0509)	(0.0503)	(0.0514)
Asset quintile 3	-0.00935	-0.0468	-0.0638*	-0.0471	-0.0439	-0.0487
	(0.0251)	(0.0377)	(0.0346)	(0.0496)	(0.0492)	(0.0506)
Asset quintile 4	-0.00711	-0.0465	-0.0873**	-0.0554	-0.0536	-0.0605
	(0.0261)	(0.0401)	(0.0344)	(0.0519)	(0.0514)	(0.0524)
Asset quintile 5 (highest)	-0.0320	-0.0760*	-0.112***	-0.105**	-0.0999*	-0.115**
	(0.0264)	(0.0422)	(0.0348)	(0.0532)	(0.0534)	(0.0541)
Household income - village mean income (KSH 1000)	-1.21e-05	-1.55e-05	-4.27e-06	-8.59e-06	8.54e-06	3.43e-05
	(5.29e-05)	(7.61e-05)	(5.38e-05)	(0.000101)	(0.000102)	(0.000103)
Household has <1 ha of land	omitted	omitted	omitted	omitted	omitted	omitted
Household has 1-3 ha of land	0.0269	0.00104	0.00629	0.00453	0.00579	0.00629
	(0.0174)	(0.0264)	(0.0347)	(0.0344)	(0.0348)	(0.0347)
Household has 3-5 ha of land	0.0727**	0.0385	0.0616	0.0572	0.0596	0.0616
	(0.0368)	(0.0479)	(0.0632)	(0.0628)	(0.0633)	(0.0632)
Household has >5 ha of land	-0.0244	-0.0748**	-0.0864*	-0.0881*	-0.0878*	-0.0864*
	(0.0251)	(0.0314)	(0.0473)	(0.0465)	(0.0467)	(0.0473)
Household size (adult equivalents)	0.0106***	0.00821*	0.00744	0.00996	0.00788	0.00744
	(0.00350)	(0.00477)	(0.00643)	(0.00636)	(0.00642)	(0.00643)
Education of household head (years)	0.00195	0.000484	0.000583	0.000882	0.000772	0.000583
	(0.00204)	(0.00279)	(0.00371)	(0.00368)	(0.00369)	(0.00371)
Household head is married = 1	0.00451	0.0204	0.0344	0.0359	0.0393	0.0344
	(0.0313)	(0.0451)	(0.0651)	(0.0639)	(0.0637)	(0.0651)
Household head is female = 1	0.0380	0.0351	0.0574	0.0595	0.0612	0.0574
	(0.0411)	(0.0579)	(0.0854)	(0.0846)	(0.0854)	(0.0854)
Household experienced mortality between 2004-07 = 1	0.0233	0.0478	0.0631	0.0700	0.0753	0.0631
	(0.0352)	(0.0509)	(0.0680)	(0.0682)	(0.0694)	(0.0680)
Percent of value production sold by household	-0.000159	0.000494	-0.000237	0.000274	-0.000133	-0.000237
	(0.000336)	(0.000484)	(0.000703)	(0.000625)	(0.000683)	(0.000703)
Number of months household eats from own production	0.00225	-0.000892	-0.00148	-0.00360	-0.00232	-0.00148
	(0.00343)	(0.00502)	(0.00696)	(0.00692)	(0.00693)	(0.00696)
Proportion of hh in village that used fert in 2007 (0-1)	0.0911	0.399**	0.232	0.414*	0.389*	0.232
	(0.0672)	(0.176)	(0.254)	(0.214)	(0.233)	(0.254)
Household did not use fert. in 2000, 2004, or 2007 = 1	-0.0599***	-0.0796**	-0.106**	-0.103**	-0.102*	-0.106**
	(0.0202)	(0.0345)	(0.0504)	(0.0520)	(0.0537)	(0.0504)
Distance to nearest fertilizer dealer (km)	-0.000797	-0.00794	-0.00899	-0.00903	-0.00875	-0.00899
	(0.00393)	(0.00586)	(0.00800)	(0.00777)	(0.00800)	(0.00800)
Distance to nearest tarmac road (km)	-0.00633***	-0.00221	-0.00189	-0.00156	-0.00425	-0.00189
	(0.00213)	(0.00301)	(0.00463)	(0.00340)	(0.00445)	(0.00463)
Province dummy variables	Yes	No	No	Yes	No	No
District dummy variables	No	Yes	No	No	Yes	No
Division dummy variables	No	No	Yes	No	No	Yes
Observations	1,063	730	538	538	538	538

Note: Marginal effects are from a probit model. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The binary NAAIAP dependent variable is observed in the 2010 survey while all of the independent variables are from the 2007 survey (unless otherwise noted).

In Table 7, we observe that the probability of receiving a fertilizer subsidy was lower for the households with the most assets under five of six model specifications. In fact, the model with division level fixed effects with the full sample of districts shows that being in the 3rd, 4th, and 5th highest asset quintiles reduced the probability of being targeted by 6, 9 and, 11 percentage points, respectively, compared to being in the lowest quintile. These results provide evidence that targeting was, in fact, in favor of the resource poor within given

geographic areas, all else equal, as it was intended. After controlling for household asset level, however, we do not observe that net income is an important predictor of subsidy receipt. Results also show that households with the largest amount of land holdings were statistically significantly less likely to be targeted across virtually all models and under both samples. The fact that those at the highest end of the landholding distribution were significantly less likely to receive the subsidy may provide further evidence that wealthy farmers were less likely to be targeted, meaning the "resource poor" criterion may have been upheld during program implementation. However, under the full sample and under two of the three model specifications, households with 3-5 hectares of land were significantly more likely to have received a subsidy than households with less than one hectare of land. We expect this finding is related to the program requirement that households have at least enough land to cultivate with the 100 kilograms of fertilizer and 10 kilograms of seed granted through the Kilimo Plus starter kit.

The probability of being targeted increased at higher values of household adult equivalents in two of the three models using the full sample. Adult equivalents can serve as a proxy for household labor supply but also of consumption needs. All else equal, we know that larger families and those with more adults were targeted, although it is difficult to isolate a reason why this might be the case. In terms of other household demographics, neither the gender, marital status, nor the educational status of the household head had any significant effect on targeting in any of the model specifications, contrary to expectations and the directive that female-headed households be considered. Mortality in the household over the last several years, a shock to the household, was also not a significant factor in targeting. Together, these findings support the fact that the demographic status of the household did not appear to be a major factor in targeting. In order to understand how the agricultural production capabilities and market-oriented status of the household affected targeting, we created variables to describe the percent of the value of household production that was sold in 2007 and the number of months that the household claimed to consume from its own production. In none of our model specifications were these variables statistically significant predictors of NAAIAP voucher receipt.

The subsidy was much more likely to be targeted to households in the villages where fertilizer use was more widespread before the inception of the program across three of the six models. Moreover, as we saw in Tables 4 and 5, consistent non-users of fertilizer were less

likely to receive a fertilizer voucher. If we had observed the former alongside a low level of fertilizer use by the households specifically targeted, then this would suggest that the subsidy was implemented to target areas where fertilizer use was perceived to be relatively less risky (or profitable) but households were unable to engage in the active market. However, because we know that these subsidy recipients purchased fertilizer routinely before the program, we believe these findings further corroborate the fact that fertilizer markets were already robust in the targeted areas and that targeted households needed no further assistance.

The negative sign on and the statistical significance of the marginal effects estimate in one model specification of the distance to tarmac road provides weak evidence that the subsidy targeted farmers that were more accessible, perhaps to ease the implementation of the program. However, in none of the model specifications do we find that an increase in distance to the nearest fertilizer dealer was correlated with a higher probability of being targeted by the program. We would have expected the opposite since, by design, NAAIAP recipients need access to agro-dealers, which are mainly located along routes and in centers more accessible from major markets, in order to redeem their vouchers. Our results suggest that targeting within more homogeneous geographic areas was not necessarily skewed towards the more accessible.

7. Discussion and Conclusions

The objective of this study was to add to the growing body of literature describing the experiences of modern input subsidy programs in sub-Saharan Africa by examining the targeting performance of the National Accelerated Agricultural Input Access Program (NAAIAP) in Kenya using household level panel data collected before and after the program inception. Using the stated criteria for inclusion in the program, characteristics that would qualify implementation as "market smart," and a range of other observable household level characteristics, we explore and assess the quality of geographic and household level targeting in the initial years of the program. Indicative of a fairly small program, especially as compared with nearby Malawi and Zambia, and the fact that another subsidy program under different goals was occurring in Kenya simultaneously, we observe relatively few households participating in the program between 2007 and 2010 in our data. As such, our results are based on a purposively cleaned and small but nationwide sample and may not be fully representative of the efforts made under the NAAIAP program more generally.

Our geographic (division) level analysis suggests that program targeting likely considered the spatial distribution of poverty trends, although targeted divisions were significantly less likely to have many female-headed households. Also, divisions with better access to markets and more widespread use of fertilizer were more likely to be targeted. These results combined with previous findings that fertilizer use intensity is relatively well-correlated with profitability in Kenya (Sheahan, Black, Jayne 2013) imply that fertilizer subsidies under NAAIAP were targeted to geographic areas where fertilizer use is a profitable endeavor and where input markets are nearby and functioning. Our household level analysis provides mixed results. To the discredit of the program, we find that over 90 percent of households targeted by the program had purchased commercial fertilizer in the past, suggesting that recipient households previously had the means to engage in the commercial fertilizer market without the help of government subsidies. We observe that households with the highest asset wealth and the most land holdings were less likely to receive the subsidy, so the "resource poor" criterion appears to have held. However, we found no evidence that female-headed households were more likely to receive the NAAIAP subsidy. This may be explained by one of the requirements that a targeted household have at least one acre of land for maize production, which has the potential to exclude land-constrained female-headed households.

We also found no evidence that those households who experienced a recent mortality shock were more likely to receive government input assistance.

Overall, our results suggest that while the NAAIAP was designed to target households with particular economic and demographic characteristics, actual implementation was not consistent with these targeting guidelines. The former suggests that the government and implementing bodies should be applauded for their efforts to focus on "pro-poor" programming. The latter finding supports the need to uncover where in the implementation hierarchy targeting glitches occur and to find ways to ensure that vouchers are given to households with an unmet demand for modern inputs. Given that the commercial fertilizer sector has thrived in Kenya in the post-liberalization era, our results suggest that imperfect targeting of a potentially useful poverty reducing scheme could actually undermine the progress in bolstering commercial demand seen over the last twenty years if not well targeted. Not only does flawed targeting negatively impact the private input distribution sector, but also reduces the likelihood that the subsidy will actually contribute to the reduction in poverty desired by the program.

This paper provides, to our knowledge, the first empirical evidence unpacking the targeting performance of NAAIAP and also serves as a cautionary tale for other governments in the region considering the use of targeted government input subsidy programs. The incidence of a relatively robust fertilizer market in Kenya creates an added layer of complexity but also an advantage in designing a program that complements the options already available to farmers in an effort to grow the overall profitable use of fertilizer and reap the related productivity and food security gains. The wave of newly branded "market smart" subsidies was thought to be a remedy to the problems inherent in the universal subsidy schemes of the past. However, establishing targeting criteria that are largely ignored during the implementation stage provides little concrete benefit over prior subsidy programs. While a sizable portion of smallholder farmers in Kenya and elsewhere in the region still have limited or no access to productivity enhancing inputs, input subsidy programs that do not properly target them diminishes the potential of these schemes to contribute to a broad-based smallholder-led Green Revolution in sub-Saharan Africa.

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