The effects of Kenya's 'smarter' input subsidy program on smallholder behavior and economic well-being: Do different quasi-experimental approaches lead to the same conclusions?

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The effects of Kenya's 'smarter' input subsidy program on smallholder behavior and economic well-being: Do different quasi-experimental approaches lead to the same conclusions?

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1. INTRODUCTION & CONTRIBUTIONS

Often cited as a prime example of successful private sector-led fertilizer market development in sub-Saharan Africa (SSA), Kenya has now joined the ranks of SSA countries implementing an input subsidy program (ISP) for improved seed and inorganic fertilizer. While other ISPs in the region (e.g., Malawi, Zambia, and Nigeria) have been studied in detail, relatively little is known about the effects of Kenya's targeted ISP, the **National Accelerated Agricultural Inputs Access Program (NAAIAP)**. NAAIAP is '**smarter**' (Morris et al., 2007) than other ISPs in the region because it:

- Targets (in practice) resource poor farmers, and
- Is implemented through vouchers redeemable at private agro-dealers.

However, it is **less 'smart'** because private sector fertilizer markets were already well developed and smallholder farmers were using nearly optimal levels of fertilizer in Kenya prior to the implementation of NAAIAP (Ariga and Jayne, 2009; Sheahan et al., 2013; Sheahan et al. 2014).

This paper contributes to the literature by:

1. Estimating the **effects of NAAIAP** participation on smallholder **cropping patterns**, **incomes**, and **poverty**;
2. Using **numerous econometric and quasi-experimental approaches** to evaluate the robustness of the results; and
3. **Comparing the effects of NAAIAP to those of other ISPs in SSA**, and discussing the likely links between **differences in program designs and differences in program impacts**.

2. KEY FEATURES OF THE NAAIAP SUBSIDY PROGRAM

- **National program** from **2007/08-2013/14**, replaced by county-designed and implemented subsidy programs beginning in 2014/15
- Between 2007/08 and 2011/12, nearly 500,000 farmers were reached by the program (see Table 1)
- **In 2009/10** (which is captured in the panel survey data used in this study), approximately **5% of Kenyan smallholders participated in NAAIAP**

- **Program goals** (focused on smallholder farmers):
  1. Improve access and affordability of fertilizer and seed
  2. Raise productivity and output
  3. Increase food security and incomes, and reduce poverty

- **NAAIAP ('Kilimo Plus') input packages:**
  - 50 kg each of basal and top dressing fertilizer (free)
  - 10 kg of improved maize seed (free)
  - One input package per beneficiary household (HH)
  - Voucher redeemable at accredited agro-dealers' shops
  - One-time grant (beneficiaries only to receive for one season)

- **Official NAAIAP targeting criteria for beneficiary farmers:**
  - Unable to afford farm inputs at unsubsidized prices
  - Grow maize and have at least 2.5 acres of land
  - 'Vulnerable' members of society (e.g., female- and child-headed HHs)
  - Have not received government support in the past

Table 1. NAAIAP number of beneficiaries, number of districts covered, and value of vouchers, 2007/08-2011/12

Year	HHs targeted	Districts targeted	Voucher value (nominal Ksh)	Voucher value (nominal US$)
2007/08	36,000	40	6,500	103.67
2008/09	92,876	70	7,300	93.95
2009/10	175,973	131	5,687	76.03
2010/11	125,883	95	6,500	81.25
2011/12	63,737	63	8,000	95.69

Source: GOK (2013). Note: More recent data not available

3. DATA

- **Tegemeo Agricultural Policy Research and Analysis (TAPRA) Rural Household Survey**, a 5-wave, nationwide panel survey
- Data cover 1996/97, 1999/2000, 2003/04, 2006/07, and 2009/10
- 1,500 agricultural HHs in first wave, 1,243 in balanced panel (83% re-interview rate; no evidence of attrition bias)
- Analytical sample: **balanced panel of 1,064 smallholder maize-growing HHs**, using data from waves 3 through 5
  - **2 waves before NAAIAP, 1 wave during NAAIAP**
- Detailed information on crop and livestock production and sales, off-farm income generating activities, demographics, and asset holdings

4. METHODS

ISP beneficiaries are not randomly selected, so correcting for the likely **endogeneity of ISP participation to the outcome variables of interest is a pervasive problem in the literature**. Most previous non-experimental studies of ISPs in SSA have used either propensity score matching (PSM) or panel data methods (often combined with instrumental variables (IV) or control function approaches) to deal with these issues; however, the validity of IVs can be difficult to defend and there are frequently multiple defensible estimation approaches that researchers could take.

To our knowledge, no previous studies on the topic have compared estimates between panel data methods and methods related to propensity scores.

We **estimate the average treatment effect on the treated (ATT) of NAAIAP participation** using:

1. **Simple difference-in-differences (DID)** (without covariates),
2. **Fixed effects (FE),**
3. **Propensity score weighting-DID (PSW-DID), and**
4. **PSM-DID,**

and calculate **Rosenbaum bounds** to assess the robustness of the PSM-DID ATT estimates to time-varying unobserved heterogeneity ('hidden bias') (Rosenbaum, 2002).

(We were not able to identify a sufficiently strong and plausibly exogenous IV, so could not utilize the FE-IV estimator.)

Use of the TAPRA panel data allows us to **control for a rich set of household, village, and regional characteristics**, such as the:

- Gender, age, and education of the HH head
- HH composition and assets
- Distance from the homestead to roads, maize seed and fertilizer retailers, extension advice, and other services
- Market prices for key inputs (fertilizer, seed, land, labor) and expected market prices for key crops
- Agro-ecological conditions (elevation, and current season and long-run average rainfall, moisture stress, and temperature)

We select control variables for the probit used to generate the propensity score following the iterative procedure described in Imbens (2014).

5. RESULTS

Table 2. ATT estimates for participation in NAAIAP

Outcome variable	Sample mean	ATT estimate			
		DID	FE	PSW-DID	PSM-DID
Total income ('000 Ksh)	304.7	**56.9**	32.8	21.7	53.6
Total income/capita/day (Ksh)	182.0	**22.7**	7.0	8.3	7.2
Poverty incidence (poor=1)	0.47	-0.04	-0.06	-0.05	-0.00
Poverty gap	0.23	**-0.08**	**-0.10**	**-0.04**	**-0.07**
Poverty severity	0.16	**-0.08**	**-0.11**	**-0.04**	**-0.09**
Crop income ('000 Ksh) [m]	95.6	11.9	9.0	7.3	-4.7
Crop income/acre ('000 Ksh) [m]	34.1	5.8	1.5	4.1	-1.8
Maize kg harvested [m]	1,334.3	**520.6**	**361.2**	**187.4**	**533.4**
Acres with maize [m]	1.53	-0.07	**0.41**	-0.15	-0.03
Maize kg/acre with maize [m]	1,2411.1	**721.4**	**556.2**	**298.7**	**684.5**
Maize % of total crop value	31.8	**4.5**	**3.9**	**2.1**	**4.4**
Total acres cultivated [m]	3.21	-0.41	-0.08	-0.35	0.15

Note: Numbers in **green** are **statistically significant at the 10% level or lower.**
[m] indicates main season; other outcome variables are for the main and short seasons combined. Income is in net terms. PSM estimates are for radius matching. Poverty metrics are based on the US$1.25/capita/day poverty line.

KEY FINDINGS

Per Table 2, the results generally suggest that **participation in NAAIAP** by smallholder farm households in Kenya:

- ↓ the **poverty gap** and **poverty severity**,
- ↑ **maize kg harvested** mainly by ↑ **maize kg/acre**, and
- ↑ the **maize share of total crop value**, but not crop income.

After explicitly controlling for other factors via FE or propensity score-based methods, NAAIAP has no significant effect on total income. This, coupled with the findings that NAAIAP participation reduces the depth and severity of poverty, suggests that **NAAIAP is likely raising the incomes of poor households**. This is consistent with Sheahan et al.'s (2014) finding that NAAIAP's criterion of **targeting resource poor farmers** was successfully implemented (on average) (MOA, 2007). As shown in Table 3, **the PSM-DID ATT estimates are quite robust to hidden bias.**

Table 3. Rosenbaum bounds (upper bound p-values for PSM-DID ATT estimates)

Γ	Poverty severity	Maize kg	Maize kg/acre	Maize % of total crop value
1	0.000	0.000	0.000	0.003
1.1	0.000	0.000	0.000	0.008
1.2	0.000	0.000	0.000	0.015
1.3	0.001	0.000	0.000	0.026
1.4	0.002	0.000	0.000	0.042
1.5	0.003	0.001	0.000	0.062
1.6	0.006	0.001	0.000	0.087
1.7	0.009	0.002	0.001	**0.117**
1.8	0.013	0.003	0.001	**0.150**
1.9	0.018	0.004	0.002	**0.187**
2.0	0.025	0.006	0.003	**0.226**

6. CONCLUSIONS & POLICY IMPLICATIONS

- Although the majority of NAAIAP recipients were using commercial fertilizer prior to NAAIAP (Sheahan et al., 2014), and crowding out of commercial demand for fertilizer by ISP fertilizer is higher in Kenya than in several other SSA countries (Jayne et al., 2013), **NAAIAP did significantly raise maize production.**
- The estimated **effects of NAAIAP on maize production are generally larger than those for Malawi's and Zambia's ISPs.** (The latter are roughly 200 kg of maize per 100 kg of subsidized fertilizer (Mason and Tembo, 2015).)
  - This could be due to **NAAIAP's implementation through vouchers redeemable at accredited agro-dealers' shops**, and resultant more timely access to the inputs relative to Malawi's and Zambia's programs. (These other programs distribute fertilizer through parallel government distribution systems plagued by late delivery.)
- **NAAIAP reduced poverty severity by a larger magnitude than Zambia's ISP**, likely due to its **more effective targeting of resource poor farmers.** (Zambia's ISP fertilizer went disproportionately to households with more land and assets (Mason and Tembo, 2015).)
- **ISP design and implementation have important implications for program impacts.**

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