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The effects of the National Agricultural Input Voucher Scheme (NAIVS) on sustainable intensification of maize production in Tanzania

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1. Introduction & Main Contributions

- Raising agricultural productivity is critical for meeting rising food demand in sub-Saharan Africa (SSA)**
- Conventional agricultural intensification** via high-yielding crop varieties and inorganic fertilizer may be **insufficient to sustainably intensify agricultural production** (Petersen and Snapp, 2015)
- Sustainable intensification (SI)** could be a possible solution. *SI = raising agricultural productivity from the same area of land over the long-term, while preserving or improving the natural resource base* (Pretty et al., 2011).
- But many SSA governments' **policies have focused on conventional intensification** – e.g., **via large scale input subsidy programs (ISPs)**
- Yet the production and welfare effects of ISPs have been smaller** than expected due in part to **low crop yield response to inorganic fertilizer caused by poor soil quality** (Jayne et al., 2018; Burke et al., 2017)
- Joint use of inorganic fertilizer with other soil fertility management (SFM) practices (e.g., organic fertilizer and maize-legume intercropping) can help
- **Research question:** do **ISPs encourage or discourage such joint use?**
- Main contributions:**
 - ✓ Previous studies (e.g., Holden and Lunduka, 2012; Koppmair et al., 2017; and Morgan et al., 2019) have focused on ISP impacts on SFM practices but not the key question of **joint use with inorganic fertilizer**
 - ✓ We focus on **Tanzania** (previous studies focus on Malawi & Zambia)



2. NAIVS

- Implemented by the Tanzanian government with financial support from the World Bank from 2008/09-2013/14
- A key example of a **“smart” subsidy program that used vouchers redeemable at private agro-dealers’ shops**
- Each beneficiary to receive 3 vouchers for 3 years:** (1) 50-kg bag of urea, (2) 50-kg bag of DAP or two 50-kg bags of Minjingu Rock Phosphate with N supplement, & (3) 10 kg of hybrid or OPV maize seed or 16 kg of rice seed
- Many beneficiaries received less than the full suite** of vouchers **but most beneficiaries redeemed the vouchers** they received (Table 1)

Table 1. Voucher receipt & redemption by sample HHs

Voucher(s)	% of beneficiaries receiving	% of recipients redeeming vouchers
Inorganic fertilizer only	66%	89%
Improved maize seed only	11%	83%
Both	23%	84%

Note: See Data section for details on data source and analytical sample.

3. Data and Methodology

- Data**
 - ✓ Main data source: **2008/09 and 2012/13 waves of the Tanzania National Panel Survey (TNPS)**, a nationally-representative survey
 - ❖ Don't use 2010/11 wave due to inconsistency in NAIVS questions
 - ✓ Other important data sources:
 - ❖ Rainfall and soils data from NOAA and FAO
 - ❖ Constituency-level data from 2005 and 2010 presidential elections
- Analytical sample**
 - ✓ **2,559 maize plots** cultivated by the balanced panel of maize-growing rural HHs interviewed in TNPS 2008/09 and 2012/13 (812 HHs/round)
- Focus on 3 maize-related SFM practices important in Tanzania:**
 - (a) **inorganic fertilizer**, (b) **organic fertilizer**, and (c) **maize-legume intercropping**
 - ✓ Group into 4 “SI categories” based on their potential to contribute to SI in maize-based systems: **None, Intensification, Sustainable, and SI**



Table 2. Maize SI categories and prevalence in Tanzania

Case	Inorganic fertilizer	Organic fertilizer	Maize-Legume Intercrop	# of maize plots	SI category	% of maize plots
1				1,159	None	45%
2	✓			224	Intensification	9%
3		✓		166	Sustainable	37%
4			✓	699		
5		✓	✓	113		
6	✓	✓		50	SI	9%
7	✓		✓	147		
8	✓	✓	✓	31		

- Econometric approach**
 - ✓ **Multinomial logit (MNL) regression of plot-level SI category** on NAIVS voucher receipt (or redemption) & other explanatory variables
 - ✓ **Correlated random effects (CRE)** to control for time-constant unobserved heterogeneity
 - ✓ **Control function approach** using two IVs: electoral threat (Chang, 2005) and the number of fertilizer vouchers distributed to HH's region



4. Results

Table 3. APE of NAIVS voucher on use of each SI category (CRE-MNL)

Maize input voucher type	NAIVS voucher <i>receipt</i>				NAIVS voucher <i>redemption</i>			
	N	I	S	SI	N	I	S	SI
Panel A								
Any input	-0.21*	0.10*	0.02	0.09*	-0.21*	0.10*	0.01	0.10*
Panel B								
Inorganic fertilizer	-0.25*	0.10*	0.05	0.10*	-0.22*	0.10*	0.02	0.10*
Maize seed	-0.03	0.01	0.02	-0.00	-0.10	0.04	0.02	0.04

Notes: N, I, and S denote “None”, “Intensification”, and “Sustainable”, respectively. * indicates that the APE is significant at the 1% level.

Table 4. APE of NAIVS voucher on use of inorganic fertilizer with maize-legume intercropping (Panel A) vs. organic fertilizer (Panel B)

Maize input voucher type	NAIVS voucher <i>receipt</i>				NAIVS voucher <i>redemption</i>			
	None	Inorganic fertilizer	Mz-Leg IC	Both	None	Inorganic fertilizer	Mz-Leg IC	Both
Panel A								
Inorganic fertilizer	-0.19*	0.12*	-0.01	0.08*	-0.19*	0.12*	-0.01	0.08*
Panel B								
Inorganic fertilizer	-0.22*	0.16*	0.03	0.03*	-0.21*	0.16*	0.01	0.04*

Note: * indicates that the APE is significant at the 1% level.

5. Key Findings & Policy Implications

- Table 3: Participation in NAIVS, particularly receipt/redemption of a **NAIVS fertilizer voucher**, appears to encourage farmers' sole use of inorganic fertilizer (**“Intensification”**) as expected **but also joint use of inorganic fertilizer with other SFM practices (“SI”)** on a given maize plot
- Table 4: Receipt/redemption of a **NAIVS fertilizer voucher** has a **positive effect on joint use of inorganic fertilizer with each “Sustainable” SFM practice: maize-legume intercropping (Panel A) & organic fertilizer (Panel B)**
 - **Positive signs for the longer-term impacts of NAIVS on soil health**
- Inorganic fertilizer use much less prevalent in Tanzania** than in Malawi or Zambia before each country implemented “second generation” ISPs in the 2000s. Prior to NAIVS, **Tanzanian farmers** relied mainly on organic sources of soil fertility → **may view inorganic fertilizer (incl. from NAIVS) as a complement to**, rather than a substitute for, **these practices**.
- Further research is needed on **changes that could be made to NAIVS-like ISPs to further incentivize SI**

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