Do input subsidies crowd *in* or crowd *out* other soil fertility management practices? Evidence from Zambia

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Motivation: Input Subsidy Programs- SSA

- **History**
  - Popular until 80’s/90’s
  - Structural Adjustment
  - Re-emergence in 2000’s- targeted populations
  - Inorganic fertilizer and hybrid seed

- **2011:**
  - 10 SSA countries spent **US$1 billion** on Input Subsidy Programs (ISP)
    - 60% of SSA population (Jayne & Rashid 2013)
    - 29% of public spending on agriculture
Inorganic Fertilizer & Soil Nutrients

- Inorganic fertilizer requires a min soil quality level

Severe soil degradation in SSA

Inefficient and ineffective fertilizer

(Marenya and Barrett 2009; Tittonell and Giller 2013)

Motivation

- Call for Soil Fertility Management (SFM) practices in order to improve crop yield response to inorganic fertilizer (Jayne and Rashid 2013)
- Benefits found in SFM practices:
  - \( \uparrow \) SOM
  - Micro nutrients
- Reduce production vulnerability to oil prices
- Exploration in requiring practices as part of ISPs to enhance fertilizer efficiency- e.g. Malawi
- ISP’s possible effect on SFM practices:
  - Encourage:
    - Farmers aware of complementarity of practices
    - \( \uparrow \) production \( \rightarrow \) cultivate less land
  - Discourage:
    - Labor constraints
Current Literature

- 2 related papers

<table>
<thead>
<tr>
<th>Paper</th>
<th>Country</th>
<th>Limitations to Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holden and Lunduka (2012)</td>
<td>Malawi</td>
<td>- Small data set (450 hh)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Manure usage</td>
</tr>
<tr>
<td>Vondolia, Eggert, and Stage</td>
<td>Ghana</td>
<td>- Small data set (460 hh)</td>
</tr>
<tr>
<td>(2012)</td>
<td></td>
<td>- “Soil and water conservation investments”</td>
</tr>
</tbody>
</table>

Research Question

- Do input subsidies crowd *in* or crowd *out* other soil fertility management practices?
  - Crowd in= Encourage
  - Crowd out= Discourage
Main Contributions

- Nationally Representative Data
- Numerous practices: Test ISP affect on 5 well defined SFM practices

Outline

- Zambia’s ISPs
- SFM Practices
- Methods
- Results
- Policy Implications
- Next Steps for Research
Zambia- FSP and FISP

02/03-08/09: Fertilizer Support Programme (FSP)
- 400 kg fertilizer, 20 kg hybrid maize seed
- Uniform package
- Farmers pay 20-50% of market price for inputs

09/10-present: Farmer Input Support Programme (FISP)
- Package size halved

2011:
- 0.8% of GDP ($184 million)
- 30% of Agricultural Sector Spending

FISP Objective

- Increase small-scale farmers’ access to inputs
- Build private sector capacity
- Improve household & national food security
- Raise incomes and reduce poverty

Source: MACO (2008); statements by Min. of Ag. And Livestock
SFM Practices

- Manure/Compost
- Soil erosion/flash flood prevention
- Minimum tillage
  - basins + ripping
- Crop rotation
  - rotate at least 1 field between cereals and legumes between 09/10 and 10/11 seasons or 10/11 and 11/12 seasons
- Fallow

Empirical Model

\[ y_i = \beta_0 + \beta_1 fisp_i + \beta_2 pmaize_i + p\_inputs_i \beta_3 + aez_i \beta_4 + assets_i \beta_5 + hh_i \beta_6 + z_i \beta_7 + u_i \]

- \textit{fisp}: kg of FISP fertilizer received by \textit{hh}
- \textit{pmaize}: lagged price of maize
- \textit{p\_inputs}: fertilizer price, ag wage
- \textit{aez}: rainfall, AEZ
- \textit{assets}: land size, tenure, cattle, TLU
- \textit{hh}: education of head, age of head and \textit{hh} members, gender of head, extension in SEA
### Estimation Methods & Data

#### Estimation Methods:

<table>
<thead>
<tr>
<th>Measure of Dep. Variables</th>
<th>Type of Variable</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH use SFM practice on any field</td>
<td>Yes/No Binary</td>
<td>Probit</td>
</tr>
<tr>
<td>HH Area under SFM practice</td>
<td>Continuous number</td>
<td>Corner Solution</td>
</tr>
</tbody>
</table>

#### Data: Zambia- Nationally Representative Survey

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>Seasons</th>
<th># of Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>RALS</td>
<td>Cross-sectional</td>
<td>2010/11</td>
<td>8839 hh</td>
</tr>
</tbody>
</table>

### Potential Endogenity of Subsidized Fertilizer

- **Problem:** Non-random distribution of fertilizer
- **Test and control:**
  - **Instrumental Variables:** Results of the *last presidential election* in the hh’s constituency
    - =1 if ruling party won (APE: 23.541, p-val: 0.017)
    - % pt. spread btwn ruling party & next closest
    - Variables multiplied (APE: 1.233, p-val: 0.000)
  - **Control function approach (CFA)**
    - Reduced form Tobit
    - Residuals plugged into structural model (following Mason and Jayne 2013)
### Descriptive Results - % of HHs using practice

<table>
<thead>
<tr>
<th>Practice</th>
<th>All HH</th>
<th>HHs that received FISP fertilizer</th>
<th>HHs that did not receive FISP fertilizer</th>
<th>Diff. (pp.)</th>
<th>P-value (test diff. btwn FISP fert. recipients and non-recipients=0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manure/Compost</td>
<td>7.1%</td>
<td>9.9%</td>
<td>5.9%</td>
<td>+ 4.0</td>
<td>***</td>
</tr>
<tr>
<td>Erosion prevention</td>
<td>20.0%</td>
<td>24.9%</td>
<td>17.8%</td>
<td>+ 7.1</td>
<td>***</td>
</tr>
<tr>
<td>Min Tillage</td>
<td>1.8%</td>
<td>2.5%</td>
<td>1.4%</td>
<td>+ 1.1</td>
<td>***</td>
</tr>
<tr>
<td>Crop Rotation</td>
<td>40.7%</td>
<td>55.0%</td>
<td>34.3%</td>
<td>+ 20.7</td>
<td>***</td>
</tr>
<tr>
<td>Fallow Land</td>
<td>29.7%</td>
<td>29.1%</td>
<td>30.0%</td>
<td>- 0.9</td>
<td></td>
</tr>
</tbody>
</table>

Note: *** p<0.01, ** p<0.05, * p<0.10

### Descriptive Results - Mean ha under practice

<table>
<thead>
<tr>
<th>Practice</th>
<th>All HH</th>
<th>HHs that received FISP fertilizer</th>
<th>HHs that did not receive FISP fertilizer</th>
<th>Diff.</th>
<th>P-value (test diff. btwn FISP fert. recipients and non-recipients=0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area cultivated (total ha)</td>
<td>1.61</td>
<td>2.22</td>
<td>1.35</td>
<td>+ 0.88</td>
<td>***</td>
</tr>
<tr>
<td>Manure/Compost</td>
<td>0.1</td>
<td>0.16</td>
<td>0.07</td>
<td>+ 0.09</td>
<td>***</td>
</tr>
<tr>
<td>Erosion prevention</td>
<td>0.31</td>
<td>0.47</td>
<td>0.24</td>
<td>+ 0.24</td>
<td>***</td>
</tr>
<tr>
<td>Min Tillage</td>
<td>0.02</td>
<td>0.04</td>
<td>0.01</td>
<td>+ 0.02</td>
<td>***</td>
</tr>
<tr>
<td>Crop Rotation</td>
<td>0.33</td>
<td>0.51</td>
<td>0.24</td>
<td>+ 0.27</td>
<td>***</td>
</tr>
<tr>
<td>Fallow Land</td>
<td>0.41</td>
<td>0.46</td>
<td>0.39</td>
<td>+ 0.07</td>
<td></td>
</tr>
</tbody>
</table>

Note: *** p<0.01, ** p<0.05, * p<0.10
### Results: Effects of FISP fert. on probability of adoption

<table>
<thead>
<tr>
<th>Practice</th>
<th>Current % of hh using practice</th>
<th>Estimated pp. change per 200 kg increase in FISP</th>
<th>Sig.</th>
<th>% change from current % of hh using practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manure/Compost</td>
<td>7.1%</td>
<td>+ 0.73 pp</td>
<td>**</td>
<td>+ 10.2%</td>
</tr>
<tr>
<td>Soil Erosion Prevention</td>
<td>20.0%</td>
<td>+ 0.84 pp</td>
<td>*</td>
<td>+ 4.2%</td>
</tr>
<tr>
<td>Minimum Tillage</td>
<td>1.8%</td>
<td>+ 0.26 pp</td>
<td>**</td>
<td>+ 14.6%</td>
</tr>
<tr>
<td>Crop Rotation</td>
<td>40.7%</td>
<td>- 0.04 pp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fallow Land</td>
<td>29.7%</td>
<td>- 3.66 pp</td>
<td>***</td>
<td>- 12.3%</td>
</tr>
</tbody>
</table>

Note: *** p<0.01, **p<0.05, *p<0.10

FISP crowds in all of our SFM practices except crop rotation and leaving land fallow.

### Results: Effects of FISP fert. on ha under practice

<table>
<thead>
<tr>
<th>Practice</th>
<th>Current mean ha for all hh</th>
<th>Estimated ha change per 200 kg increase in FISP</th>
<th>Sig.</th>
<th>% change from current mean ha for all hh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manure/Compost</td>
<td>0.1</td>
<td>+ 0.011</td>
<td>**</td>
<td>+ 10.8%</td>
</tr>
<tr>
<td>Soil Erosion Prevention</td>
<td>0.31</td>
<td>+ 0.022</td>
<td>**</td>
<td>+ 7.1%</td>
</tr>
<tr>
<td>Minimum Tillage</td>
<td>0.02</td>
<td>+ 0.004</td>
<td>**</td>
<td>+ 21.7%</td>
</tr>
<tr>
<td>Crop Rotation</td>
<td>0.33</td>
<td>+ 0.032</td>
<td>**</td>
<td>+ 9.8%</td>
</tr>
<tr>
<td>Fallow Land</td>
<td>0.41</td>
<td>- 0.092</td>
<td>***</td>
<td>- 22.5%</td>
</tr>
</tbody>
</table>

Note: *** p<0.01, **p<0.05, *p<0.10

FISP crowds in all of our SFM practices except for leaving land fallow.
Policy Implications

- **Effect:** ISP increases usage of SFM practices, except for fallow land
  - More research needed: do benefits from ISP outweigh long-term potential costs of reduced fallows
- **Magnitude:** Increases are small in absolute terms
  - Due to complementarity of fertilizer and SFM, encouraging SFM practices could become part of ISPs.
  - Extension
  - SFM practice requirement
  - Incentive programs

Next Steps for Research

1. **Panel analysis:** Nationally representative Supplemental Surveys- ’99/’00, ’02/’03, and ’06/’07
2. **Double hurdle model**
3. **Share of land:** Analysis of share of land under each practice
4. **Plot level analysis:** probability of adoption
5. **Residue retention:** Analysis of effect on additional SFM practice
6. **Explanatory variables:**
   - other major crops’ prices
   - population density
   - slope of the land
   - nutrient availability
   - nutrient retention capacity
   - distance from home to the field
Thank you!

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