Smallholder farmers’ access to seeds and fertilizer in sub-Saharan Africa

J. Ricker-Gilbert (Purdue University and T. S. Jayne (Michigan State University)

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1) Improved seed use is increasing among smallholders in SSA.
   – But developing a sustainable supply chain is challenging

2) Breeding needs to focus on more than just varieties with higher yields.

3) Inorganic fertilizer in SSA is low but may be growing

4) Low response rates are a bigger problem. Little evidence that MB > MC.

5) Points 3 and 4 have implications for cost effectiveness of input subsidy programs.
   - Two big challenges for input subsidies
Seeds.

• Use of improved seeds important
  Maize
  – Open Pollinated Variates (OPV) can be recycled
  – Hybrid, cannot be recycled
  – But smallholders sometimes prefer local varieties for various reasons.

• Early maturing, drought tolerant varieties of cereal are desirable in the face of climate change.

• Returns to new varieties in research station and on real farms may be different

• Viewed as an important complimentary input to fertilizer
  – But not always used together
Yield response to fertilizer by variety in Malawi

Policy point: Input subsidy programs should not forget to promote improved seeds

From Chibwana et al. (2014)
The possible complementarities are not always realized.

Input use on plots in Ethiopia

Use inorganic fertilizer

Use improved seed variety

Use irrigation

<15 percent of plots with at least 1 of these inputs uses 2 or more of them together!

From Sheahan and Barrett (2014)
Breeders need to consider traits other than just yields

• Southern Africa, local maize varieties preferred for home consumption compared improved varieties (Smale et al. 1995; Lunduka et al. 2012).

• Local varieties store better, so households who use improved storage technologies more likely to adopt improved maize varieties (Ricker-Gilbert, and Jones 2015).

• Household preference for maize causes households to plant maize in areas better suited for sorghum.
Sometimes what works on research station does not work in the field.

Butle et al. (2015) Double blind RCT in Tanzania with cowpea

1. Group **received** improved seed and **knew**
2. Group **received** improved seed and **did not** know
3. Group **did not receive** improved seed and **did not** know
4. Control group, **did not receive** improved seed and **knew**.

Results: Yield Group 1 > Yield Group 4
Yield Group 2 = Yield Group 3
Yield Group 3 > Yield Group 4
Yield Group 1 = Yield Group 2 = Yield Group 3

All of effects attributed to effort effect induced by improved seed, rather than seed genetics.
Market development for improved varieties in SSA is challenging

- Local/traditional – can be recycled, lower yields
- OPV – can be recycled, higher yields than local
- Hybrid – shouldn’t be recycled, highest yields

- Many farmers & NGO’s like OPV because they can be recycled.
- Private companies like hybrids because they cannot be recycled.
- Challenging to develop a sustainable supply chain with proper incentives for all participants.
Conclusions on seeds

• Improved seed varieties are obviously a key input into the production process (supply curve shifter).
  – Need complimentary inputs, fertilizer, water, labor
• Supply side (productivity) aspects of seed are important.
  – But breeders need to consider demand side (consumption) characteristics of smallholder producer/consumer households
• Public sector has a key role in breeding but challenge is to develop a sustainable private sector supply chain.
Common perception that inorganic fertilizer use is low in SSA

Inorganic fertilizer Use by Region in 2003

<table>
<thead>
<tr>
<th>Region</th>
<th>kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.S.A</td>
<td>9</td>
</tr>
<tr>
<td>Latin America</td>
<td>86</td>
</tr>
<tr>
<td>South Asia</td>
<td>104</td>
</tr>
<tr>
<td>S.E. Asia</td>
<td>142</td>
</tr>
</tbody>
</table>

Source: Crawford et al. (2006) compiled from FAOSTAT

Usually based on aggregate data
Research Side: View of low fertilizer use influenced a number of studies

What are the constraints to fertilizer use in SSA?

**Supply Side**
- Poor infrastructure, late delivery, few input suppliers, inappropriate blending and qty recommendations (Gregory & Bumb 2006)

**Demand Side**
- Credit constrained (Coady 1995, Dorward et al. 2004, Duflo et al. 2009)
- Not profitable
  - a) unfavorable input / output prices (Croppendstedt et al. 2003, Duflo et al. 2008)
  - b) poor soil quality, low response rates (Marenya and Barrett 2009, Sheahan et al. 2014)
Policy side: view of low fertilizer use inspired Abuja declaration in 2006

• Many governments in SSA committed to increasing smallholder inorganic fertilizer use.
  – Part of Comprehensive African Agricultural Development Process (CAADAP)
  – Often achieved through input subsidy programs (ISP)
  – Belief that it would drive productivity and rural development

• 10 countries spent US $1.05 billion in input subsidies in 2011 (Jayne and Rashid 2013).
• Equivalent to 28.6% of public spending on agriculture.
## Expenditures of Input Subsidy Programs

<table>
<thead>
<tr>
<th>Country</th>
<th>Annual Program Cost (USD million)</th>
<th>% of Ag Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malawi</td>
<td>152 to 275</td>
<td>47 to 71%</td>
</tr>
<tr>
<td>Tanzania</td>
<td>92 to 135</td>
<td>39 to 46%</td>
</tr>
<tr>
<td>Zambia</td>
<td>101 to 135</td>
<td>21 to 40%</td>
</tr>
<tr>
<td>Senegal</td>
<td>36 to 42</td>
<td>26 to 31%</td>
</tr>
<tr>
<td>Ghana</td>
<td>53 to 112</td>
<td>20 to 31%</td>
</tr>
<tr>
<td>Nigeria</td>
<td>108 to 190??</td>
<td>?? (officially 26%)</td>
</tr>
<tr>
<td>Kenya</td>
<td>22 to 81</td>
<td>9 to 26%</td>
</tr>
</tbody>
</table>

Source: Jayne and Rashid (2013)
Recent works suggest that inorganic fertilizer application may not be so low. Application rates higher than generally expected, but still lower than most official recommendations.

Sheahan and Barrett (2014)

% Percentage of cultivating households using inorganic fertilizer in main season

- **Ethiopia**: 56%
- **Malawi**: 77%
- **Niger**: 17%
- **Nigeria**: 41%
- **Tanzania**: 17%
- **Uganda**: 3%
- **LSMS-ISA avg**: 35%

**Average application rate = 26 kg/ha**

**Application rates of users > 40 kg/ha in 4 of 6 countries!**

Application rates higher than generally expected, but still lower than most official recommendations.
Malawi, with large subsidy has high inorganic fertilizer use

From Ricker-Gilbert and Jayne (2015)
Fertilizer use has gone up, but maize:fertilizer response rates are low

Recent Estimates of Maize Response to Nitrogen Applications in SSA

<table>
<thead>
<tr>
<th>Study</th>
<th>country</th>
<th>Agronomic response rate (kgs maize per kg N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marenya and Barrett (2009)</td>
<td>Kenya</td>
<td>17.6</td>
</tr>
<tr>
<td>Liverpool-Tasie (2015)</td>
<td>Nigeria</td>
<td>8.0</td>
</tr>
<tr>
<td>Burke (2012)</td>
<td>Zambia</td>
<td>9.6</td>
</tr>
<tr>
<td>Snapp et al (2013)</td>
<td>Malawi</td>
<td>7.1 to 11.0</td>
</tr>
<tr>
<td>Holden and Lunduka (2011)</td>
<td>Malawi</td>
<td>11.3</td>
</tr>
<tr>
<td>Pan and Christiaensen (2012)</td>
<td>Tanzania</td>
<td>8.5 to 25.5</td>
</tr>
</tbody>
</table>

(adapted from Jayne & Rashid, 2013, and Burke et al. 2015)

Most of these response rates are too low to break even in a benefit/cost ratio setting, (other than maybe Kenya)
Highly variable crop response rates – even among farmers in same areas in same seasons
Variation in farmers’ efficiency of fertilizer use on maize, Agroecological Zone Ila (central/northern), Zambia

Note: Zone Ila is a relatively high-potential zone suitable for intensive maize production; mean national NUE = 9.6 kgs maize per kg nitrogen (Burke, 2012).
African farming systems in densely settled areas commonly display 4 forms of unsustainable land intensification

1. Soil mining
2. Inadequate recycling of organic matter → loss of SOC
3. Demise of fallows
4. Limited profitability of using fertilizer at full market prices
Fertilizer response rates in degraded areas

Estimated marginal value product of nitrogen fertilizer conditional on plot soil carbon content

Source: Marenya & Barrett 2009
Photo courtesy of Dingi Banda, Lusaka Province, Zambia
Challenge 1:
Low response rates of maize to fertilizer among smallholders in SSA has important implications for the cost-effectiveness of input subsidy programs (ISP)
Findings on Input Subsidy Programs

1) Have increased total fertilizer use
   - Although issues with diversion (≈33%) Holden & Lunduka 2010; Lunduka et al. 2013
   - And crowding out (≈15%-30%) Ricker-Gilbert et al. (2011) Mason and Jayne (2013); Jayne et al. (2013)

2) Statistically significant **BUT SMALL** yield impacts (Jayne et al. 2013; Ricker-Gilbert & Jayne 2015; Holden & Lunduka 2010; Chibwana et al. 2014).
   - Beneficiaries enjoy the subsidy
   - But Benefit/Cost ratios ≈ 1.00

3) Statistically significant **BUT SMALL** indirect impacts
   - on agricultural wage rates (Ricker-Gilbert 2014)
   - and maize prices (Ricker-Gilbert et al. 2013; Arndt et al. 2015).
Implications for ISP

• Just increasing fertilizer use is not enough.
• It is about how efficiently the fertilizer is used!
• Important to remember that inorganic fertilizer is just one input into production.
  – Land
  – Seed
  – Labor
  – Water
  – Soil fertility
  – Management

• These other inputs affect the efficiency of fertilizer use – need a more holistic approach (Snapp et al. 2014)
Challenge 2: clarify program goals and objectives

Malawi’s Farm Input Subsidy Program (FISP)

- Gives 100 kgs of fertilizer and 5-8 kg of improved maize seed at subsidized rates (up to 95% off).
- Redeemed at government fertilizer depots

- Also requires complimentary inputs.
  - (land and labor)
- Should be targeted to people who don’t buy (much) commercial fertilizer.

Therefore, input subsidies SHOULD BE production enhancing programs first.

Social protection to reduce poverty and vulnerability second.
FISP NPK
2011/2012

Supply the bearer of this coupon with 50kg bag of NPK at K500.00.

Do not sell this voucher
Osagulitsa chitupachi

Republic of Malawi
TOM095749
Can be difficult to have **BOTH** productivity and poverty as program goals.

The Intersection of Input Subsidies and Vulnerability

- Some households reduce vulnerability due to input subsidies.
- The extent of the overlap depends on how many households can make use of the fertilizer.

*Source: Ellis and Maliro, 2013*
Different interventions have different objectives and intended beneficiary group.

No one program is superior, but all potentially compete for same scarce budget resources.
Cash Transfer

• Target to people little or no land.
• Provide money directly to recipients
• Help survive shock and smooth out income and consumption.
• **Cash for work** can help build productive assets in community to generate future income.
  – Good for households with available labor
• **Direct cash transfer** for labor constrained households.

• Not perfect, some of the same problems with ISP
  • Elite capture, corruption, etc.
  • But administration costs should be lower than ISP.
Output price supports are likely not pro-poor

Need to have enough surplus production to have something to sell. Hurts net-buyers of maize, who are likely to be poorer.
Lesson from Zambia: Scaled up purchase for grain reserve through parastatal.

- Induced supply response through area expansion, and less fallow (Mason et al. 2014)
- Benefited wealthier farmers who could expand area, could produce a surplus and could get it to depot
- Increased maize price likely hurt poor smallholders who are net-buyers of maize.

Not recommended as a pro-poor policy!
### ISP vs other long run investments

**Returns in Ag Growth to Investments & Subsidies in India, 1960-2000**

<table>
<thead>
<tr>
<th>Returns to Ag. GDP</th>
<th>1960’s</th>
<th>1970’s</th>
<th>1980’s</th>
<th>1990’s</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Return</td>
<td>rank</td>
<td>Return</td>
<td>rank</td>
</tr>
<tr>
<td><strong>Rup. prod/Rup. spent</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road investment</td>
<td>8.79</td>
<td>1</td>
<td>3.80</td>
<td>3</td>
</tr>
<tr>
<td>Education investment</td>
<td>5.97</td>
<td>2</td>
<td>7.88</td>
<td>1</td>
</tr>
<tr>
<td>Irrigation investment</td>
<td>2.65</td>
<td>5</td>
<td>2.10</td>
<td>5</td>
</tr>
<tr>
<td>Irrigation subsidies</td>
<td>2.24</td>
<td>7</td>
<td>1.22</td>
<td>7</td>
</tr>
<tr>
<td><strong>Fertilizer subsidies</strong></td>
<td>2.41</td>
<td>6</td>
<td>3.03</td>
<td>4</td>
</tr>
<tr>
<td>Power subsidies</td>
<td>1.18</td>
<td>8</td>
<td>0.95</td>
<td>8</td>
</tr>
<tr>
<td>Credit subsidies</td>
<td>3.86</td>
<td>3</td>
<td>1.68</td>
<td>6</td>
</tr>
<tr>
<td>Agriculture R&amp;D</td>
<td>3.12</td>
<td>4</td>
<td>5.90</td>
<td>2</td>
</tr>
</tbody>
</table>

Source: Fan et al. 2007

**Compare with R&D investment in Africa (Fuglie and Rada 2013):**
- National research B/C = 1.6 for small countries; 4.4 for large countries
- International CGIAR research B/C = 6.2 across Africa
Conclusions: on fertilizer use & ISP

1) Input subsidy programs have helped raise fertilizer use in SSA.

2) **Challenge 1:** High program costs and low response rates raises concerns about program efficiency and sustainability.

3) **Challenge 2:** ISP are production/productivity enhancing programs, but often expected to reduce poverty too.

4) Can crowd out spending on social protection programs and other investments that may have higher returns.
Conclusions: (continued)

4) Because input subsidies are politically popular and difficult to remove they will likely continue.

5) Steps to improve ISP:
   a) Improve transparency in budget allocation process
   b) Clarify goals and expectations of the program
   c) Increase required farmer contribution (currently < 5% in Malawi)
   d) Adopt more holistic approach to raise response rates and make fertilizer use more efficient
      i) Conditional subsidy (requires adoption of soil fertility management practices to participate).
      ii) Improve land tenure system to encourage investment in soil fertility
Thank you for your time!

jrickerg@purdue.edu
References


References (continued)


Some evidence that farmers may not be clear on what varieties they are growing

- SPIA, IITA, CIAT, MSU project comparing traditional farmer assessment of improved bean and cassava varieties with DNA fingerprints