Overcoming barriers to agricultural productivity for smallholder farmers

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what drives productivity?

Agricultural productivity = f

- **labor**
  - Irrigation infrastructure
- **technology**
  - Access to inputs
  - Extension services
- **transport infrastructure**
- **Finance**
- **Resource management**
- **resilience to shocks**
Productivity linked to input use

**Improved varieties of cereals**

- Sub-Saharan Africa: 24% (1980), 77% (2000)
- South Asia: 48% (1980), 85% (2000)
- East Asia & Pacific: 59% (1980), 80% (2000)

**Fertilizer use**

- Sub-Saharan Africa: 13% (1962), 73% (1982), 81% (2002)
- South Asia: 34% (1962), 73% (1982), 81% (2002)
- East Asia & Pacific: 98% (1962), 190% (2002)
- Middle East & North Africa: 34% (1962), 73% (1982), 81% (2002)
- Europe & Central Asia: 34% (1962), 73% (1982), 81% (2002)
- Latin America & Caribbean: 34% (1962), 73% (1982), 81% (2002)

*World Development Report (2008)*
role of technology

• Increases in output for cereals have come mostly from extensification, which is unsustainable
  – Damaging to environment
  – Land is a limited resource
  – Growing populations in much of the world

• Intensification requires technology adoption
Low adoption of technologies in Africa (despite large gains in lab/field trials)

Figure 2.13  Exploitable yield gaps are high for maize in Africa

<table>
<thead>
<tr>
<th>Country</th>
<th>Average national yield</th>
<th>Average yield in farm demonstrations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malawi</td>
<td>1.0</td>
<td>4.5</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>1.5</td>
<td>5.0</td>
</tr>
<tr>
<td>Nigeria</td>
<td>1.7</td>
<td>5.0</td>
</tr>
<tr>
<td>Uganda</td>
<td>1.6</td>
<td>5.0</td>
</tr>
<tr>
<td>Mali</td>
<td>1.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Mozambique</td>
<td>1.0</td>
<td>3.0</td>
</tr>
</tbody>
</table>
results chain

Hypothesis: *Increase agricultural productivity & profitability through innovation*
results chain

Agricultural Innovations

Black Box!

Increased productivity & farm income

What is the path from research center to sustained productivity ...?
innovations

• Improved varieties (higher yield, resilient)
• Irrigation (solar, micro)
• Storage & transport
• Conservation techniques
• ICTs
• Weather-indexed insurance
• Mechanization
results chain

Which are the best strategies to use, as we move along the results chain?

- Technology generation
- Technology dissemination (supply)
- Technology Adoption (demand)
- Post-harvest management and profit generation
results chain

• Do we know the best strategies to ...
  – disseminate new technologies?
  – sustain adoption of new technologies?
  – help farmers commercialize products?

• Use IE to maximize project effectiveness
  – test different strategies to overcome barriers along each step of the results chain
  – determine the best strategies in your context
results chain

• Technology generation: Assume productivity gains (from test plots)
results chain

• How to spread new technologies?

Technology generation

Technology dissemination (supply)

Technology Adoption (demand)

Post-harvest management and profit generation
barriers to dissemination

Common constraints to dissemination:

1. Inefficient (or missing) input markets

2. Missing information
INPUT MARKETS

Farmers may be unable to access new technology due to barriers within input markets:

– Missing, incomplete, or unreliable supply chains
– Unprofitably high input prices

• Potential strategies:
  – Improve reliability of input delivery
  – Use free, existing social networks
supply chain reliability
dissemination

- **Kenya** [Casaburi et al, 2014]
  - When farmers can report delays in input (fertilizer) provision to the company, it reduces delivery delays by 22%

- **Pakistan** [Berman et al, ongoing]
  - Households report by mobile phone on livestock extension services (quality, price) and results are reported back to the extension workers’ supervisors

- **Uganda** [Yanagizawa-Drott et al, ongoing]
  - High incidence of counterfeit fertilizers on the market: unreliability
  - What are the impacts of counterfeiting on small-holder adoption rates?
social networks

dissemination

• **India** [Sadoulet et al, 2014]
  – Decentralized trade of improved seeds (through social networks) does not meet demand, in part because of closed networks (within-caste).
Missing information can prevent adoption:

– Farmers need to know how to use new technologies, and what the benefits are

– Public extension networks have challenges: understaffed, lack of accountability / incentives

– Risks of inaccurate information
Potential strategies to overcome information gaps:

– Take advantage of existing social networks
– Help farmers participate in dissemination
– Improve incentives for extension providers
– Make demonstrations more effective

Understand gender dimensions
social networks

• Who talks to whom?
• How to take advantage of existing social networks?
• Trade-off:
  Frequent interactions with similar/nearby farmers vs.
  Limited interactions with extension workers
• **Ghana** [Conley & Udry, 2008]
  – Farmers more likely to adopt a new crop when social network has had recent good experiences

• **Malawi** [Magruder, Beaman, BenYishay & Mobarak, ongoing]
  – Concentrating extension services on multiple well-networked contact farmers can accelerate the spread of information in villages

• **Malawi** [BenYishay, Jones, Kondylis & Mobarak, 2014] & Mozambique [Kondylis & Mueller, 2014]
  – Can village-level contact farmers be as effective as traditional extension workers?
  – Uses IE to test complements and alternatives to traditional extension systems
Trainings don’t work if farmers don’t participate!

– Evidence from other sectors that feedback can improve quality of service delivery

• **Rwanda** [Jones, Kondylis & Stein 2014]
  – Does giving farmers opportunities to provide feedback on quality and content of private extension services improve attendance, satisfaction, or take-up?

• **Indonesia** [Hanna et al, 2013]
  – Participating in a trial itself has little effect on adoption of new practices, but participation plus a summary of effects on the farmer's own plot increases adoption
incentives

Link pay to performance for extension providers

• **Malawi** [BenYishay, Jones, Kondylis & Mobarak, 2014]
  – in-kind incentives (seed, fertilizer, bicycles) for extension workers who increased rates of adoption of key technologies

• **Mozambique** [Kondylis & Mueller, 2014]
  – material and social incentives (public recognition) for extension workers
demonstrations

What is the best way to demo new technologies?

• **Bangladesh** [Jones, Kondylis, Mobarak & Stein, ongoing]
  – Test increasing number of demo plots per village: is there a “tipping point”?
  – Decentralize demonstration: learning by seeing vs. learning by doing

• **Rwanda** [Duflo & Suri, ongoing]
  – Tests impact of demonstration-based training on productivity & adoption for smallholder coffee farmers
  – Training covers ¼, ½, or ¾ of HHs in village to test how knowledge spreads through the rest of the village
Gender gap: women produce less per hectare

- Malawi: 25% lower average productivity for women
- Could women learn more from other women? Extension work traditionally male dominated.
- Do interventions affect women differently?

- **Malawi** [BenYishay, Jones, Kondylis & Mobarak, 2014]
  - randomized gender of contact farmers

- **Mozambique** [Kondylis & Mueller, 2014]
  - added female contact farmers to supplement existing extension staff
Quality of the information matters

- **Kenya** [Duflo et al, 2008]
  - Fertilizer can be profitable for farmers, but extension that optimizes for yield only (instead of profits) reduces adoption.
  - Optimizing for profit requires consideration of microclimates, farmer’s access to synergistic inputs, and market conditions.
results chain

• How to promote & sustain adoption of new technologies?

Technology generation
Technology dissemination (supply)
Technology Adoption (demand)
Post-harvest management and profit generation
barriers to adoption

• Dissemination of technology is not necessarily enough to increase take-up!

• Additional barriers include:
  1. Poor access to credit/loans
  2. Risk/uncertainty of new technology
  3. Failures of coordination & externalities
  4. Behavioral biases that prevent adoption
facilitating adoption

• Opportunities to facilitate adoption
  1. Increase access to **finance**
  2. Help overcome **risk aversion**
  3. Foster **collective** action & overcome externalities
  4. **Sustain** adoption over time

  *Understand **gender** dimensions*
FINANCE

adoption

Farmers may be unable to adopt new technology due to missing or inefficient credit markets.

• Potential strategies:
  – Access to flexible credit
  – Finance timed to seasons
  – Pre-commitment devices
Credit markets provide access to capital for key inputs...

- **Kenya** [Suri et al, forthcoming]
  - Flexible, collateralized loans for water tanks (irrigation) had higher take-up than other loans
- **Kenya** [Ashraf et al, 2009]
  - Loans helped farmers switch to export crops but did not increase income

Caveat: *Access to capital alone is not adequate to increase profits*

- **Ghana** [Karlan et al, 2013]
  - Cash grants to farmers had no impact on profitability
Seasonal timing of loans to smooth consumption, improve adoption and increase profits.

- **Zambia** [Jack et al, forthcoming]
  - take-up of maize loans to farmers in the lean season was 90 percent. Borrowers reported fewer missed meals and were less likely to work on other farms.

- **Kenya** [Duflo et al, 2011]
  - free delivery of fertilizer right after harvest increases fertilizer use more than a 50% price subsidy

- **Mali** [Beaman et al, 2014] & **Uganda** [Matsumoto et al, 2013]
  - Loans or credit with repayment scheduled after harvest increased farm-level investment (and profits)
People do not choose to do now what would increase their wellbeing later... Pre-commitment products can shift behavior

- **Rwanda** [Jones, Kondylis & Stein, 2014]
  - Accounts targeted for agricultural input savings increase investments in seeds and fertilizers, and the total value of production and sales for men

- **Malawi** [Brune et al, 2013]
  - Commitment savings accounts increase agricultural input use, crop sales, and household expenditures
RISK

adoption

Take up of a new product/technology may require an initial leap of faith...
New technologies that decrease risk can stimulate investment in other inputs.

• **India** [Sadoulet *et al*, 2013]
  – Submergent-tolerant rice improved yields by 45 percent in flood-prone areas, causing farmers to invest more in fertilizer, with less reliance on traditional seeds.
Insurance sold to farmers gets low adoption and does not necessarily drive adoption. Selling to groups may be more sustainable.

- **India** [Cole *et al*, 2012]
  - Take-up of rainfall insurance constrained by lack of trust, liquidity constraints, and limited salience

- **Ethiopia** [McIntosh *et al*, 2013]
  - Take-up of index insurance was zero among farmers who did not receive a subsidy.

- **Malawi** [Gine & Yang 2009]
  - Credit for high-yield hybrid maize and groundnut seeds tested against package of credit + weather insurance; Insurance made people less likely to adopt inputs
Insurance can promote farm-level investment, in some cases...

- **Ghana** [Karlan et al, 2012]
  - Tested: cash grant vs. grant for weather insurance vs. cash grant + grant for weather insurance vs. status quo
  - Demand for crop insurance increased when individual’s social network received payouts in previous year
  - Underinvestment is more due to risk-aversion than to lack of capital
COLLECTIVE ACTION

Adoption of some technologies requires coordinated action by producers or buyers

• Adoption may require upfront coordination
• Adoption may generate public externalities, with costs to early adopters
• Technology may require collectively-owned resources
contracts

Enforcing contracts can improve producer effectiveness and benefit-sharing

- **Senegal** [De Janvry et al, ongoing]
  - Facilitate partnerships of smallholder organizations and commercial actors to monitor members’ behavior and to enforce rules

- **Sierra Leone** [Casaburi et al, ongoing]
  - Introduce quality contracting into cocoa export markets

- **India** [Banerjee et al, ongoing]
  - Displaying milk quality seems to be associated with reduced variance in milk quality
Natural resource management strategies may help overcome externalities

- Common pool resource management
- **Kenya** [Leino et al, 2008]
  - Women’s participation in water management boards do not improve outcomes
• Many people try *new things* but then stop using them after the first use
  – Will farmers plant improved seeds year after year?
  – Will farmers invest in inputs every season?
  – Will contact farmers continue to disseminate new technologies?
  – Does the impact of incentives reduce over time?

• Limited evidence on longer-term impacts of most technologies
reminders

**SMS reminders & contracts may be helpful**

- **Kenya** [Casaburi et al, ongoing]
  - Tested whether sending SMS text reminders to plant, fertilize, weed, etc can improve take-up of extension information
  - SMS reminders increased yields by 11.5%

- **Kenya** [Mullainathan et al, ongoing]
  - Contracts to sugar cane producers providing cash advances, conditional on farmers' performance along harvest cycle
Do interventions affect women differently?

- **Mali** [Beaman et al, 2014]
  
  Access to capital generally does not increase farm income, but cash grants to female farmers increases profits.
How to make sure new technologies lead to productivity gains?

- Technology generation
- Technology dissemination (supply)
- Technology Adoption (demand)
- Post-harvest management and crop sales
OUTPUT MARKETS

Increasing yields won’t increase incomes if farmers cannot access markets (at the right time)

• Inefficiencies in output markets
  – Lack of access to additional markets
  – Low prices for yields, including high quality crops
structure matters

profit generation

Shallow/ local markets with fixed demand

Lower profits for farmers adopting yield-increasing technology

Access to deeper markets

New technology brings higher profits as well as higher yields
OUTPUT MARKETS

• Opportunities to improve commercialization

1. **Storage** to smooth seasonal price differences
2. Increase **value add** with processing, grading, HVCs
3. **Linkage** of farmers to markets to lower search cost
4. Access to **price information** and market demand

Foster **collective action** among producers
• **Kenya** [*Burke et al, forthcoming*]
  – Harvest loan aimed at improving grain storage had high take-up (60 to 70 percent) and led to significant increases in farmer storage and subsequent farm profits (selling high).

• **Sierra Leone** [*Casaburi, ongoing*]
  – Does access to storage reduce price fluctuation and increase bargaining power?
  – Testing providing community storage & individual inventory credit

• **Uganda** [*McIntosh et al, ongoing*]
  – Tests the distribution of grain storage stocks in e-warehouses to intermediaries, to facilitate match between buyers and sellers
value add

profit generation

• **Kenya** [Ashraf, Gine & Karlan 2008]
  – how to encourage farmers to shift to high-value export crop production?
  – Tested providing information on how to switch + marketing services + credit for inputs
  – Increased production of export crops *but didn’t increase profit*

• **Brazil** [Kondylis et al, ongoing]
  – strengthening rural organizations
  – Capacity: Technical assistance to strengthen managerial capacity
  – Identifying opportunities: Support the development of business proposals
  – Credit: Matching grants to invest in processing infrastructure to increase value-added
linkage

profit generation

• **Niger** [Aker, 2010]
  – mobile phones led to a 10-16% reduction in grain price dispersion, primarily through reducing farmer cost to search for sellers

• **Bangladesh** [Ali, 2010]
  – Transport infrastructure (roads) increased adoption of high yielding varieties by farmers

• **Sierra Leone** [Casaburi et al, 2013]
  – Quality road improvements reduce transport costs for producers but decrease prices of staple crops
Farmers get price information.

Farmers sell at markets where prices are high.

Market prices converge.
price information

profit generation

• **India** [Jensen, 2007]
  – adoption of mobile phones by fishermen & wholesalers reduced price dispersion, eliminated waste, increased fisherman profits

• **Uganda** [Svenssen et al 2008]
  – providing commodity market prices via FM radio increased farmgate prices because farmers could bargain with traders

• **India** [Minten & Fafchamps 2012] & [Mookherjee et al, 2013]
  – SMS messages providing price information to farmers in India did not affect market prices received, because no change in market structure
  – Potato farmers provided with wholesale market prices did not receive higher prices from middlemen, because no change in bargaining power

• **India** [Cole et al, ongoing]
  – Price variations can be unpredictable, and price risk is a barrier to investment in smallholder farms
  – Testing whether providing financial training & information on futures and spot prices helps farmers manage price risk
results chain

BARRIERS & CONSTRAINTS

- Unreliable input markets
- Missing information
- Lack of Finance Risk
- Externalities Biases
- Lack of access to output markets
  - Low prices

STRAATEGIES

- Audit deliveries
- Social networks
- Engagement
- Extension Incentives
- Demo Intensity
- Timely Finance Insurance
- Contracts
- Pre-Commitment Reminders
- Storage Value add
- Linkage
- Price Info

Innovation
Dissemination
Adoption
Profit generation
results chain

Think about which barriers affect your program, and which strategies you want to test...

Technology generation
Technology dissemination (supply)
Technology Adoption (demand)
Post-harvest management and profit generation
final notes

*Rarely does one intervention solve all problems!*  
- Mix of flexible credit/finance plus risk reduction or information may be required  
- Successful interventions consider seasonal variation in farmer income  
- Need to consider market structure when designing linkage or price information strategies

*Other issues to consider (not addressed here):*  
- Labor market inefficiencies  
- Land markets