Smallholder Adoption of Integrated Soil Fertility Management

Speakers
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Facilitator
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Dr. Moore has more than 30 years of experience in the design, implementation, and analysis of agricultural and natural resource-based projects and policies around the world. He has managed research, education, and technology transfer programs, diagnosed institutional and technical constraints, designed information systems, facilitated stakeholder communication, and led conflict management workshops. Dr. Moore currently serves as Interim Executive Director of the Office of International Research, Education, and Development at Virginia Tech.
Ephraim Nkonya
International Food Policy Research Institute

Dr. Nkonya is a senior research fellow at the International Food and Policy Research (IFPRI) Institute and has conducted research on land management and natural resources in sub-Saharan Africa and central Asia. He joined IFPRI in 1999 and was outposted in Uganda where he led a project on land management and poverty reduction from 1999 to 2003. Ephraim now leads a program on land resources for poverty reduction.
Technological Change in Soil Management Practices: Context and Innovation

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Office of International Research, Education and Development
What is the problem?

- Agriculture in sub-Saharan Africa is constrained by degraded soils

- There are no universally predictive factors for the adoption of improved soil management practices (Knowler and Bradshaw 2007)
What is Integrated Soil Fertility Management?

“A set of soil fertility management practices that necessarily includes the use of fertilizer, organic inputs, and improved germ plasm combined with the knowledge on how to adapt these practices to local conditions, aiming at maximizing agronomic use efficiency of the applied nutrients and improving crop productivity. All inputs need to be managed following sound agronomic principles.”

-- Vanlauwe (2010)
Objectives

What drives small-farmer decision making?

How can we leverage this understanding to foster innovation in agricultural practices?
Analytical Approach

Phase 1: Framing the problem, its context, and the consequent choices faced by small farmers

Phase 2: The process of farmer decision making with respect to technological change in agriculture
Outlining the Analytical Approach

1. **Frame** the problem
   - Differences in soil fertility perceptions
   - Economic factors affecting smallholder enterprises
   - Faith-based framings of agricultural knowledge

2. **Change Paradigm** of Adoption and Innovation
   - Actors, time, innovations

3. **Adapt Technical Assistance**
   - Innovation networks and platforms
# Perceptions of Soil Fertility

<table>
<thead>
<tr>
<th></th>
<th>Scientist’s Perception</th>
<th>Farmer’s Perception</th>
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<tbody>
<tr>
<td><strong>Measured Through:</strong></td>
<td>Chemical analysis of nutrients</td>
<td>Visual assessments of crop performance and yield</td>
</tr>
<tr>
<td><strong>Factors for determining soil fertility:</strong></td>
<td>Threshold levels of nitrogen, phosphorus and potassium (NPK)</td>
<td>Soil color, crop yield, and presence of indicator weeds</td>
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<tr>
<td><strong>Consequent Prescription:</strong></td>
<td>Maximize soil quality for improved production</td>
<td>Optimize soil use for livelihood priorities</td>
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</table>
Economic Context: Mixed Production and Consumption Units

- Off-farm income
- Diversification and risk
- Informal network pressure
- Investment trade-offs
- Implications for econometric analyses
The Role of Faith-Based Knowledge

Adoption of new technologies involve the farmer’s broader attitudes, beliefs, and practices

Faith and conservation agriculture

• Faith-based organizations
• Brian Oldrieve

Must take into account how worldviews provide meaning to perceived choices
What have we learned?

1. Farmers and scientists see the world with different lenses and objectives.

2. Economic factors that shape ISFM choices include complex farm-household livelihood systems.

3. Ideologies and religions can be mobilized to help frame ISFM choices.
Smallholder Adoption of Integrated Soil Fertility Management

Ephraim Nkonya
International Food Policy Research Institute
What is integrated soil fertility management (ISFM) & why is it important?

- **What is ISFM?**
  - ISFM is a set of land management practices that combine use of organic inputs, judicious amount of inorganic fertilizer and improved crop varieties (Vanlauwe et al 2010).

- **Why is ISFM important?**
  - Could reduce use of inorganic fertilizer by >50% ➔ beneficial to the environment,
  - More appealing to smallholder farmers – especially in SSA where transaction costs for external inputs are high
  - Enhances mitigation of adaptation to climate change by increasing soil carbon
  - More sustainable than use of inorganic fertilizer only
  - More profitable than inorganic fertilizer only
ISFM and climate-related production risks

• **Yield variance** under land management practices which combine chemical fertilizers with organic inputs was lower than those which use either chemical fertilizer or organic inputs only (**yield variance**).
  • This suggests ISFM reduces climate change related production risks.
  • This underscores the crucial role, which ISFM can play in reducing climate change related risks.
Relationship of soil carbon and yield & production risks, household survey data 

Uganda

Land management practices that increase soil carbon reduce production risks & increase crop yield
Change in millet yield variance (30 year period), Mali, DSSAT simulation

- 100% crop residue only
- Manure 1.7 tons/ha, 50% crop residues
- 40kgN/ha, manure 1.7tons/ha & 50% crop residue
- 80kgN/ha, 100% crop residue
- 80kgN/ha, 5 tons/ha manure, 100% crop residue
ISFM practices are more sustainable

Millet yield change after 30 years, Mali

Yield change (tons/ha)
ISFM practices are more profitable

Net benefit, maize & rice (Nigeria)

- All zero
- 100% residue
- Compost 1.67 tons/ha, residue 50%
- Manure 1.67 tons/ha, residue 50%
- 40kgN/ha, manure 1.67 tons, 50% residue
- 80kgN, residue 100%
- 80kgN/ha, compost 5 tons/ha, residue 100%
- 80kgN/ha, manure 5 tons/ha, residue 100%

Net benefit (000Naira/ha)

- Rice
- Maize
Returns to fertilizer and ISFM, Maize

Change of Profit when farmer switches from 80kgN/ha to 40 kgN/ha, 1.7 tons/ha manure
The unholy cross: Inverse relationship between profit and adoption rate

Average adoption rate & returns of land management practices, Kenya, Malawi, Mali, Nigeria, Niger & Tanzania

Adoption rate (%); Profit (US$/ha/year)
Why low adoption rate of ISFM?
Extension messages on organic inputs is low – case of Nigeria

- Improved seeds: 56%
- Inorganic fertilizer: 18%
- Agrochemicals: 10%
- Planting: 10%
- Organic fertilizer: 1%

Note: No advisory Services on CC ➔ Send back to School AEA
ISFM is labor intensive, requires livestock to produce and transport organic inputs

• Land management practices using organic inputs have high labor intensity
  • Labor accounts for 50% of the production cost of combining chemical fertilizer and organic inputs

• Manure production & other organic inputs need to be produced and transported to crop plots
Contribution of labor to total production costs, Mali

Assuming 40kgN/ha, & 1.7 tons/ha of manure or compost

Share of labor to total cost

- Millet
- Cotton
- Rice
- Cowpea
- Maize
Women less likely to adopt inorganic fertilizer but more likely to adopt organic inputs
Lack of public investment on organic soil fertility management

- Government investment on soil fertility management practices largely focuses on inorganic fertilizer and improved seeds. Limited support on organic soil fertility management.

<table>
<thead>
<tr>
<th>Country</th>
<th>% of GDP</th>
<th>% subsidy</th>
<th>Subsidized inputs</th>
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</thead>
<tbody>
<tr>
<td>Malawi</td>
<td>2-3%</td>
<td>64-79%</td>
<td>Fertilizer &amp; seed</td>
</tr>
<tr>
<td>Zambia</td>
<td>0.40%</td>
<td>60%</td>
<td>Fertilizer &amp; seed</td>
</tr>
<tr>
<td>Ghana</td>
<td>0.05-0.1%</td>
<td>50%</td>
<td>Not specified</td>
</tr>
<tr>
<td>Tanzania</td>
<td>0.40%</td>
<td>50%</td>
<td>Fertilizer &amp; seed</td>
</tr>
<tr>
<td>Nigeria</td>
<td>-</td>
<td>50%</td>
<td>Fertilizer &amp; seed</td>
</tr>
</tbody>
</table>
What could be done to increase adoption of ISFM?
Conditional fertilizer subsidy & other incentives: The case of Malawi
Targeted Vouchers conditional on adoption of ISFM

**Scheme 1:**
Fertilizer Voucher
Discount for a 50kg bag

**Scheme 2:**
Rainfall Insurance Voucher
Discount on premiums

**Scheme 3:**
Cash
Direct Payment or Credit from a revolving fund
Choice experiment, Malawi

Percent choosing subsidy/insurance

Cash payment (t)

Insurance
Fertilizer subsidy
Key Findings & implications

• With no exception, all farmers responded to incentives to plant agroforestry trees!!

• Cash Payments preferred to an ideal crop insurance contract by most farmers, even when the value of the ideal crop insurance contract was substantially higher

• Fertilizer subsidies preferred to the ideal insurance contract
Conclusions and policy implications

- ISFM adoption could be increased by:
  - Offer **short-term training for agricultural extension agents** on ISFM, climate change, & other new changes
  - Farmers strongly respond to incentives. ➔ For countries that provide subsidies, conditioning such benefit to easily verifiable organic soil fertility management practices (e.g. agroforestry) will more than reduce current cost of subsidies, yet increase yield and profit
  - High labor intensity of ISFM could be addressed by promoting **agroforestry** and other plant-based organic soil fertility management practices
Thank you
Phase 2: Technological Change

Tracing a Paradigm Shift

• From Rogers’ The Diffusion of Innovations (1962)
• To The Innovation Systems Perspective

Changing Perceptions of:

• The identity of actors
• The dynamics of time
• The concept of innovation
Rogers’ Diffusion of Innovations

From Rogers, 1971
Rogers’ Diffusion of Innovations

Actors

• Categorized based on the time-frame in which they adopted the innovation

Time

• Only relevant as its passing alters the percentage of the population that has adopted the technology

Innovations

• Transferable, unchanging objects
More Dynamic Models

Recognize:

- Changes over time
- Influence of marketing networks and market positions
- Early adopters change landscape for late adopters

However, most still assume an unvarying innovation
Actor Interaction and Social Learning

Innovators and Imitators

- Henrich (2001): biased cultural transmission
Biased Cultural Transmission

Henrich (2001)

The S-shaped diffusion curve

S-Curve

The R-shaped diffusion curve

R-Curve
Innovators and Imitators
  • Henrich (2001): biased cultural transmission

Actors embedded in social networks
  • Granovetter (1974, 1985)

Collaboration for innovation
Broadening the Concept of Innovation

Reflexive and continuous process
  • Biggs (1990), Biggs and Clay (1981)

Adaptive management and social learning
  • Sayer and Campbell (2004)

Institutional and organizational change
  • Nederlof and Pyborn (2012), Tenywa et al. (2011)
Paradigm Shift

Actor Interaction and Social Learning
- Imitation
- Collaboration
- Innovation

Broadened Concept of Innovations
- Dynamic
- Context-specific
- Time-responsive
The Innovation System Paradigm

Soil management in complex adaptive systems involves:

- Constant adaptation to changing climate and markets
- That all partners learn and adapt simultaneously
- Recognizing farmers as the key actors

How does the innovation system paradigm change our approach to fostering technical change in agriculture?
Innovation Networks and Platforms

Networks
- Mutual desire to improve a product or process
- Foster access to knowledge and physical inputs

Platforms
- Deliberately formed innovation network
- Assemble actors to identify and resolve issues
- Innovation brokers
Innovation Brokers

Main Functions of Innovation Brokers:

- Facilitating social learning
- Relationship building and brokering
- Analyzing the context and articulating demand
- Lobbying and translating innovation results
- Facilitating interaction between organizations
The Educational Challenge

Change agent perspectives

- Agricultural extension agents are trained in conventional production practices and that are conveyed as memorized scientific “facts”

Negotiating new roles and skills for facilitators and learners

- Local leadership development
- Support and sustain new brokerage roles
- Create space for innovation
- An enabling national policy environment
Formulating the Messages

To influence stakeholders, scientific knowledge needs to be:

- **Credible**: scientific adequacy for technical evidence and arguments

- **Salient**: relevant to decision-maker assessment of needs

- **Legitimate**: perception that information has been respectful of stakeholders’ divergent values and beliefs
Conclusion

Phase 1: Local context matters

Phase 2: Innovation is a dynamic and social process

Innovation platforms as a forum for a farmer-driven innovation process

Moving forward:

Need for trained innovation brokers
Thank You

comments, critiques, and questions
Thank you for joining us!

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Contact Us: agrilinks@agrilinks.org

OR

Julie MacCartee, USAID/BFS jmaccartee@usaid.gov

Upcoming Events

Feb 2 | Webinar | Food Price Volatility

February Ag Sector Council

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