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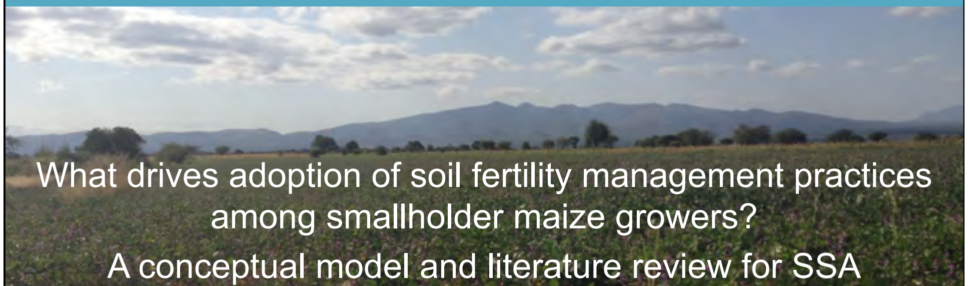

What drives adoption of soil fertility management practices among smallholder maize growers? A conceptual model and literature review for SSA

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MOTIVATION

- Growing recognition that increasing **inorganic fertilizer use alone insufficient to sustainably raise maize yields** in SSA
- Maize **rotations and intercrops with legumes**, use of **animal manure**, & **other soil fertility management (SFM) practices** have the potential to **increase SOM**/**soil fertility**, and raise **crop yields** and/or **profitability** of inorganic fertilizer use
- In this presentation:
  1. How might we **conceptually model** maize farmers' adoption of SFM practices?
  2. **Literature review for SSA**
     a. Modeling approaches
     b. Empirical findings

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Simple conceptual model

A profit-maximizing maize producer **chooses levels of inputs** (e.g., f, m, $\boldsymbol{s}$) **and set of SFM practices** (ϕ_i in Φ) **to maximize the discounted stream of profits** (π) subject to production function (technology) and soil fertility change constraints and given their initial soil fertility level

Discounted stream of profits $\max_{f_t, m_t, \phi_{it}, \mathbf{s}_t} \sum_{t=0}^{\infty} \beta^t \pi_t$

Profit = Revenue - costs where $\pi_t = \mathbf{y}_{it}\mathbf{p}_t - w_t^f f_t - w_t^m m_t - \mathbf{s}_t \mathbf{w}_t^{\mathbf{s}} - c_i(x_t, \phi_{it})$

subject to:

Production function $\mathbf{y}_{it} = \mathbf{y}_i(x_t, f_t, m_t, \mathbf{s}_t, \phi_{it}; \mathbf{z}_t)$

Soil fertility change $x_{t+1} = x_t + g_i(x_t, f_{t,} m_t, \mathbf{s}_t, \phi_{it}; \mathbf{z}_t)$

Initial soil fertility $x_0 = \alpha > 0$

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Conceptual model implications for empirical work: Likely drivers of SFM adoption

- **Crop prices** (maize, legumes, etc.)
- **Input prices** (inorganic fertilizer, seeds, wages (or labor availability), etc.)
- Farmer's **discount rate**
- **Initial soil fertility**
- **Agro-ecological conditions** (rainfall, temperature, etc.)

Many other potentially important determinants from an economics perspective

- Landholding and plot size, in-fields vs. out-fields, tenure security
- Access to information, markets
- Farmer characteristics, knowledge
- Quasi-fixed factors of production; off-farm income; access to credit
- Government policies (e.g., input or output markets)
- Risk profile of SFM practices vis-à-vis farmer's risk preferences

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Review of SSA literature (ag econ & interdisciplinary journals)

- 19 papers (so far)
- Ethiopia, Ghana, Kenya, Malawi, Rwanda, Tanzania, Zambia, Zimbabwe
- Main SFM practices analyzed:
  - **Maize-legume intercropping, rotations**
  - **Animal manure and/or compost** (organic fertilizer)
  - **Crop residue retention**
  - **Soil and water conservation** (SWC – e.g., min. tillage, terraces, etc.)
  - **Inorganic fertilizer**

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Observations

- Most have **no conceptual model** → kitchen sink regressions
- Very few include input and/or output **prices**
- Most (14 of 19) based on **cross-sectional data**
- Most **model adoption as a binary decision** without considering extent/intensity

➔ ***A lot of room for improvement and better insights/policy guidance!***

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Broad findings: socioeconomic factors & SFM adoption

- ↑ **Inorganic fertilizer price:** ↓ for own quantity, ↑ for manure use
- ↑ **Labor endowment:** ↑ for labor-intensive technologies
- ↑ **Landholding size:** ↓ for land-saving technologies
- ↑ **land tenure security:**
  ↑ esp. for longer-term investments
- ↑ **Livestock owned:** ↑ esp. for manure
- ↑ **Education of HH head:** ↑

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Broad findings: fertilizer subsidies & SFM adoption

ZAMBIA (Levine, Morgan, Mason, & Zulu-Mbata)
- ↓ fallowing, rotation, and intercropping
- No stat. sig. effect on manure use
- ↑ maize yields in short-run but ↓ soil fertility in the longer-run?

MALAWI & GHANA
- No stat. sig. effects on manure use, legume intercropping, or SWC (Holden & Lunduka 2012; Vondolia et al. 2012; Koppmair et al. 2016)

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Work in progress

1. **Zambia's FISP** & **SFM** adoption (Levine, Morgan, Mason, & Zulu-Mbata)
2. **Conceptual model** of SFM adoption & simulations of optimal SFM regimes (Morgan, Kim, Olson, & Mason)
3. ** Drivers of **SFM adoption & nutrition impacts** in Tanzania (Kim, Mason, Snapp, & Kassim)
4. ** **Kenya's NCPB & SFM** adoption (Olson & Mason)

*** Consider adoption of* ***combinations of SFM practices*** *with the potential to contribute to SI in maize-based systems*

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Combinations of SFM practices (on maize plots) and degree of SI

Case	Inorganic fertilizer	Organic fertilizer	Legume intercrop	SI ranking
1				0
2	X			1
3		X		2
4			X	2
5	X	X		3
6		X	X	3
7	X		X	3
8	X	X	X	4

Note: For "SI ranking", 0 = "least SI", 4 = "most SI" among the 8 cases

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