Heterogeneous Constraints and Incentives and the Uptake of Agricultural Innovations by Smallholder Farmers

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LSMS-ISA data show that uptake of modern ag inputs varies markedly, both within and among countries. (Sheahan & Barrett, *FP* in press)
Poor but efficient revisited

Observations of smallholder inefficiency often reflect failure to control for variation in natural conditions uncontrollable by farmer.

Ex: Ivorien rice farmers – median is on PPF w/ control for soils, rain, pests, etc. vs. 52% w/o (Sherlund, Barrett & Adesina JDE 2002)

If smallholders really are poor but efficient, perhaps non-uptake is optimal as well??

Fig. 2. Distribution functions for estimated plot-specific technical efficiencies.
Likely reflects heterogeneous returns

Probably relatedly, a number of recent studies find spatially heterogeneous returns to inputs:

- Suri (*EMTRA 2011*) – Kenya hybrid maize seed
- McCullough et al. (WP 2016) - Ethiopia fertilizer
- Burke et al. (*AgEcon 2016*) - Zambia fertilizer
- Harou et al. (*JAfrEcon in press*) - Malawi fertilizer

https://www.ag-analytics.org/AgRiskManagement/EthiopiaGeoApp
Disadoption rates often high

If ag innovations always superior, we should see negligible disadoption. But disadoption common.

Example: System of Rice Intensification (SRI)
In spite of 60-80% true yield gains often found:
- Haiti (Turiansky WP 2016)
- Indonesia (Takahashi & Barrett AJAE 2014)
- Madagascar (Moser & Barrett AgEcon 2006)
1. Nature limits profitability

The profitability of modern ag inputs commonly depends on natural endowments:

- Soil quality
  - Soil organic carbon, other nutrients, Ph (Marenya & Barrett AJAE/AgEcon 2009, Suri EMTRA 2011, Harou et al. Ag Econ in press, Burke et al. Ag Econ 2016, Harou et al. JAfrEcon in press)
  - Within-village variability in soil quality also impedes learning (Tjernstrom WP 2015)

- Water (irrigation, rainfall, soil water retention capacity, evapotranspiration)

- Temperature, altitude and growing season length

- Biotic and abiotic stresses (e.g., aluminum, iron, salt, striga)

Agroecological niches therefore crucial to suitability/profitability
1. Nature’s complementary inputs

**Example: Soil degradation in Kenya** Marginal returns to fertilizer application low on degraded soils; and poorest farmers are on the most degraded soils. Soil degradation also feeds a striga weed problem that discourages uptake ($7bn/yr in crop losses).

Marenya & Barrett *AJAE* 2009
2. Labor availability

Many agricultural innovations also require labor availability (hh or hired).

Examples:

SRI (Haiti, Madagascar, Indonesia, Timor Leste – Moser & Barrett Ag Econ 2006; Noltze et al. EcolEcon 2012; Takahashi & Barrett AJAE 2014, Turiansky WP 2016)

Mucuna (Honduras, Neill & Lee EDCC 2001)

Herd splitting among pastoralists(Toth AJAE 2014)
3. Gender

Male-run plots more likely to use modern inputs (Sheahan & Barrett *FP* in press).

Returns to inputs appear lower for female farmers (due to social norms on labor and market access, etc.)
4. Market access and prices

Market access:
Transport costs and reliable access to intermediaries drive input/output prices
Omamo (AJAE 1996)

Fuel prices have a big impact on food prices due to infrastructure deficiencies
(Dillon & Barrett AJAE 2016)

Burkina Faso school feeding program and cowpeas (Harou et al. WD 2013) – trader seasonality, market access and bulking
Two puzzles: Uneven adoption within hhs
Ex 1 - Limited joint input application

LSMS-ISA data show little joint uptake of modern ag inputs despite agronomic synergies and contrary to ISFM principles.

(Sheahan & Barrett, FP in press)
Plot-level inverse size-productivity relation

Plot-level input application and productivity varies inversely w/plot size. True within-hh and w/controls for soil quality and actual size, so not due to ORV, measurement error, or heterogeneous shadow prices.

Adoption varies even across plots w/n hh ... why? Edge effects hypothesis?

(Barrett, Bellemare & Hou WD 2010; Carletto, Savastano & Zezza JDE 2013; Sheahan & Barrett, FP in press; Bevis & Barrett, 2016 WP)
Key implications

1. Context matters
- Best technologies vary among farmers, even among plots ... one size fits all rarely works
- Agroecological niches crucially important
- Physical and institutional infrastructure likewise affect incentives and constraints
- Lots of focus on developing new technologies ... but *adaptation* to agro-ecological niches is equally important
  - Requires adequate local applied scientific research capacity
  - Requires companies with incentive to invest in adaptive research
Key implications

2. Bundled approaches often needed
   - Multiple constraints often bind (nested or simultaneously)
     - Second-limiting factors can limit gains from new technologies (e.g., Bt cotton in China)
   - Success of BRAC ultra-poor programs (Bandiera et al. WP 2016, Banerjee et al. Science 2015)
   - Often need to address market access and modern inputs simultaneously
     - Contract farming can help leverage private capital: e.g., sugar farms in Kenya; vegetables in Madagascar
Key implications

3. Need to be intentional about gender

- Technology development/adaptation need to pay more attention to gender
- Crop selection – vegetables, small livestock – is a major issue. Cereals focus may be limiting.
Thank you for your interest and comments!