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

Christopher B. Barrett, Cornell University
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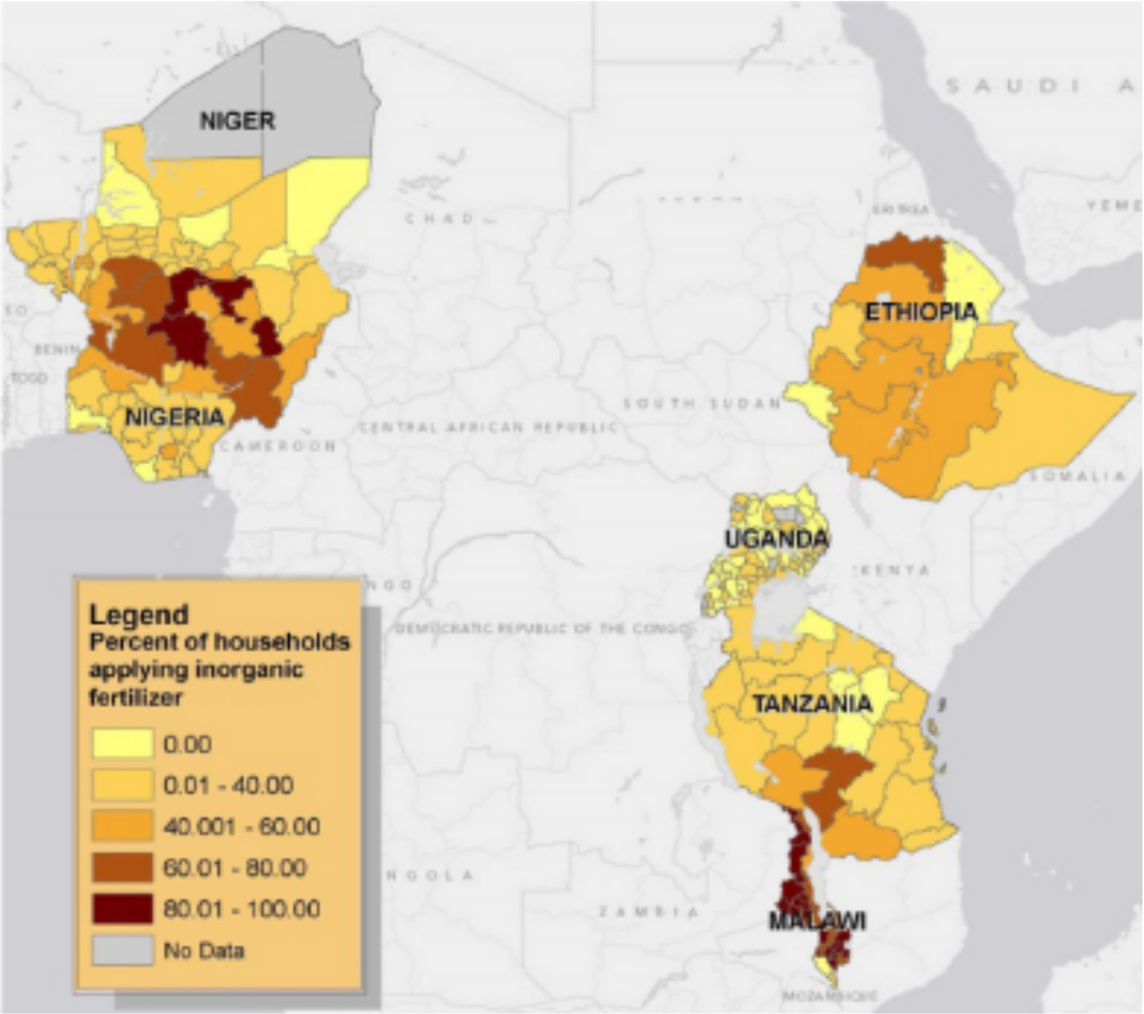
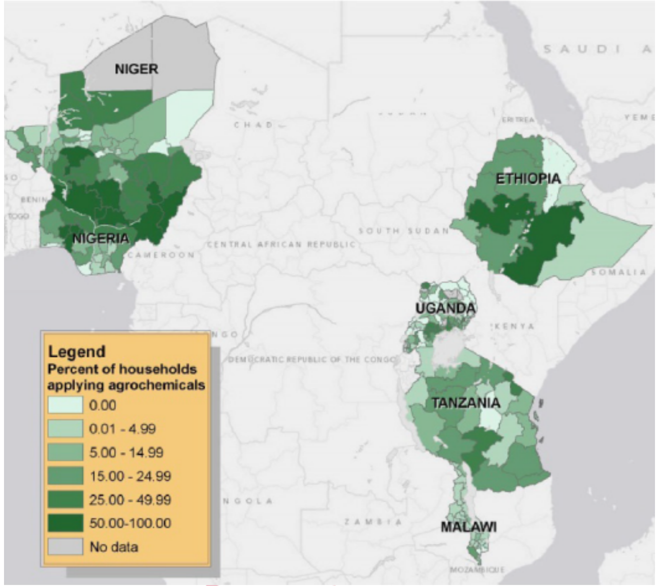
Heterogeneous uptake of innovations



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



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Poor but efficient revisited

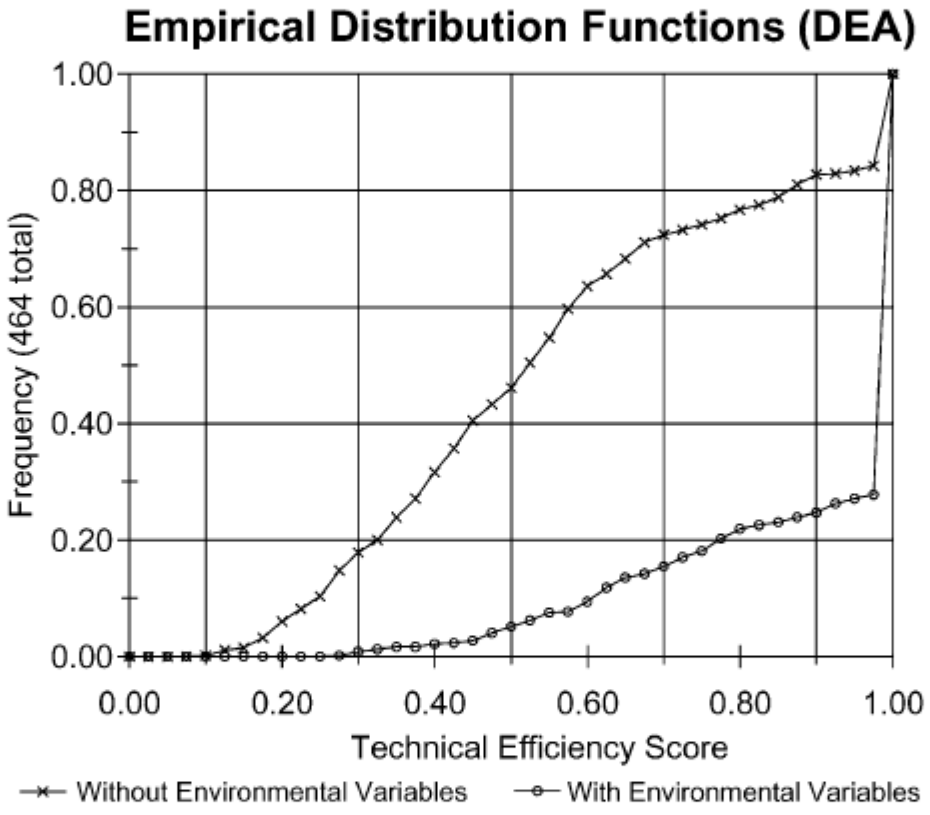

Fig. 2. Distribution functions for estimated plot-specific technical efficiencies.

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??

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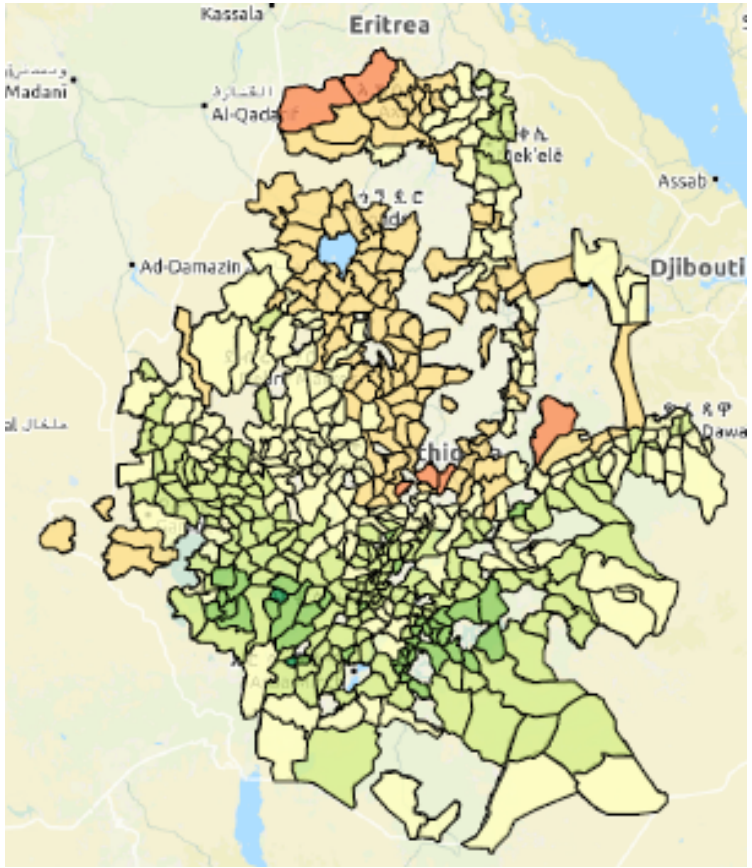
Likely reflects heterogeneous r



https://www.ag-analytics.org/AgRiskManagement/EthiopiaGeoApp

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

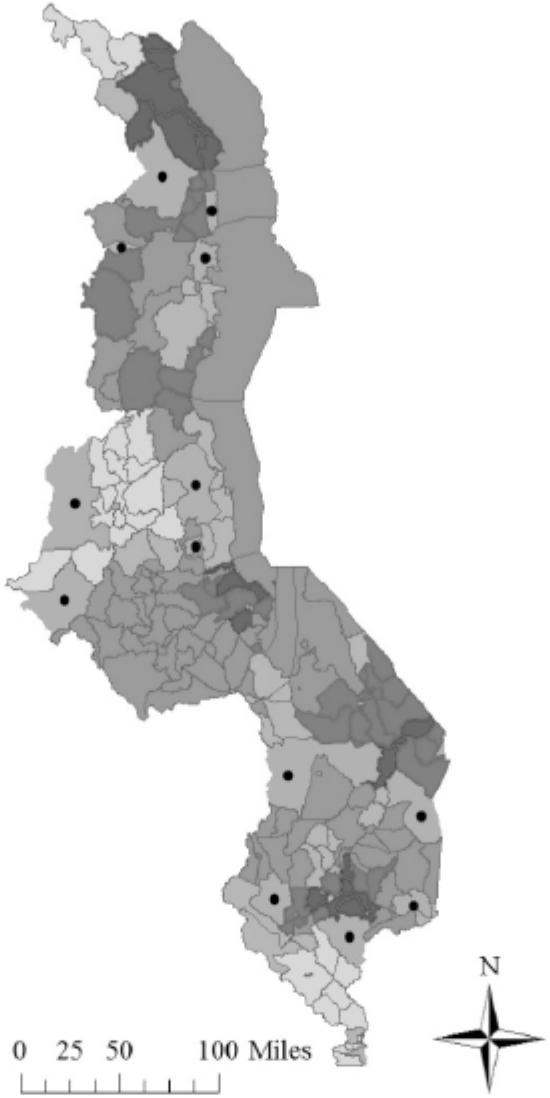
Suri (*EMTRA* 2011) –
Kenya hybrid maize seed

McCullough et al. (WP 2016) -
Ethiopia fertilizer

Burke et al. (*AgEcon* 2016) -

Zambia fertilizer

Harou et al. (*JAfrEcon* in press) -
Malawi fertilizer



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Disadoption rates often high

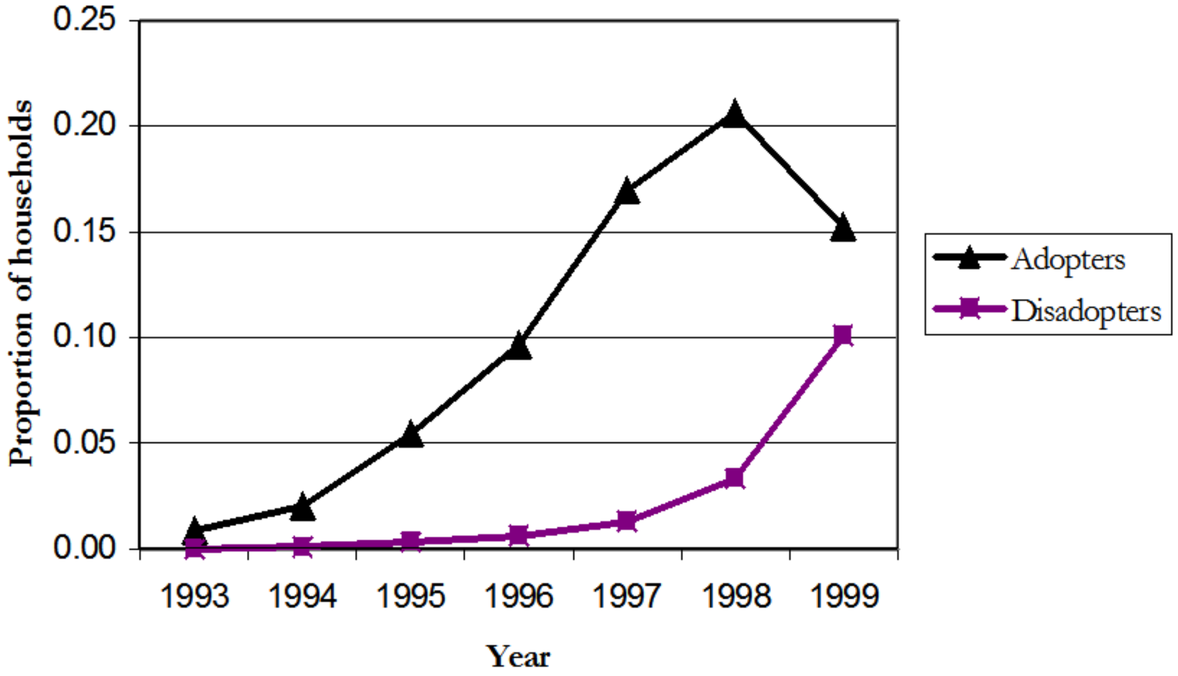
If ag innovations always superior, we should see negligible disadoption. But disadoption common.

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)

SRI adoption-disadoption in Madagascar



Moser & Barrett *AgEcon* 2006

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explanations
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

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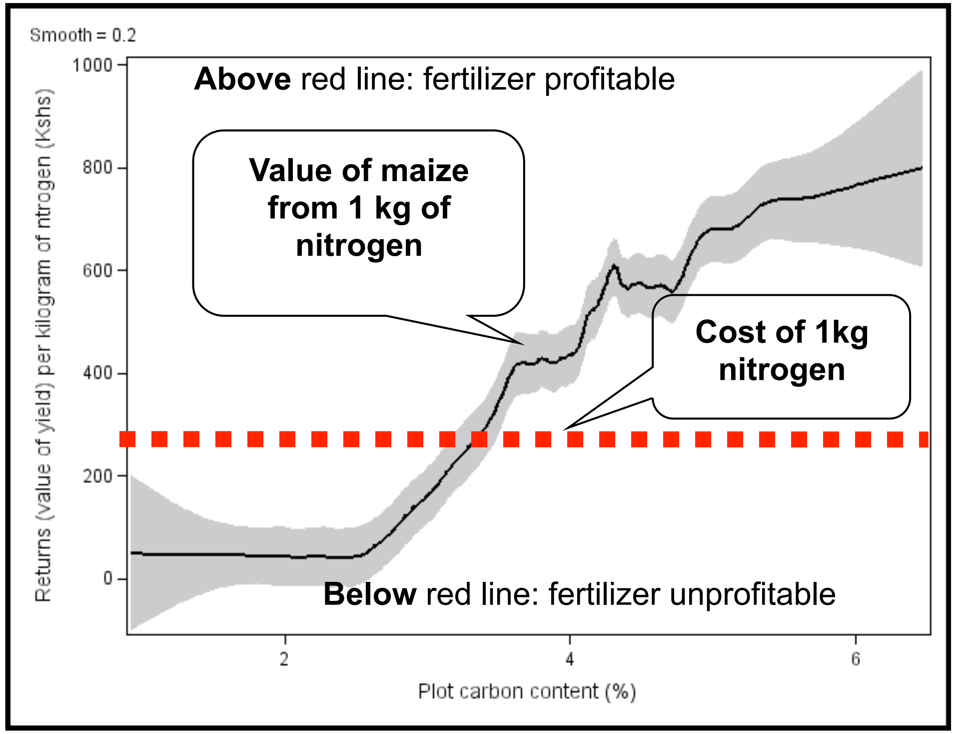
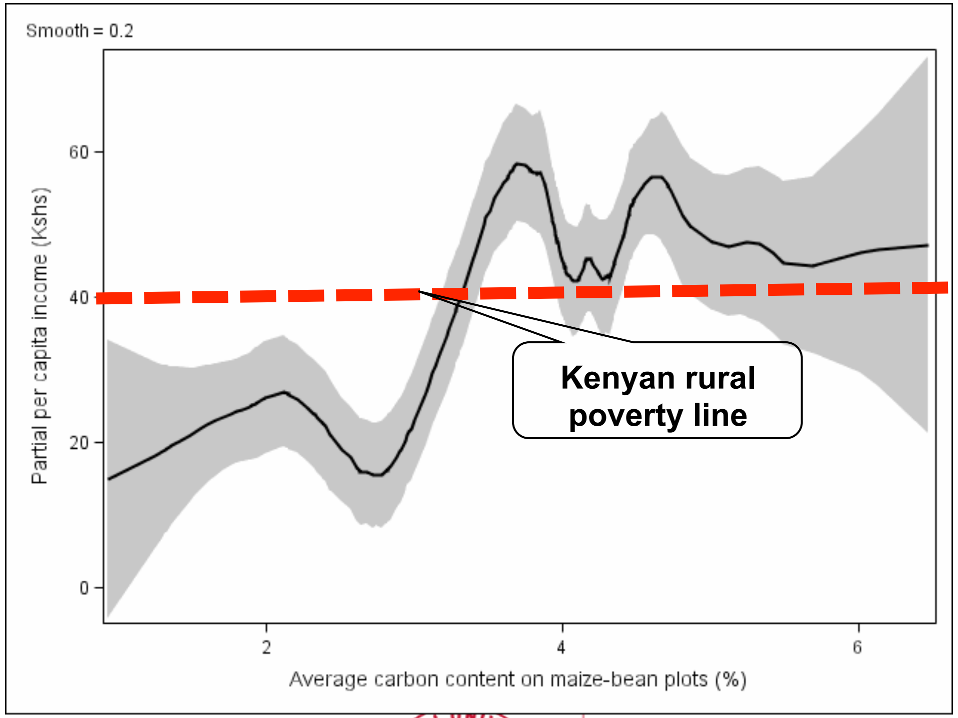
1. Nature's complementary inputs

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

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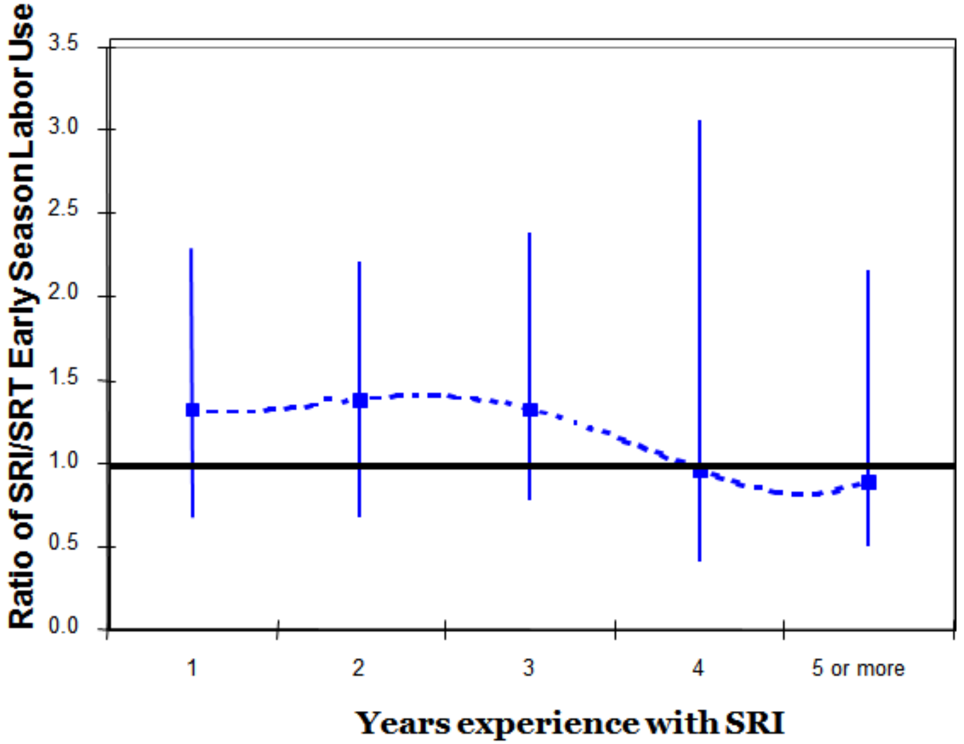
2. Labor availability

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)

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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

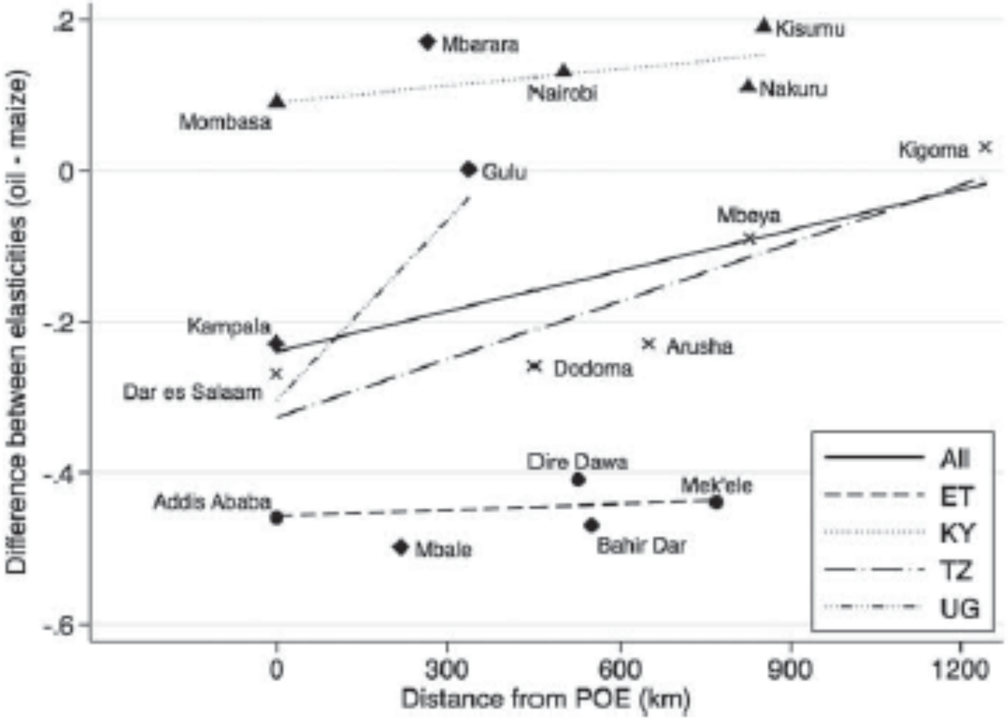

Figure 4. (Elasticity of local maize to global oil) – (Elasticity of local maize to global maize) plotted against distance from POE

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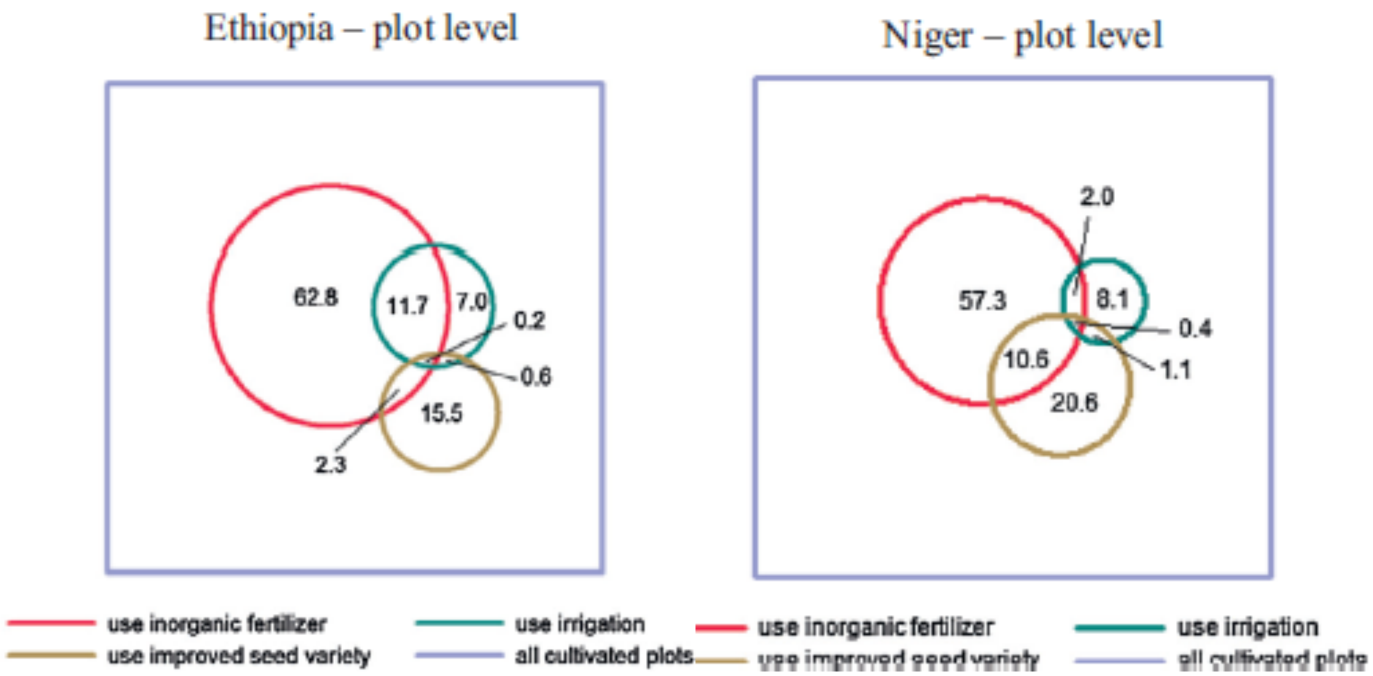
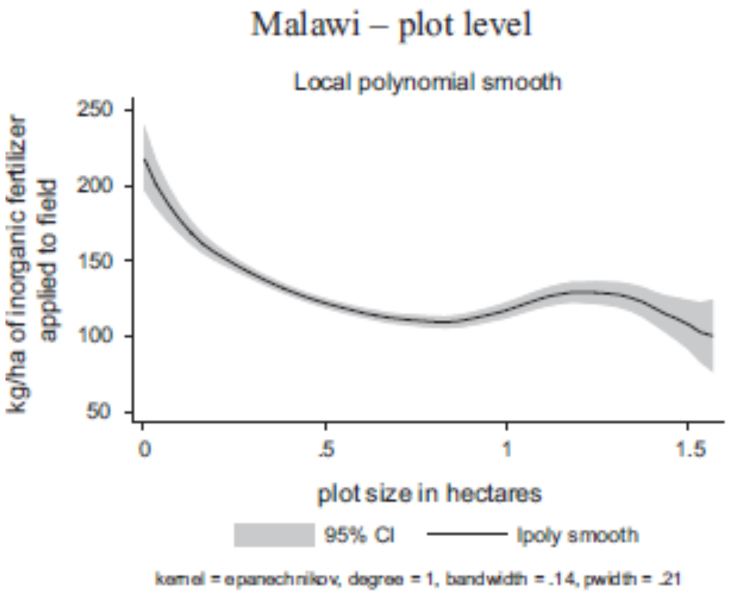
Two puzzles: Uneven adoption within hhs
Ex 1 - Limited joint input application

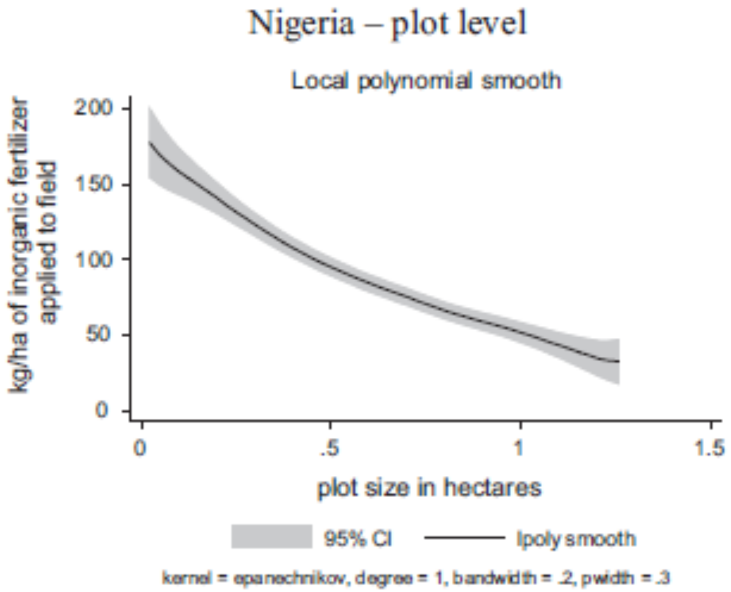
LSMS-ISA data show little joint uptake of modern ag inputs despite agronomic synergies and contrary to ISFM principles.

(Sheahan & Barrett, *FP* in press)



2 – 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)

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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!