

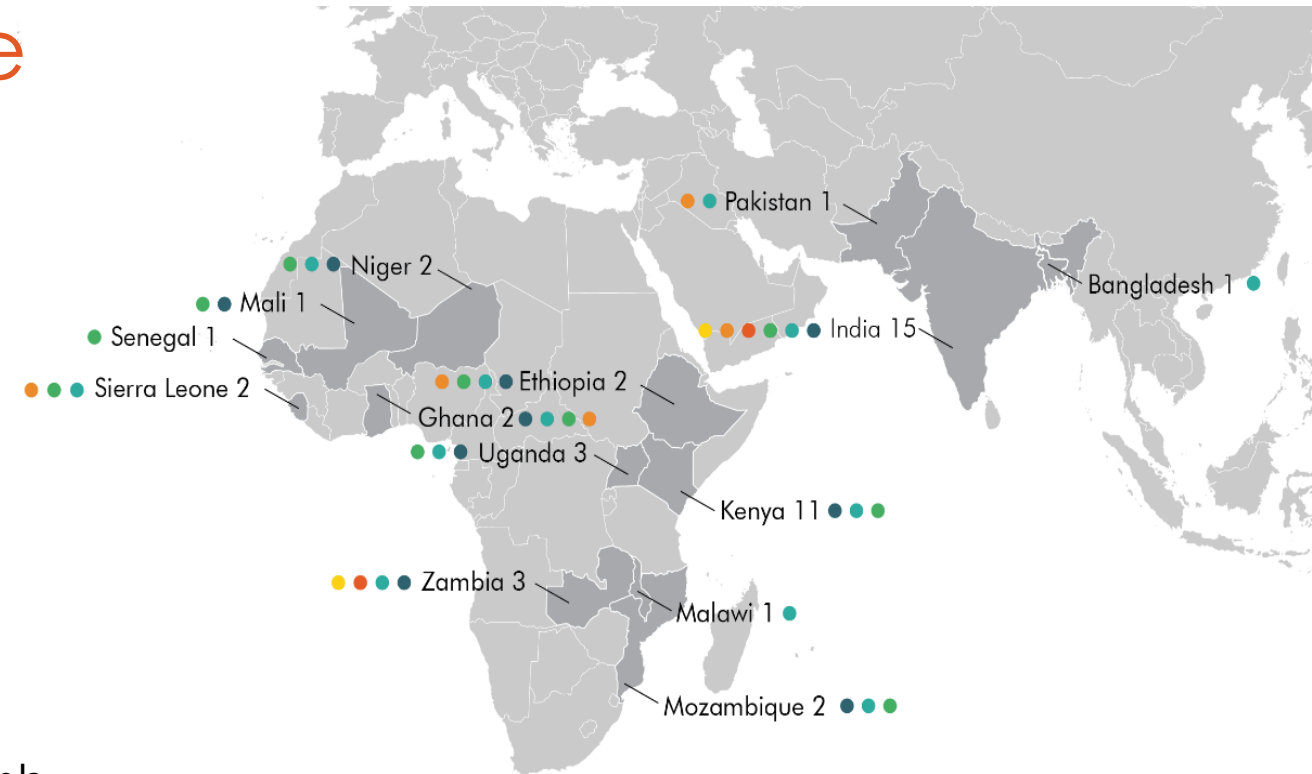
Experimental Insights on the Constraints to Agricultural Technology Adoption

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Experimental Insights on the Constraints to Agricultural Technology Adoption

Outline (10 minutes):

- **Motivation:** scope, evidence review inclusion criteria
- **Experimental insights** (high-level takeaways, **~70 RCTs**):
 - Credit & Savings
 - Risk
 - Information
 - Input & Output Markets
- **Conclude**, where do we go from here?

Motivation

Technology Adoption:

- Policy emphasis over the last decade to see a Green Revolution in Africa (AGRA)
- Yet **macro-level input usage and yield gaps persist** between regions

TABLE 8.1 Area planted to modern varieties, 1960-2000 (% of total area harvested)

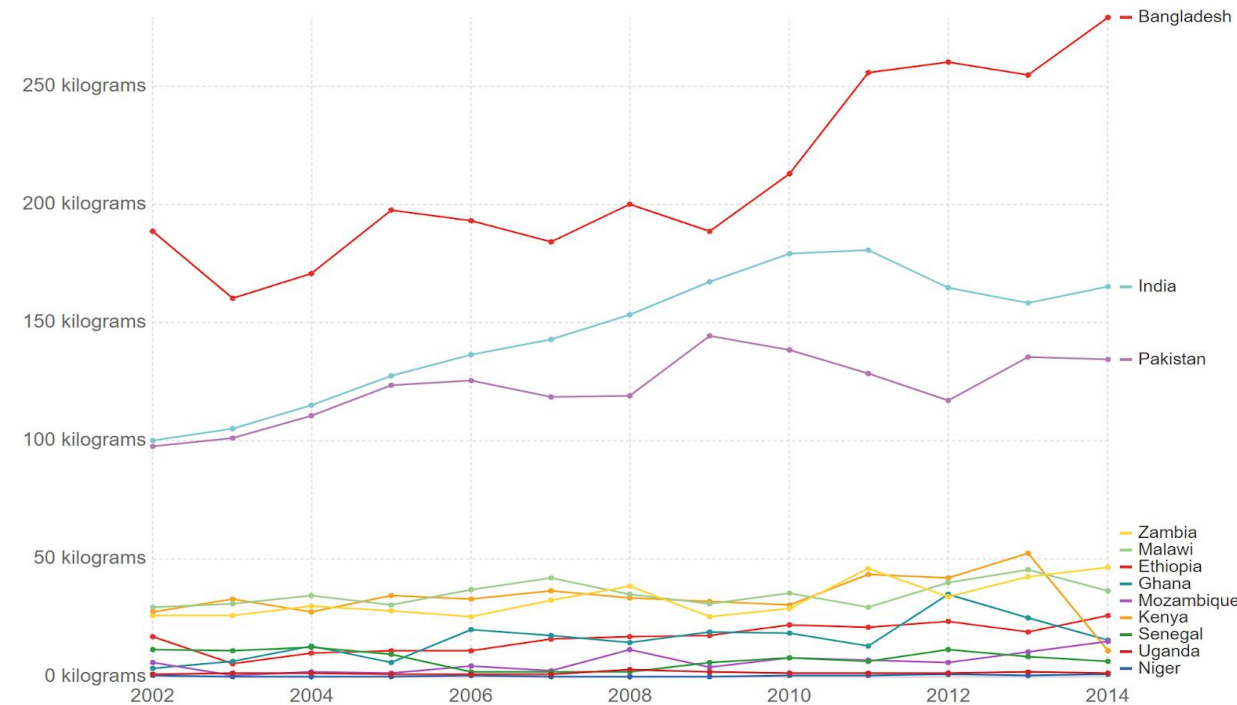
	Year	Sub-Saharan Africa	East and South-East Asia and Pacific	South Asia	Middle East and North Africa	Latin America and the Caribbean
Wheat	1960	0.0	0.0	0.0	0.0	0.0
	1970	0.4	0.0	39.6	7.6	11.4
	1980	4.1	27.5	78.2	33.8	61.3
	1990	6.3	58.7	87.3	43.8	79.3
	2000	47.4	89.1	94.5	69.1	93.2
Maize	1960	0.0	0.0	0.0	n.a.	0.0
	1970	0.0	16.2	17.1	n.a.	1.6
	1980	0.4	61.7	34.4	n.a.	11.2
	1990	7.5	73.0	47.1	n.a.	27.0
	2000	16.8	89.6	53.5	n.a.	56.5

Source: Gollin et al. 2005, p. 1313, based on data shared by Robert E. Evenson

Fertilizer use in kg per hectare of arable land

Fertilizer products cover nitrogenous, potash, and phosphate fertilizers (including ground rock phosphate). Animal and plant manures are not included.

Our World in Data

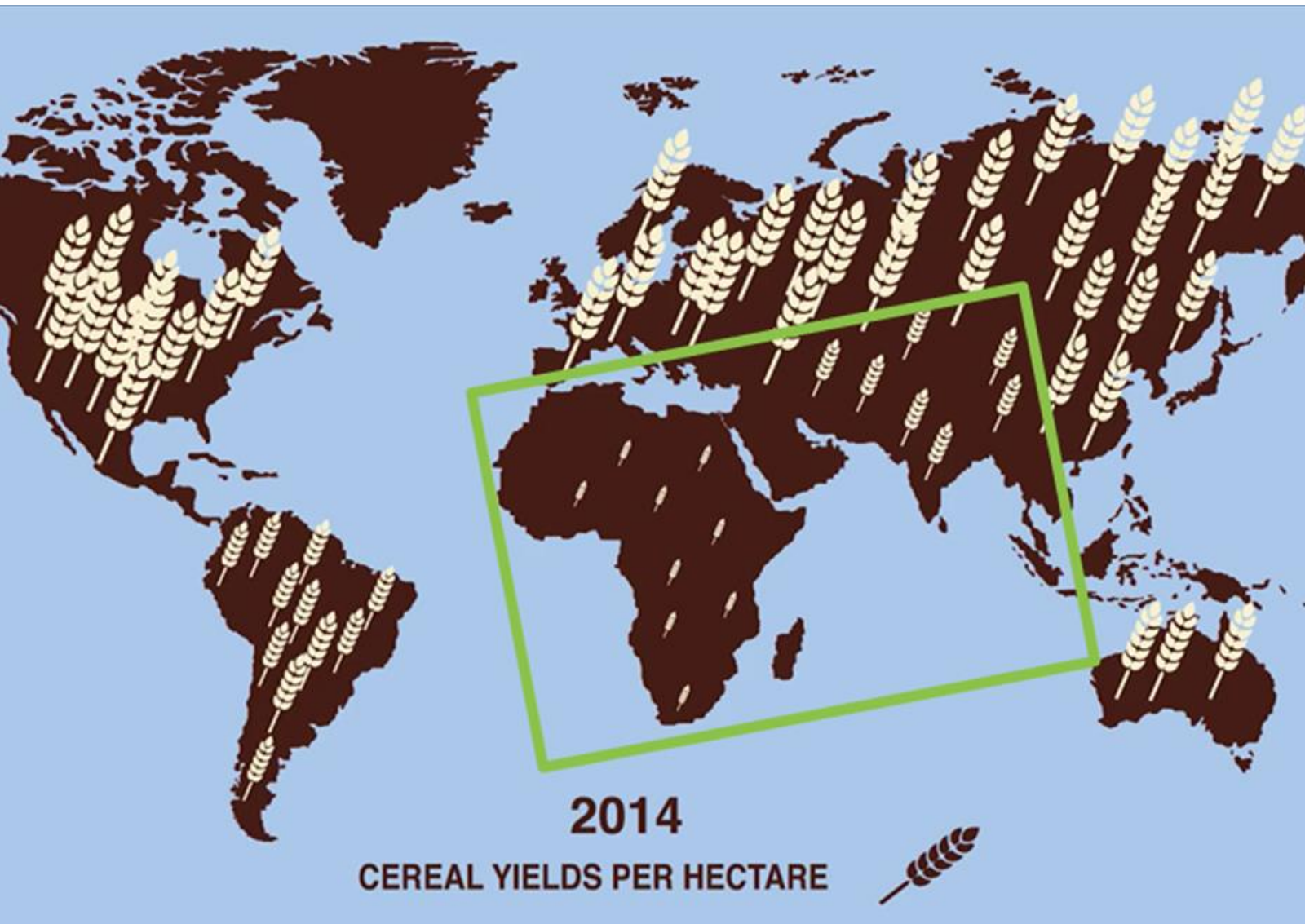


Source: World Bank – WDI: Fertilizer consumption (kilograms per hectare of arable land)

OurWorldInData.org/fertilizer-and-pesticides/ • CC BY-SA

Motivation

Technology Adoption:



What helps and what hinders smallholder farmers' adoption of technologies and access to markets?

Which approaches impact farmer profits and welfare?

- Summarize a decade of RCTs: trace causality (interventions, tech adoption, final outcomes)

Motivation

Experimental Evidence (randomized evaluations, RCTs):

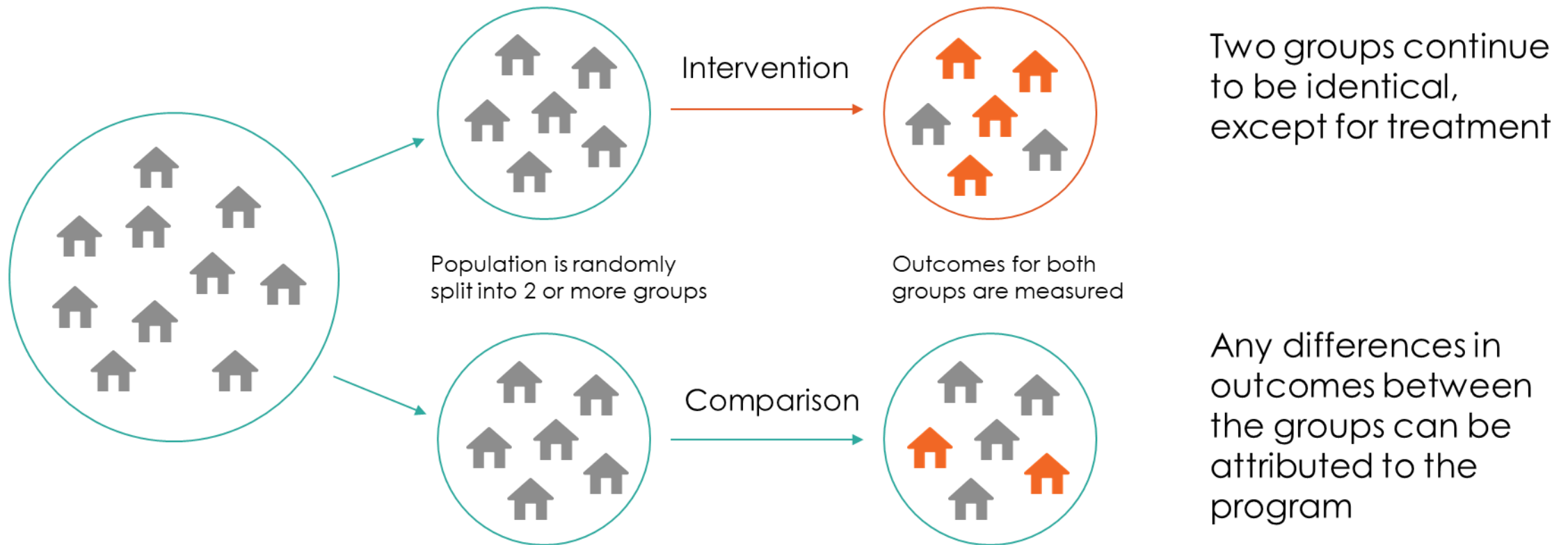
Micro-level investigation: **farmer (SHF) or household behavior change**

- **Complex decision-making:** multi-faceted, risky, over long time frames
 - *inputs, labor allocation, consumption, points of sale,...*
 - Ag interventions can have **long, complex causal chains**
 - *intervention(s) → behavior change(s)? → yields? → welfare improvements?*
 - Key **variation**
 - Over time: volatile prices, weather, financial/life events
 - Across space: soil chemistry, microclimates, distance from market hubs, etc.
- Need rigorous, internally valid impact estimates to **identify causal pathways**

Motivation

Experimental Evidence (randomized evaluations, RCTs):

Before the program starts, eligible individuals are randomly assigned to two or more groups so that they are statistically identical before the program.



Motivation

Constraints to Adoption Framework (Jack 2013)

Farmers as entrepreneurs – 7 market inefficiencies constrain adoption

- **Credit (& Savings):**

Not enough cash at the right times - how can I invest?

- **Risk:**

My yields might be diminished for uncontrollable reasons - why invest?

- **Information:**

What technologies could help me achieve which benefits?

How would I change my investments and farming practices to reap the benefits?

- **Input & Output Markets:**

How do I access improved technologies? If my yields were to improve, can I sell at a profit?

Also constrained by **land**, **labor**, and **externalities**

CREDIT & SAVINGS: Constraints and Interventions

Farmers' Context

- Large cash flows 1-2x/yr
- Saving difficult, informal lending available but comes with costs (interest rates) and perhaps benefits
- Investment returns and ability to repay uncertain, limited financial literacy

FSPs often do not lend to ag sector

- Repayment risk, limited liability without collateral
- Group liability model is inappropriate for localized farmers

Interventions

- A. Improved information about borrowers (given adverse selection)
- B. Flexible collateral
- C. Account for seasonal variation (production, prices)
- D. Saving to invest: Labeling, Commitment

CREDIT & SAVINGS: Summary

- Increasing the availability of formal credit had **limited impacts on SHF profitability**
 - **Low take-up** is a reason (17-33% across credit and savings experiments)
 - Targeted savings products can increase ag investments, but active use difficult to spur
- **Tailoring credit products** to agricultural contexts is important where introducing new sources of liquidity is needed
 - Some promising ways of using **information, timing, and new types of collateral to improve take-up and impact**
- Access to credit affects farm activities, but mixed evidence on profit suggests other constraints may be binding
 - **Risk is a dominant issue for credit**; insurance and credit likely to need to be grown hand-in-hand

RISK: Constraints and Interventions

Risk matters

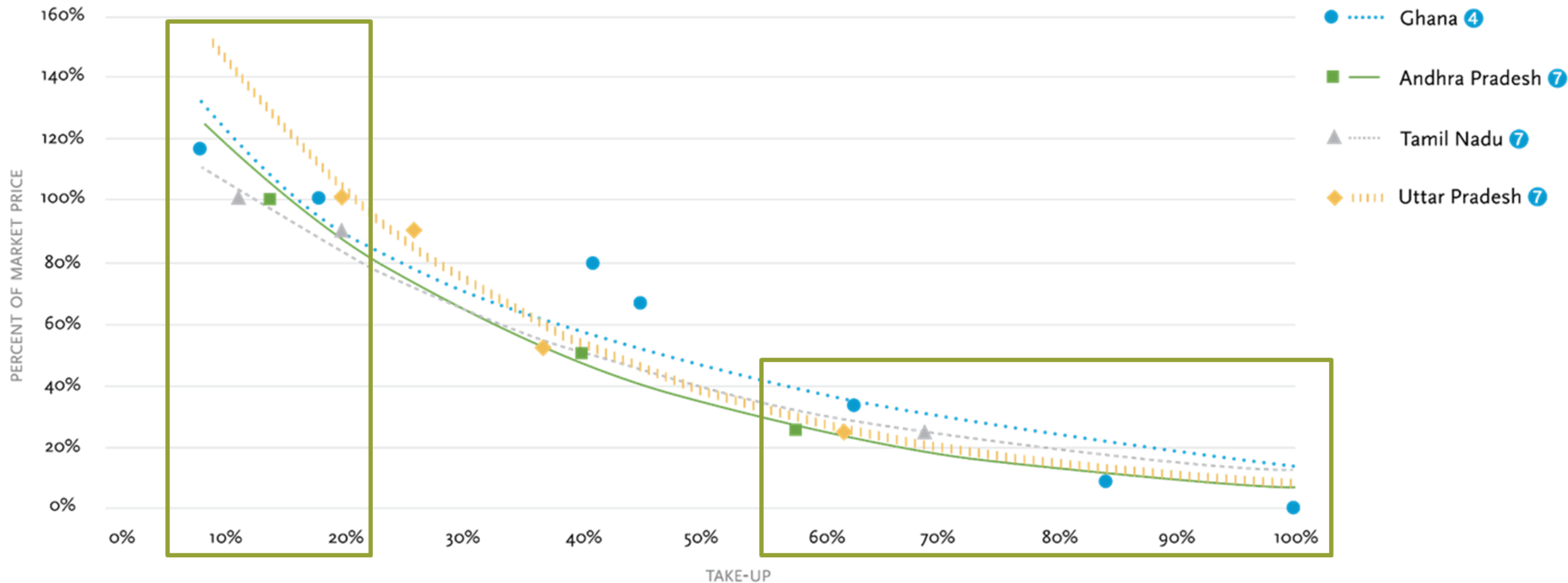
- Most investments in improved inputs increase the financial risks of farming
- Farmers make **conservative production decisions to self-insure**

Some potential solutions to ag risk (beyond basic public sector safety nets)

1. Financial instruments: Weather Index Insurance (WII)
 - **Weather Index Insurance (WII): low demand**, financial education, group protection, links to credit not enough
 - Credit products with (explicit or implicit) limited liability in case of weather shocks
2. Technology that structurally decreases risks
 - **Promising early results (within a risk range) on risk-mitigating crops**

RISK: Limited demand for WII at commercial prices

10 randomized evaluations in various contexts (India, Ethiopia, Ghana, Malawi)



Take-up ranged from only 6-18% at market prices

[ATAI "Make It Rain" 2016.](#)

RISK: Summary

- Risk binds: **when protected, do see increased higher-risk higher-yield agricultural production investments**
- Commercial index insurance targeted directly at farmers unlikely to solve the problem. Rethink insurance:
 - Provide subsidized policies as an alternative to cash transfers?
 - More promising at meso-level?
 - Sell to financial or governmental institutions exposed to ag risk
 - Offer index insurance to groups who already provide informal risk pooling for idiosyncratic risks
 - Improve data to align index triggers & experienced losses at farm
- **Promising preliminary results on risk-mitigating crops:** achieve benefits of insurance, decrease aggregate exposure to weather **(still fails outside a specific severity range)**
- **“Risk layering” bundling products for comprehensive protection** (Carter et al. 2017)

INFORMATION: Constraints and Interventions

- Information helps farmers assess and effectively use novel technologies
 - risk profile, potential profitability, how to use
- **Use of traditional agricultural extension services is low**
 - Limited agents and large geographic distances
 - Low engagement and adoption of recommendations
 - Low information diffusion within communities
- Interventions designed to induce behavior change and improve returns, focus on improving
 - **Pedagogy:** what to teach and how
 - **Channels:** accessibility, customization, frequency (ICT can help with these)
 - Inclusivity and spread of information through **social networks**

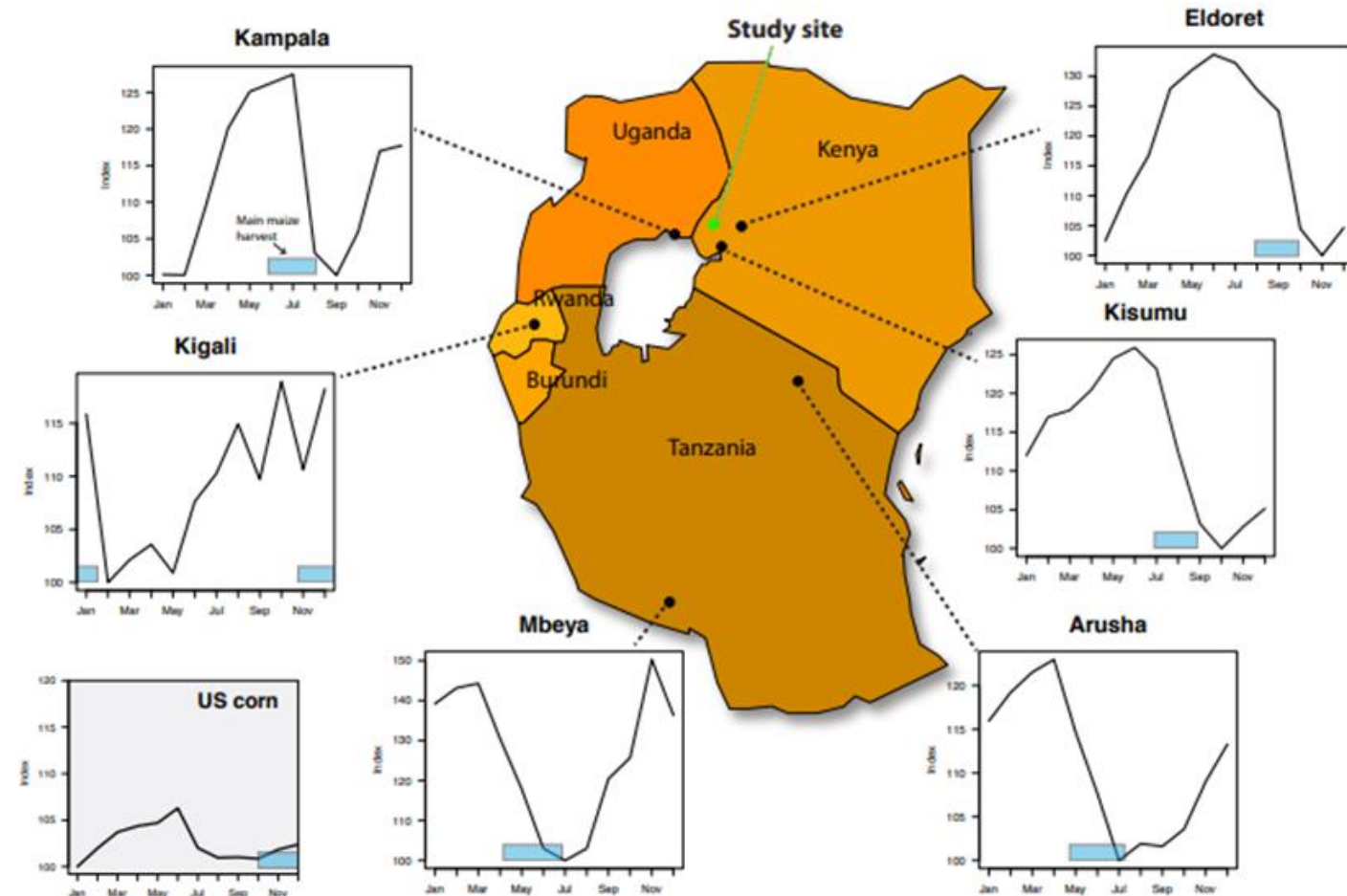
Beaman et al. 2015, BenYishay & Mobarak 2014, BenYishay et al. 2015, Blair et al. 2013, Casaburi et al. 2014, Cole & Fernando 2012, Duflo et al. 2008, Duflo et al. forthcoming, Hanna et al. 2012, Islam 2014, Kondylis et al. 2014, Tjernstrom 2015, Waddington et al. 2014

INFORMATION: Summary

- Information interventions appear promising only to the degree that they are **profitably actionable (look beyond yield enhancement guidance)**
- Improved extension may be **critically important for new or challenging tech adoption**
 - **When tech requires unfamiliar complementary shifts in behavior to reap benefits**
 - To overcome **behavioral biases** (e.g. procrastination)
- Provide **accessible, tailored, and timely** information, focusing on the important **aspects that are difficult to observe**
 - customization can be important, ICT can help)
- **Social networks matter: lessons on selecting and mobilizing messengers** for sufficient intensity and improved equity of exposure:
 - **consider multiple farmers, similar farmers, convenings, and/or incentives**

INPUT/OUTPUT MARKETS: Constraints and (Early) Insights

- **Access to inputs should not be assumed**
 - e.g. inadequate infrastructure, missing supply chains, unprofitably high prices
- **Shallow markets stunt technological upgrading**
 - If increased supply crashes local prices (limited arbitrage), productivity investments go unrewarded (unprofitable)
 - increasing farmers' access to deeper output markets may create incentives to adopt technology and improve yields and profits



INPUT/OUTPUT MARKETS: Constraints and (Early) Insights

- **Spreading price information can reduce price dispersion, but farmers often need more than this to access more profitable points of sale**
 - long distances, poor infrastructure, market distortions, intermediaries' power
- **Quality certification is an important contracting problem**
 - **Inputs (e.g. fertilizer fakes) and outputs (incentivizing higher-value production)**
 - Especially quality unobservable, no regulation - reliance on trust and reputation
- **Understanding trader-farmer relationships is key**
 - Traders can provide inter-linked services, e.g. **stand-in for financial institutions**
 - **Interventions aiming to shift market relationships can produce important, unanticipated effects**

Final Takeaways

- Rainfed agriculture is challenging, and can have **important variation over time and space**, which can **hamper both access to tech, learning, and returns to investment**
- **Protecting farmers from risk is key, and should be considered alongside financial service provision efforts**
- **Financial services need careful, tailored design** to help farmers, and **should not be presumed sufficient** to spur tech adoption, profits
- Training and info services should **share information in a timely and tailored way focused where efforts could translate to profits/consumption improvements**; how the “messenger” is selected and deployed matters
- Price information alone is unlikely enough – there is work to be done to understand **relationships with intermediaries**, and **how to strengthen value chains with durable models** that **improve input and output market access with returns for the rural poor**

RCTs are an excellent way to figure out what does *not* work, as well as what does!



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