

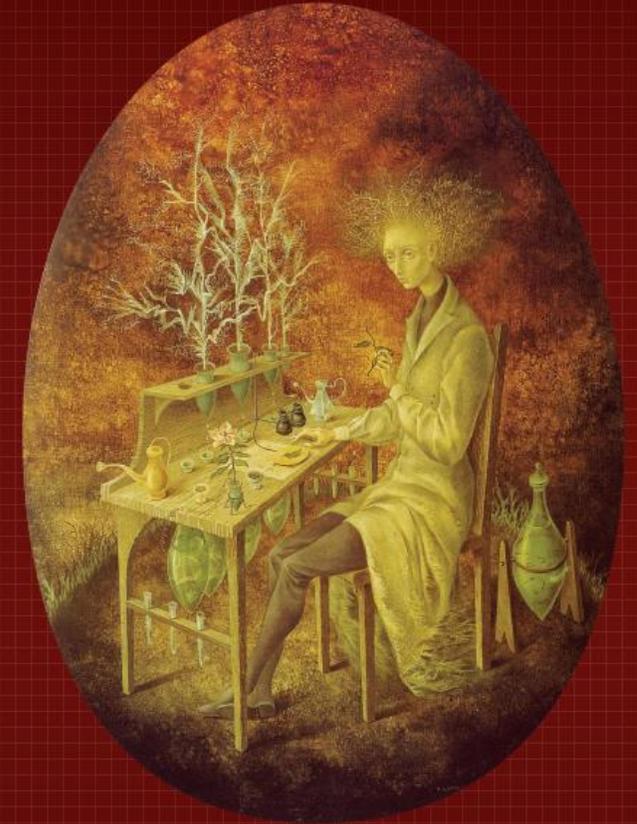
# Harvesting Prosperity: Technology and Productivity Growth in Agriculture

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Keith Fuglie  
Madhur Gautam  
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William Maloney

Tokyo, December 2019

## Harvesting Prosperity



### Technology and Productivity Growth in Agriculture

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## The Innovation Paradox



Developing-Country Capabilities and the Unrealized Promise of Technological Catch-Up

Xavier Cirera and William F. Maloney



## Productivity Revisited

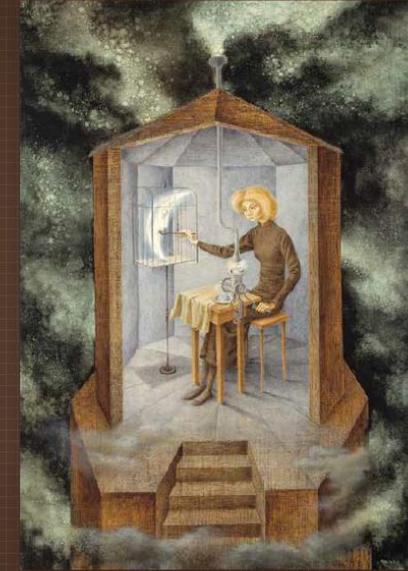


Shifting Paradigms in Analysis and Policy

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## High-Growth Firms



Facts, Fiction, and Policy Options for Emerging Economies

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# World Bank Productivity Project

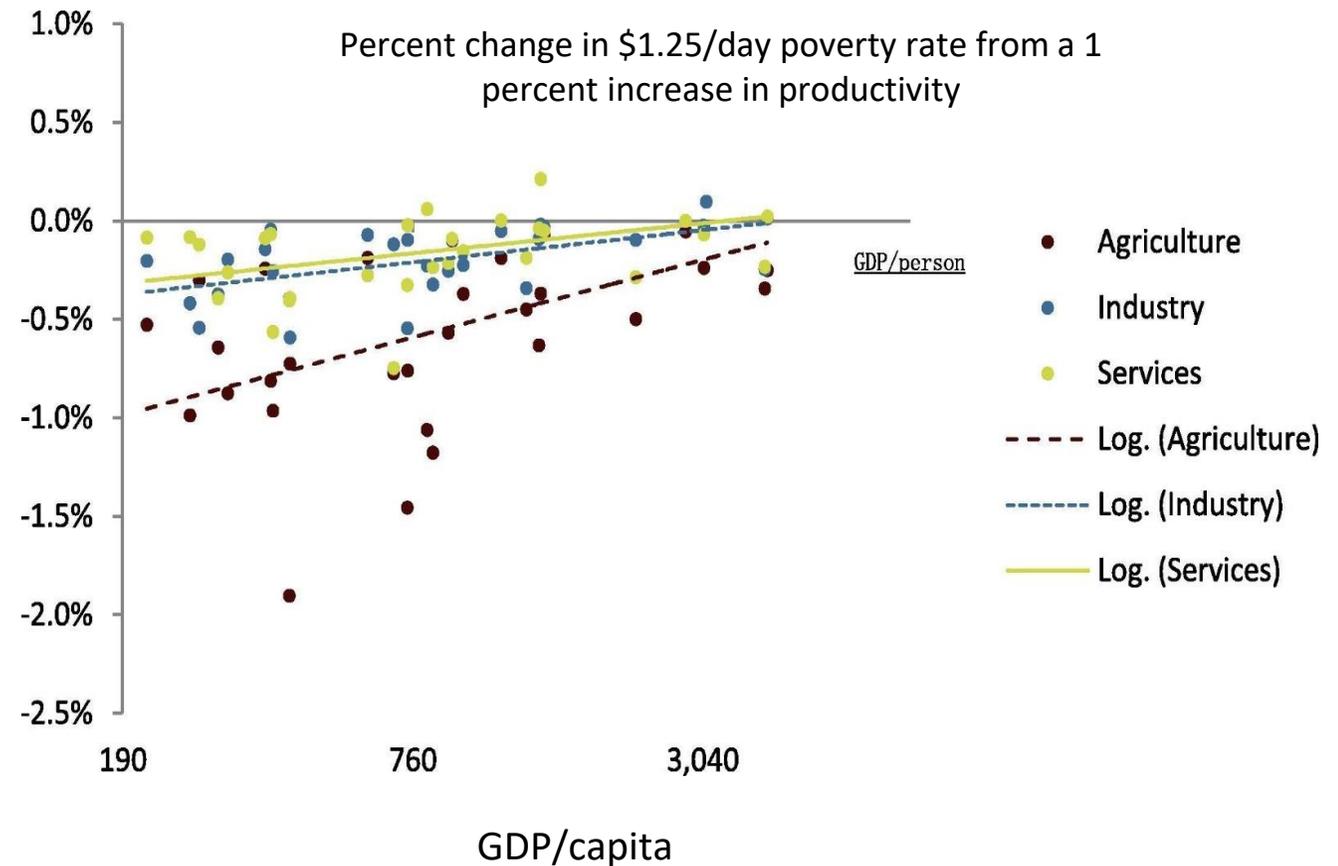
The Productivity Project: [www.worldbank.org/productivity](http://www.worldbank.org/productivity)



What's at stake?

- Extreme Poor: 2/3 work in farming. Productivity growth in Ag has highest impact on poverty reduction of any sector.
- Global undernourishment: remains significant and is on the rise.
- Climate change: will hit agriculture hard particularly where large numbers of poor live.
- Convergence: impeded by slow ag productivity growth in poorest countries.

## Poverty Elasticity of Growth by Sector

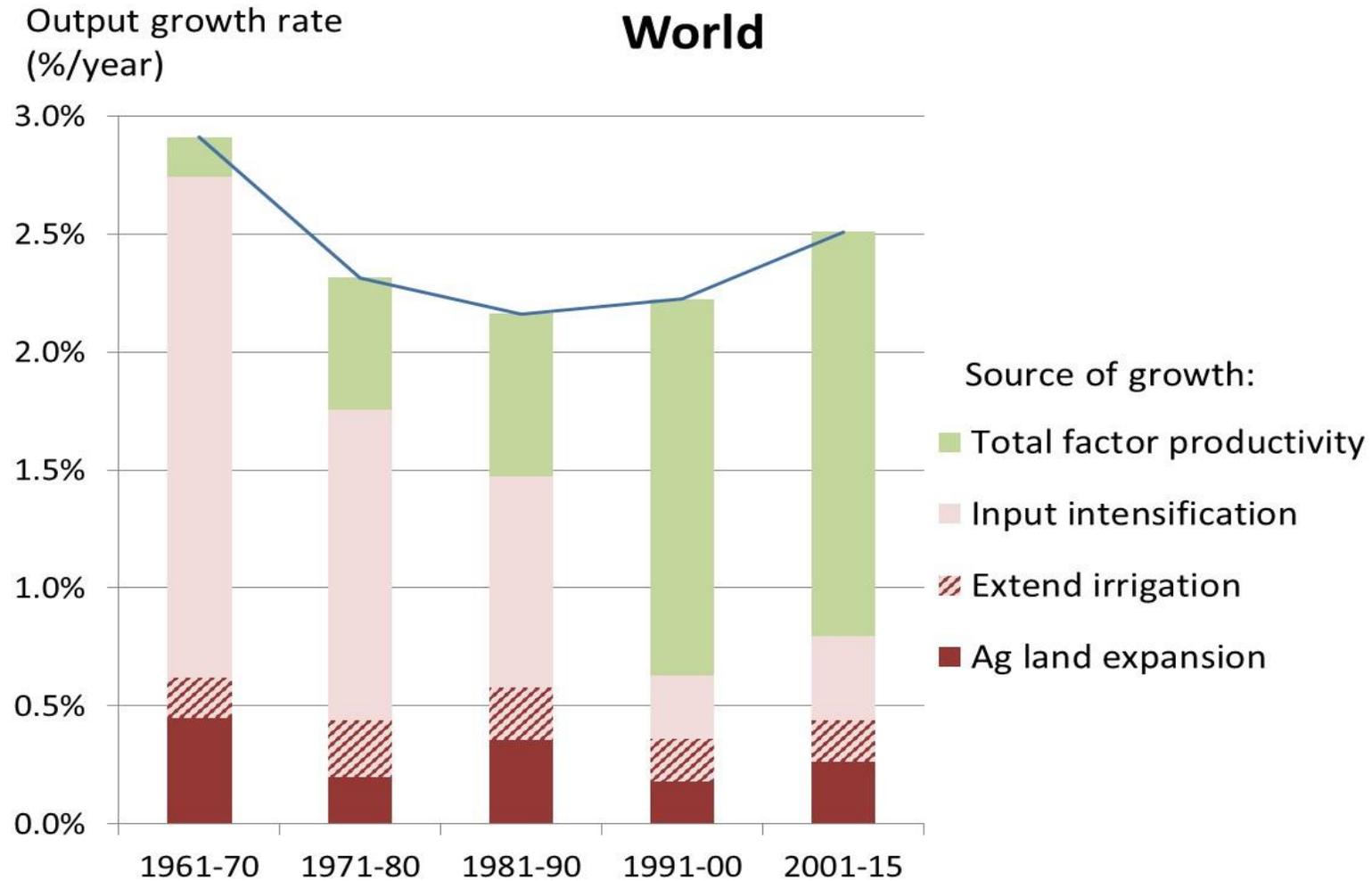


Source: Ivanic & Martin (2018)



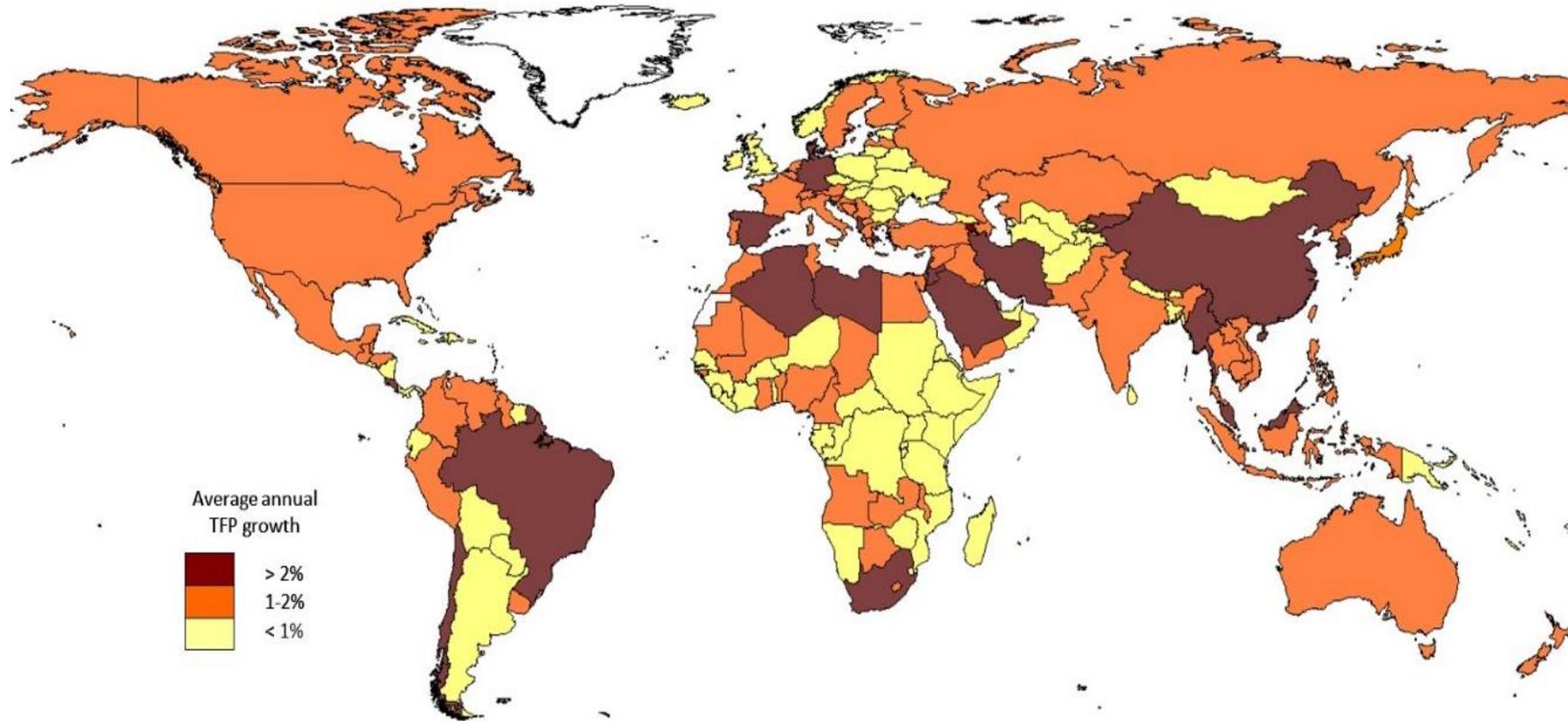
What drives  
agricultural growth?

# Ag. growth is increasingly productivity-dependent



Source: USDA-ERS *On-line database*

However, TFP growth is slow in key high-poverty regions.  
average annual TFP growth rate, 1971-2015

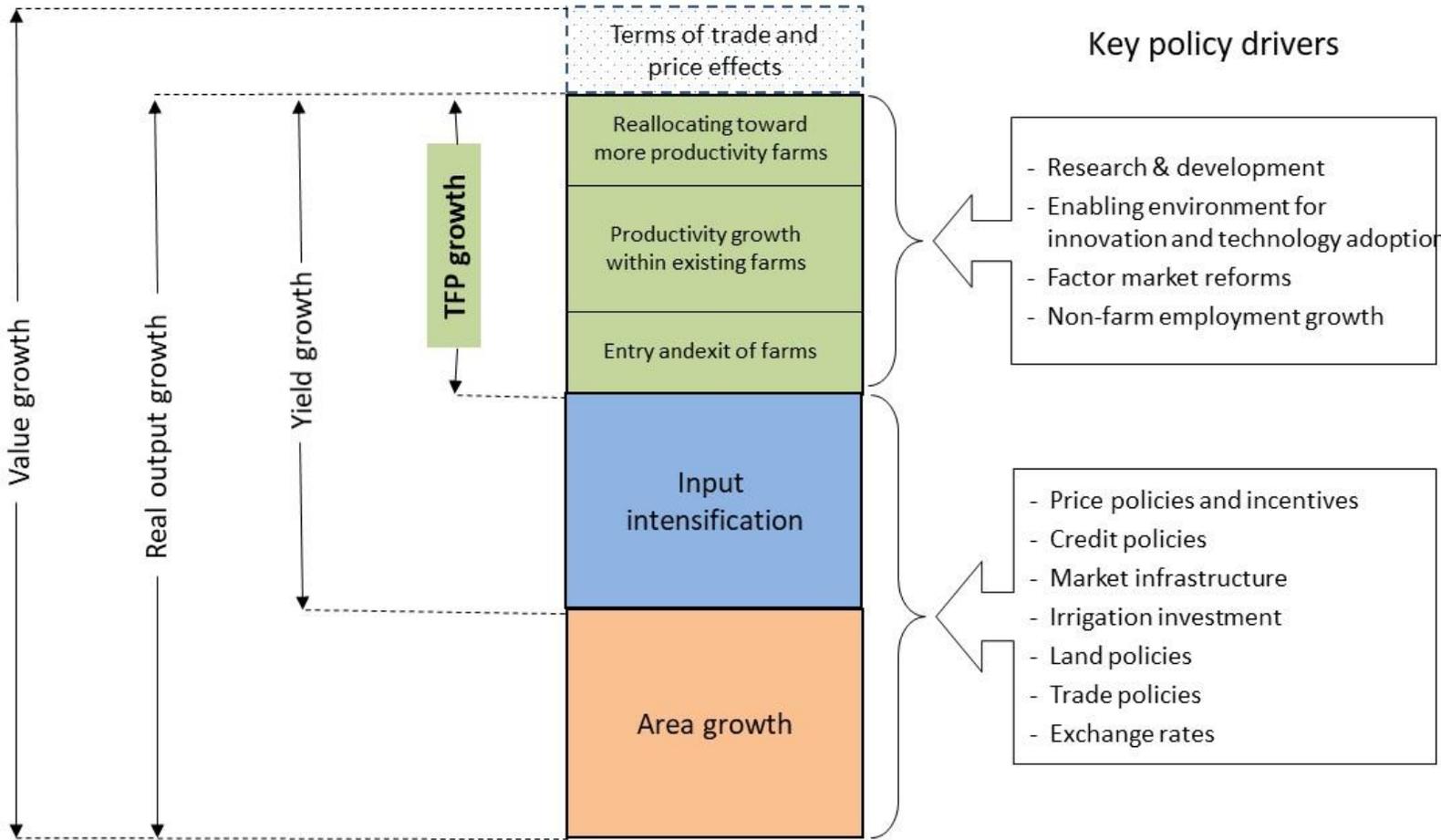


Source: USDA-ERS *On-line database*



What impedes  
productivity growth?

# Decomposing Growth and Total Factor Productivity (TFP)



# Revisiting an old debate: Large ag sector represents...

## Misallocation of resources

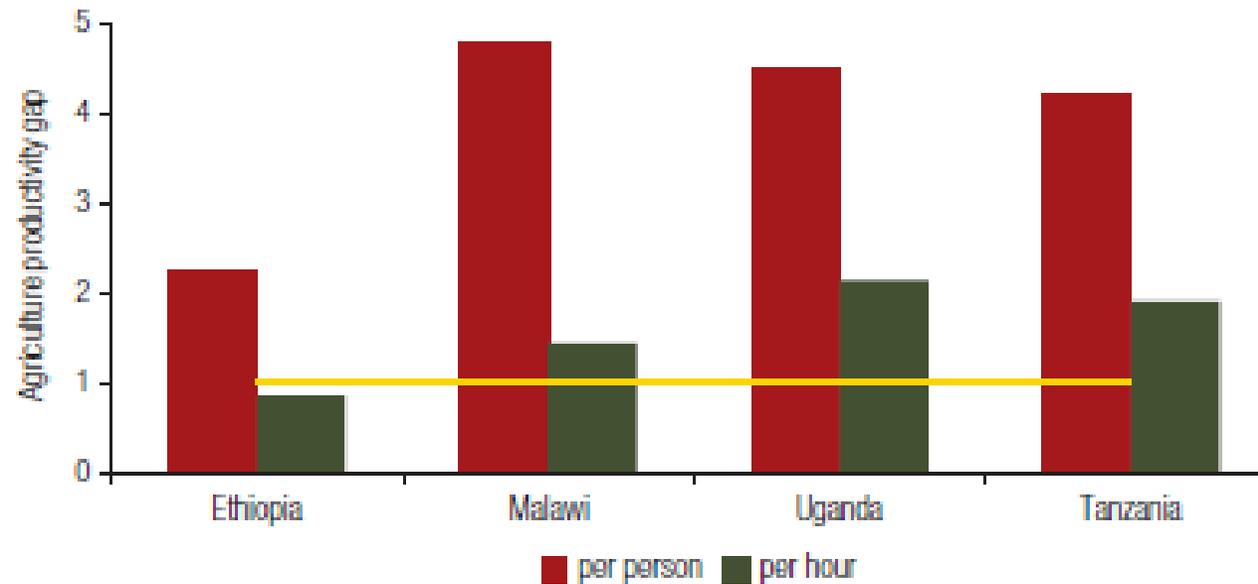
- Smallholder agricultural is a drag on development
- Too much labor is tied up in low-productivity farming
- Imperfect factor markets prevent resource reallocation (labor out of agriculture, land to most efficient farmers)

## Dynamic sector with growth and poverty reduction potential

- Raising agricultural productivity is key to stimulating inclusive economic growth
- Farmers are resource efficient in traditional setting
- Need public investment in new technology for growth

# Labor Misallocation?: Ag/Non-Ag gap in labor productivity is not large when measured correctly.

**FIGURE 0.2** Gaps in Labor Productivity across Sectors Diminish When a Measure Based on Hours Worked, Rather than the Primary Sector of Work, Is Used

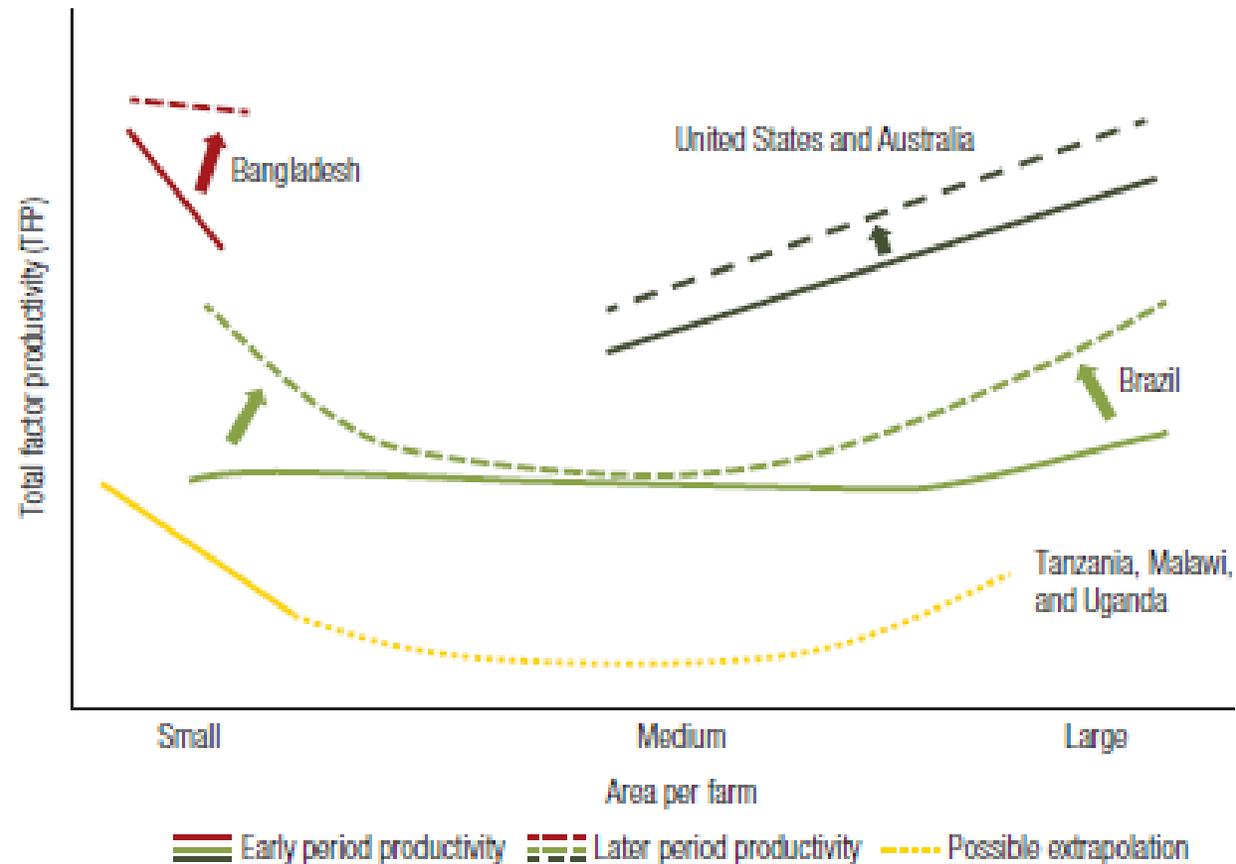


Source: McCullough 2017.

In fact average productivity is a *faux amis*: Really need to look at Marginal Productivity- we find wages broadly equated in India

# Land Misallocation?: Productivity growth occurs in both large and small farms

## Labor Productivity vs. Farm Size



# Investment in knowledge generation and diffusion: The key driver of productivity

Region	Agricultural research intensity			
	R&D/GDP (%)	Trend	R\$/Cropland (\$/hectare)	R&D/Ag labor (\$/worker)
<b>Public agricultural R&amp;D</b>				
Latin America & Caribbean	1.06	↑	\$25	\$107
Brazil	1.65	↑	\$31	\$174
East & South Asia	0.46	↑	\$27	\$22
China	0.73	↑	\$47	\$40
Southeast Asia	0.34	↓	\$18	\$17
South Asia	0.30	↑	\$17	\$13
Sub-Saharan Africa	0.38	↓	\$9	\$10
<b>Developing country total public R&amp;D</b>	0.52	↑	\$23	\$26
<b>Developed country total public R&amp;D</b>	3.25	↓	\$52	\$1,311

## The Research Gap

- Rates of return to R&D= 30-40%
- R&D/worker: 50X higher in ACs than DCs.
- R&D/GDP: 6X higher in ACs than DCs.
  - Rising in LA, Asia, (China, South Asia)
  - Falling in Africa, Southeast Asia
  - R&D falling in half of African countries.

# Increasing R&D: New opportunities, but new challenges

Country	Total ag R&D spending (mil \$)	Private sector share (%)
South Africa	272	19
Brazil	2,719	14
China	5,730	25
India	1,140	25
Bangladesh	80	26
Kenya, Senegal, Tanzania & Zambia	159	8
USA	9,960	59

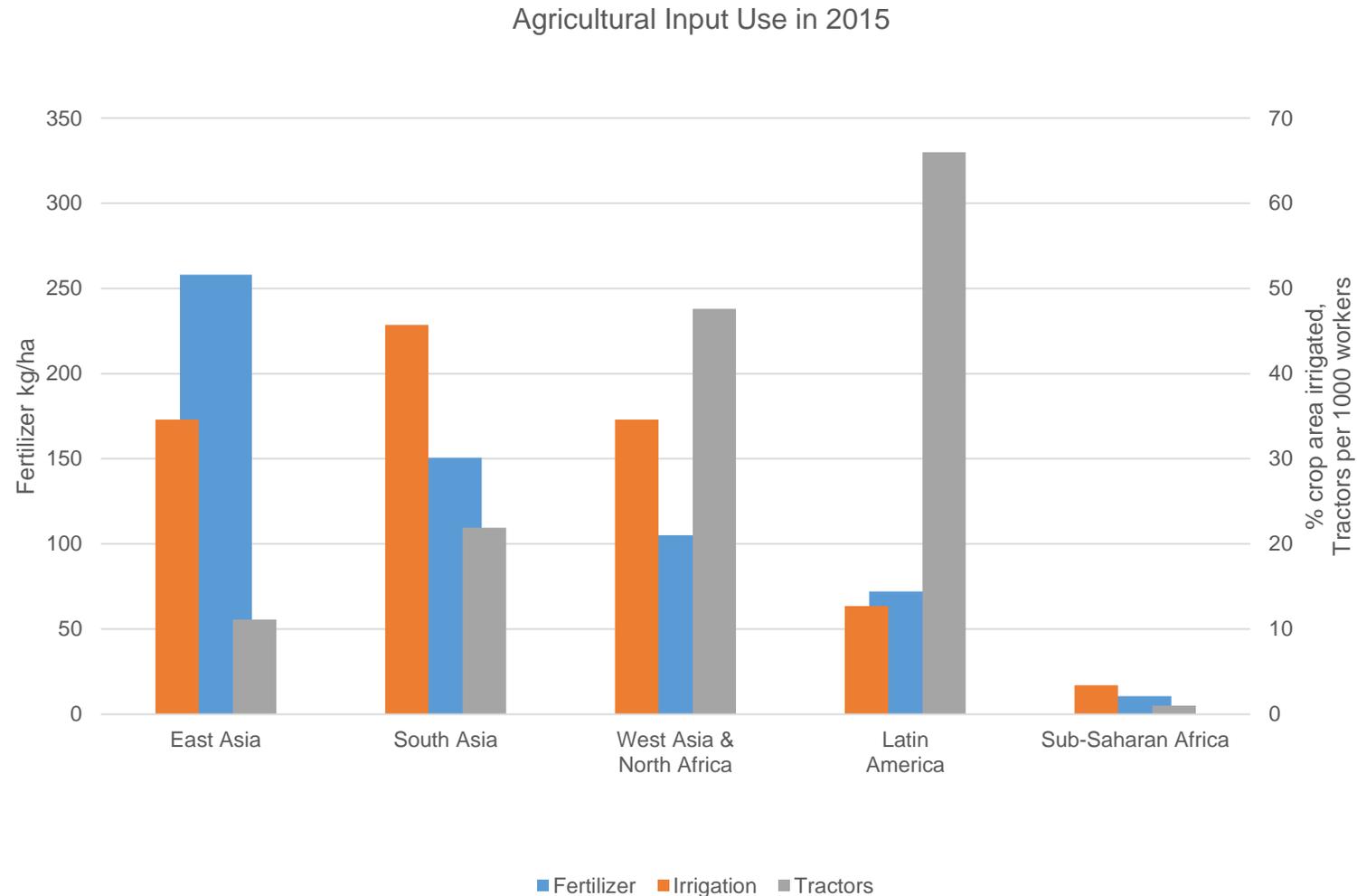
## Strengthening the Public sector

- Increase, stabilize & diversify funding
- Incentivize scientists and strengthen U's and PRIs
- Align priorities with user needs
- Partner with foreign & international research

## Mobilizing the Private Sector

- Market Liberalization
- Regulatory reform
- Intellectual Property Rights
- Complementary Public R&D

# The technology adoption paradox: why don't farmers adopt new technologies if returns are so high?



# The Demand side: Why don't small farmers adopt these technologies if returns are so high?

## Enabling Environment

- Remove biases against agriculture
- Secure land tenure rights
- Improve agricultural advisory services
  - Digital extension
- Help farmers manage risk
  - Weather index insurance?
- Improve access to finance
- Improve access to markets
  - Reduce marketing margins
  - Rural roads; competitive market services

## Human Capital

- Literacy and numeracy
- Managerial, financial and risk management, and marketing and negotiating skills. Capabilities

Digital technologies offer cheaper, more ubiquitous ways of achieving these goals.

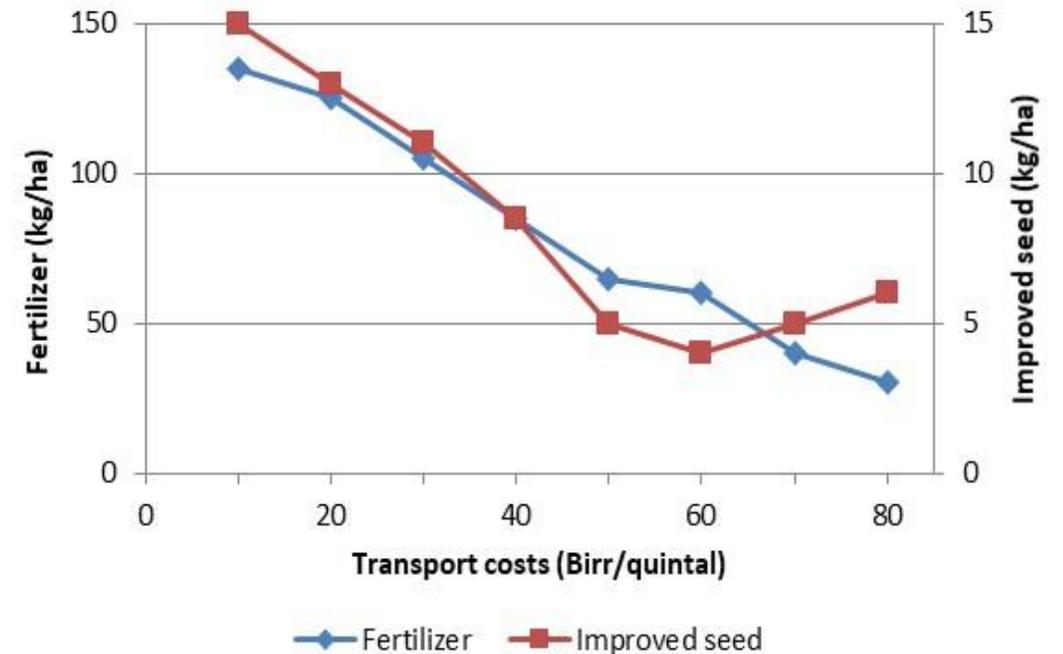
But...all require capabilities and coordination that are a challenge for many countries

# Findings from recent studies point to...

## Uninsured risk

- Farmers in rainfed environments avoid investing in profitable technologies in order to avoid risk of financial losses
- But demand for index-based crop insurance remains low
  - Imperfect insurance (“basis risk”)
  - Trust, financial literacy

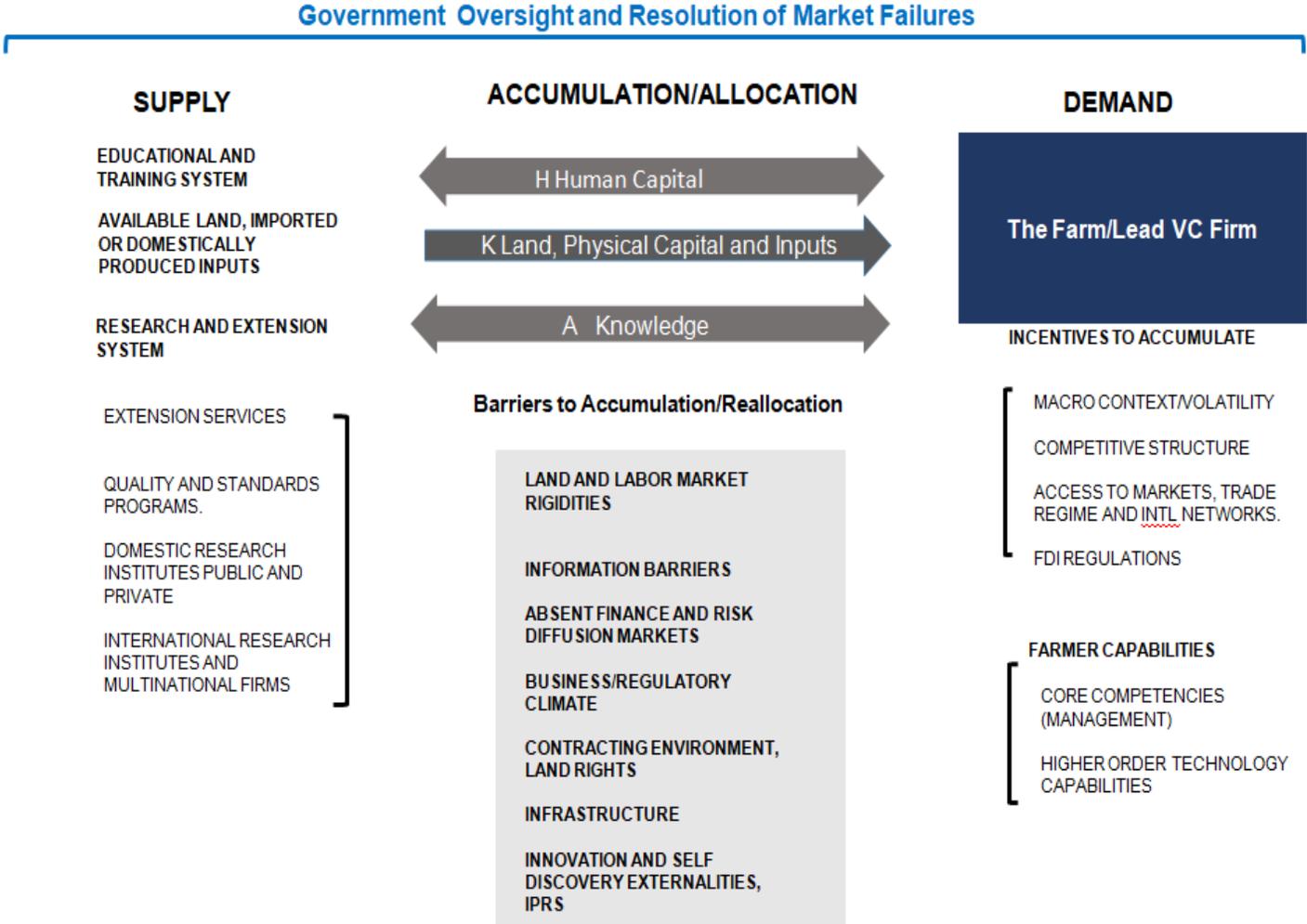
## Poor access to markets-Ethiopia



...as key constraints to technology adoption

# Gov'ts need to work on multiple fronts:

## The Agricultural Innovation System



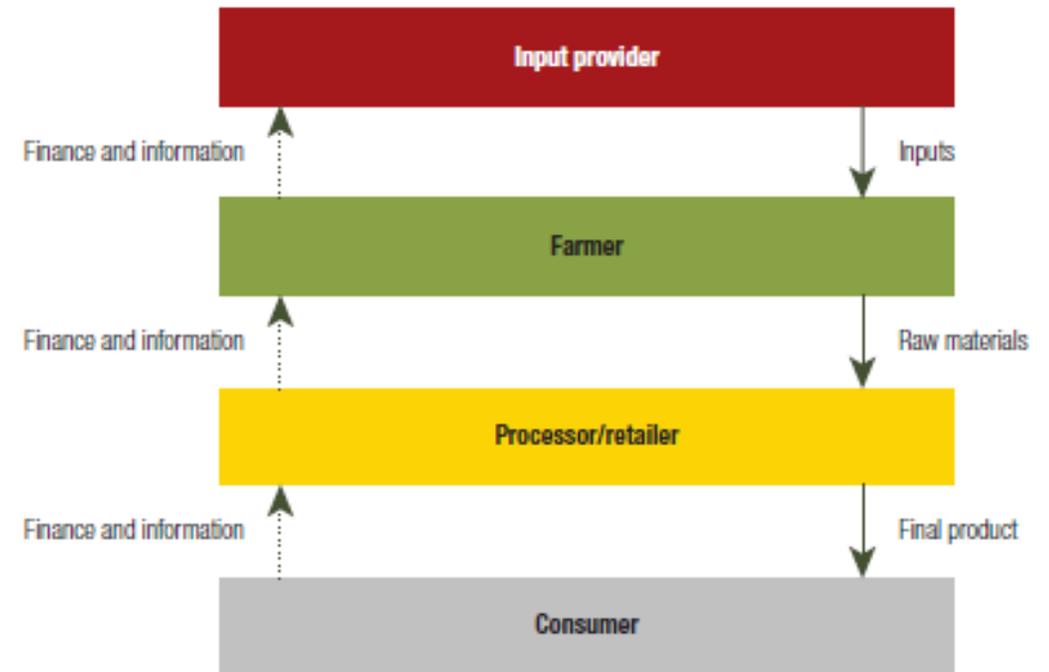
# With limited capabilities, what can governments do?

- Reduce the dimensionality of the problem
  - Identify truly binding constraints
- Experiment, evaluate, learn
- Employ incentives to involve private sector

# GVCs help open markets and resolve market failures

- Structural changes in food & agricultural markets
  - Rise of supermarkets; consumer demand for diverse, quality foods
  - Private quality standards, scale economies, global sourcing
- Market value chains can help overcome market failures
  - Lead coordinating firm can provide access to markets and sources of credit, insurance, information
  - Face high transactions costs in dealing with small holder farmers
  - Policy environment matters
    - Contract enforcement, conflict resolution mechanisms
    - Barriers to entry, competition and bargaining power

**FIGURE 0.4 Food Value Chain with Perfect Markets**



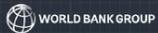
Source: World Bank.

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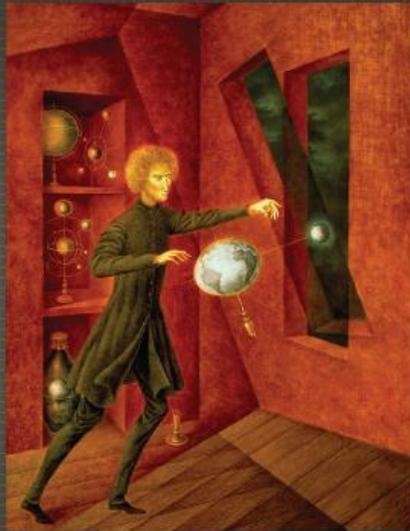


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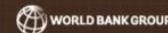


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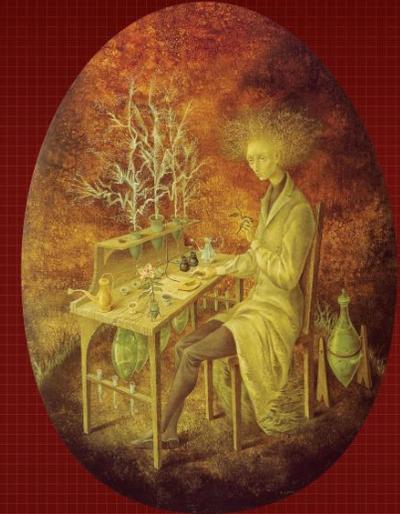


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# Fortune favors the prepared - Pasteur

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