



# Agricultural R&D as an Investment

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***Reframing the Food Security Agenda  
A National Forum on Food Security to 2050***

**University of Adelaide, School of Economics**

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Department of  
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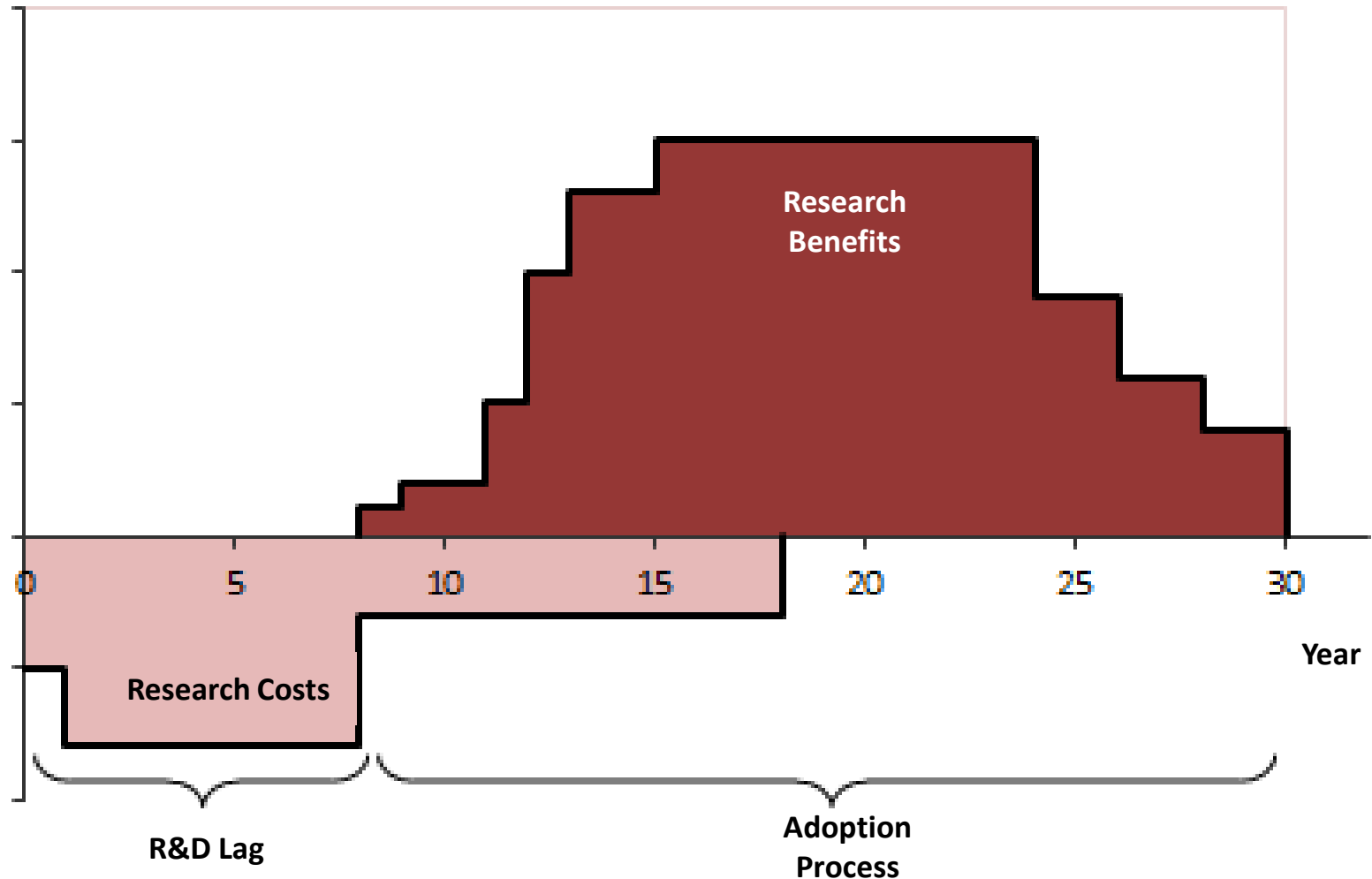
**HarvestChoice**  
BETTER CHOICES, BETTER LIVES



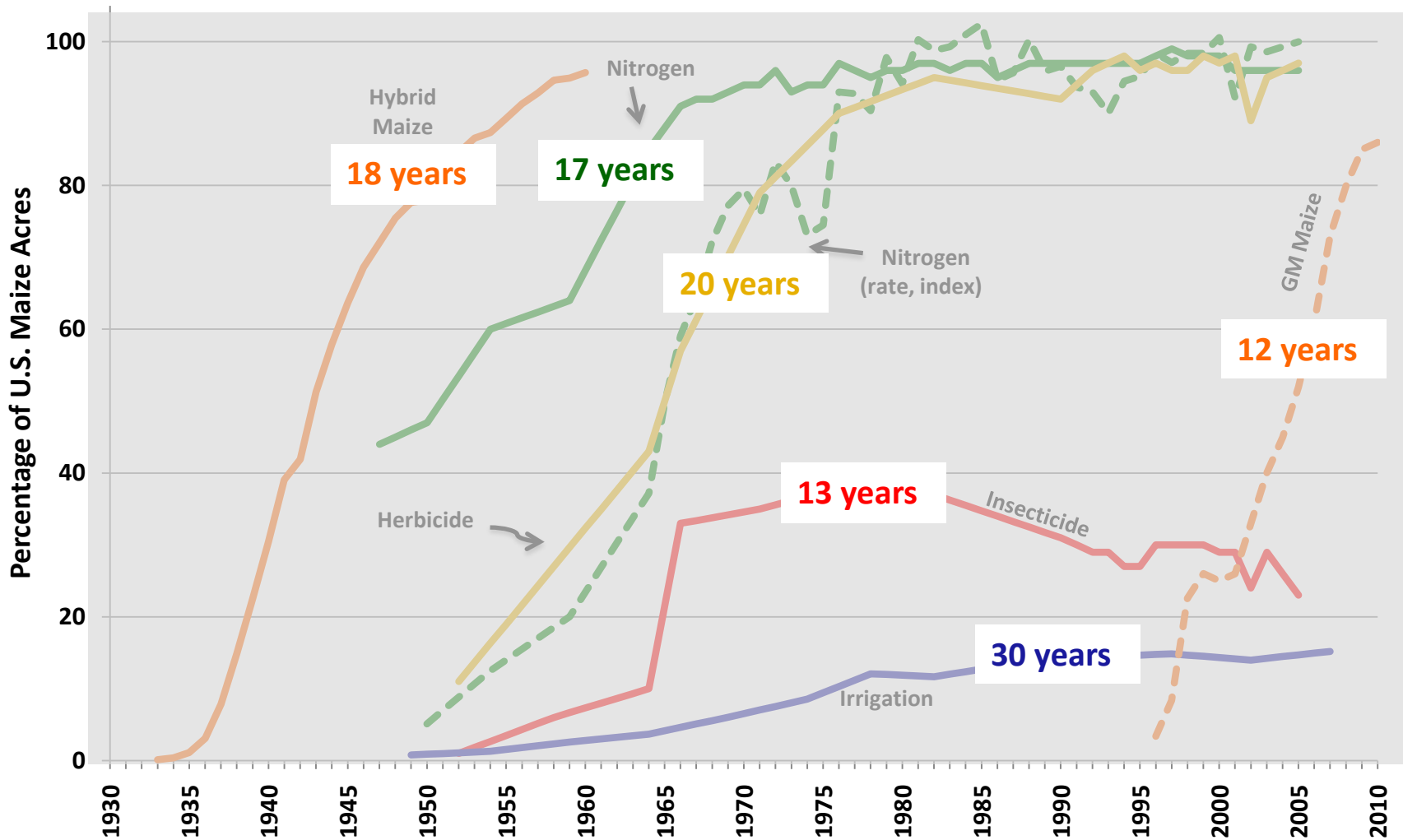
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# Stylized Representation of the Benefits and Costs of an Agricultural Innovation

Gross annual benefits (dollars per year)

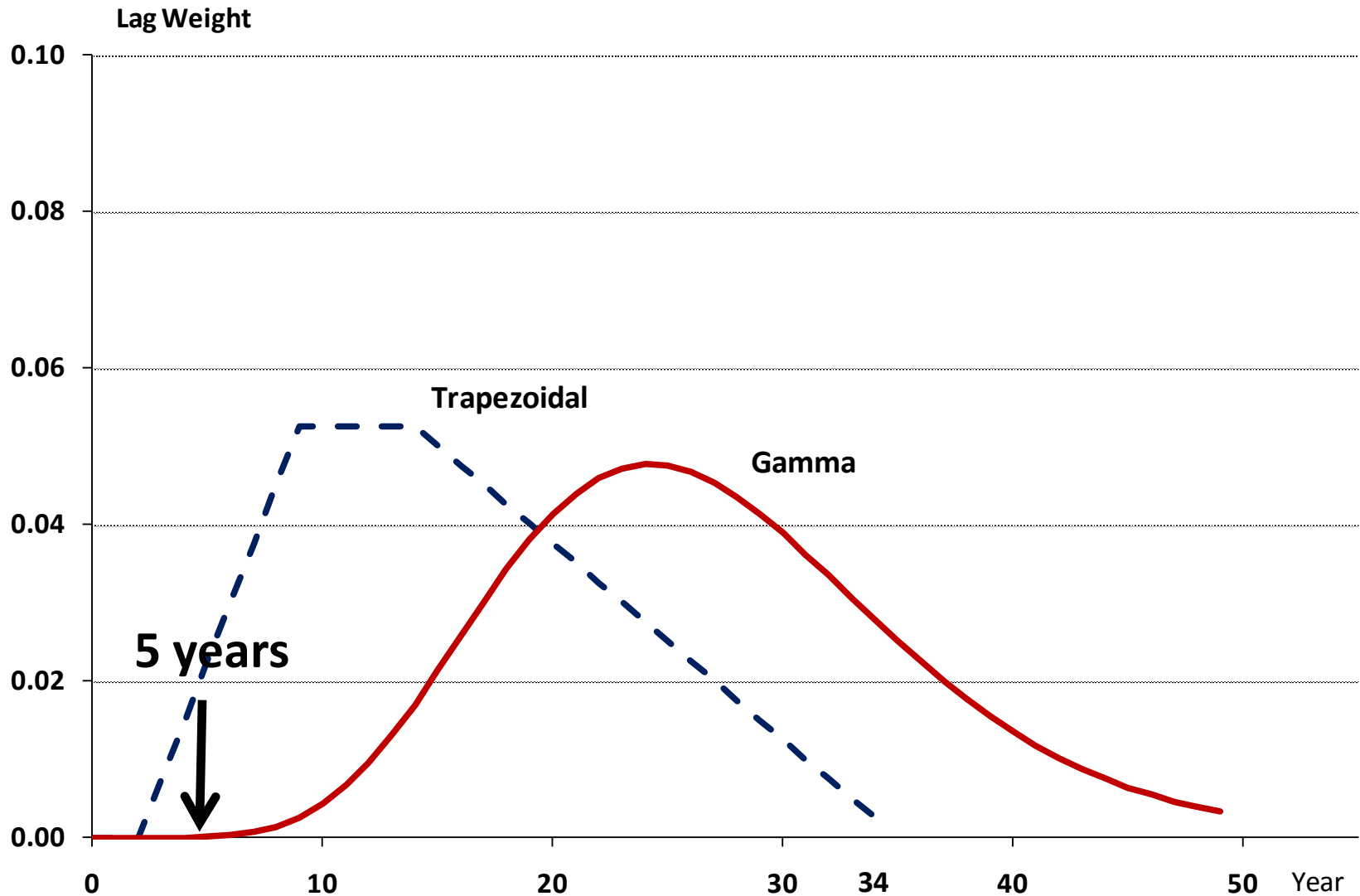


# U.S. Maize Technology Adoption Lags



Source: Beddow (2012)

# Aggregate R&D-Productivity Lag



Source: Alston, Pardey and Ruttan (2008) and Alston et al. (2010)

# Payoffs to Public Spending

## Direct Effects

- benefits (via cost reductions) to farm firms and others who adopt

## Indirect Effects

### Induced Output Price Changes

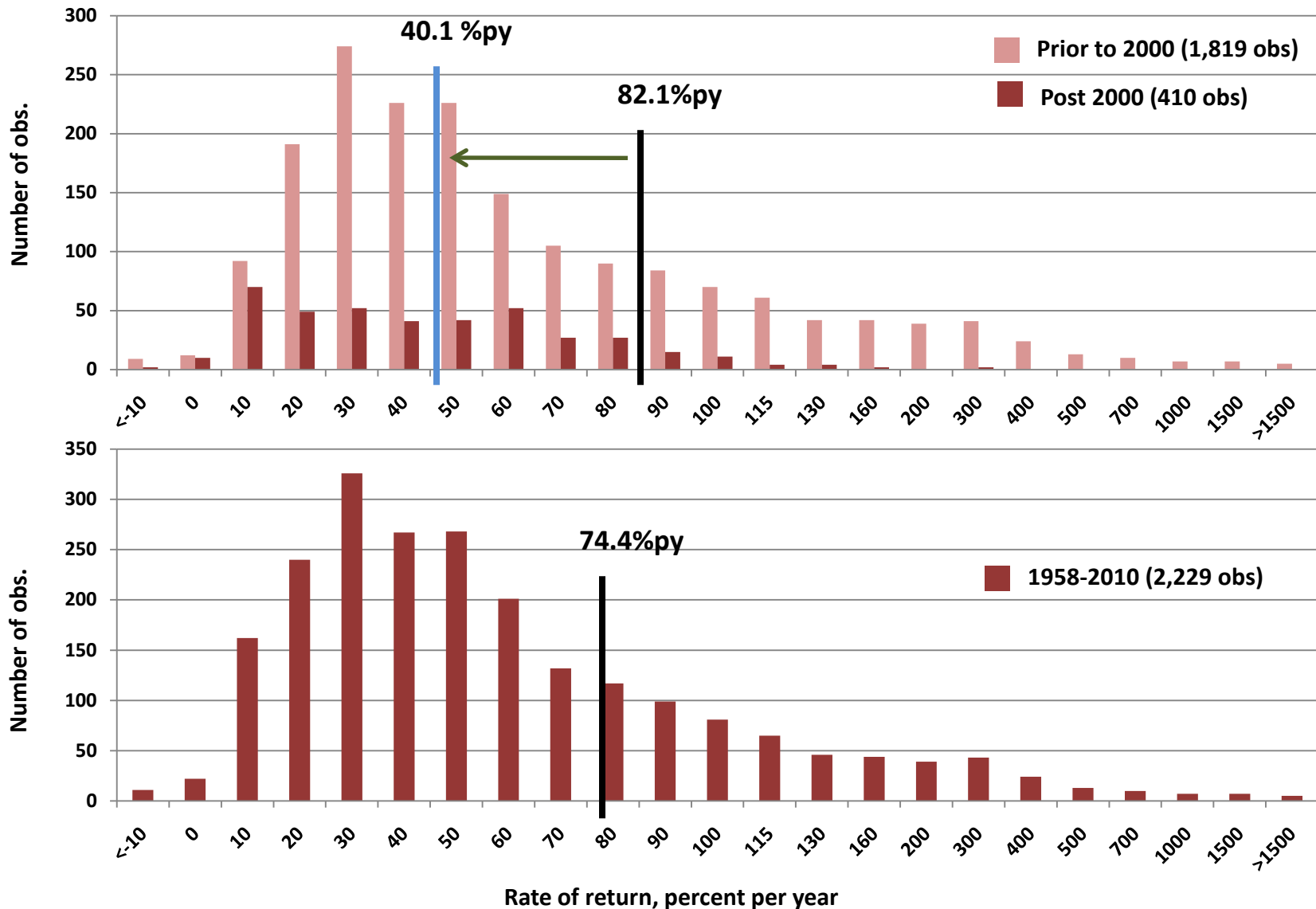
- benefits to consumers
- reduced benefits to farmers who adopt
- cost to farmers who do not adopt (or adopt late)

net benefits to farm firms depends on whether they adopt and whether the farm is a net surplus or deficit producer

### Employment and Wage Effects

- in agriculture
- in other sectors

# Meta Evidence on the Returns to Agricultural Research



Source: Xudong, Hurley and Pardey (2012 beta version) and Alston et al. (2000)

# **What's Been Happening to Food and Agricultural R&D Investments Globally?**

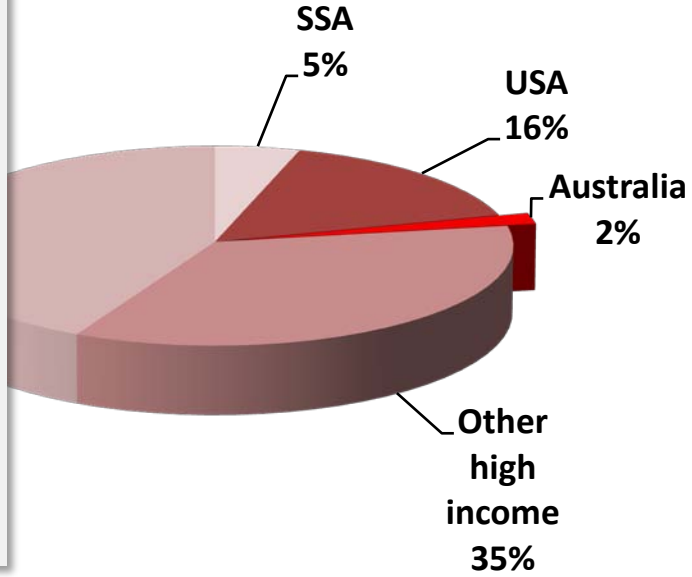
# Public Agricultural R&D Spending Worldwide, 1970 vs 2005

## OECD Total Food & Ag R&D

<b>TOTAL</b>	<b>30.6 billion (2005, intl. prices)</b>
<b>Australian Share</b>	<b>(percent)</b>
<b>Public</b>	<b>3.3</b>
<b>Private</b>	<b>1.8</b>
<b>Total</b>	<b>2.5</b>

**\$11.4 billion (2005 intl. prices)**

## 2005

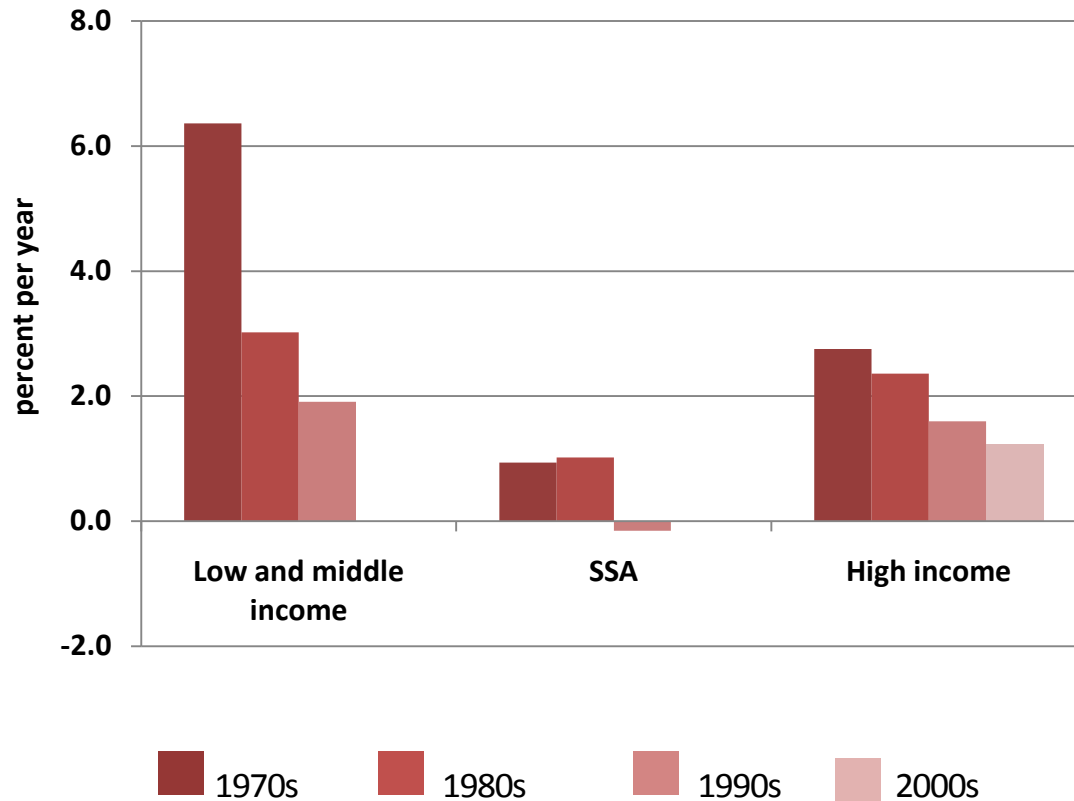


**\$28.7 billion (2005 intl. prices)**

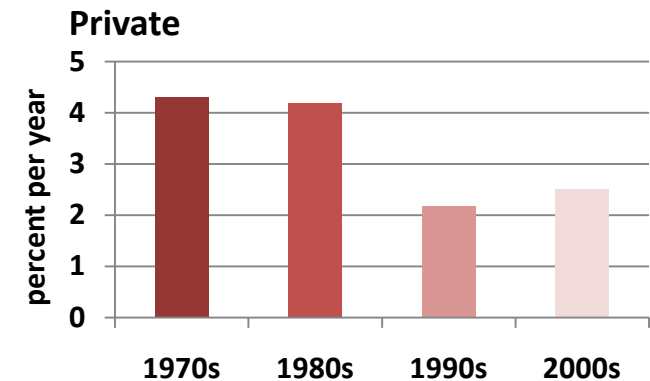
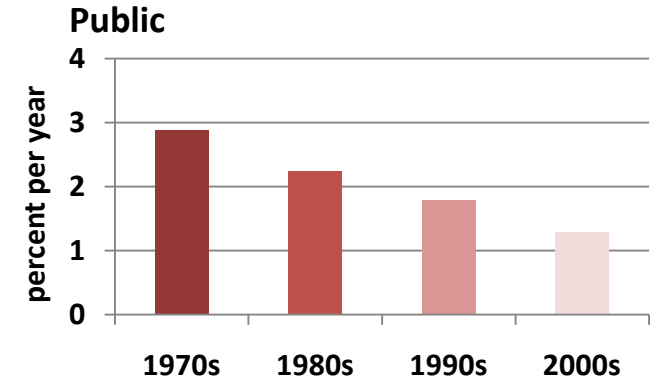
Source: Pardey and Chan-Kang (2012, beta version)

# Growth in Food and Agricultural R&D Expenditures

## “Global” Public Spending

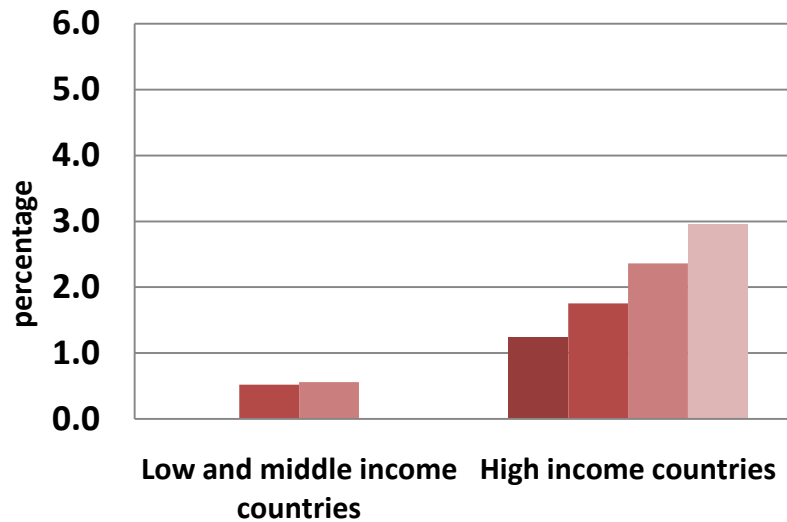


## OECD Countries

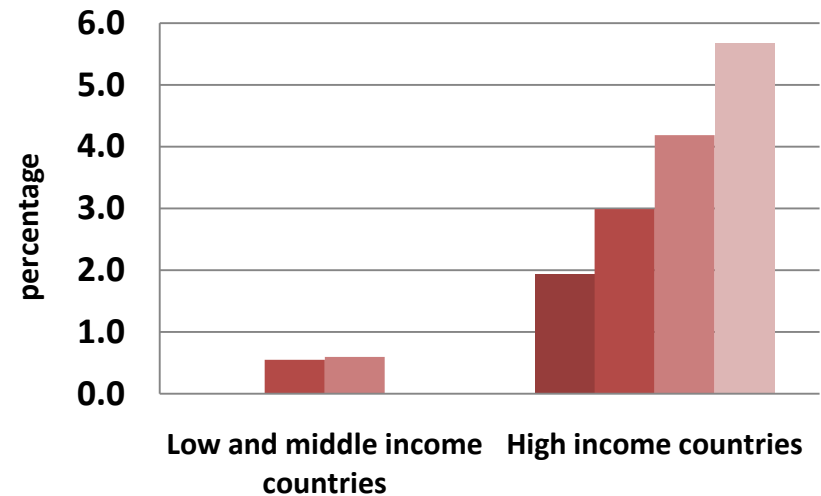


# Food and Agricultural Research Intensity Ratios, 1970-2005

Panel a: Public



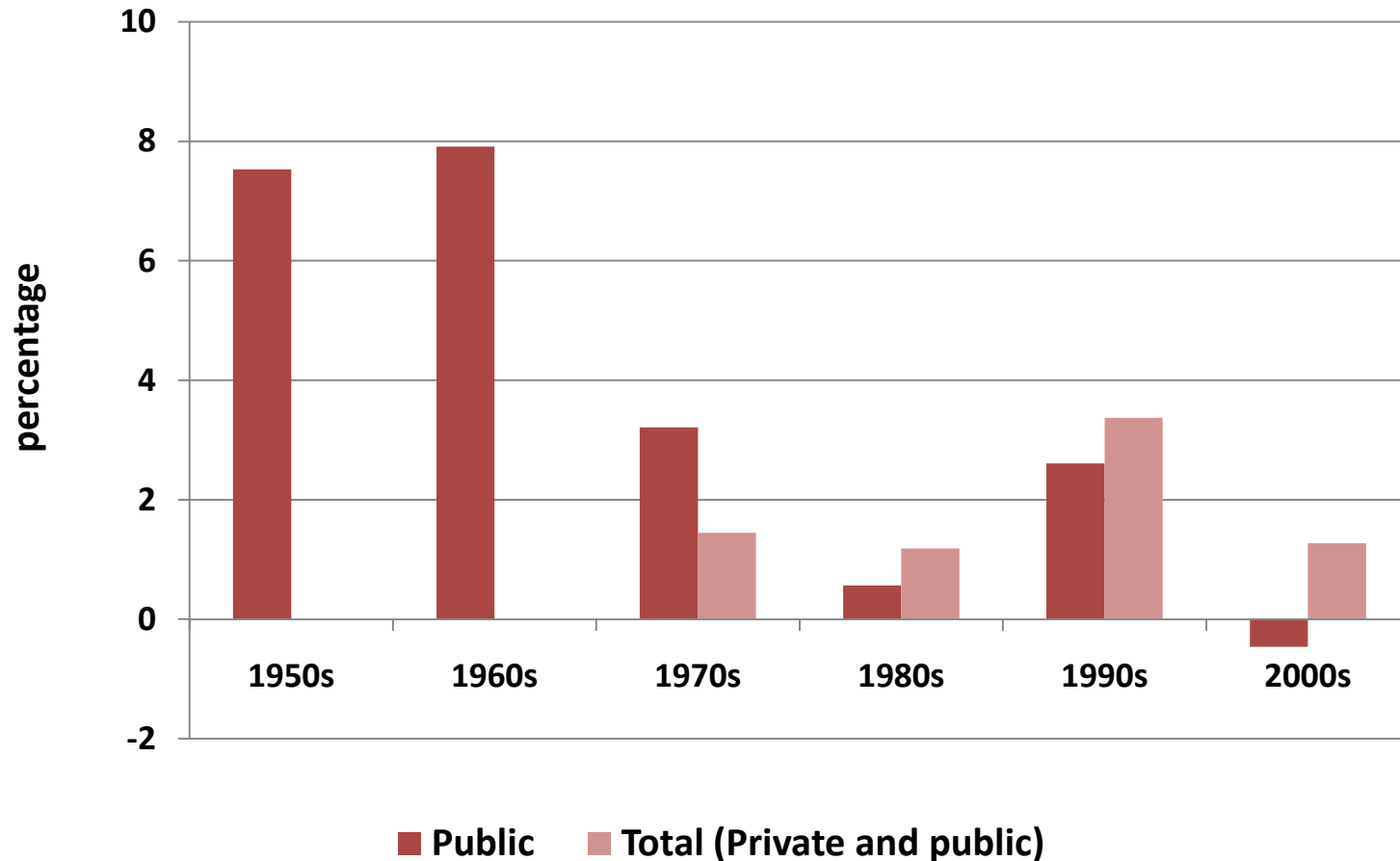
Panel b: Public and Private



1970s 1980s 1990s 2000s

# **Where Does Australia Fit into these R&D Spending Patterns?**

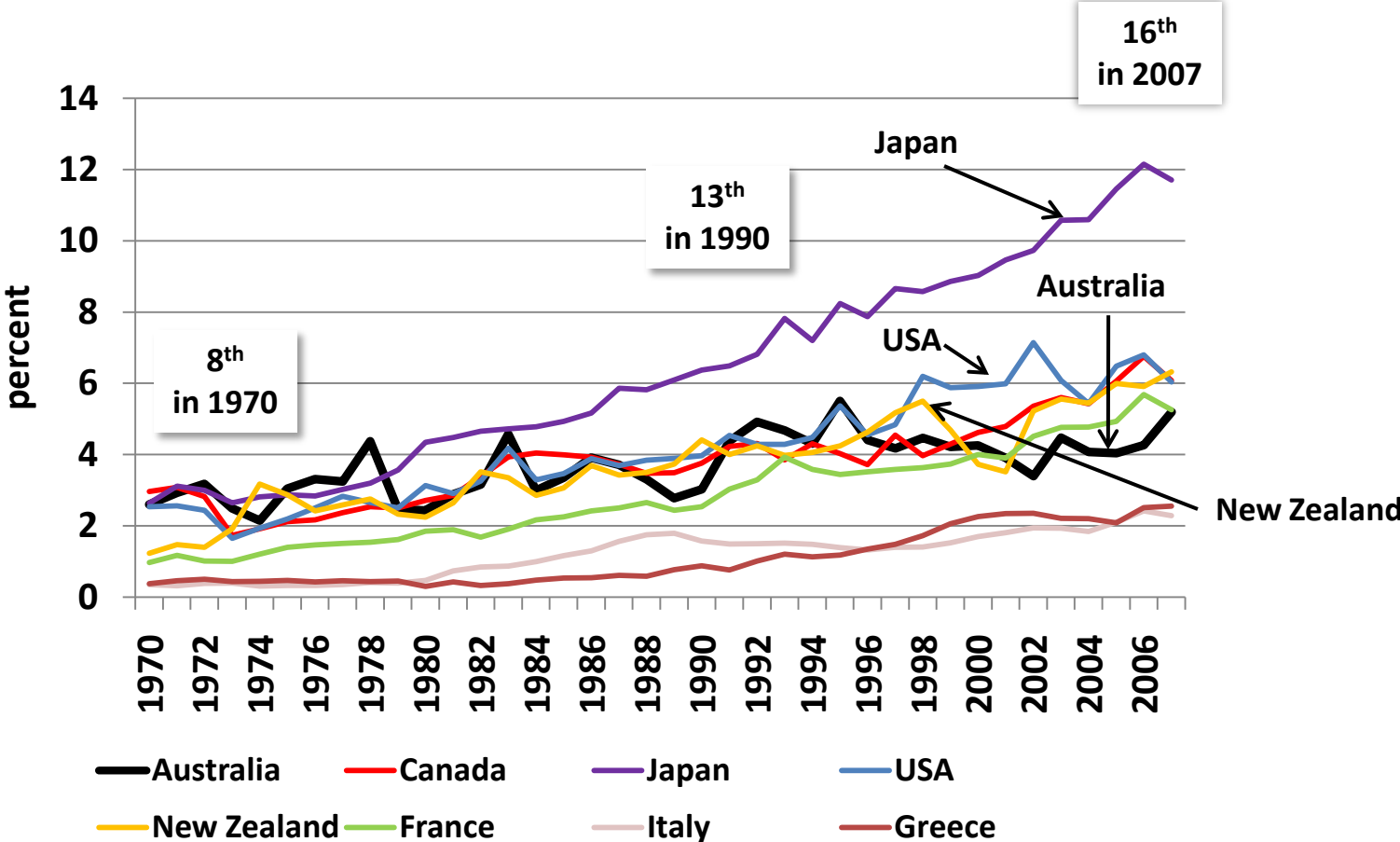
# Australian Agricultural R&D Spending Growth, 1950-2007



Note: Excludes fisheries, forestry and environmental research

Source: Pardey and Chan-Kang (2012, beta version)

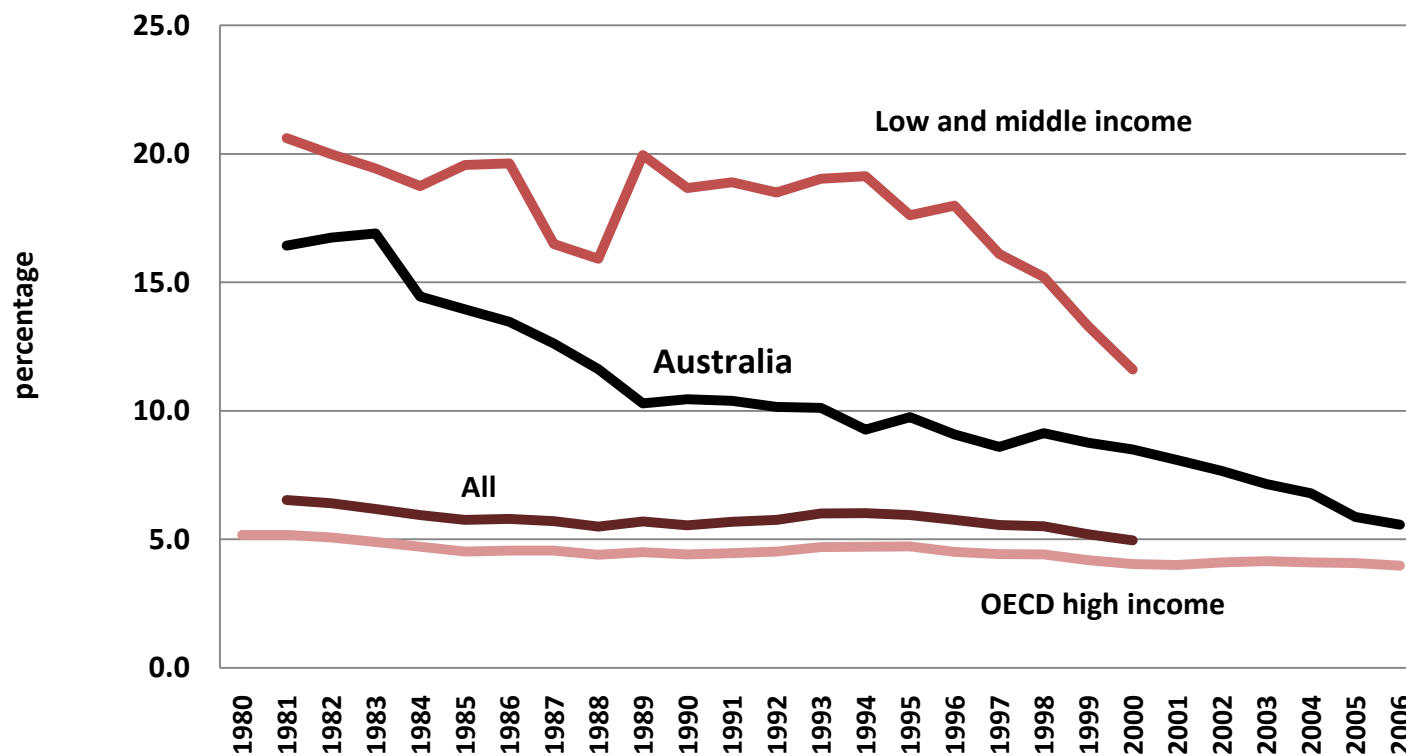
# Total Food & Agricultural Research Intensities, 1970-2007



Note: Total includes public and private R&D spending for 26 OECD countries.

Source: Pardey and Chan-Kang (2012, beta version)

# Food and Agricultural R&D Share in Total R&D



Note: Low and middle income group excludes Eastern Europe and countries that were part of the former USSR

Source: Pardey and Chan-Kang (2012, beta version)

# Optimizing the Payoffs



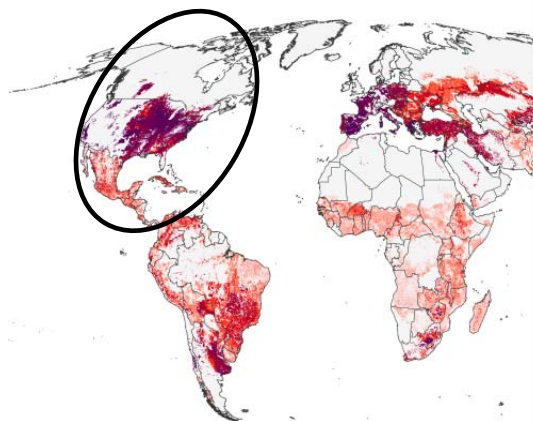
# **Targeting Technologies to Maximize their Productivity Effects**

# Informing Strategic Investment Decisions

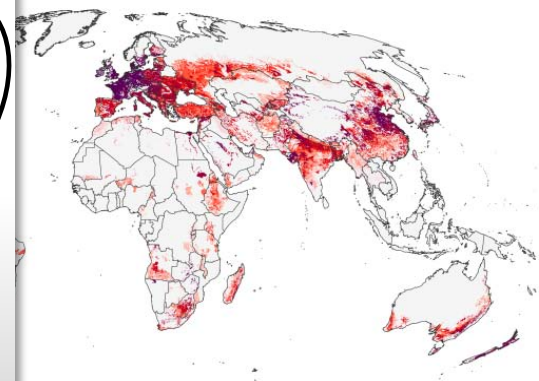
- **How much to invest?**
- **What production constraints on what crops?**
  - **Drought tolerance**
  - **Soil constraints**
  - **Pests and diseases**
  - **New varieties vs crop management or chemical controls?**
- **In what locations?**
- **Balance between**
  - **Short vs long term**
  - **Local vs adaptive (spill-ins)**
  - **Crops vs livestock (and feed)**

# Spatial Distribution of Crop Yields, 2000

Panel a: Maize



Panel b: Wheat



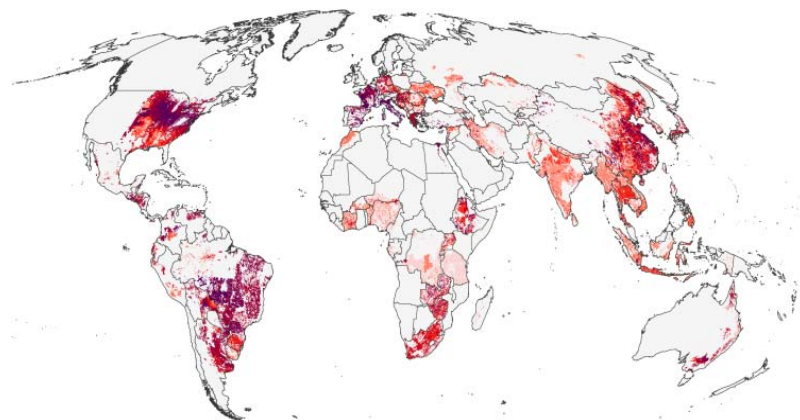
## Share of World's High-Yielding Area

	US	Africa	Australia
		<i>(percent)</i>	
Maize	32	2.5	1.6
Wheat	28	3.6	1.6
Soybean	25	5.6	2.1
Rice	5.3	5.7	1.3

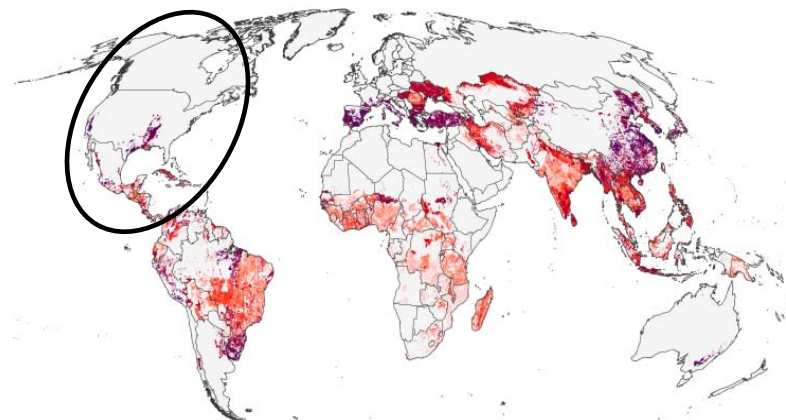
Yield (decile)



Panel c: Soybean



Panel d: Rice



# Long-Run Spatial Dynamics of Crop Production, 1899-2007

## Myriad of reasons for the movement

- Technical change was at least enabling if not a significant causal factor
- Genetics (hybrid corn), mechanization, chemical, irrigation, drainage
  - Shorter duration varieties
  - Change in planting (tasseling and harvesting) dates
  - Change in planting densities
  - Improved drought and disease tolerance

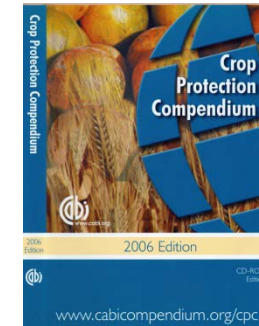
Central Illinois to southeastern Iowa



# Global “Occurrence” of Stem Rust



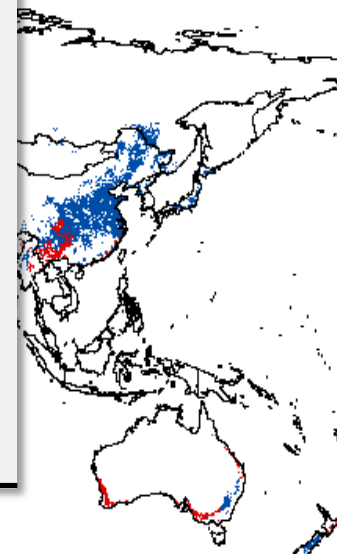
CABI Compendium (2006)



- ◆ present, no further details
- ◆ widespread
- ◇ present, localized
- ◇ occasional or few reports

## Share of Susceptible Wheat Area

	Suitable	Persists
	(Percentage)	
US	71	1
India	74	9
China	92	5
Australia	38	30
Africa	90	67
<b>WORLD</b>	<b>68</b>	<b>14</b>

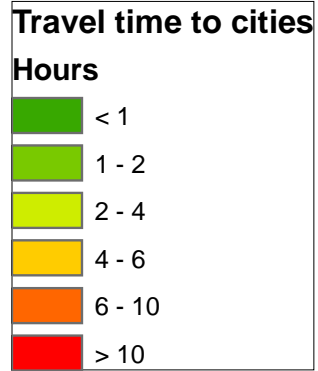
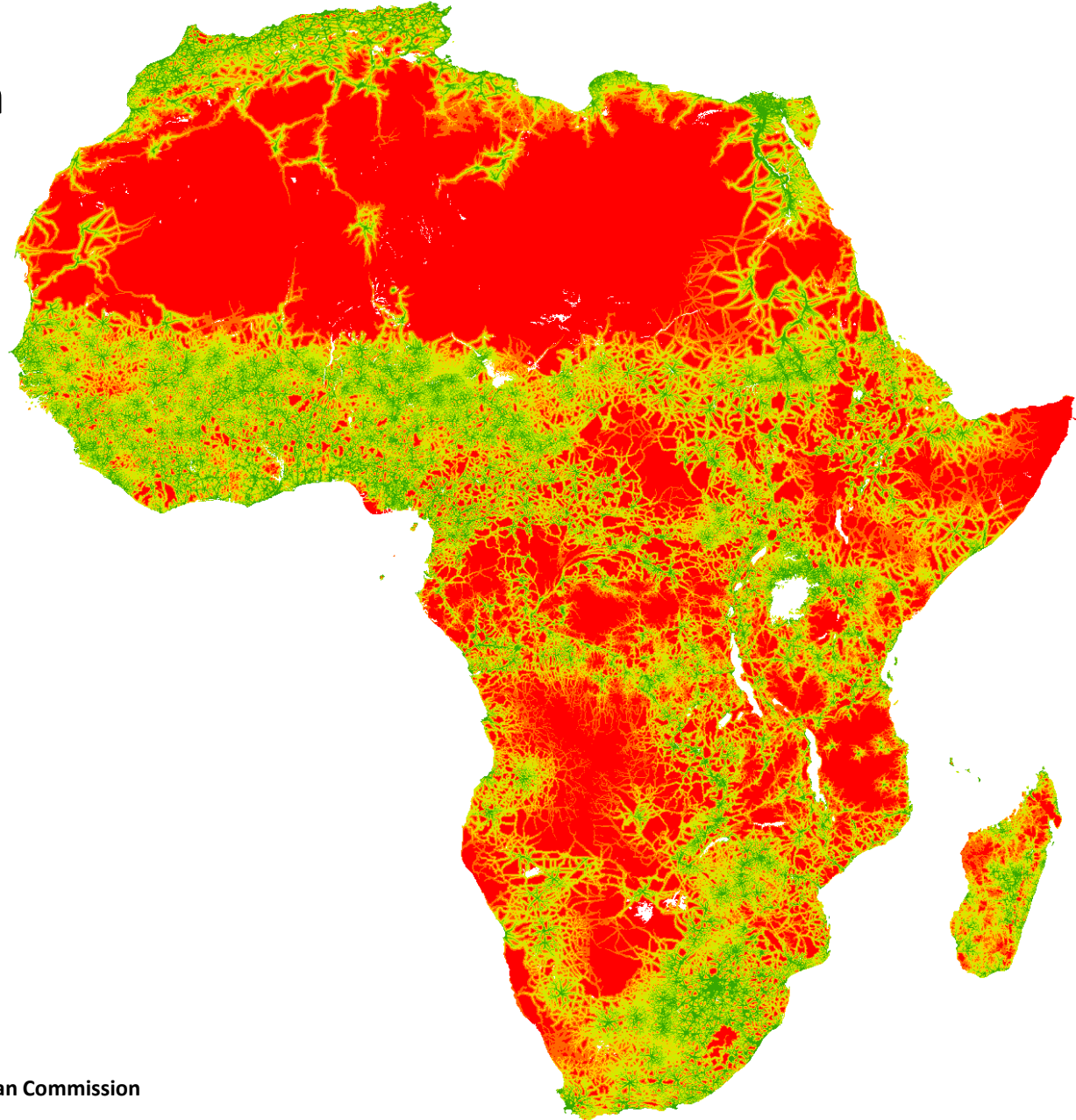


## Climate suitability of stem rust

- Suitable
- Persist

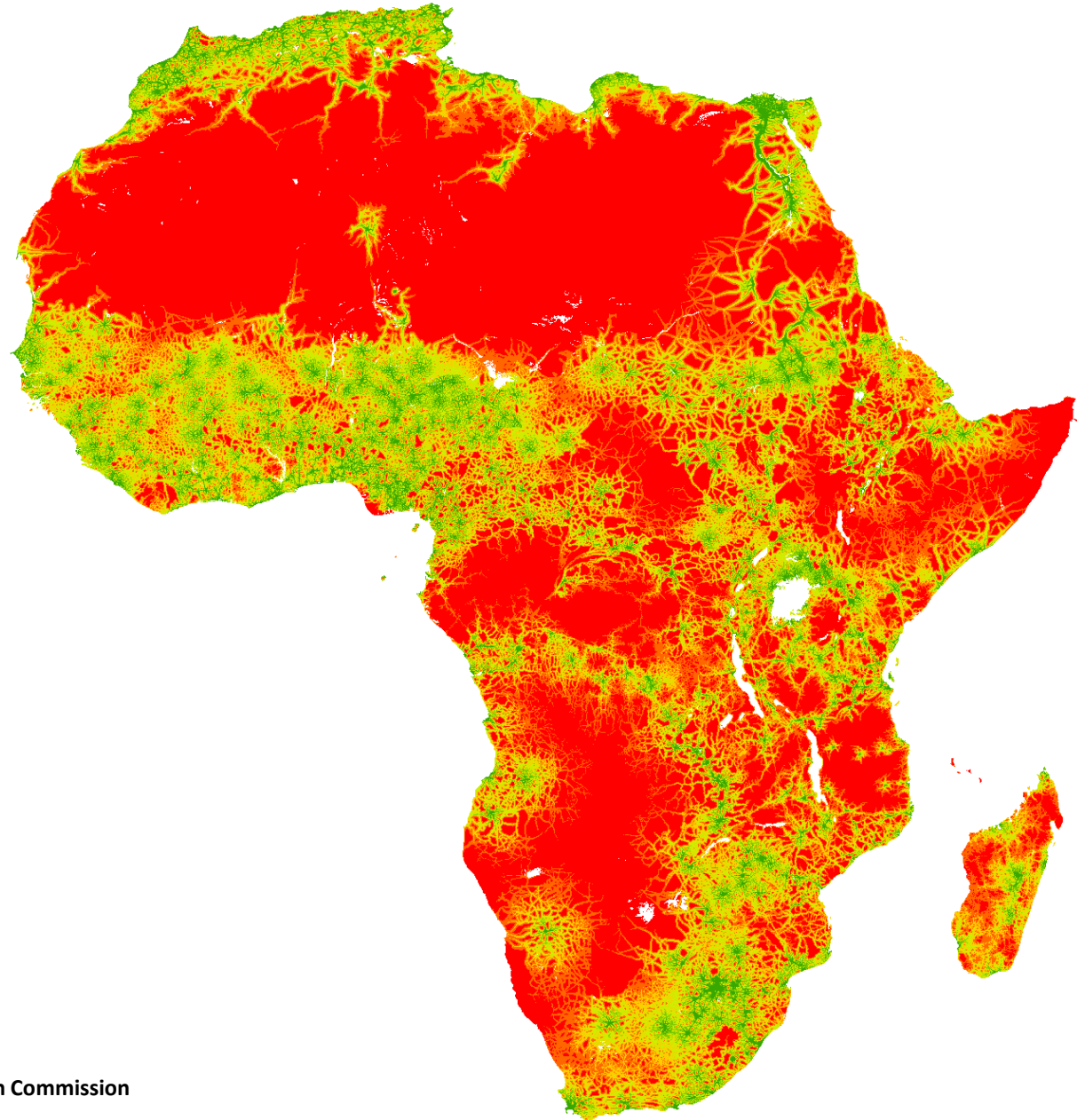
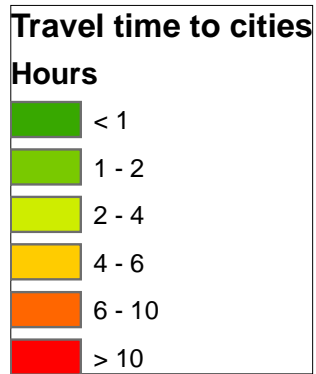
# Production and Markets—Spatial Matters

Travel time to cities with  
pop greater than 20,000



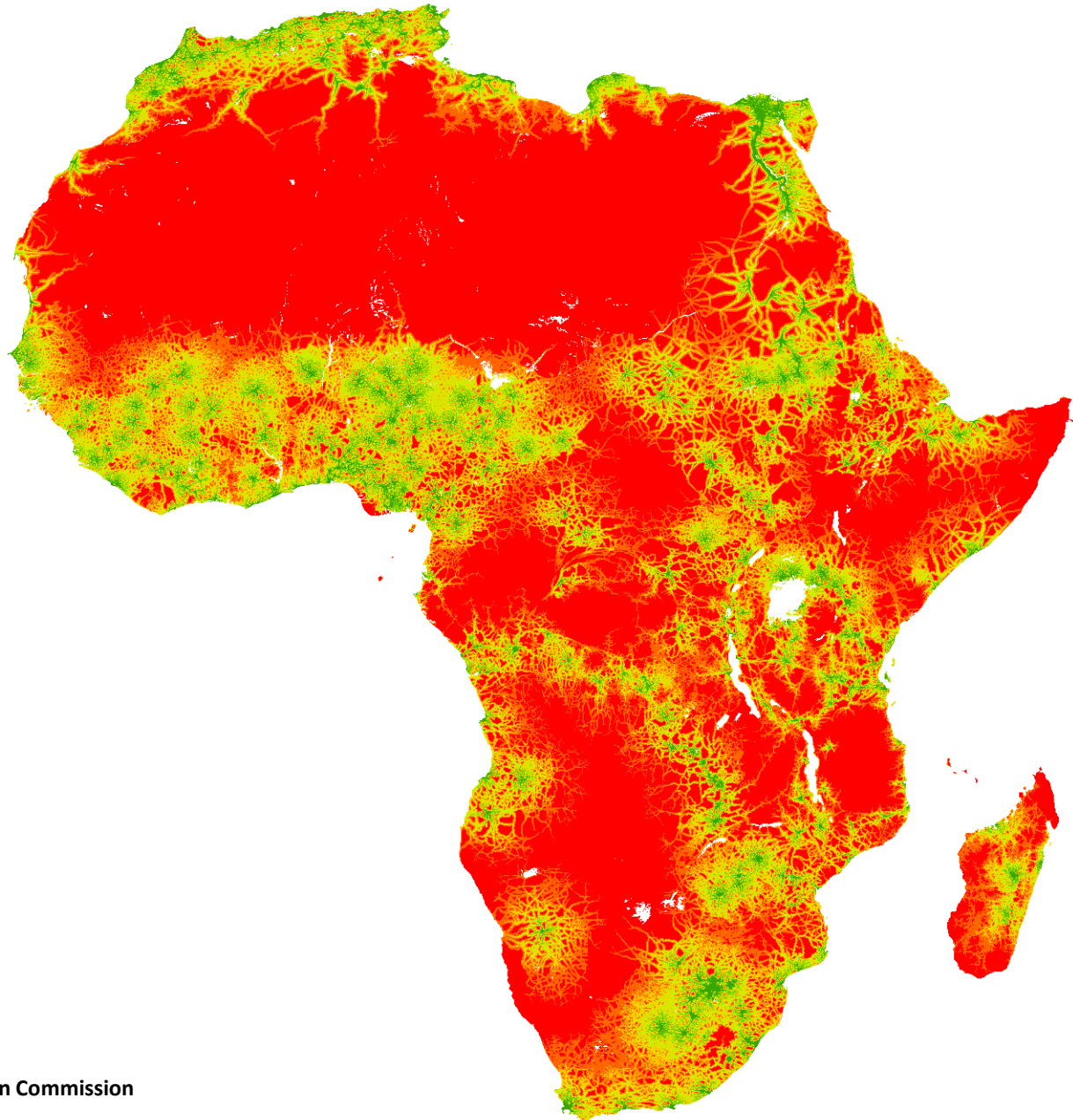
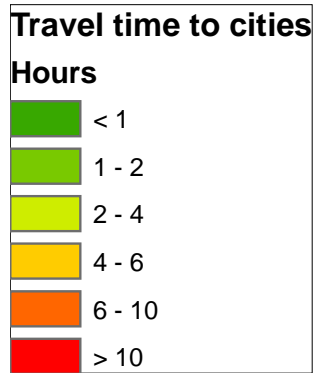
# Production and Markets—Spatial Matters

Travel time to cities with  
pop greater than 50,000



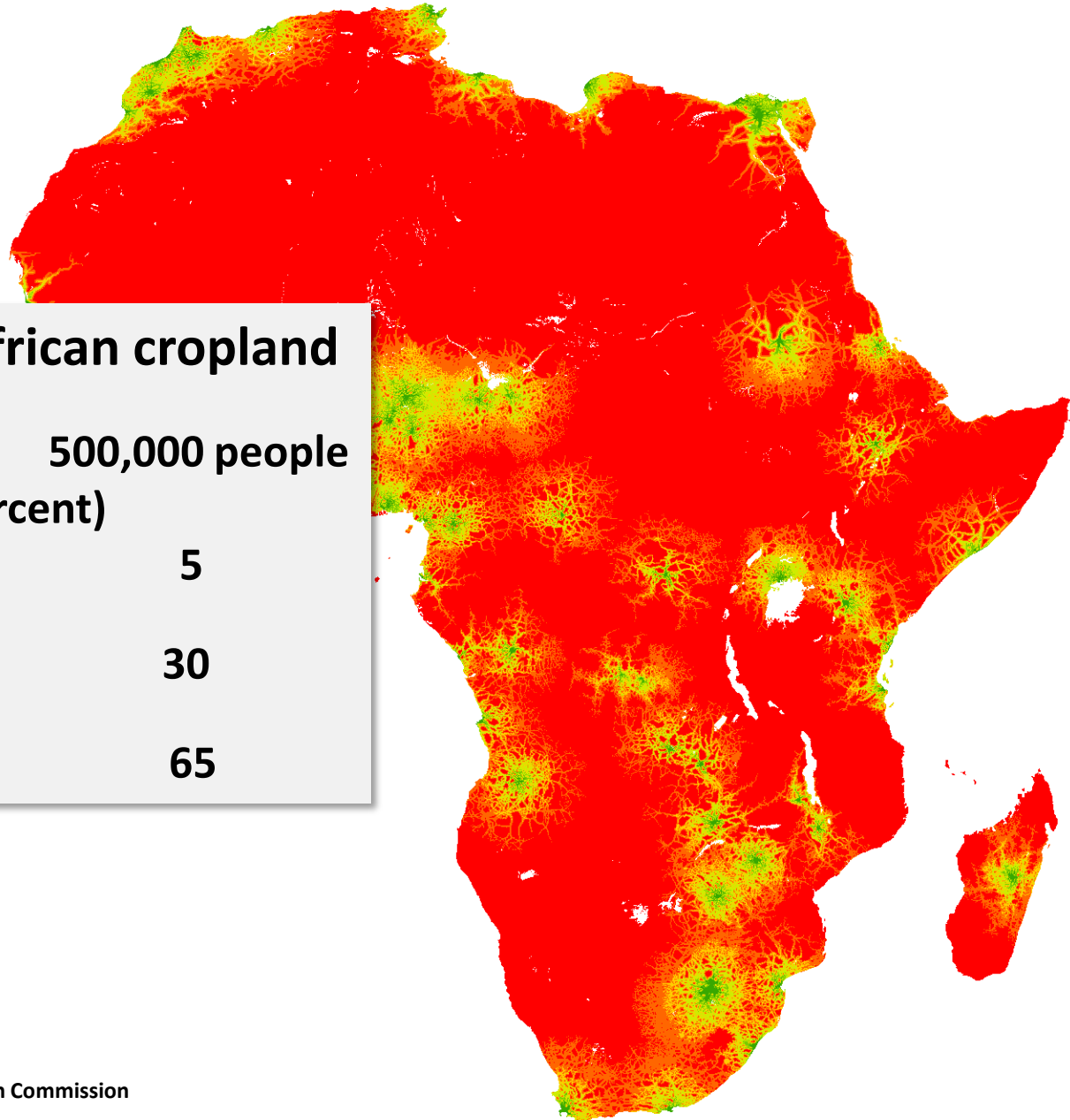
# Production and Markets—Spatial Matters

Travel time to cities with  
pop greater than 100,000



# Production and Markets—Spatial Matters

Travel time to cities with  
pop greater than 500,000



## Time to market from African cropland

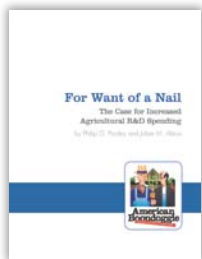
	20,000 people	500,000 people (Percent)
<2 hrs	28	5
2-6 hrs	50	30
> 6 hrs	27	65

## Final Remarks

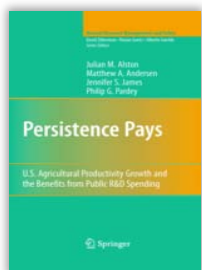
- 1. High rates of return to agricultural R&D**
  - Implies persistent underinvestment
- 2. Shifting patterns of public support for R&D**
  - High-income countries
    - Slowdown in spending growth
    - Diminishing share for on-farm productivity enhancement
  - A different pattern in China, for example
- 3. Shifting productivity patterns**
  - Productivity slowdown (especially in high-income countries)
  - A different pattern in China
- 4. Refocus on *long-run* productivity growth, but conscious of the trade-offs involved**
- 5. Evidenced-based investments**

# Thanks!

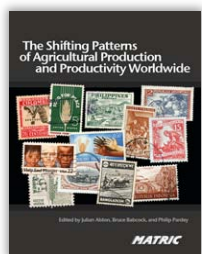
## Selected Sources



Pardey, P.G. and J.M. Alston. ***For Want of a Nail: The Case for Increased Agricultural R&D Spending***. Report in the *American Boondoggle: Fixing the 2012 Farm Bill* series. Washington, D.C.: American Enterprise Institute, 2011



Alston, J.M., M.A. Andersen, J.S. James, and P.G. Pardey. ***Persistence Pays: U.S. Agricultural Productivity Growth and the Benefits from Public R&D Spending***. New York: Springer, 2010.



Alston, J.M., BA. Babcock and P.G. Pardey. ***The Shifting Patterns of Agricultural Production and Productivity Worldwide***. Ames: Iowa State University, 2010.



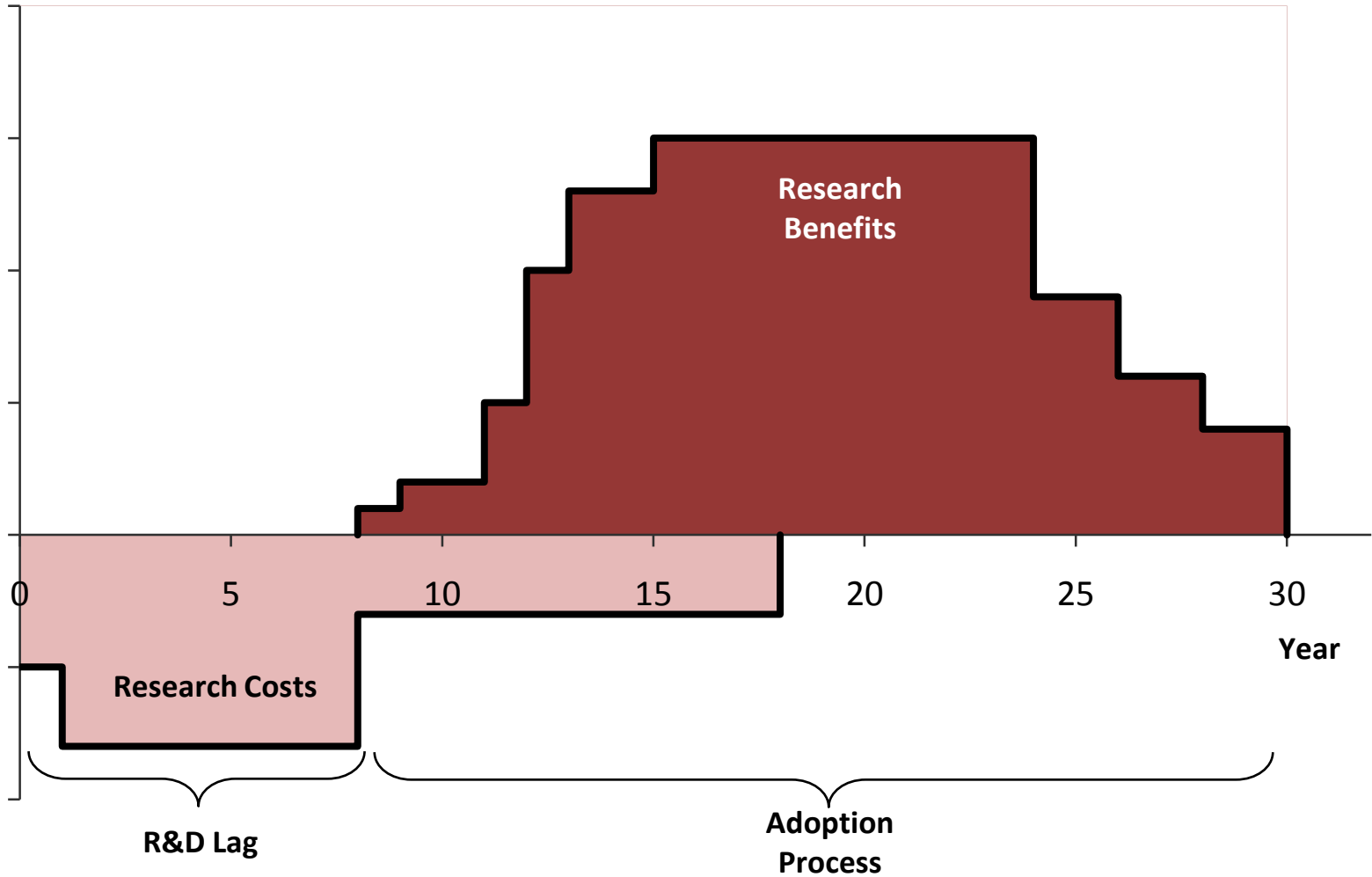
[www.instepp.umn.edu](http://www.instepp.umn.edu)



[www.harvestchoice.org](http://www.harvestchoice.org)

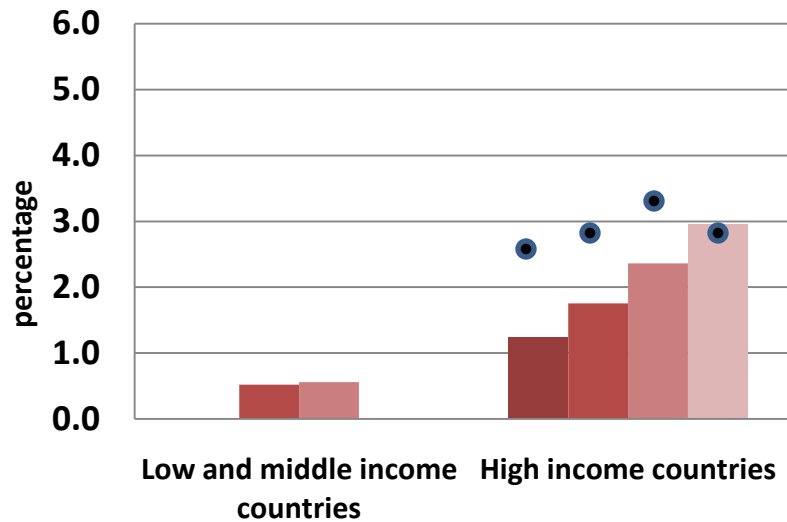
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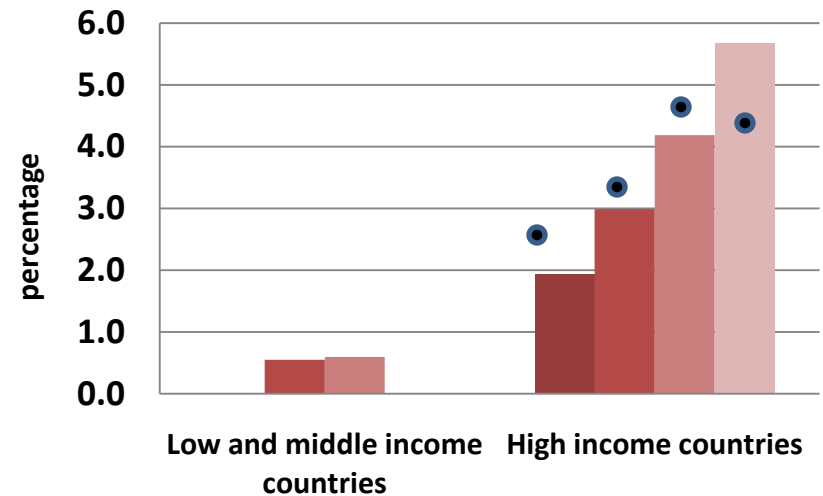


# Food and Agricultural Research Intensity Ratios

Panel a: Public



Panel b: Public and Private



1970s 1980s 1990s 2000s