

Putting U.S. Agricultural R&D and Productivity Developments in Perspective

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Department of
**APPLIED
ECONOMICS**

UNIVERSITY OF MINNESOTA



Collaborators

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Outline

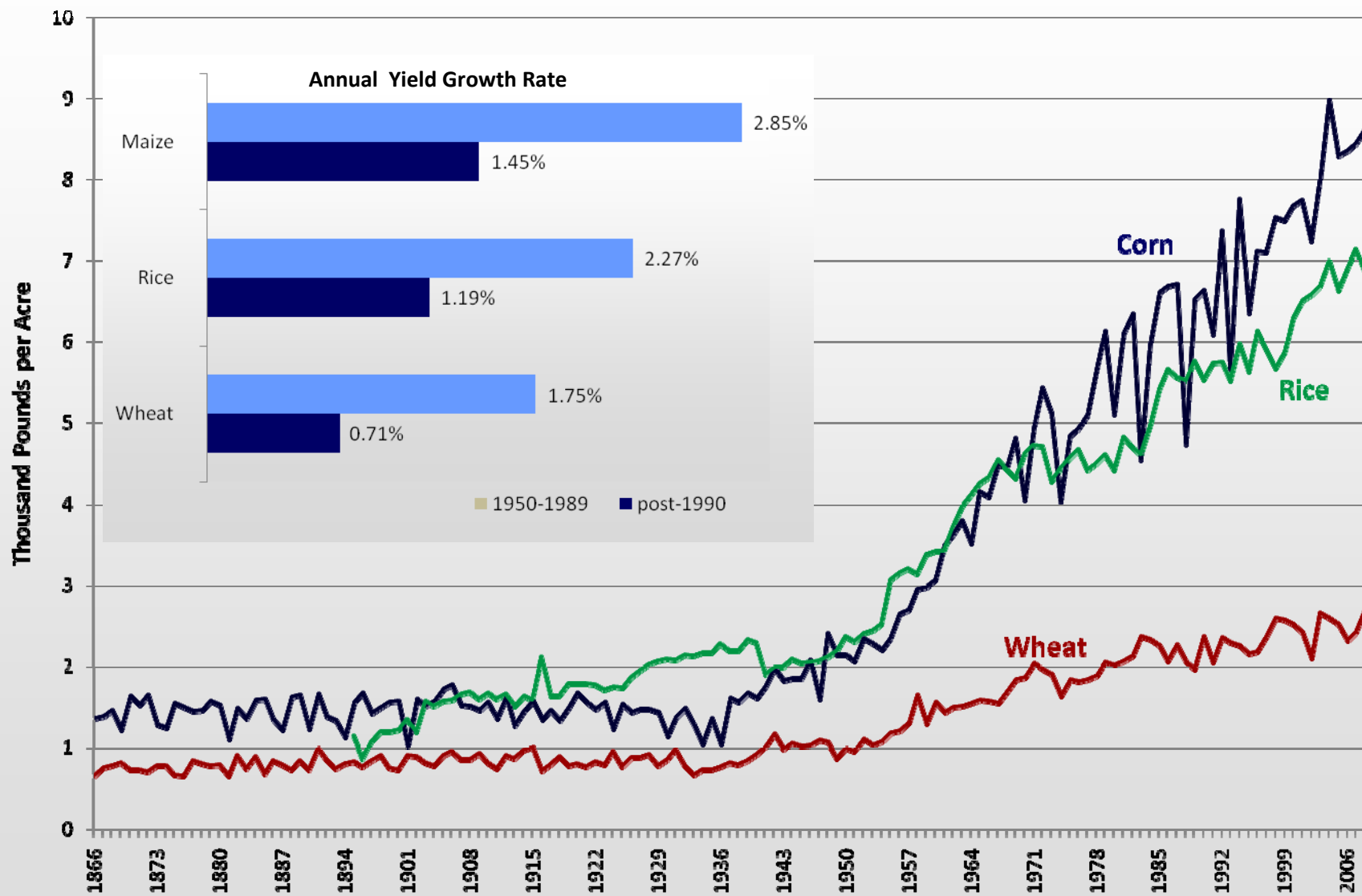
- **U.S. and World Agricultural Productivity Patterns**
 - Partial Productivity Measures
 - Multifactor Productivity
 - A Productivity Slowdown?

- **Linking Agricultural R&D to Productivity**
 - Attribution Problems (R&D Lags, Spillovers-spatial, fields of science, etc)

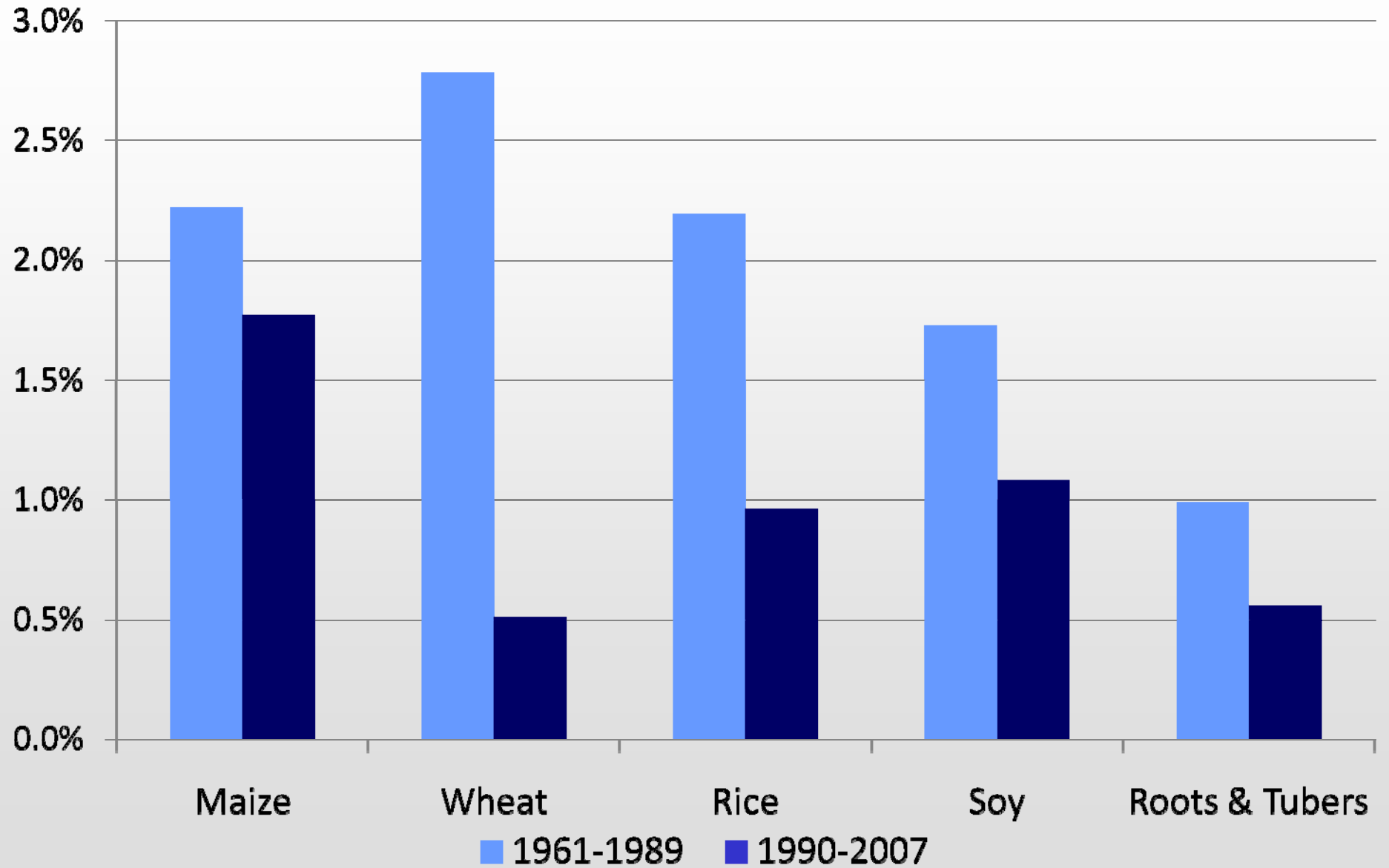
- **R&D Spending Patterns**
 - United States vs Global
 - All Science vs Agriculture
 - Sources and Forms of Funding

U.S. and World Productivity Patterns in Agriculture

U.S. Commodity Yields, 1866 - 2008

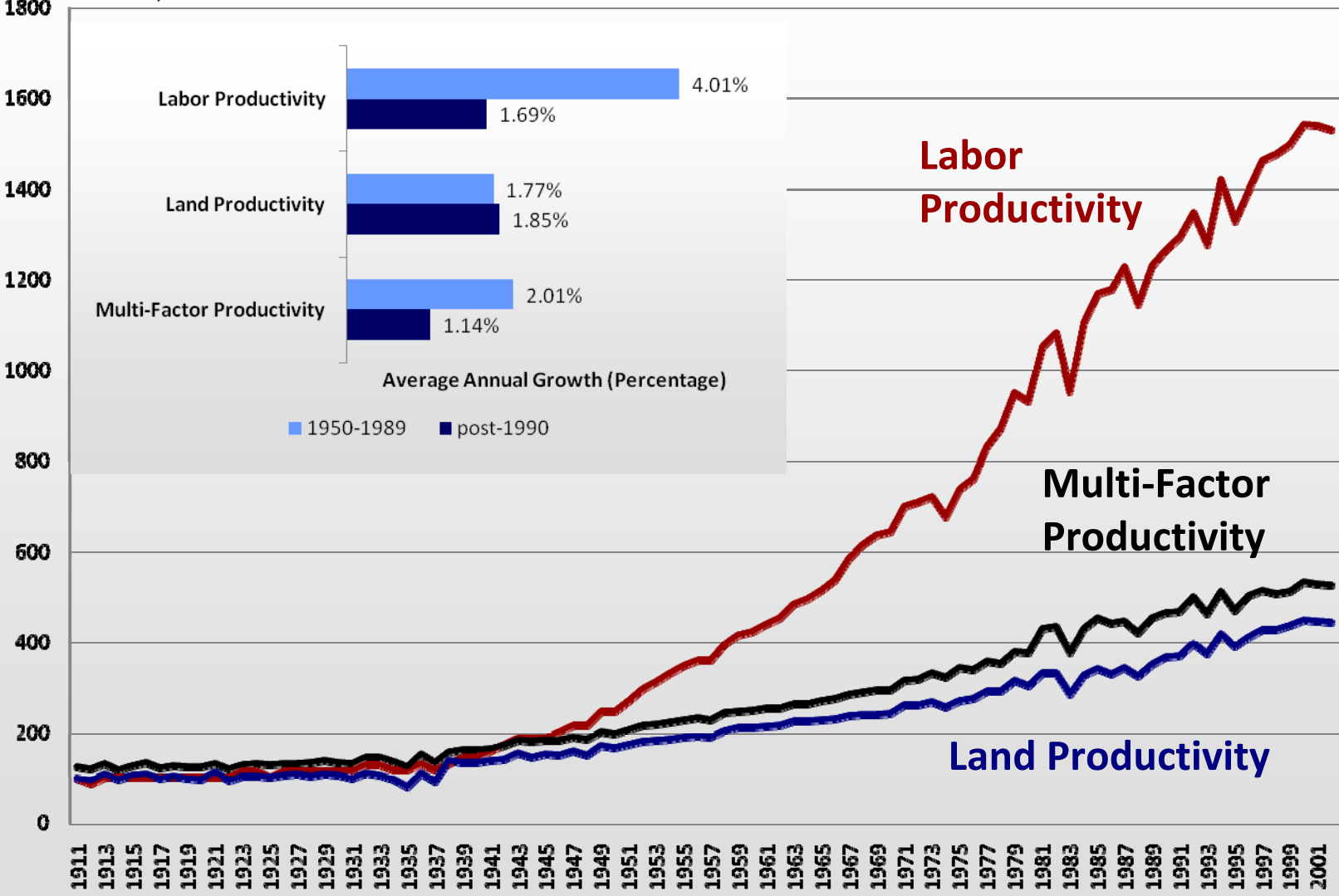


Global Average Yields – Annual Percent Change



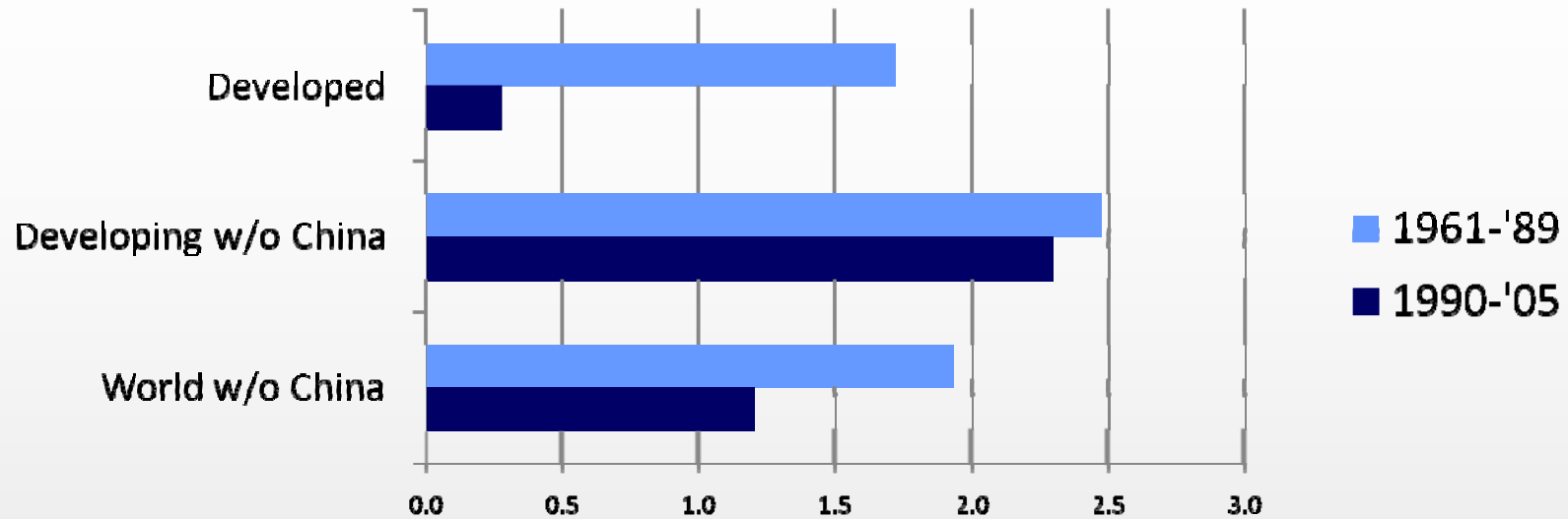
U.S. Labor, Land, and Multi-Factor Productivity, 1911-2002

Index (1911=100)

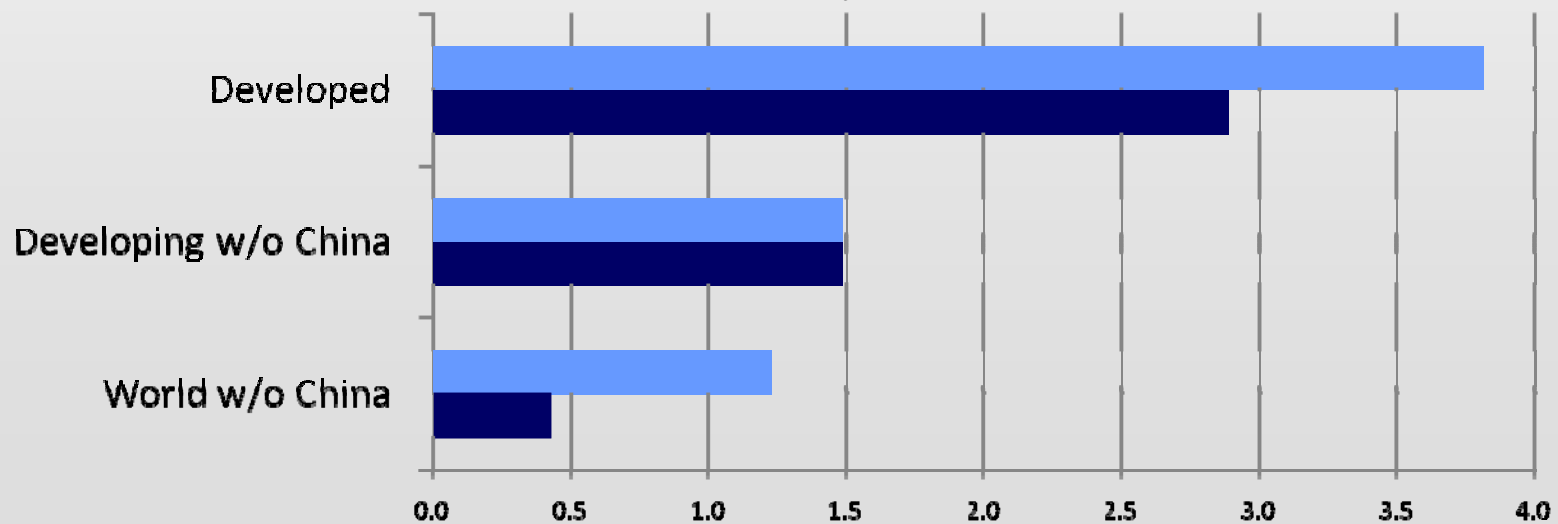


Land and Labor Productivity Growth Rates: 1961-1989 vs. 1990-2005

Land Productivity Growth Rate



Labor Productivity Growth Rate



Causes of Slower Productivity Growth

■ Some Possibilities

- Bad weather?
- Other factors?
 - Changing regulatory environment?
 - Degradation of natural resource base?

■ Research Related Factors

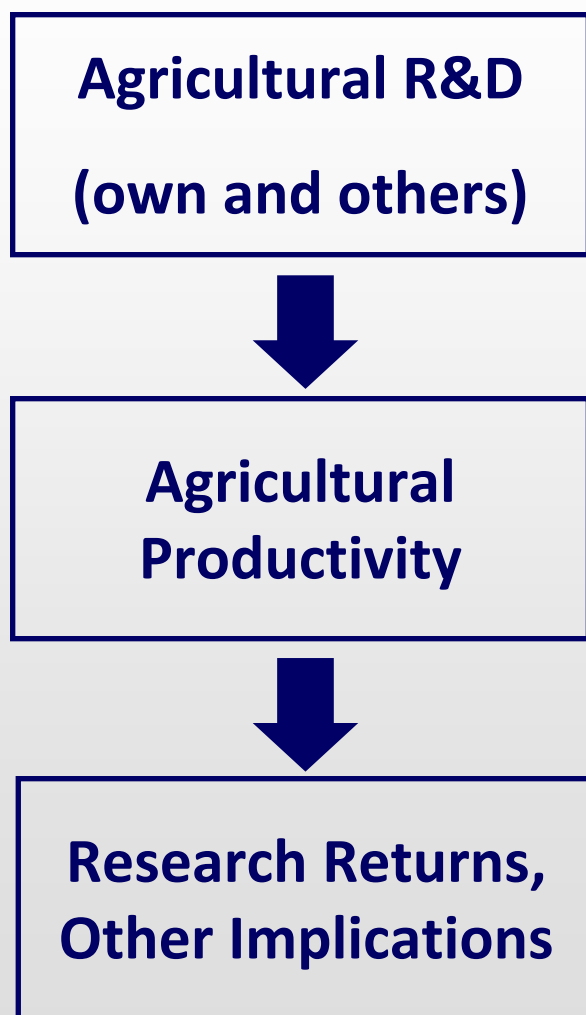
■ Reduced support for farm productivity R&D?

- Slower growth in total agricultural R&D investments
- Changing composition of “agricultural research”
(e.g., shrinking share for farm productivity)

■ Other aspects of R&D ?

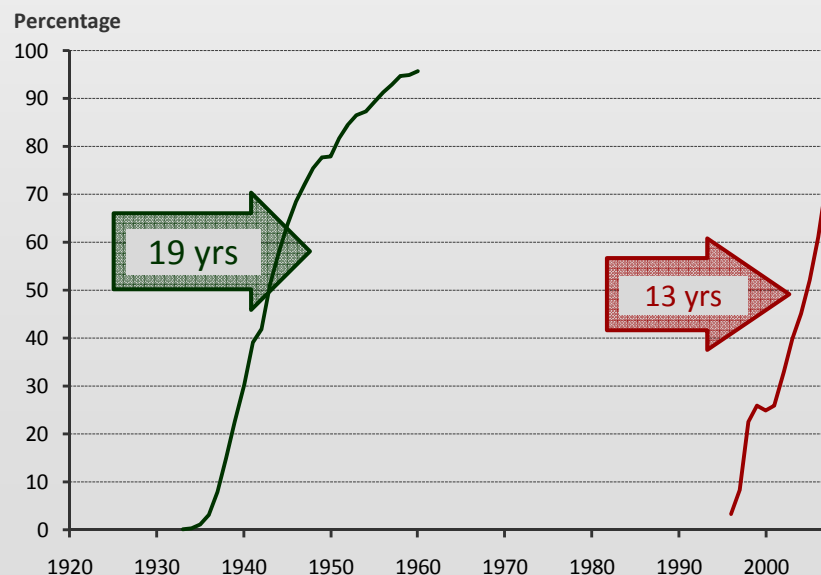
- Shifting structure of U.S. general public R&D?
- Changing private sector roles?
- Reduced spillins from other countries and CGIAR?

R&D – Productivity Relationships



- Research spending to productivity lags are long (matters of decades not years)
- Research results “spillover” affecting locales beyond where the research was performed.
- Significant research required to *maintain* not just *increase* yields/productivity

Hybrid and Biotech Share of US Corn Acreage



R&D Spending Patterns

Overall trends

Global and all science comparisons

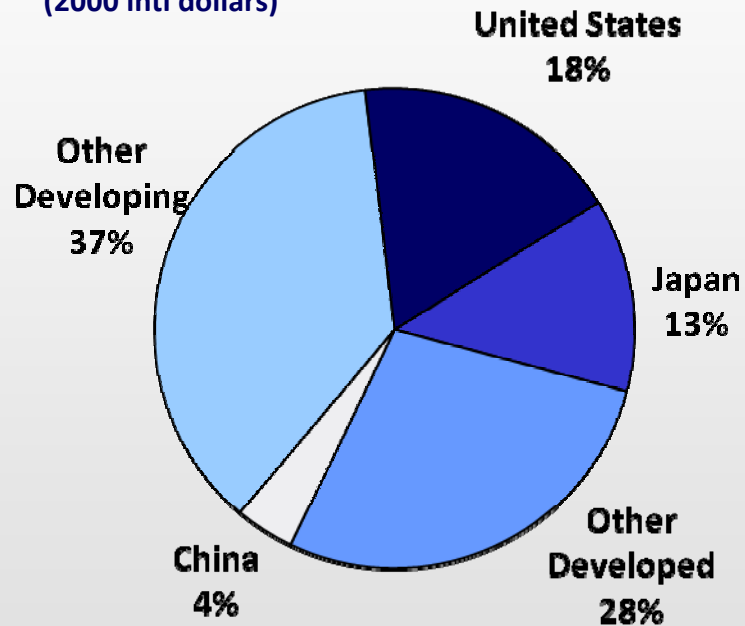
Sources and forms of funding

Public Agricultural R&D Spending Worldwide 1981 & 2000

1981

\$14.84 billion

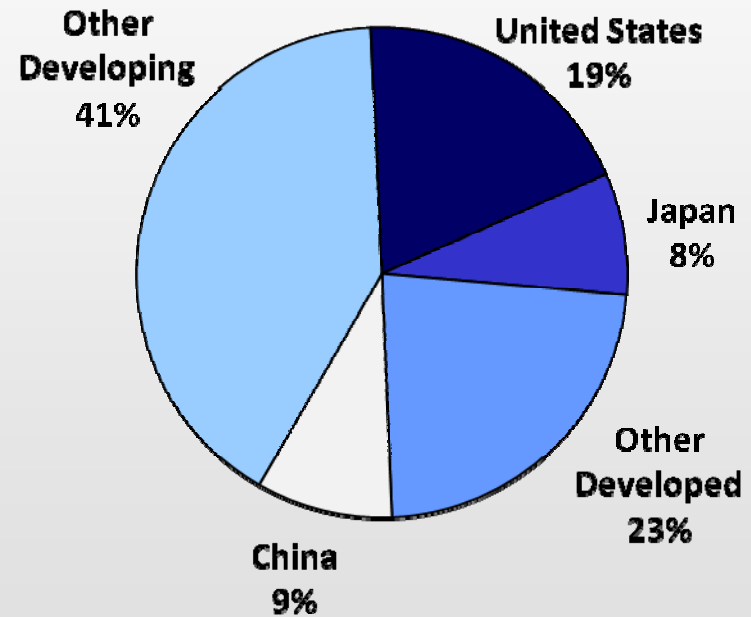
(2000 intl dollars)



2000

\$20.30 billion

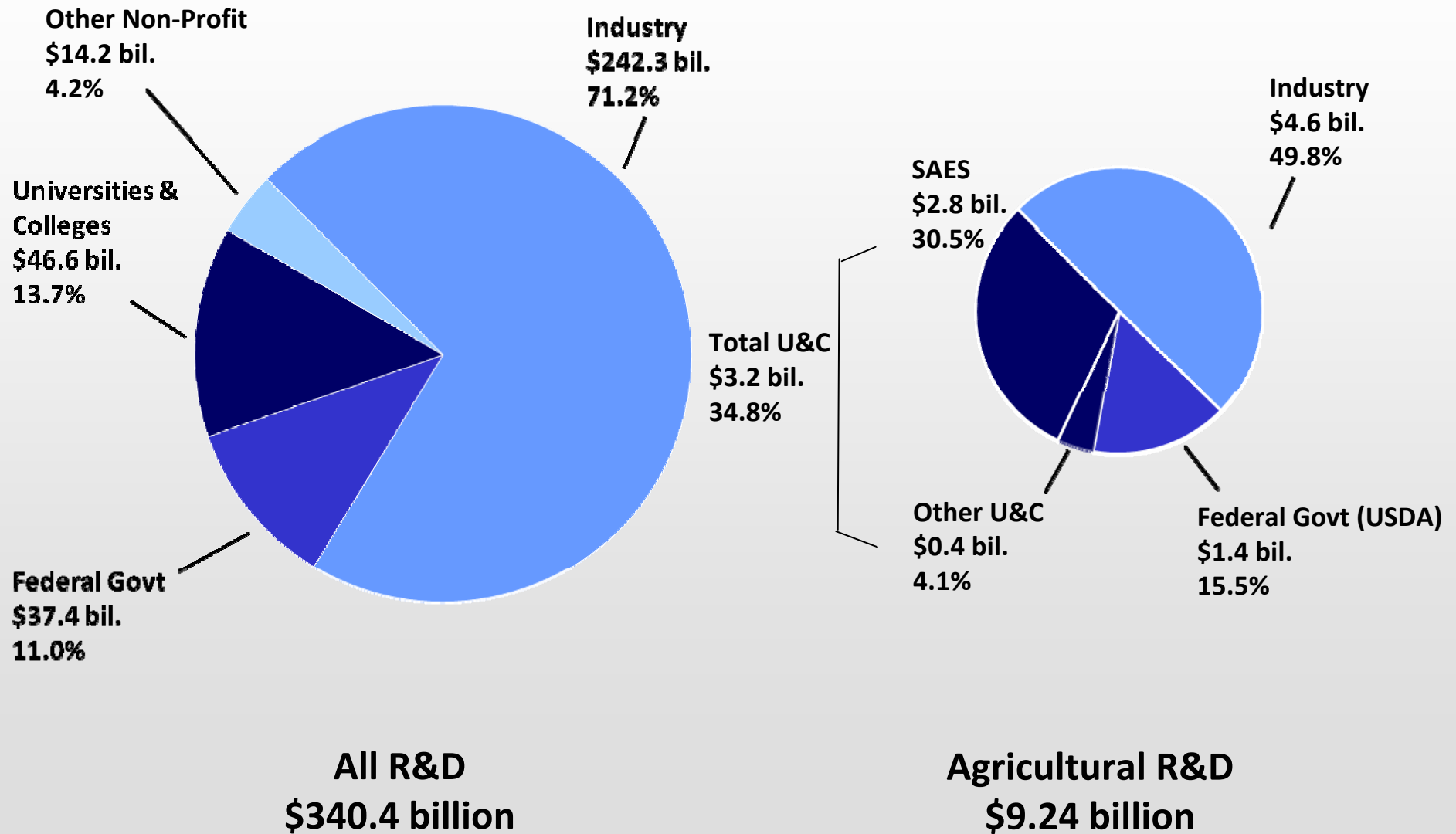
(2000 intl dollars)



Rich country ag share all R&D (year 2000) 1.8%

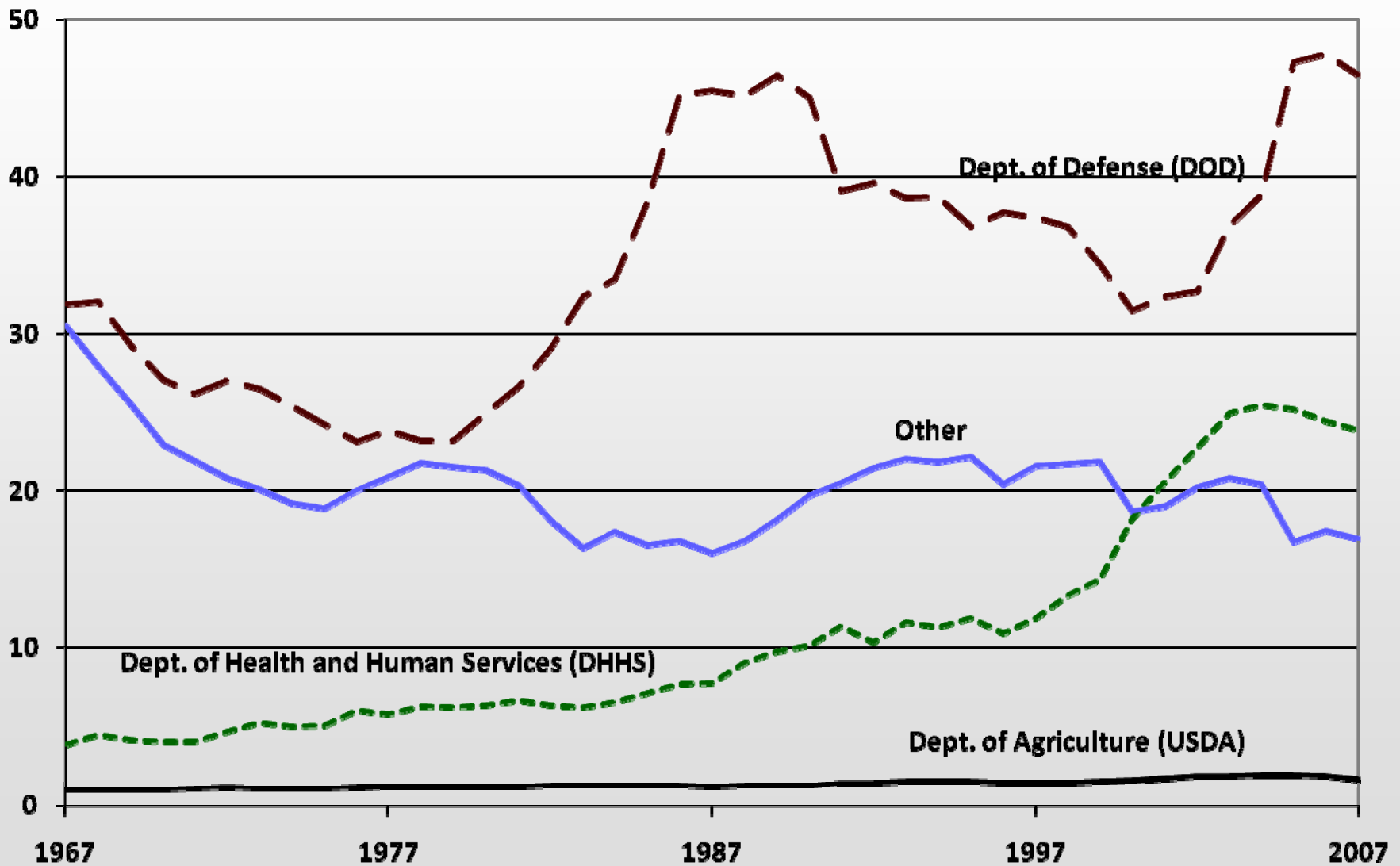
Developing country ag share of all R&D (year 2000) 8.2%

U.S. R&D Spending by Performing Sector, 2006



U.S. Federal Government Spending by Department, 1967-2007

Billions of dollars, 2000 prices

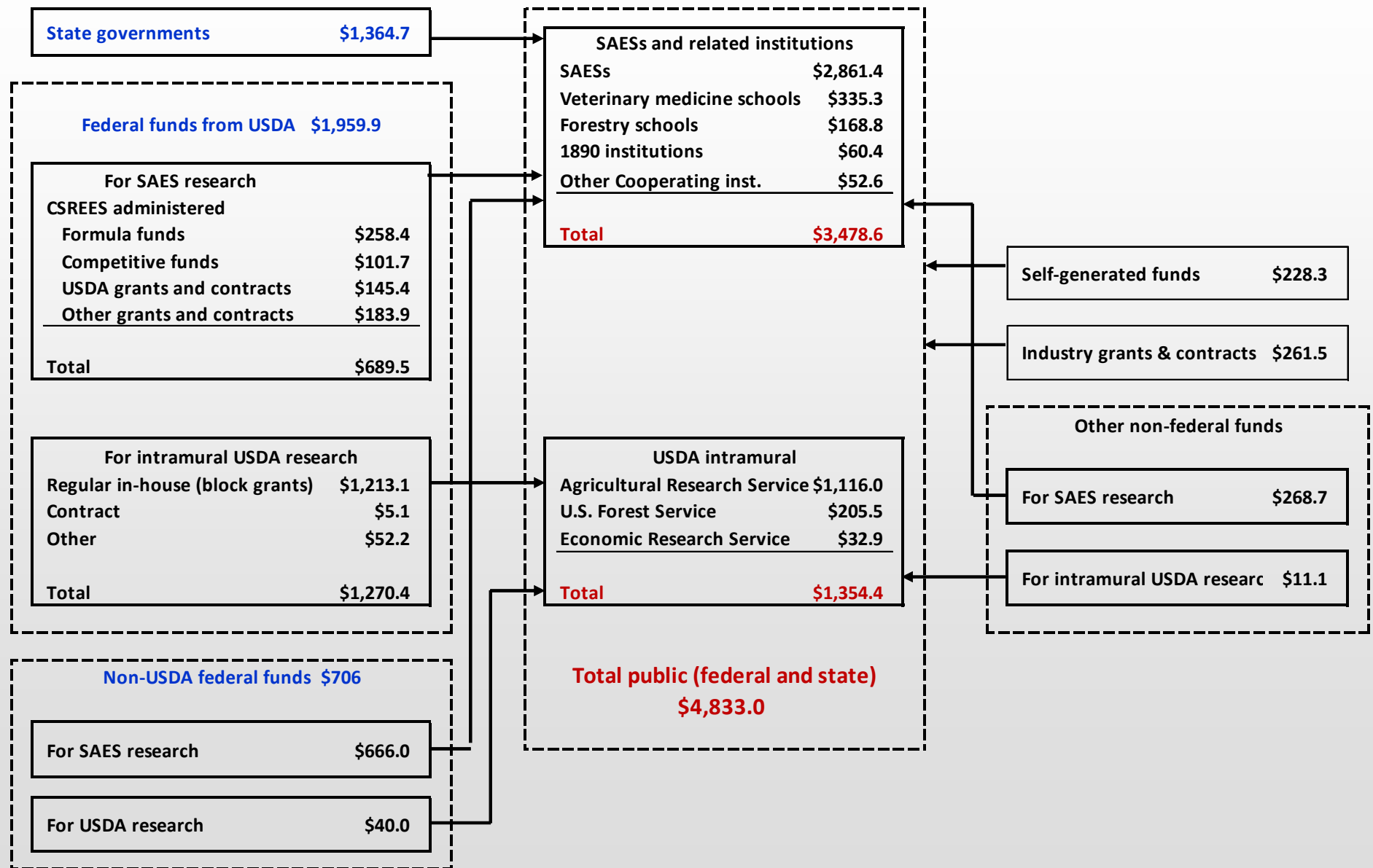


Funding Channels for U.S. Public Sector Agricultural R&D, 2007

Public Funding Sources

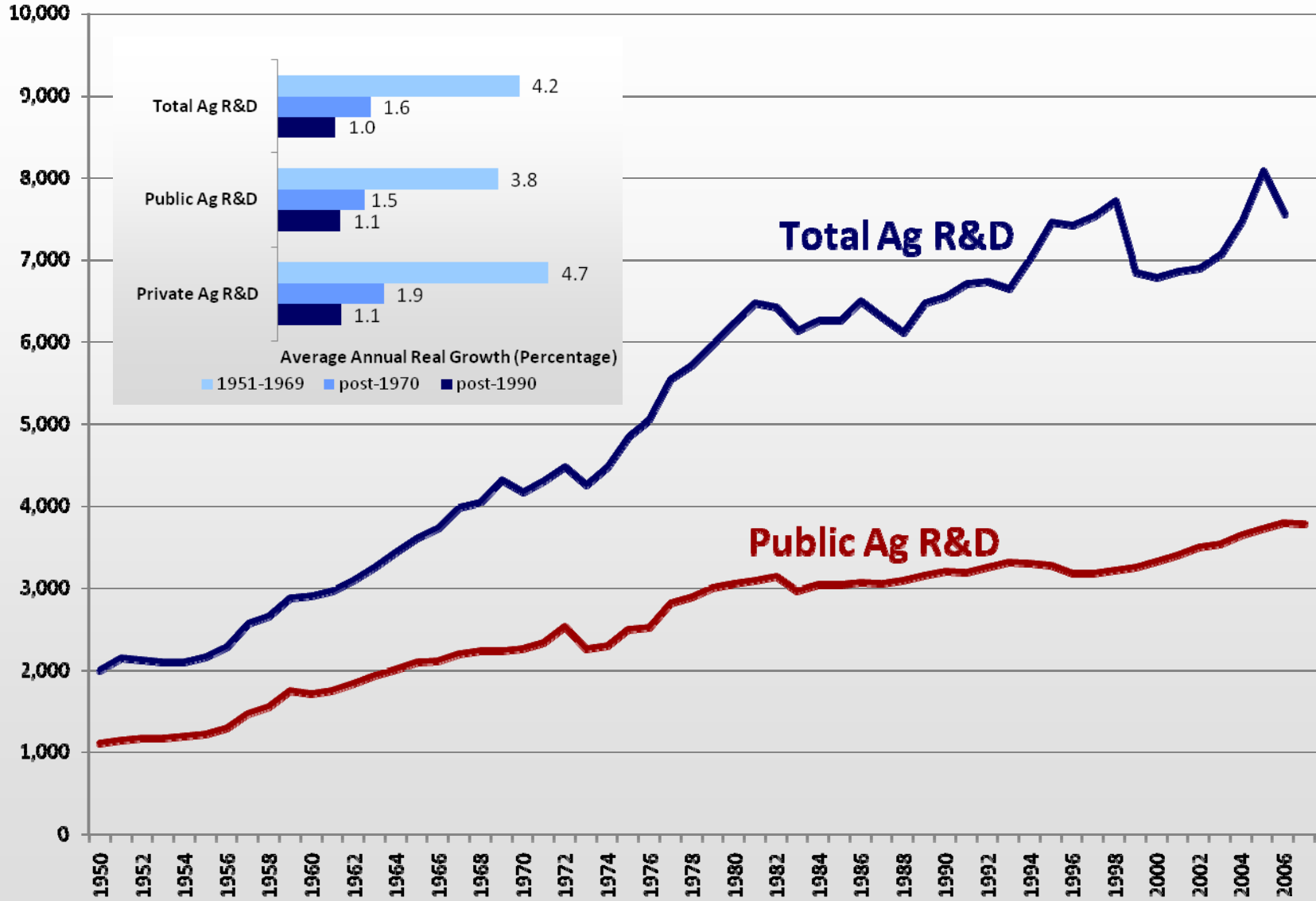
Research Performers

Other Funding Sources

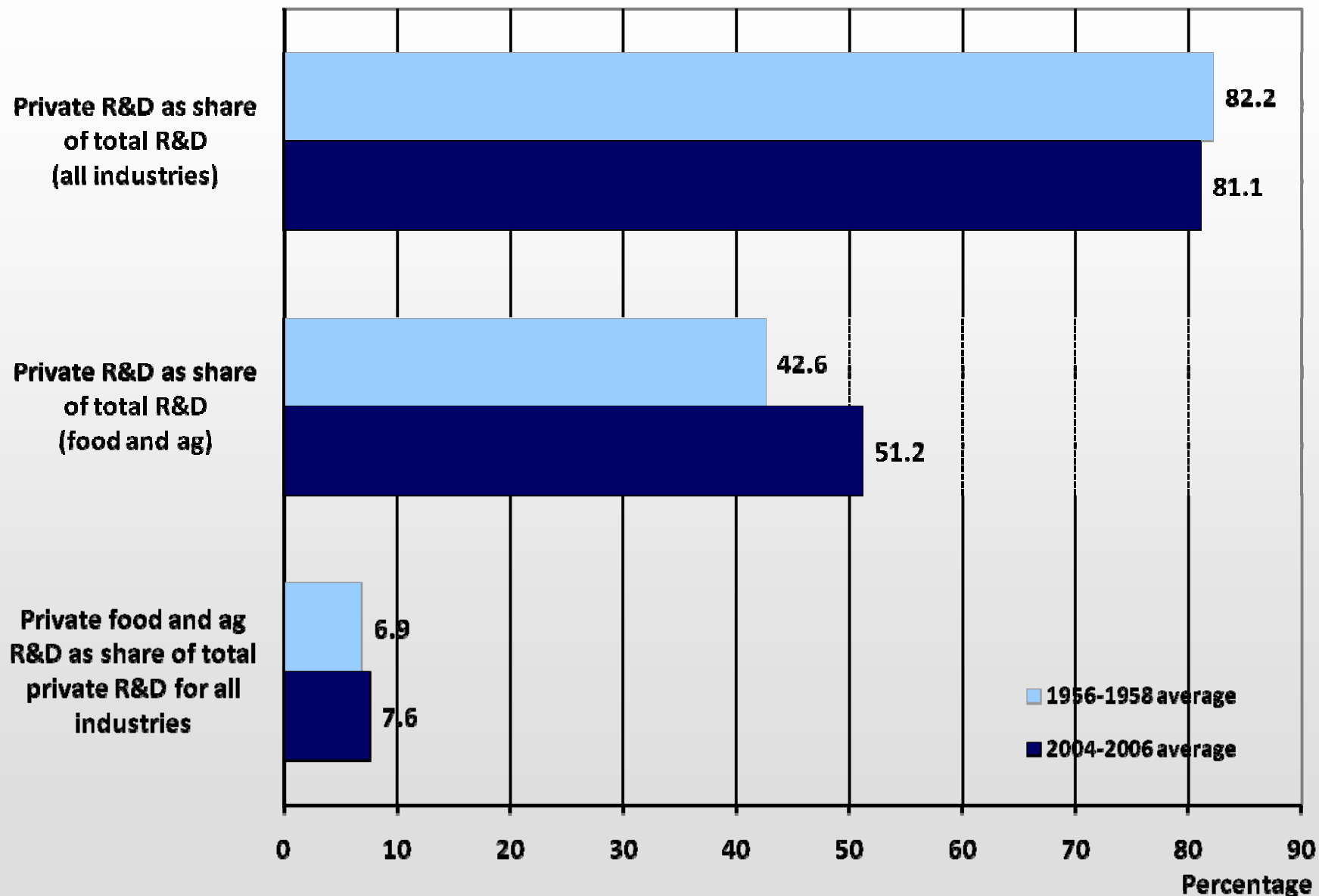


Total and Public Spending on Ag R&D, 1950-2007

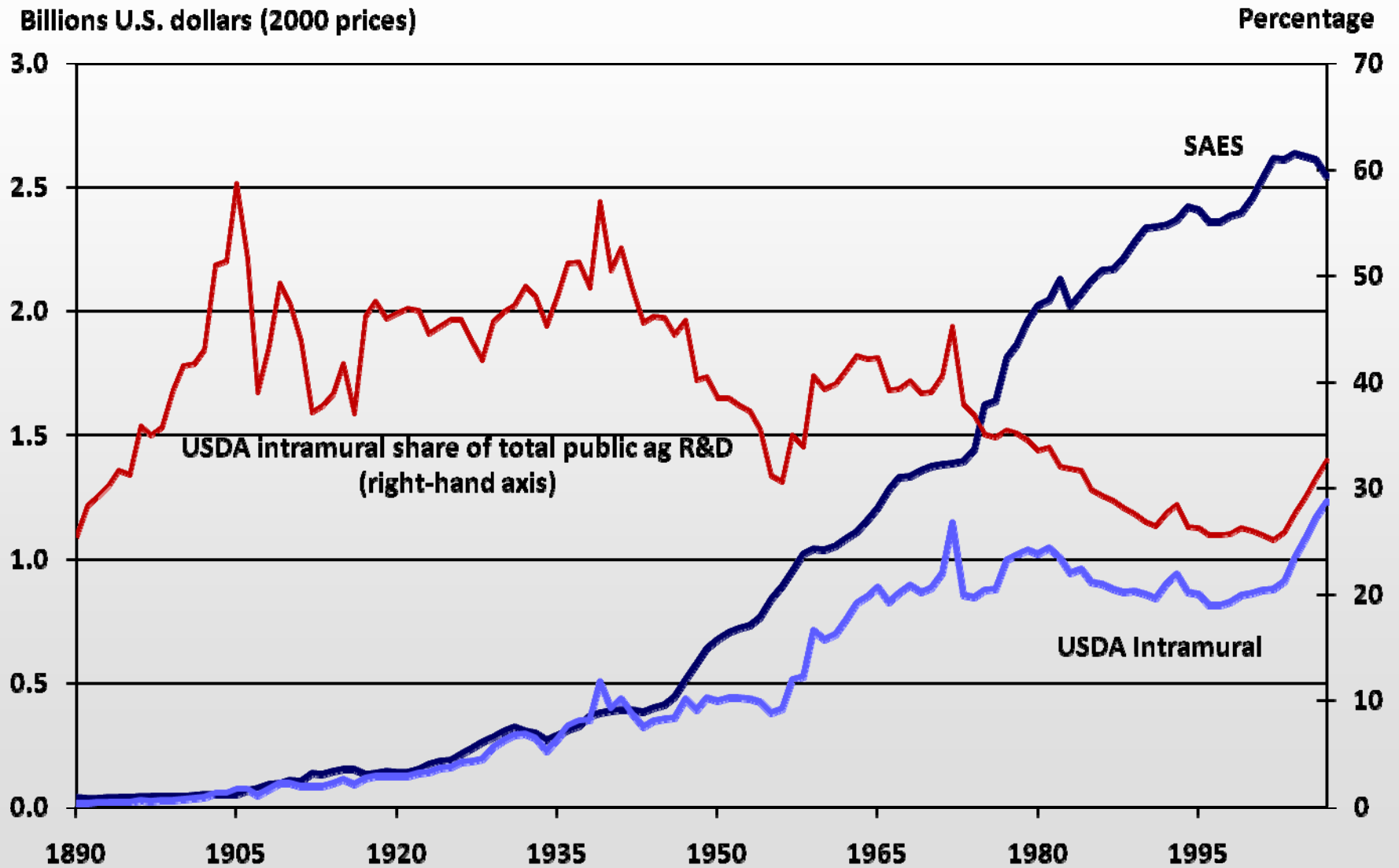
millions of 2000 dollars



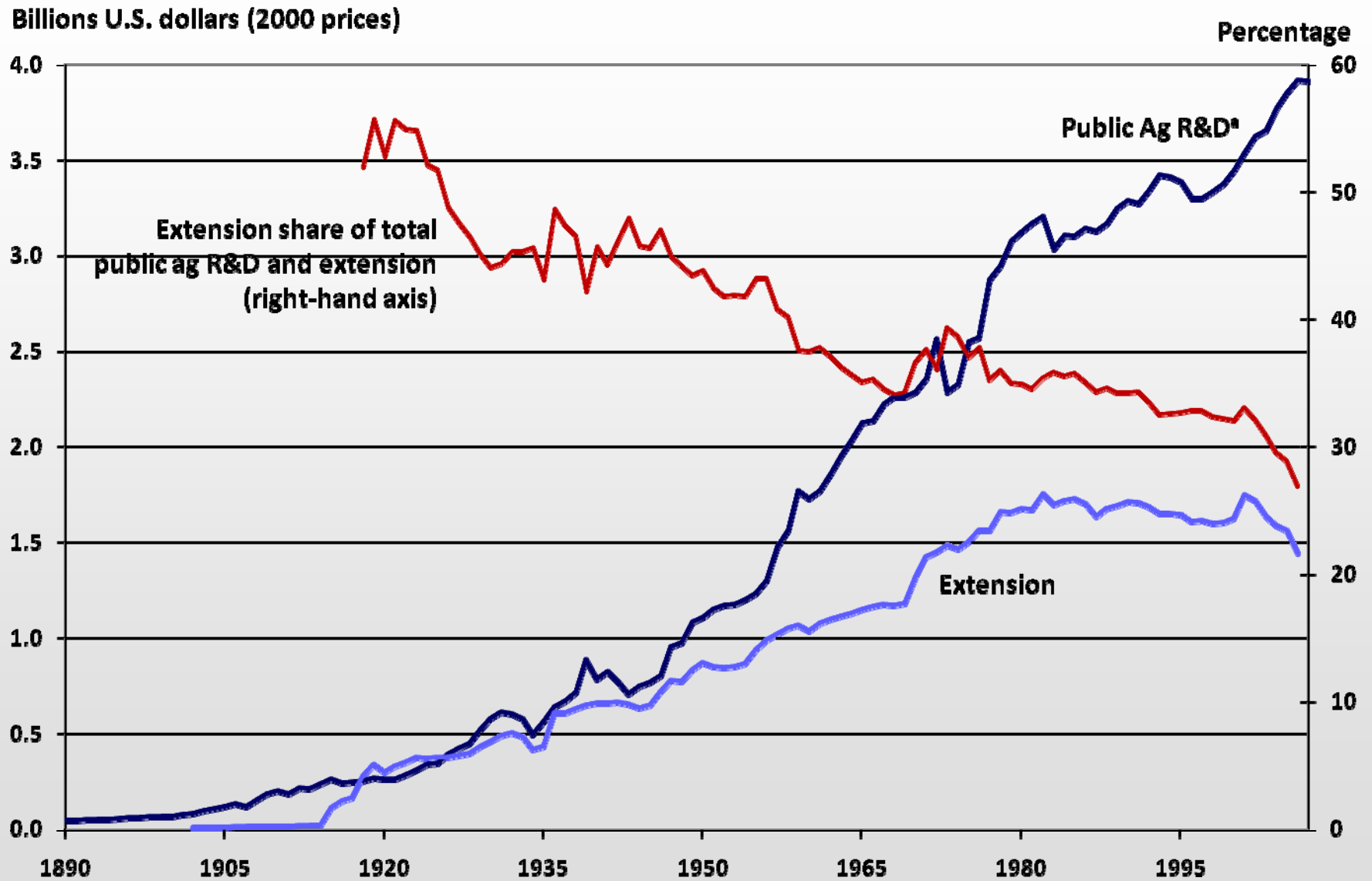
Private Shares of R&D, 1950s vs 2000s



U.S. Public Agricultural R&D by Performing Agency, 1890-2007

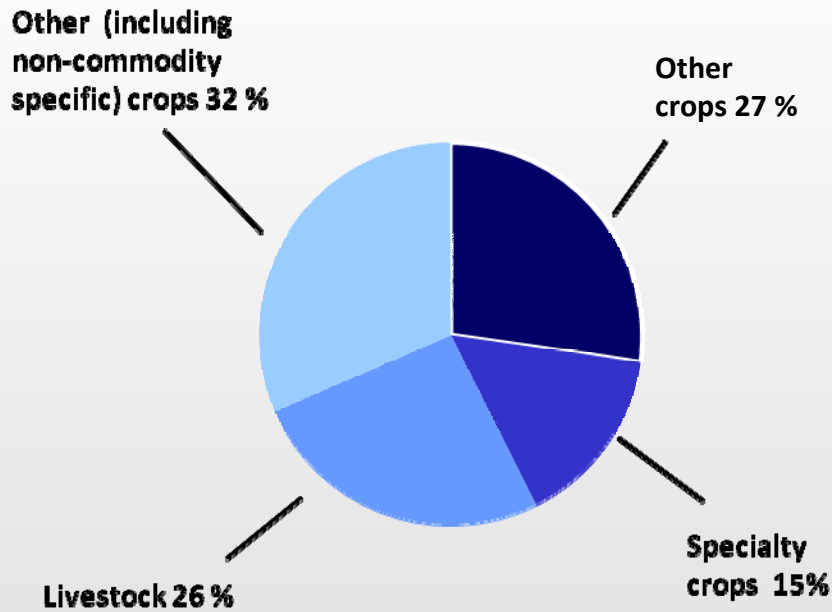


U.S. Public Agricultural R&D vs Extension, 1890-2007



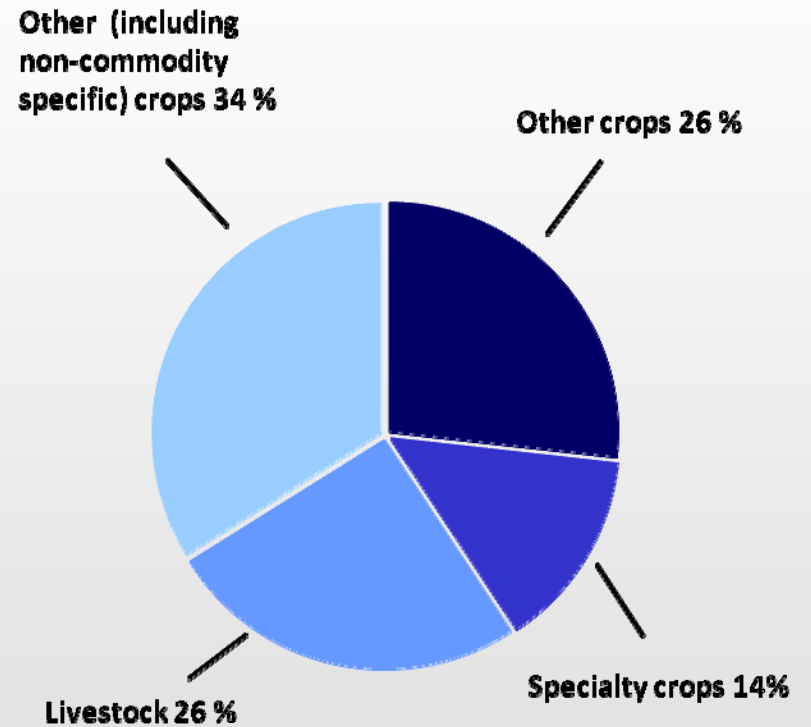
Commodity Orientation of U.S. Public Agricultural R&D

1975



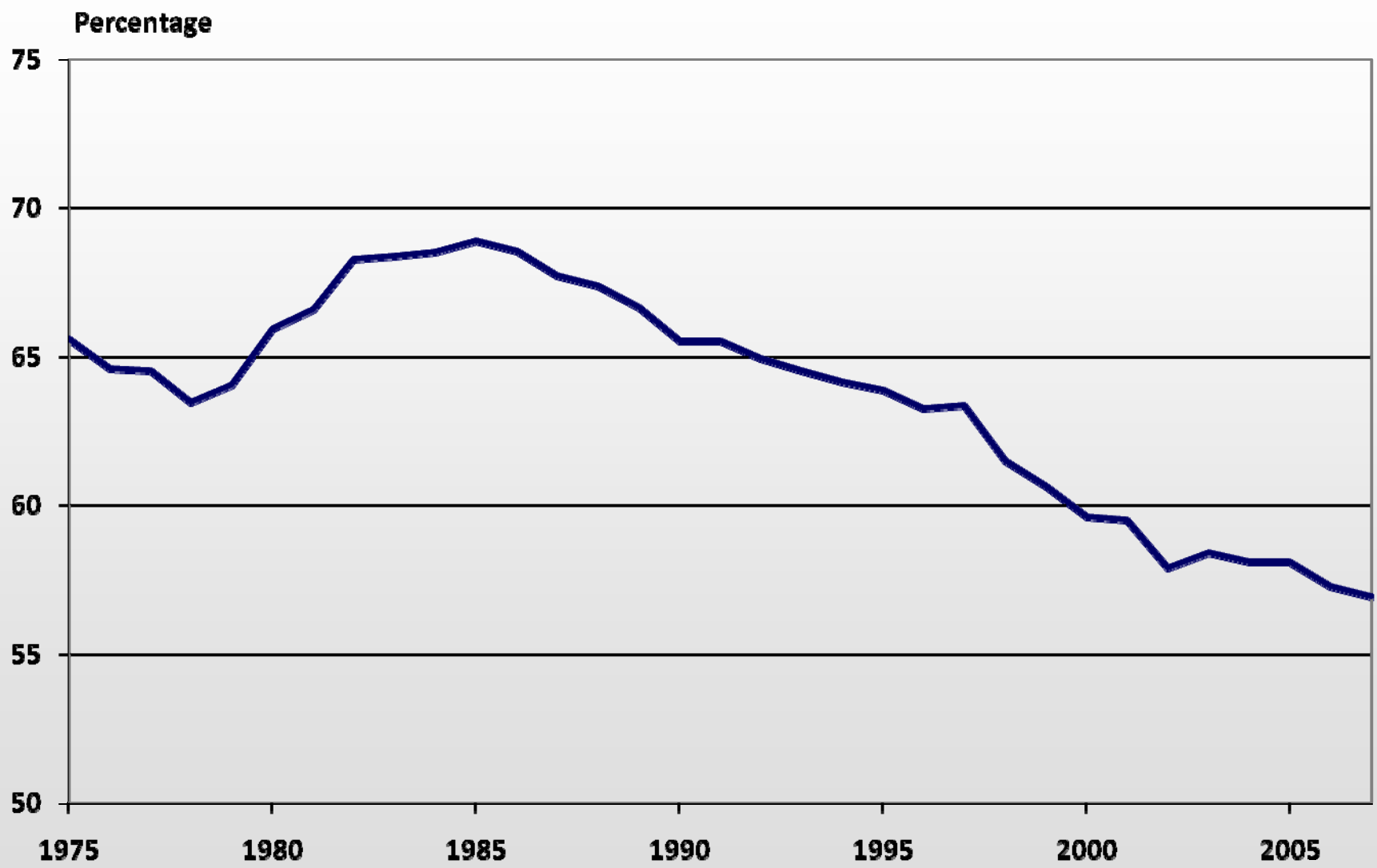
\$2.19 billion (2000 prices)

2007

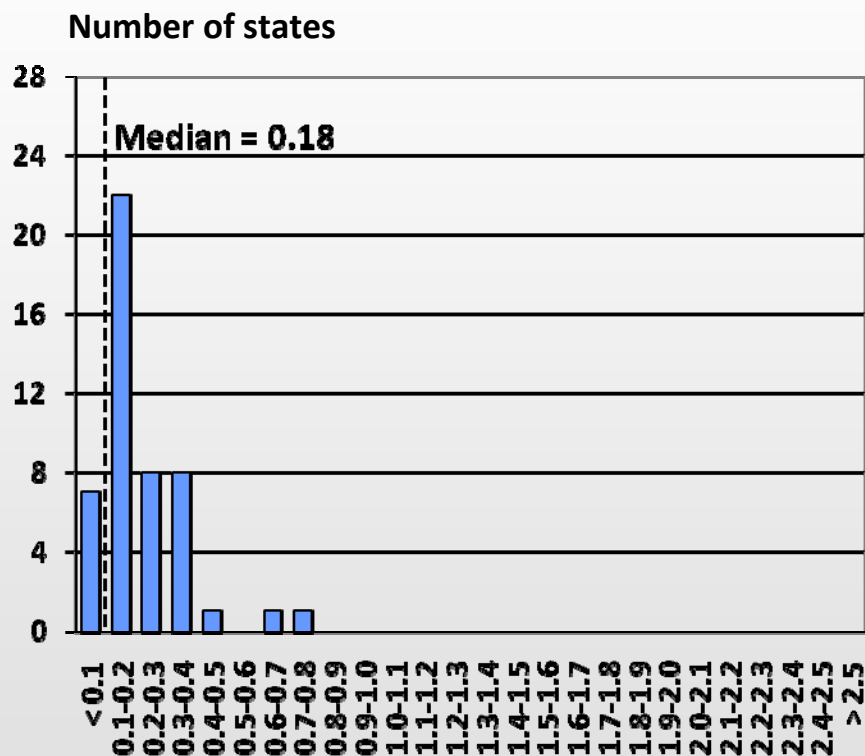


\$3.01 billion (2000 prices)

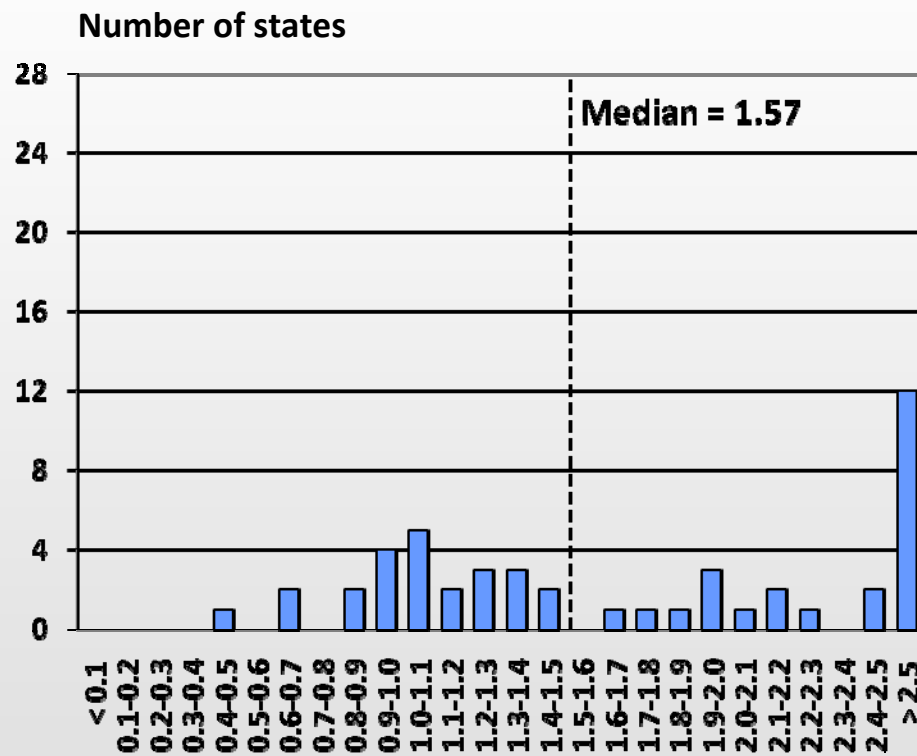
Farm Productivity Orientation of U.S. Public Agricultural R&D



Distribution of SAES Research Intensities



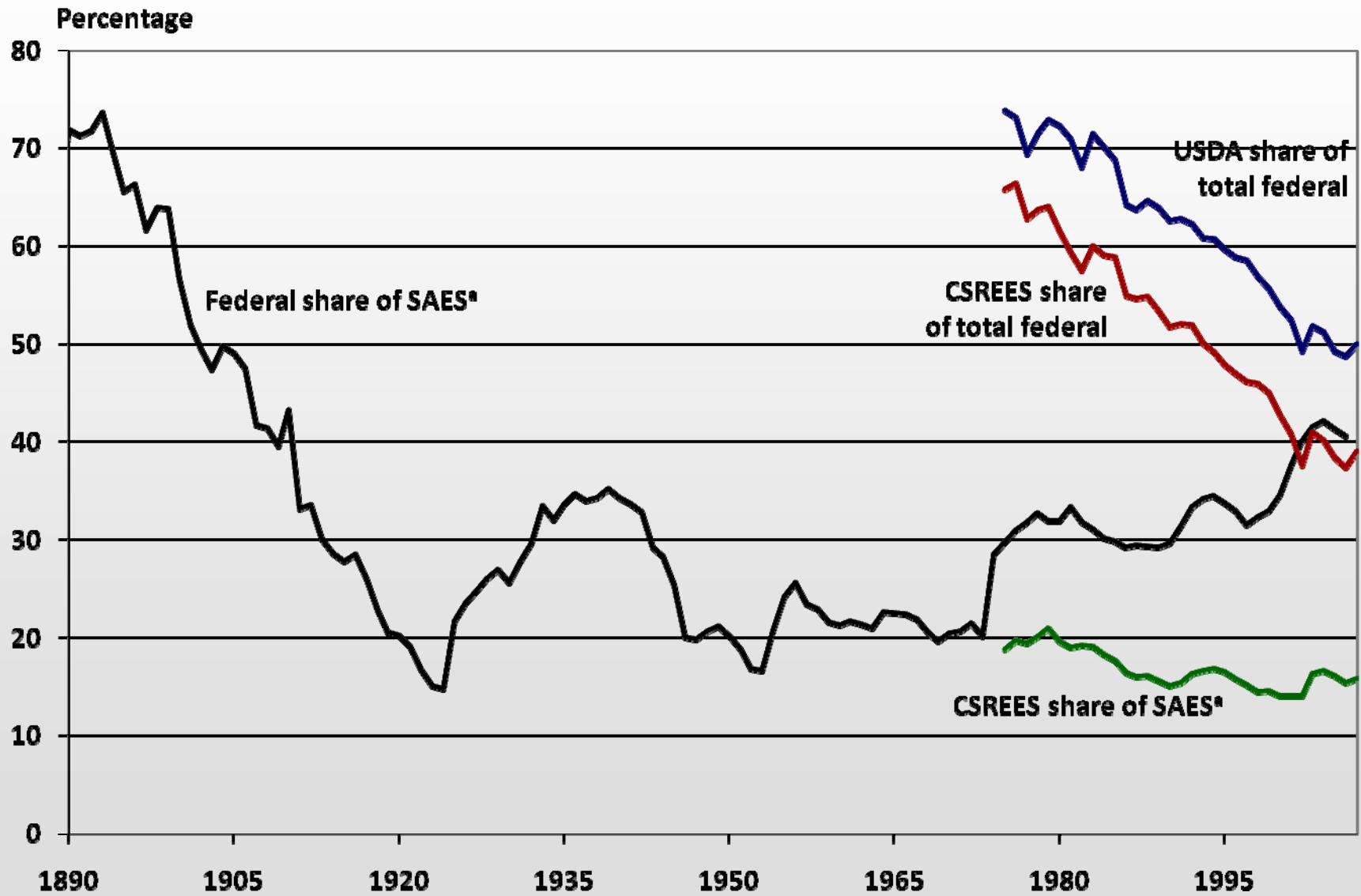
Average 1949-1951



Average 2003-2005

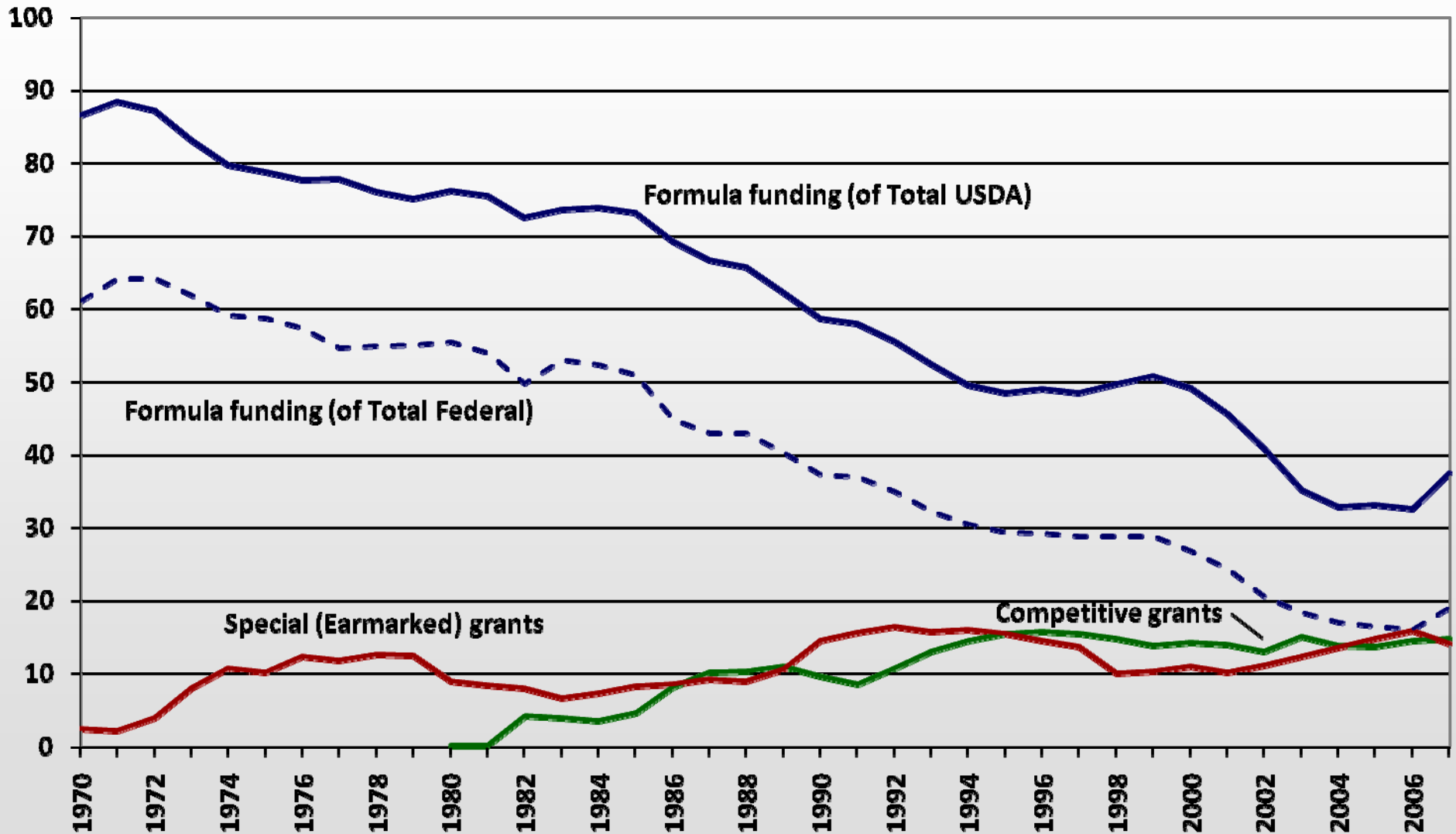
Ratio represents SAES research spending relative to state value of agricultural production

Federal and USDA Roles in Funding SAES Research



USDA Funding of SAES Research (by form of funding)

Percentage



Concluding Remarks

- **Significant slowdown in US ag productivity growth since early 1990s**
- **Preceded by**
 - slowdown in rate of ag R&D spending growth
 - Redirection of ag R&D away from maintaining or enhancing productivity
- **Major shifts in the sources and forms of funding for public ag R&D**
 - Very substantial decline in share from formula funding
 - Shift of federal funding away from USDA
 - Comparatively small share disbursed as competitive grants
 - Rise in share of funding via special (earmarked) grants

Thanks!



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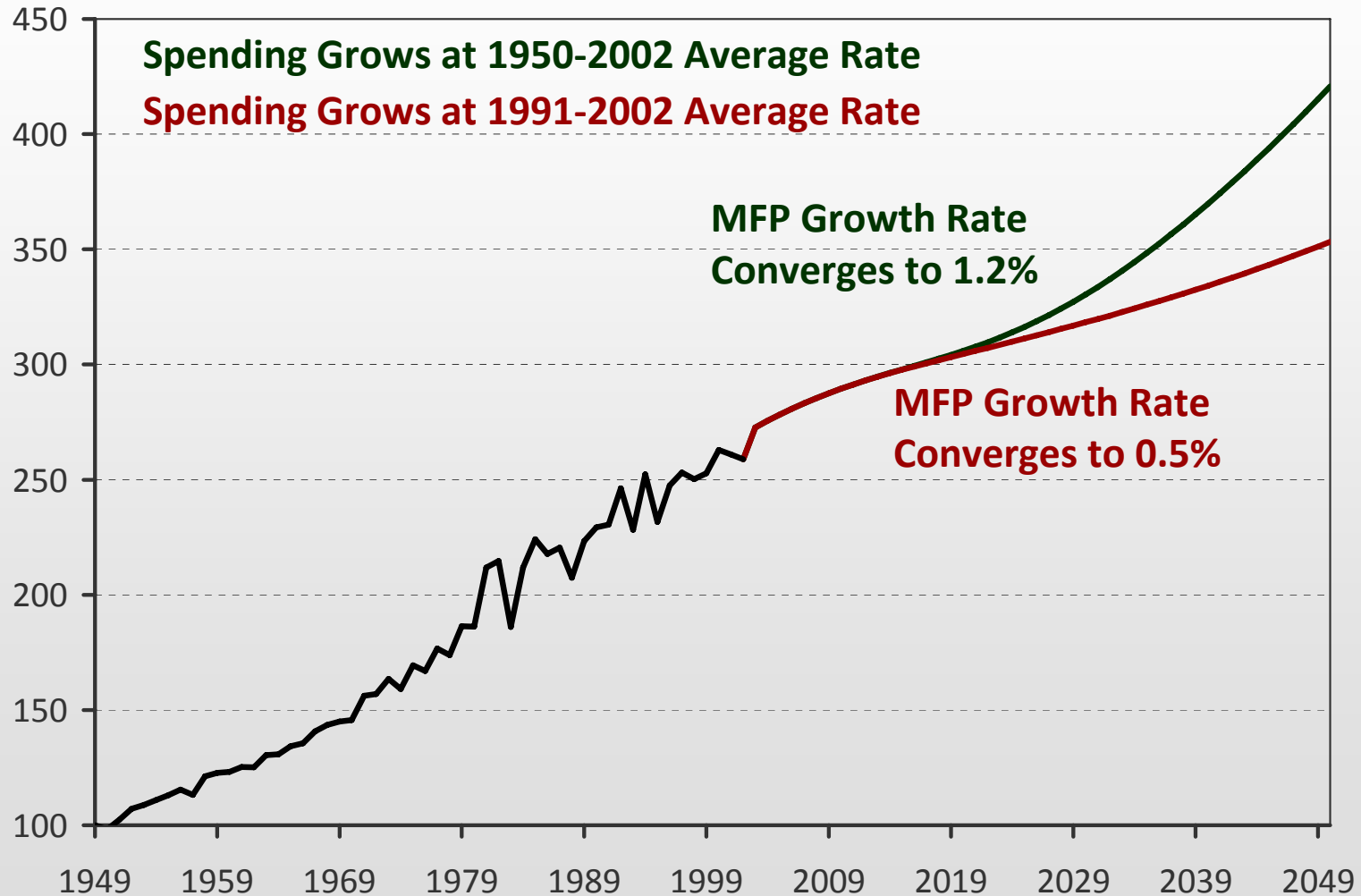
www.apec.umn.edu



www.HarvestChoice.org

Out-of-Sample Projections of MFP

Index (1949=100)



Predicting the Future

The New York Times

Monsanto Seeks Big Increase in Crop Yields

Monsanto, the leader in agricultural biotechnology, pledged Wednesday to develop seeds that would double the yields of corn, soybeans and cotton by 2030 and would require 30 percent less water, land and energy to grow.



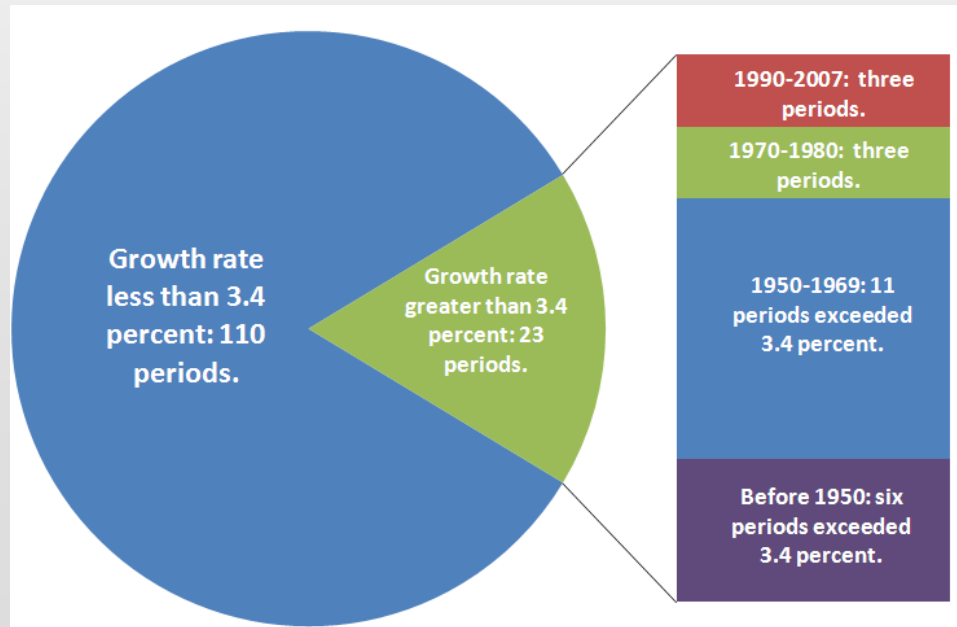
By Andrew Pollack
June 2008

DuPont Leader Discusses Agricultural Productivity at USDA Agricultural Outlook Forum

“We expect the traits and technologies in our product pipeline to help meet that demand by doubling the rate of genetic gain – targeting a 40 percent yield increase in our corn and soybean products over the next 10 years.”

By Paul Schickler
February 2008

US Maize Yields



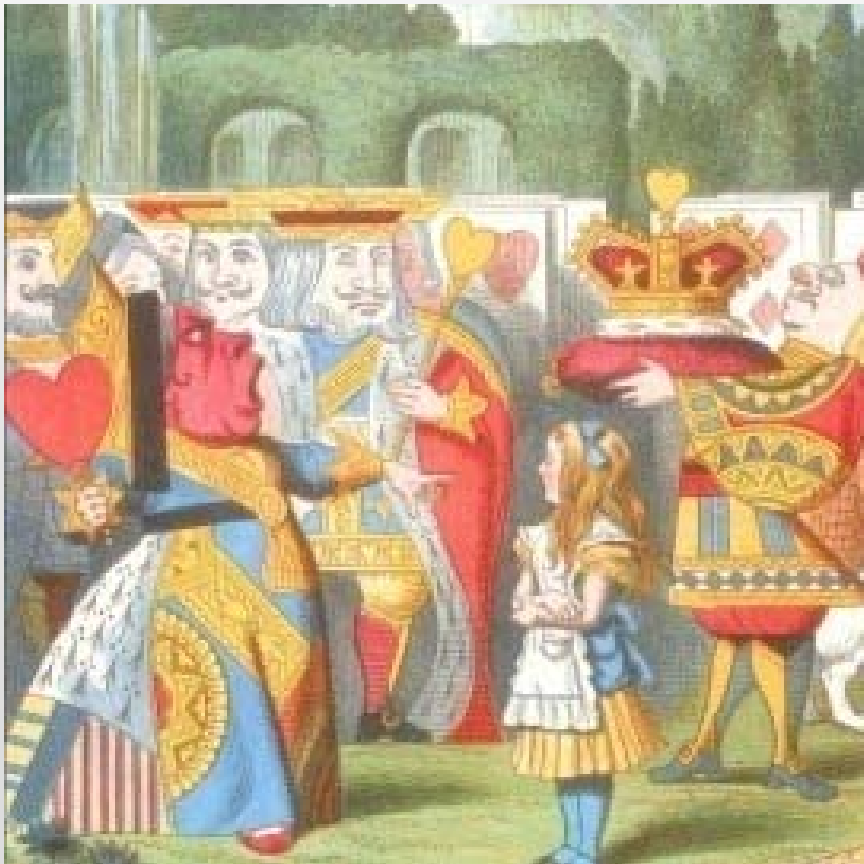
Since 1961, 10 year **global** maize yield growth has **never** exceeded 3.4%



The Tyranny of the Red Queen

- **Biological innovations masked by**
 - Changing location of production => **adaptive** research
 - Co-evolving pests and diseases => **maintenance** research

The “Red Queen” Effect



"Well, in our country," said Alice, still panting a little, "you'd generally get to somewhere else — if you run very fast for a long time, as we've been doing."

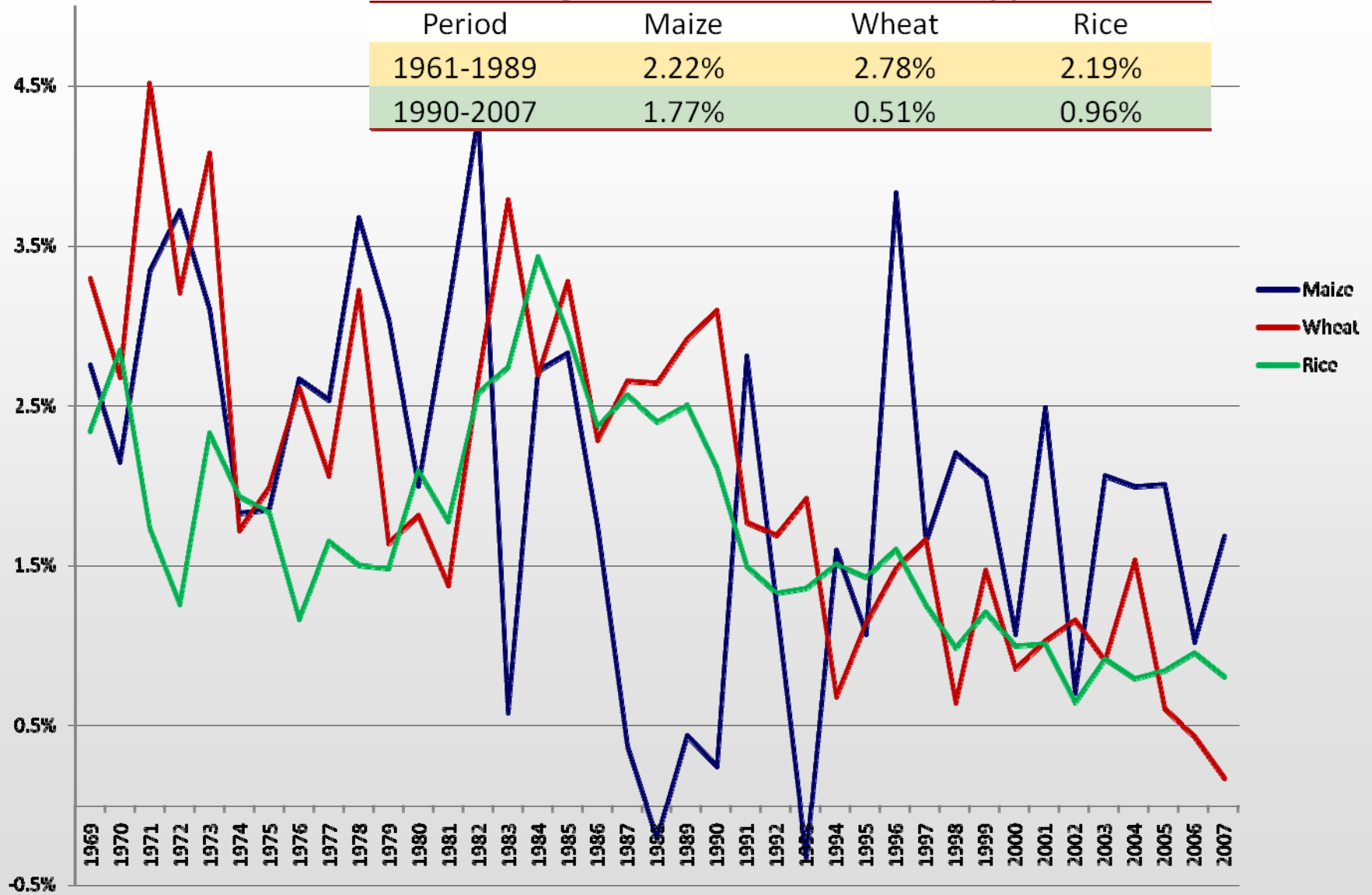
"A slow sort of country!" said the Queen. "Now, here, you see, **it takes all the running you can do, to keep in the same place**. If you want to get somewhere else, you must run at least twice as fast as that!"

– *Through the Looking Glass*

Global Average Yields – Annual Percent Change (8 year moving average)

Average Annual Yield Growth Rate, by period

Period	Maize	Wheat	Rice
1961-1989	2.22%	2.78%	2.19%
1990-2007	1.77%	0.51%	0.96%



A Slowdown in Crop Yield Growth

Percentage of countries for which the rate of yield growth during 1990-2007 was less than the rate during 1961-1989

	Maize	Wheat	Rice
Total Number of Countries included in "All Countries"	146	106	110
	<i>Percentage</i>		
All Countries	58	75	55
Top 10 Producing Countries	50	90	60
Top 25 Producing Countries	60	80	52

Average yield growth reflects the changing location of production around the world as well as the changing country-specific yields