Reassessing Public-Private Roles in Agricultural R&D for Economic Development

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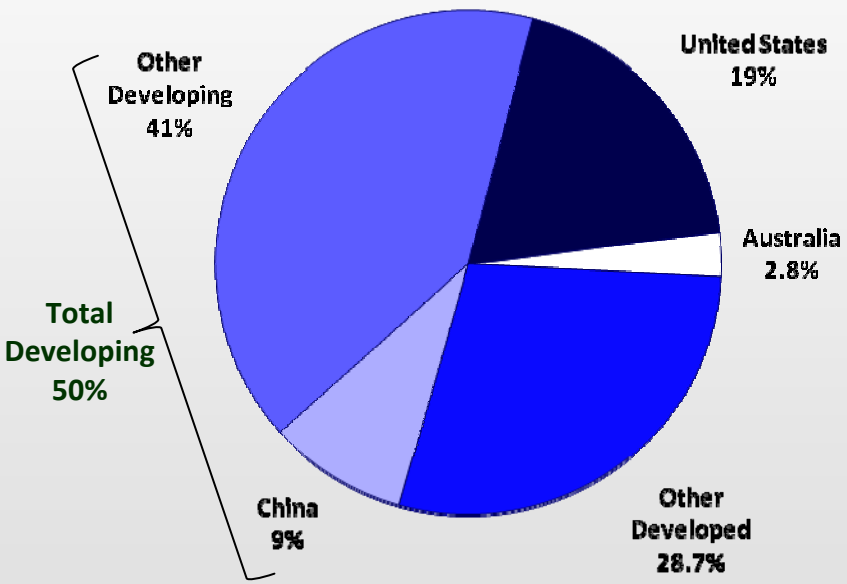
Outline

- Global Public-Private R&D Spending Trends
- Economic Drivers of Private R&D in and for LDCs
- Agricultural Productivity Patterns
- Agricultural Research Time Lags
- R&D Spillovers
- Implications

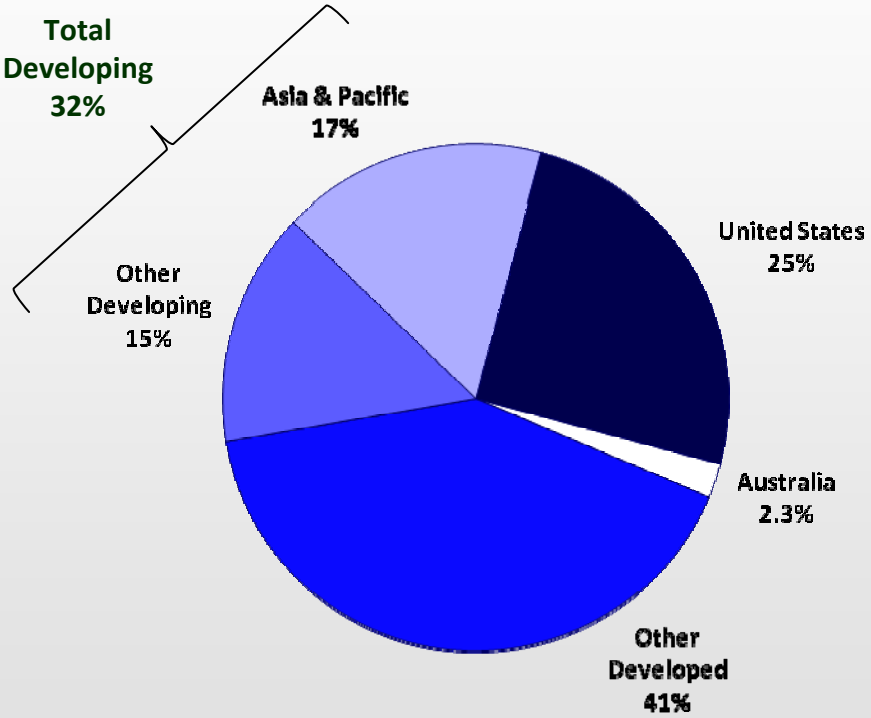
Global Agricultural R&D Spending, 2000

Public



$20.3 billion

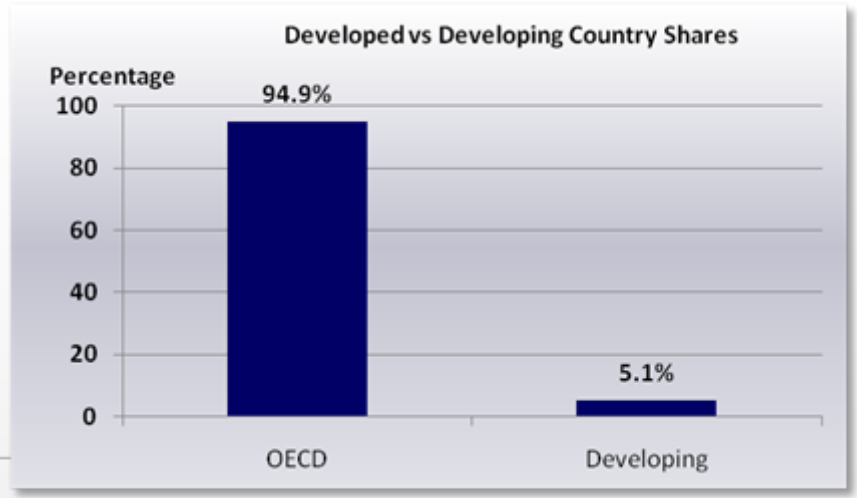
Public and Private

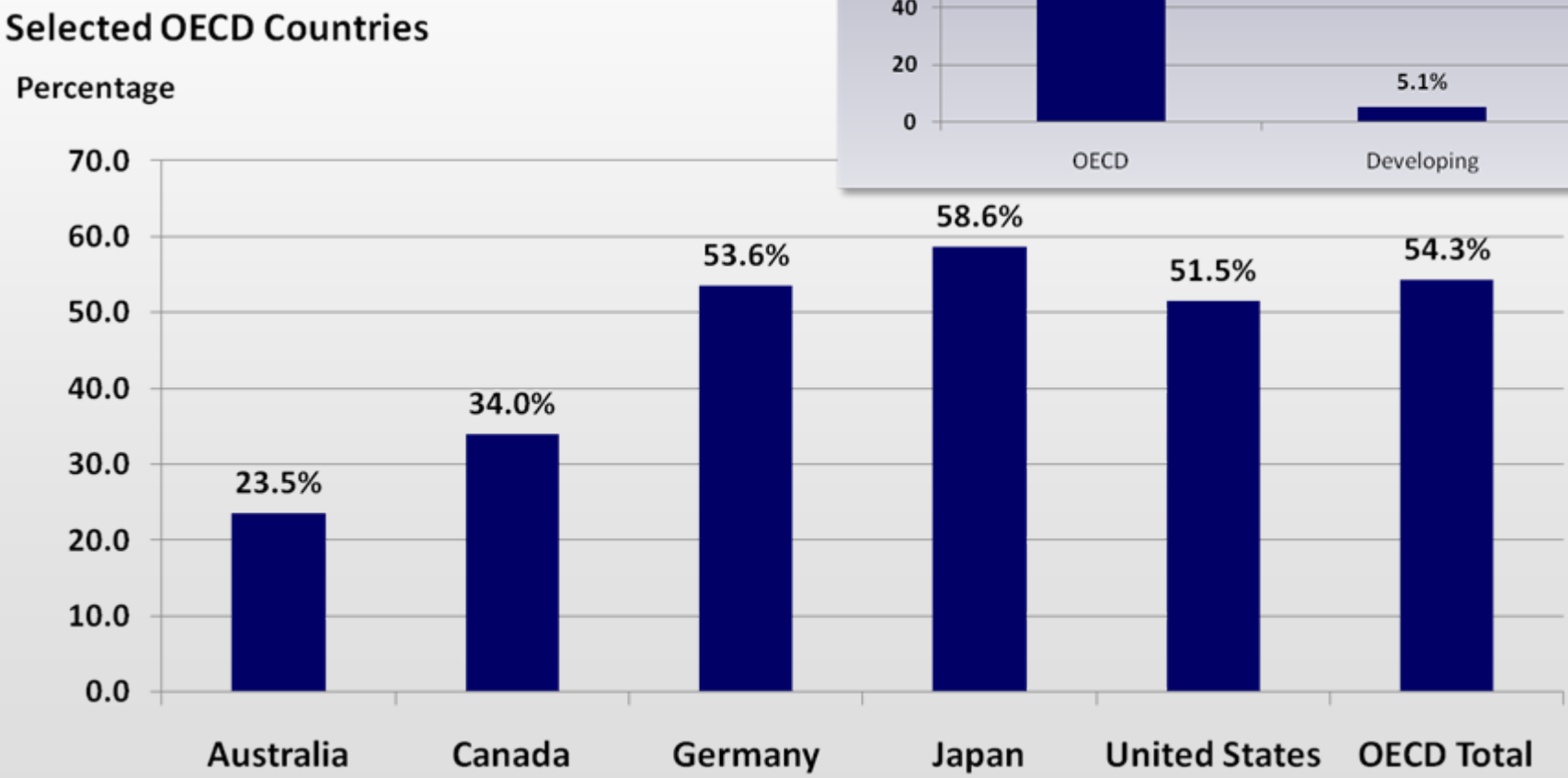


$33.7 billion

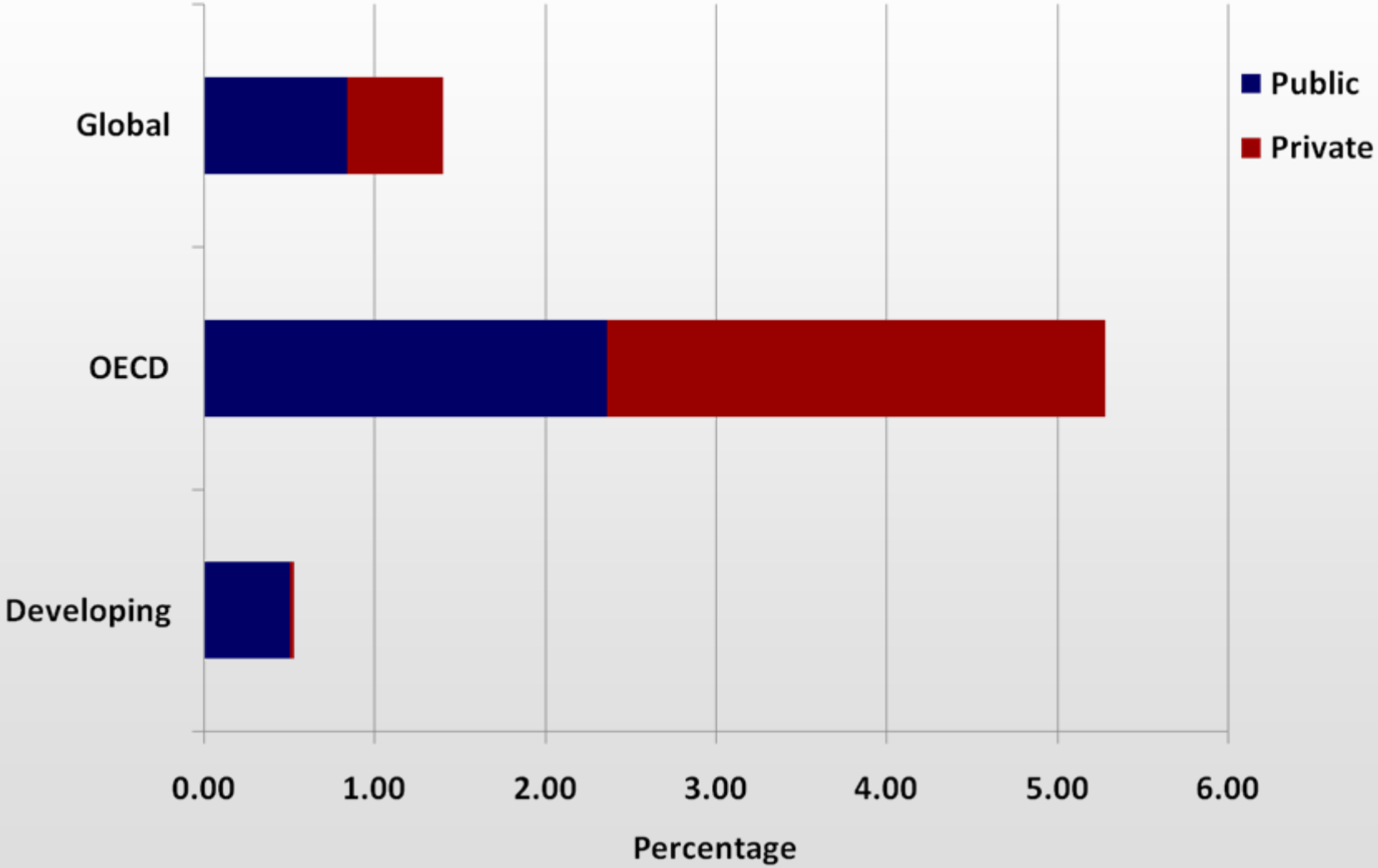
Expenditures in international dollars (converted with World Bank (2008) purchasing power parities)

Private Shares of Agricultural R&D, 2000

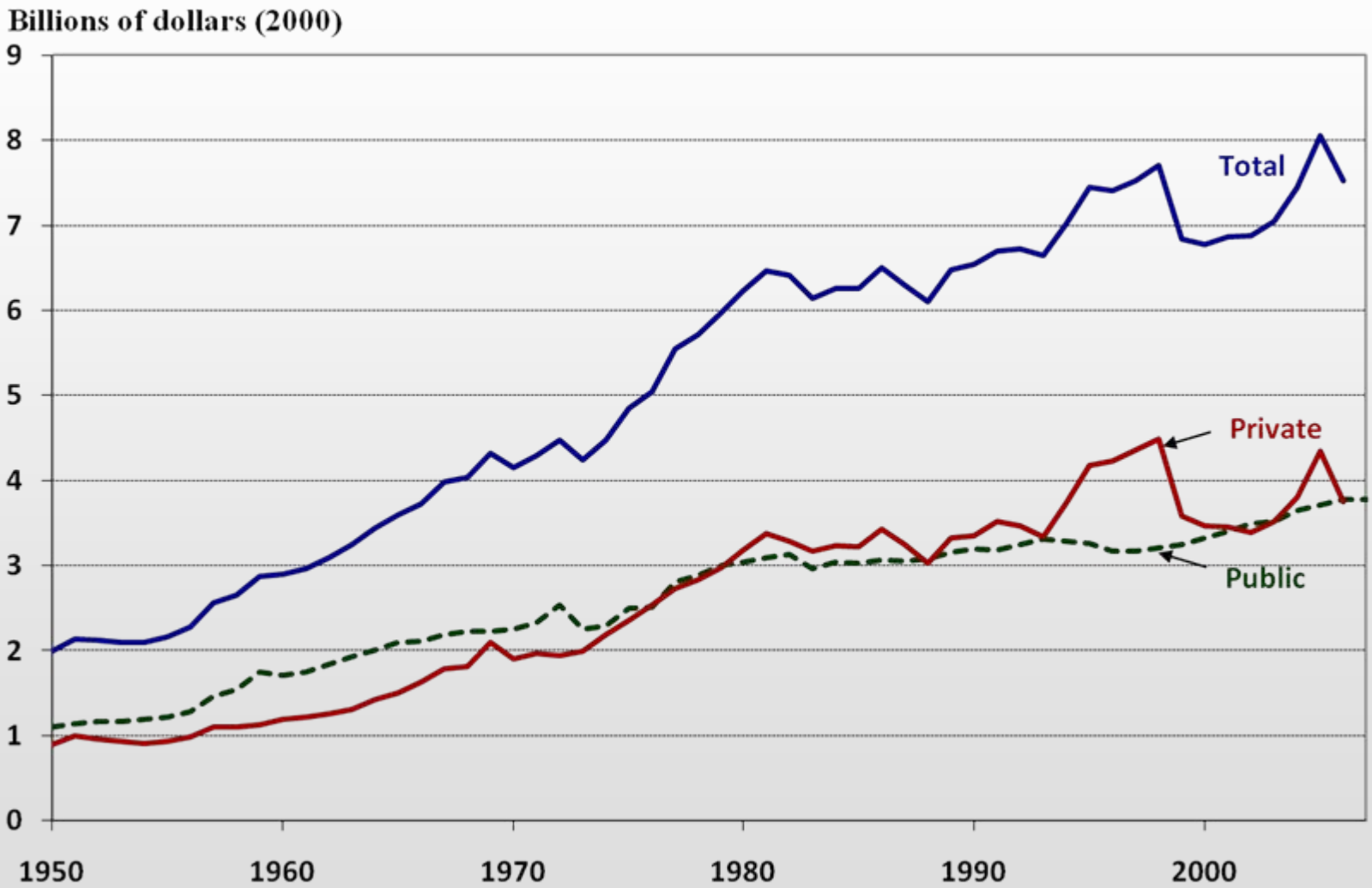




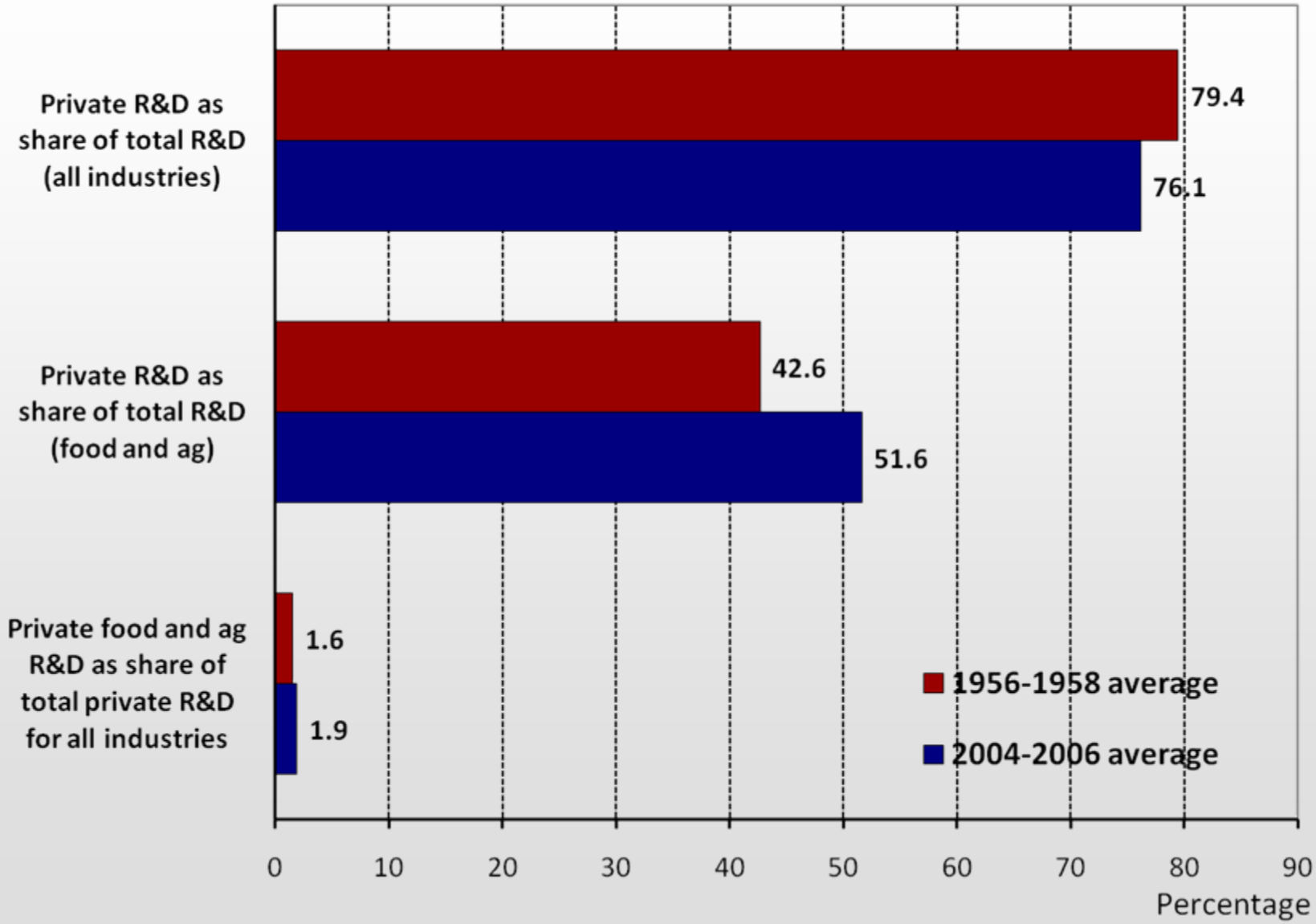
Intensity of Agricultural R&D, 2000



Trends in U.S. Public and Private Agricultural R&D, 1950-2007



Public and Private Research in the U.S.



Agricultural R&D Done Where, When, and for Whom?

- Data above reported on where public and private R&D is performed

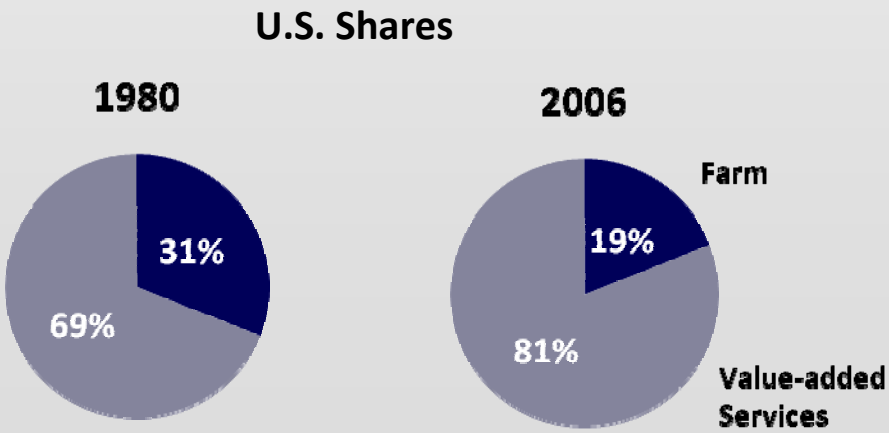
- Not always coincident with
- Where it is used
- Who captures the benefits

- What shapes private agricultural R&D done in or for low-income countries ?
- When – R&D lags
- Spillovers – Patterns of use and benefits

Economics of Private R&D Participation in LDCs

- A significant share of food produced in developing countries is consumed within the household where it is produced. Even when commodities enter the marketing chain, in less-developed countries they are less often purchased in highly transformed forms with food more-often prepared and eaten at home.

- Consequently, a much smaller share of the food bill in developing counties accrues to post-farm food processing, shipping and merchandising activities; areas where the incentives for private innovation are relatively pronounced.



Factors Affecting Private R&D Participation in LDCs

- Likewise, on the supply side, purchased inputs (such as herbicides, insecticides, improved crop varieties or animal breeds, and all sorts of agricultural machinery) constitute a comparatively small share of the total costs of production in many parts of the developing world.

- The cost of doing business in places characterized by small and often remote farms subject to poor market access, lack of farm credit, and limited communication services also undercuts private participation in these agri-business sectors, in turn reducing the private incentives to invest in R&D targeted to these markets.

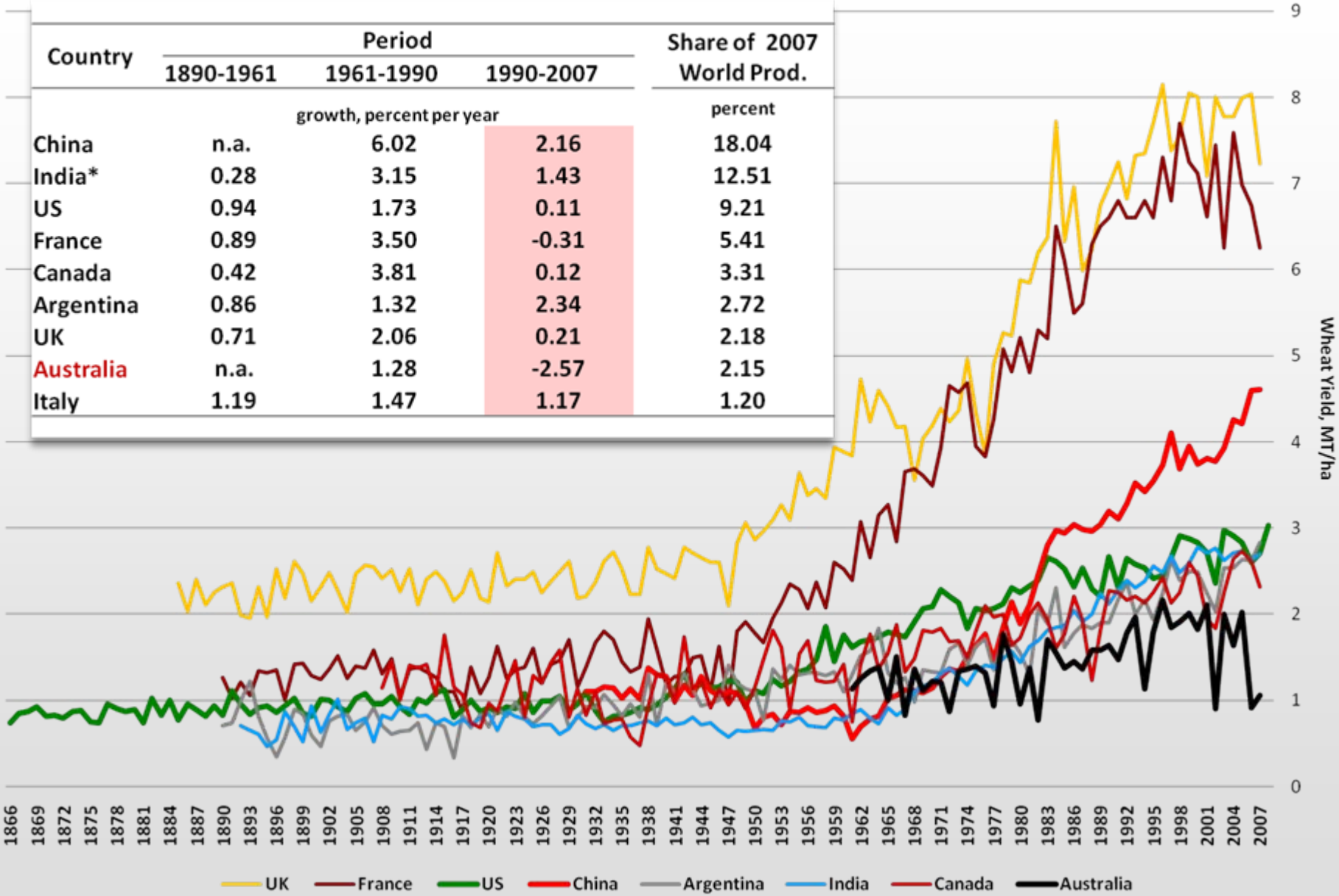
- Finally, either a lack of or plethora of regulations, often inefficiently enforced, make it difficult for local and multi-national private interests to penetrate agricultural markets with new seed, chemical or other agricultural technologies in substantial parts of the developing world.

Slowdown in Agricultural

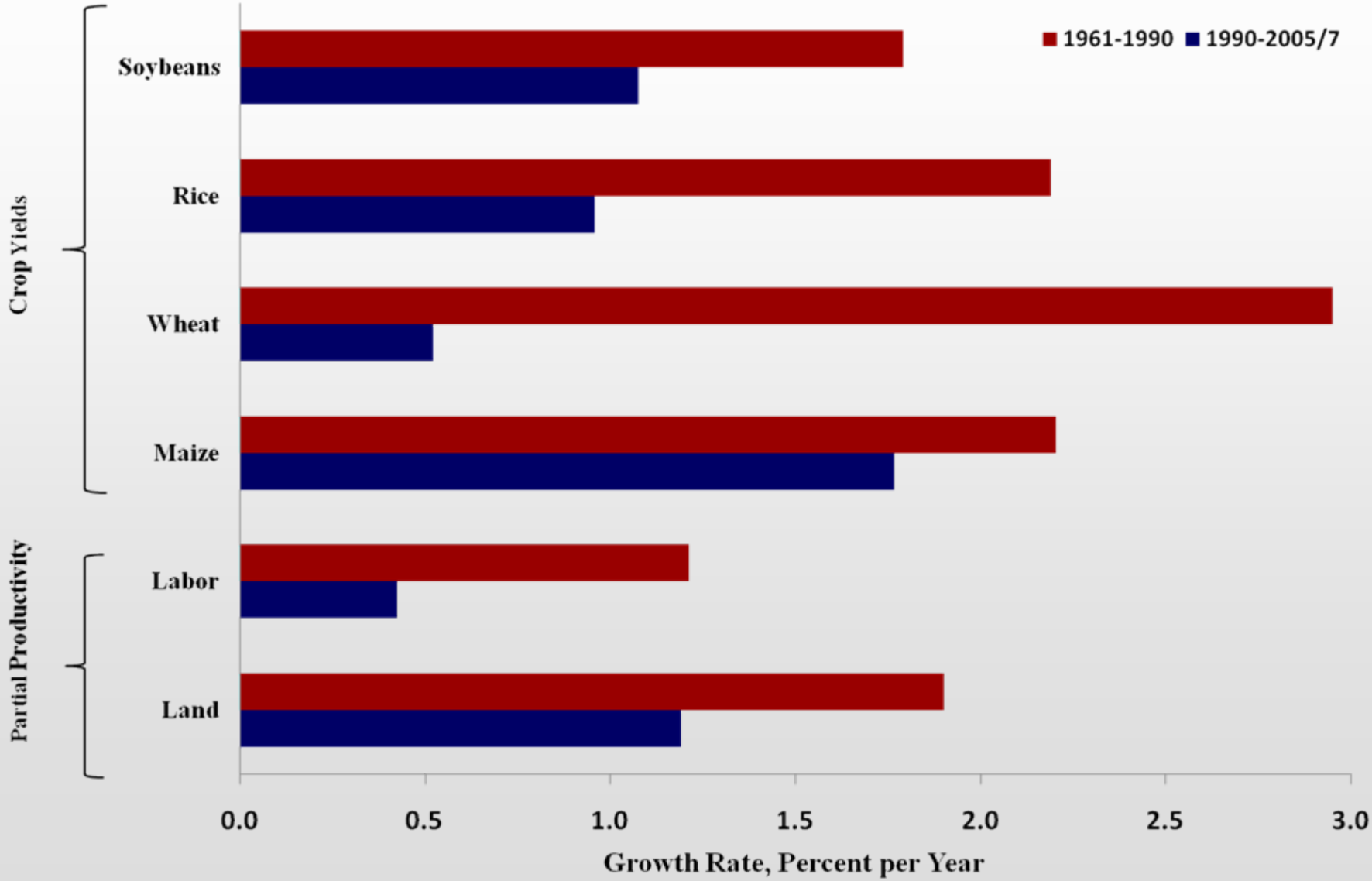
Productivity Growth?

Global Wheat Yields, 1890-2007

Country	Period			Share of 2007 World Prod.
	1890-1961	1961-1990	1990-2007	
	growth, percent per year			percent
China	n.a.	6.02	2.16	18.04
India*	0.28	3.15	1.43	12.51
US	0.94	1.73	0.11	9.21
France	0.89	3.50	-0.31	5.41
Canada	0.42	3.81	0.12	3.31
Argentina	0.86	1.32	2.34	2.72
UK	0.71	2.06	0.21	2.18
Australia	n.a.	1.28	-2.57	2.15
Italy	1.19	1.47	1.17	1.20



Growth in Global Crop Yields and Productivity, 1961-2007



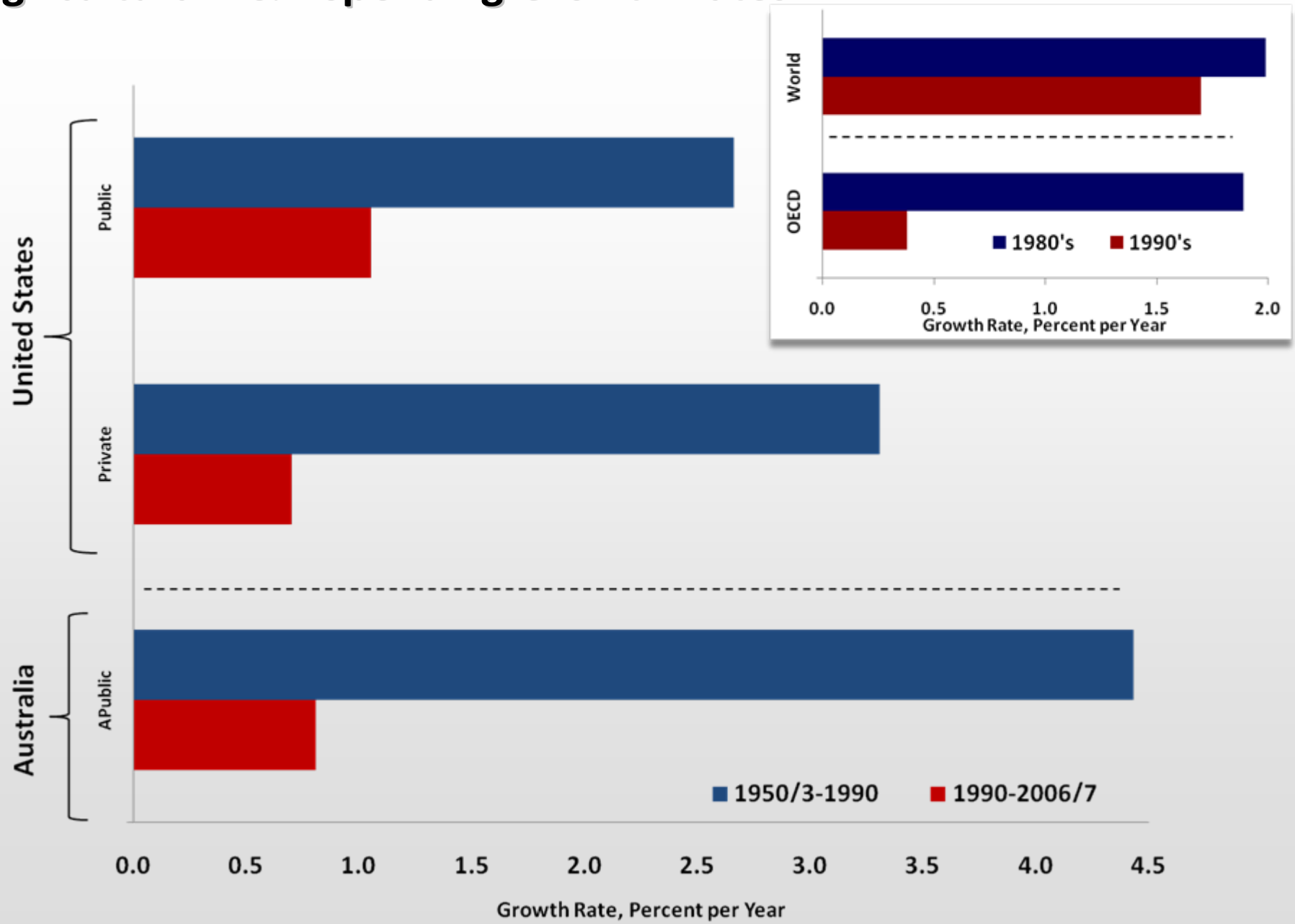
Note: Yield data end in 2007, partial productivity data end in 2005 and exclude China.

Why Might the Growth in Agricultural Productivity be Slowing?

- **Some possibilities**
  - Shifting structure of general public R&D?
  - Changing private sector roles?
  - Changing regulatory environment?
  - Reduced spillins from other countries and CGIAR?
  - Degradation of natural resource base?
  - Diminishing returns to new technology?
  - Bad weather?

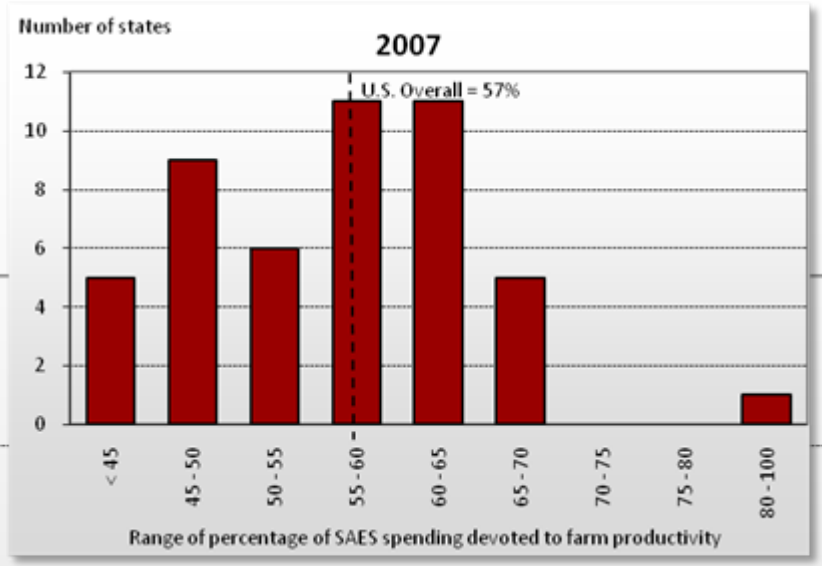
- **Reduced support for farm productivity R&D?**
  - Slower growth in total agricultural R&D investments
  - Shrinking share for farm productivity

Agricultural R&D Spending Growth Rates



Note: US data are for 1950-2006, Australia data are for 1953-2007

R&D Diverted Away from Maintaining or Enhancing Productivity (U.S. Trends)



What Do We Know About the Linkages Between Research and Productivity?

- The economic payoffs to R&D remain substantial, but they take considerable time to happen
- The benefits from research are difficult to appropriate
- They spill over from firm to firm, crop to crop, and country to country

Agricultural Technology Timelines

Hybrid Corn

1877	Beal conducts first controlled crosses/hybrid vigor
1905-1912	Shull developed correct understanding of inbreeding and cross breeding
1917	James developed double cross-hybrid
1922	Iowa State station began corn in-breeding program
1933	First commercial planting of Hybrid Iowa 939 developed by Merle Jenkins
1936	First release of a widely popular double-cross hybrid developed at Purdue University
1960	Vastly improved in-breds led to shift to single-cross hybrids
1960	95 percent of U.S. corn acreage in hybrids

Bt Corn

1901	Bacillus thuringiensis (Bt) discovered in Japan (and 1911 in Germany)
1950s	Bt used as a control agent and registered
1986	Cry1Ab gene sequence published
1986	Cry1Ab cloned into root colonyzing Pseudomonas bacteria
1992	YieldGard insect protected corn event Mon810 produced by "gene gun"
1996	FDA, USDA & EPA approvals for Yield Guard
1997	Bt corn (corn borer protection) commercialized in U.S.
1998	Stacked with other traits (e.g. herbicide tolerance)
2004	U.S. patent issued to Monsanto for Mon810
2008	Regulatory approval in 20 countries

Agricultural Technology Timelines

Roundup Ready Soybean

1970	Glyphosphate shown to have herbicidal activity
1976	Roundup herbicide commercialized in U.S.
1980	Idnetification of 3 mechanisms to infer glyphosphate tolerance
Late 1980s	Several genes encoding glyphospate insensitivity isolated
1987	First soybean transformation achieved
1990 & 91	Glyphosphate tolerant seeds evaluated
1996	Roundup Ready Soybeans commercialized

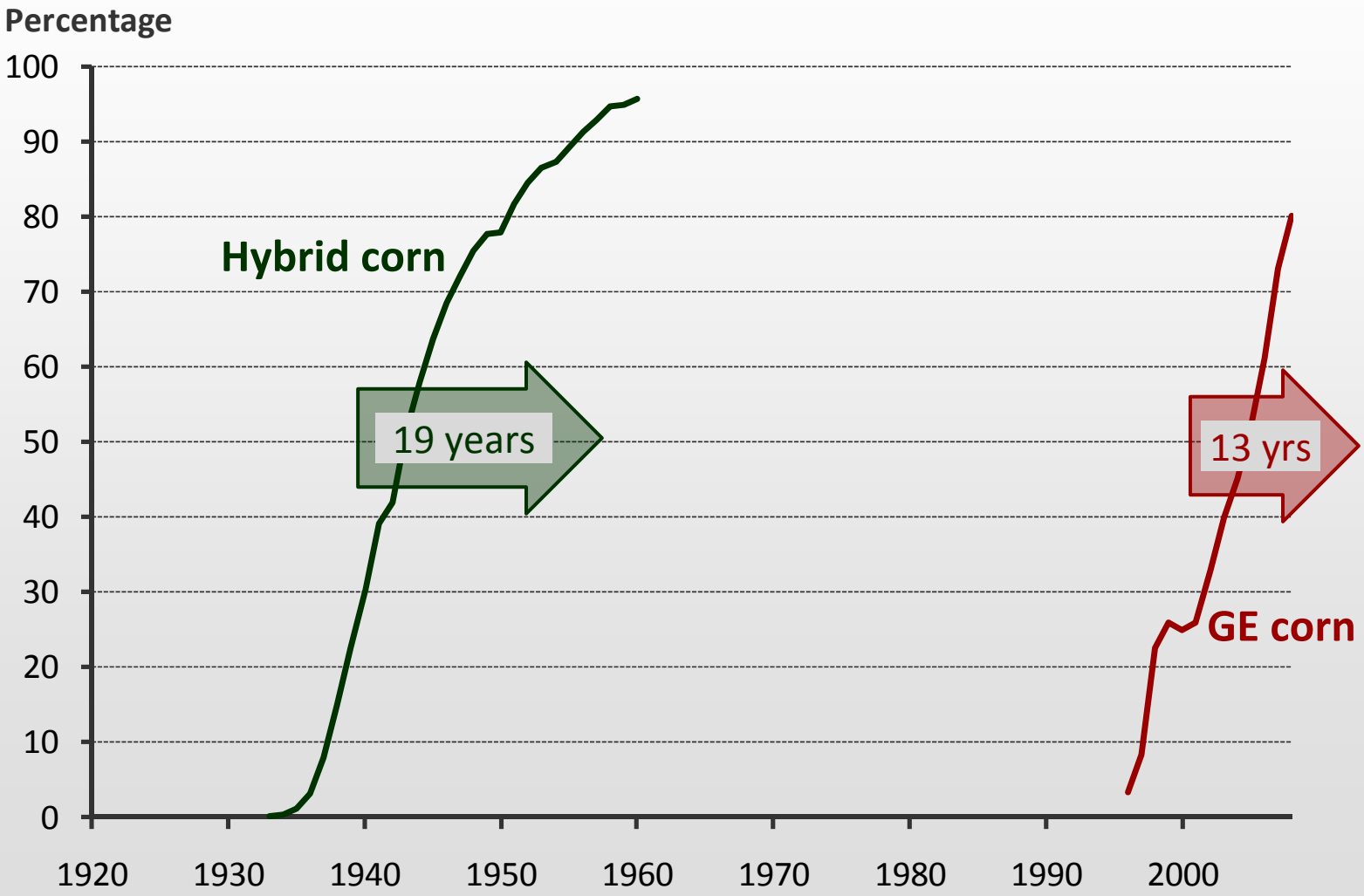
Golden Rice

1992	Project initiated by Ingo Potrykus
1999	One daffodil and one soil bacterium introduced to Japonica rice to express beta-carotene
2001	Humanitarian lisence agreement with Syngenta
2002	Trait expressed in Indian rice
2004	First field trial in Louisiana
2005	Enhanced expression of beta-carotene
2007	Bioavailability studies launched
2012	Anticipated commercialization of technology

Lessons from the Timelines

- The timing, duration, and specifics of public and private roles vary among technologies
- It is not public versus private research, but rather public *and* private research that matters
- Complementary roles
- In the U.S., much legislative action to facilitate public-private partnerships and stimulate the commercialization of research (especially since the early 1980s)
- The lags from initial ideas to commercial release are typically matters of decades not years

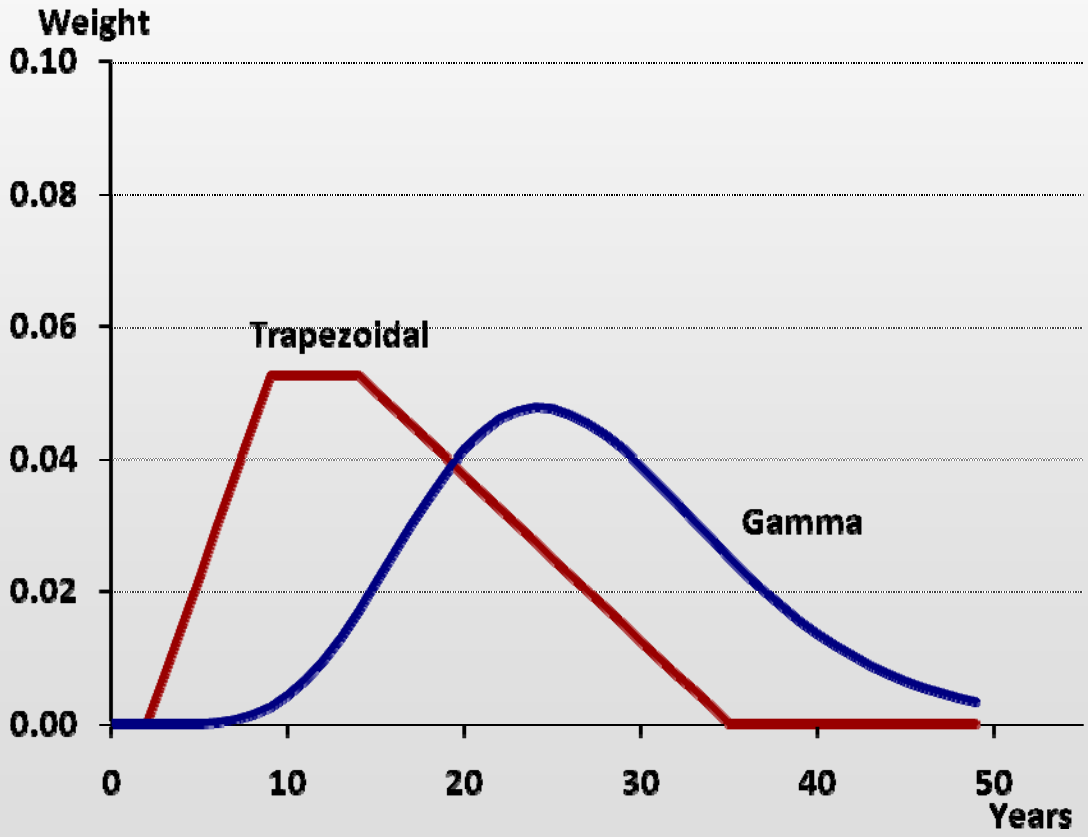
Hybrid and Biotech Share of US Corn Acreage



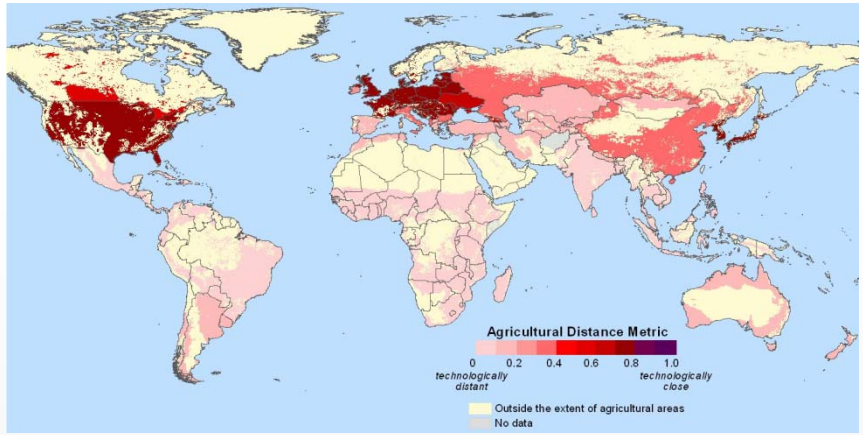
R&D Lags

- Basic or pre-commercialization research
- Technology development
- Regulatory approval
- Adoption

Overall R&D lag for
U.S. Agricultural R&D



Technology Spillovers



- Evidence indicates up to one half of local productivity gains are attributable to someone else's R&D
- Spillover potential of many agricultural technologies are circumscribed by differences in agroecologies
- But policy and institutional restraints are just as problematic, if not more so
- Efficient regulation and stewardship of new technologies is important (mitigate business risk), and substantial and on-going research is required to properly inform regulatory responses

Implications for Policy

- Clear requirement to revitalize investments in public agricultural R&D emphasizing farm productivity
- Fostering creative complementarities between private and public sectors important
- Incentivize private sector to increase commitment to technology generation (and transfer) efforts relevant for poorer countries -- e.g., health R&D examples, program vs project funding (perhaps competitively bided), pooled funding, end-point royalties, contract for research services (distinct from technology development), joint ventures
- Target efforts to higher payoff possibilities
- Research done in developing countries critical, but so too is research done in rich countries
- Sustain the commitment over the log haul

Close with a Foreword by Norman Borlaug

Persistence Pays: U.S. Agricultural Productivity Growth and the Benefits from Public R&D Spending (in press 2010)

The story looking back is of remarkable returns to investment. The story going forward is one of faltering agricultural productivity gains, almost surely due to a slowdown in the growth of farm productivity oriented agricultural R&D in America. Unless these disturbing trends change, the future adequacy of U.S. and global food supplies is in jeopardy.

July 4, 2009

Norman E. Borlaug (1914–2009)
Founder, the World Food Prize
1970 Nobel Peace Prize Laureate