Agricultural Innovation—The United States and the Developing World

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University of Minnesota

USDA 92nd Outlook Forum, Transforming Agriculture

Session: Applying USDA Technological Achievements to Global Agricultural Challenges

February 26, 2016 Marriott Hotel, Arlington

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UNIVERSITY OF MINNESOTA

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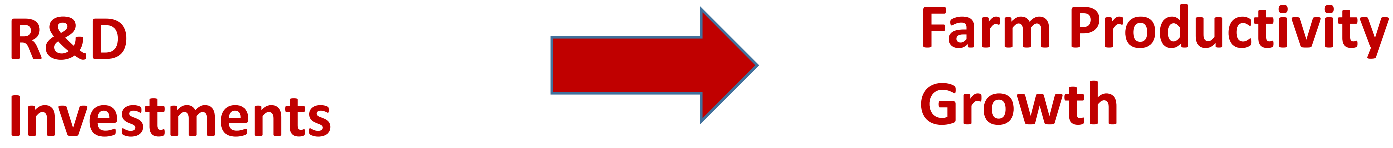
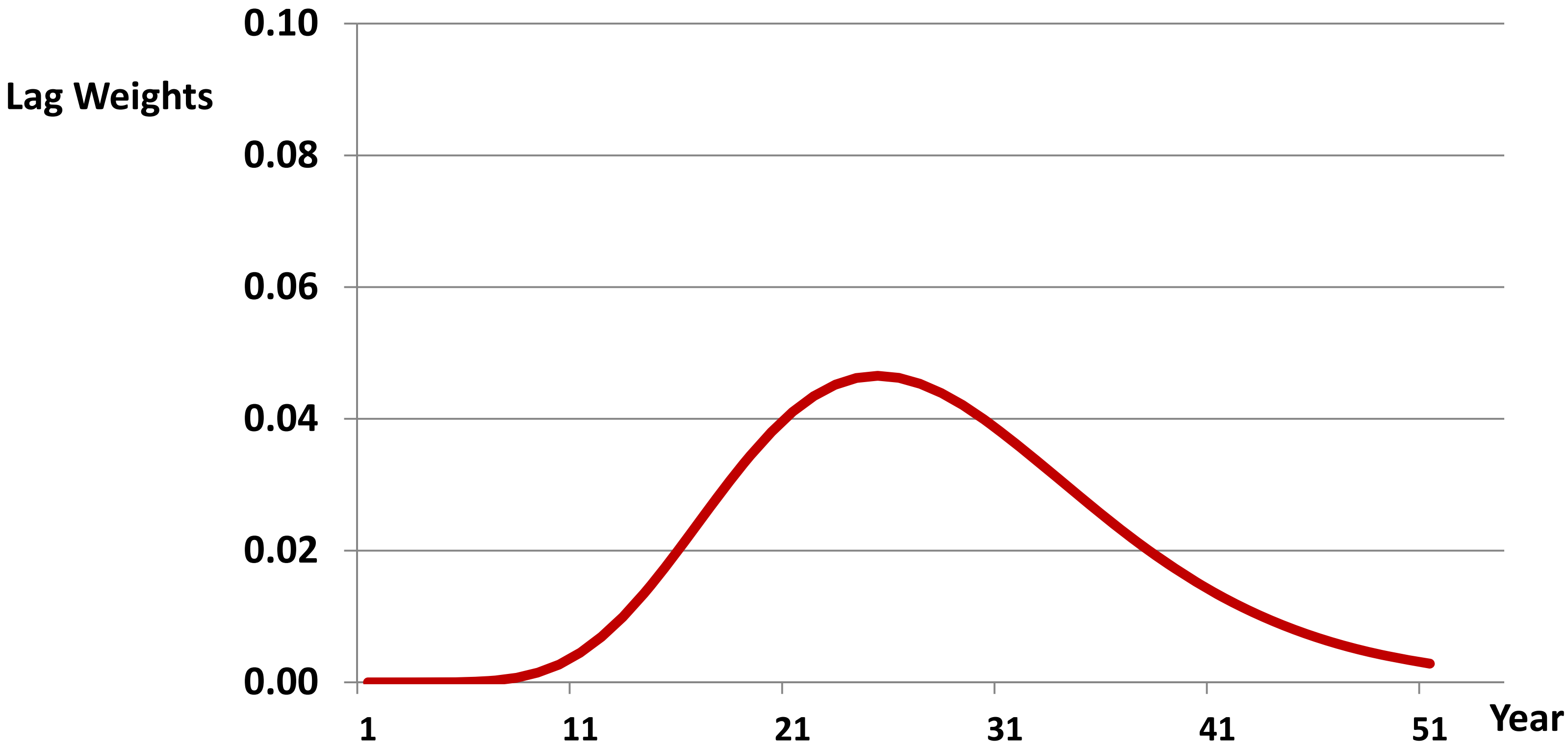
Outline

- Persistence Pays! – R&D and Adoption Lags
- Changing Food and Agricultural R&D Realities Worldwide
- U.S. Agricultural Innovations in a Global Context
    - The Case of Wheat Rusts

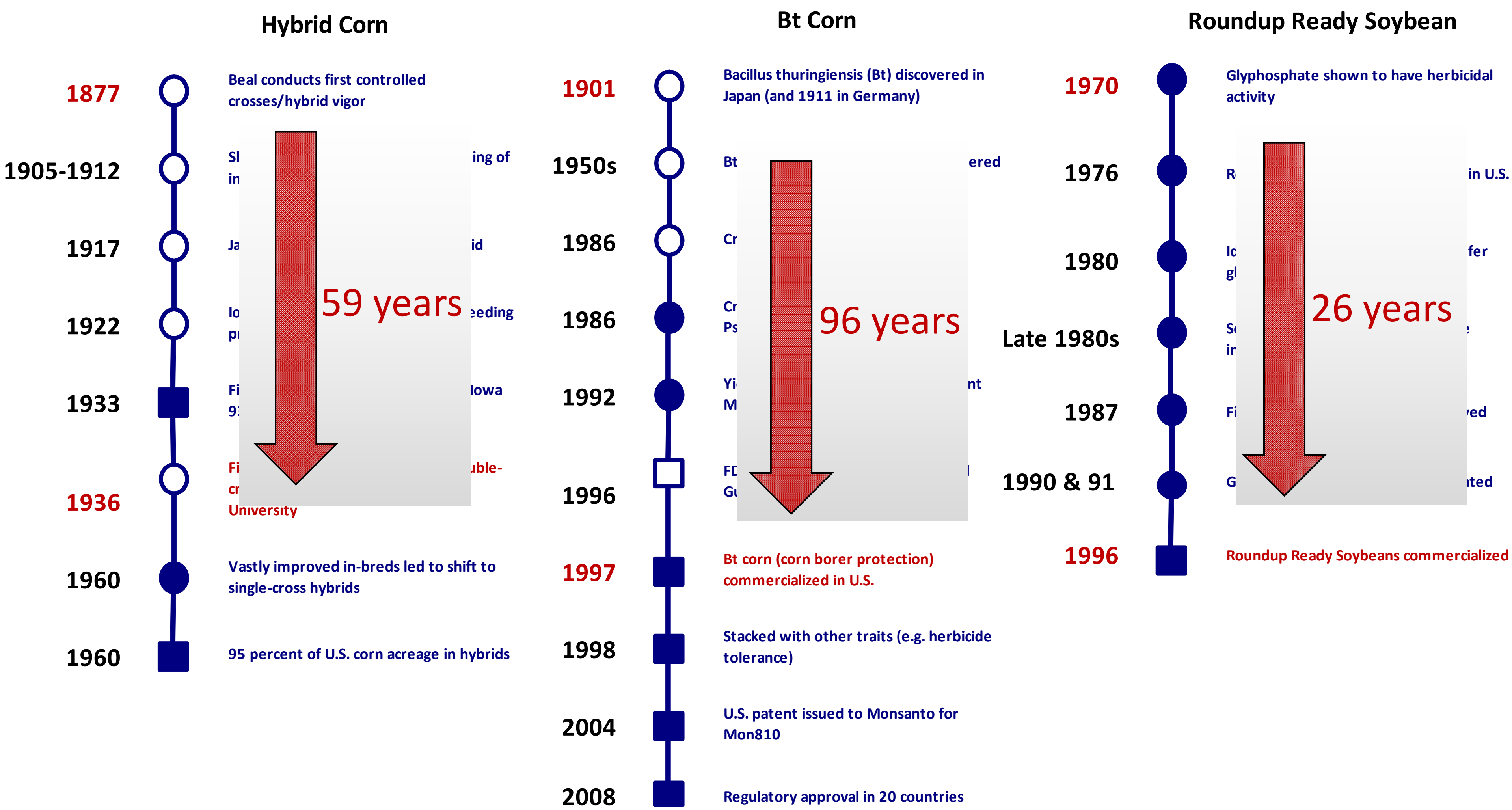
From Innovation Investment to Adoption and Impact





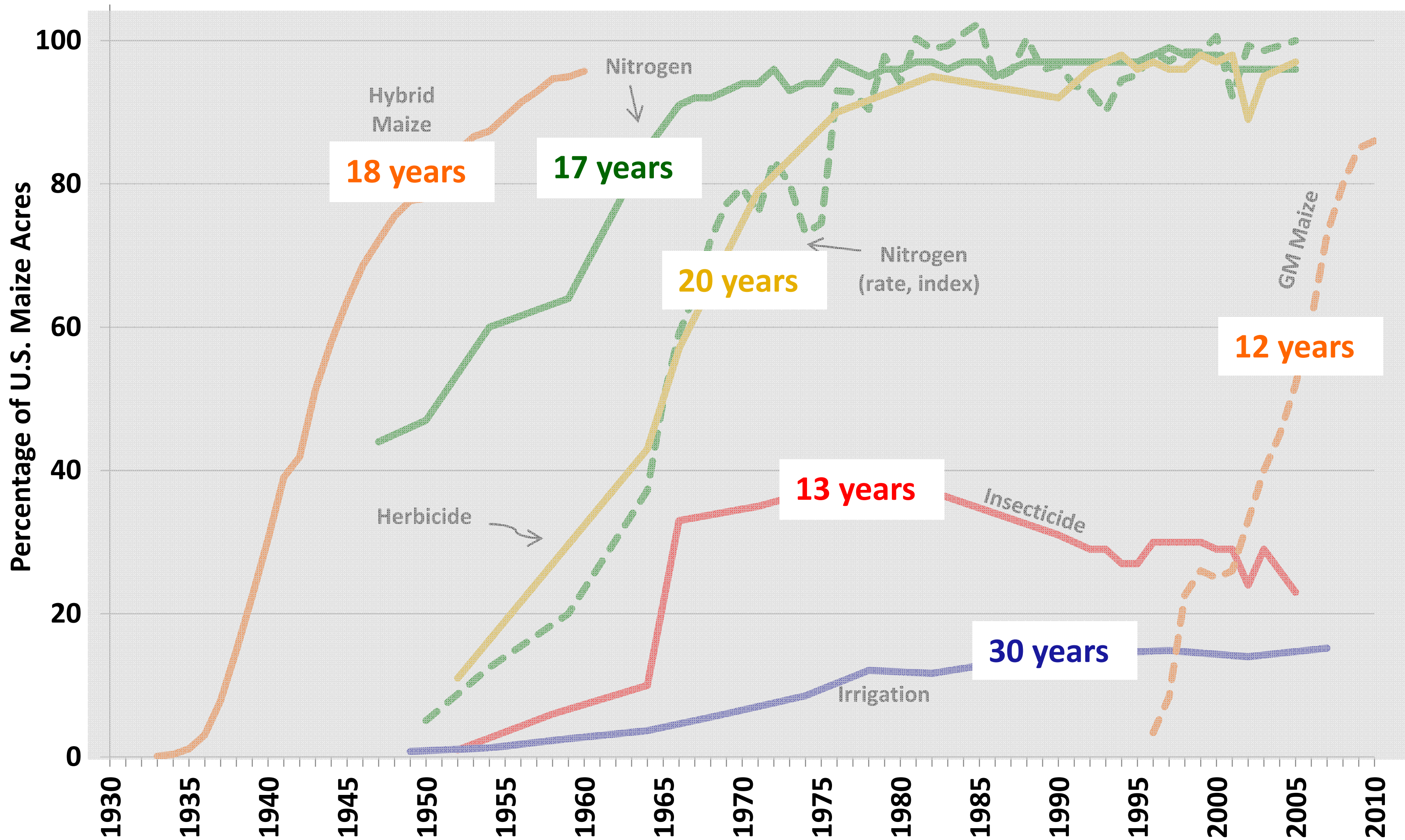
Source: Alston, Anderson, James and Pardey (2010, 2011)

Illustrative Technology Timelines (US)



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

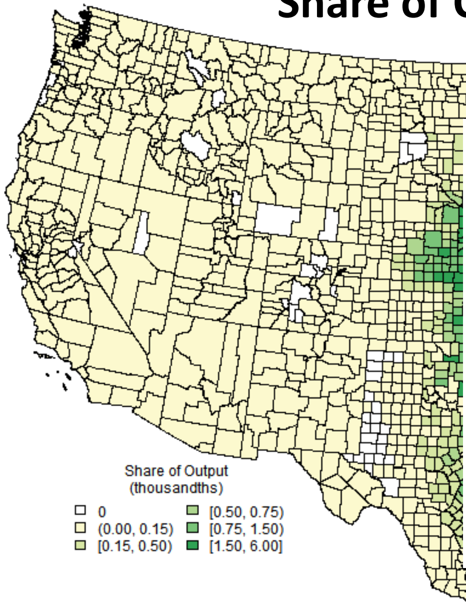
U.S. Maize Technology Adoption Lags



Source: Beddow (2012)

Corn Movement in the U.S., 1899-2007

Share of Corn Output by County, 1899

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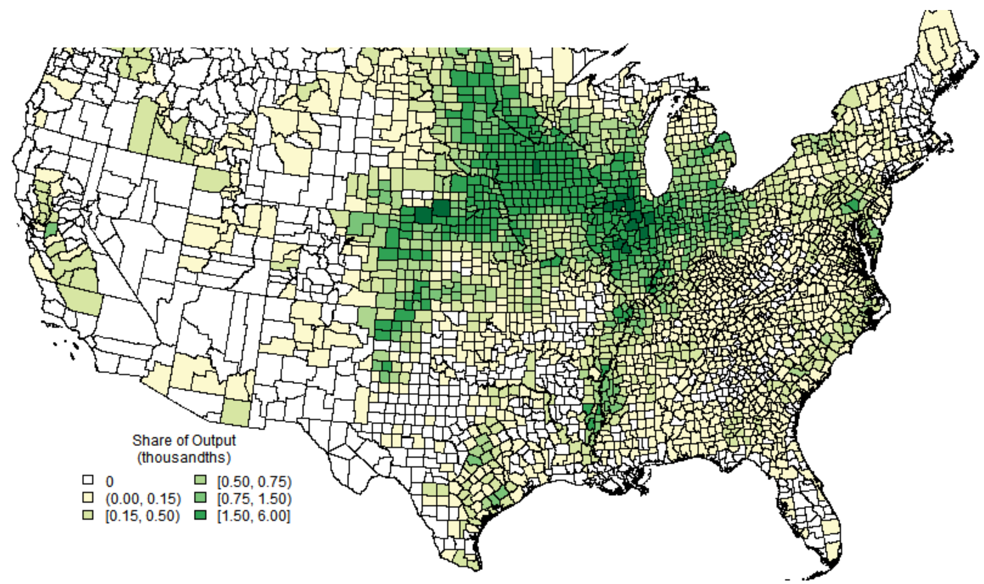
Moving Matters

279 kilometers north

342 kilometers west

16 to 21 percent of corn output growth

ut by County, 2007

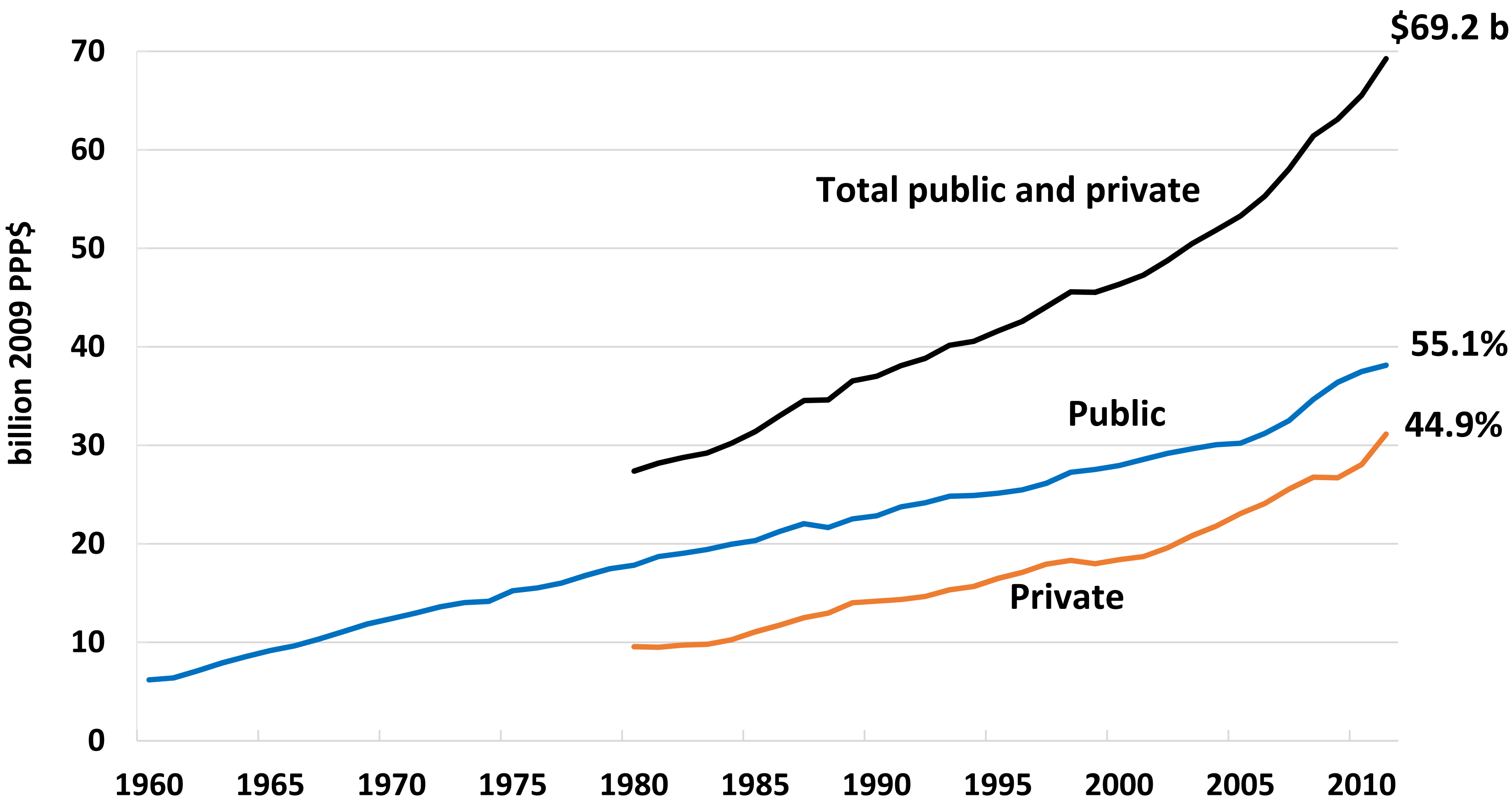


Source: Beddow and Pardey (2015)

Shifting Ground

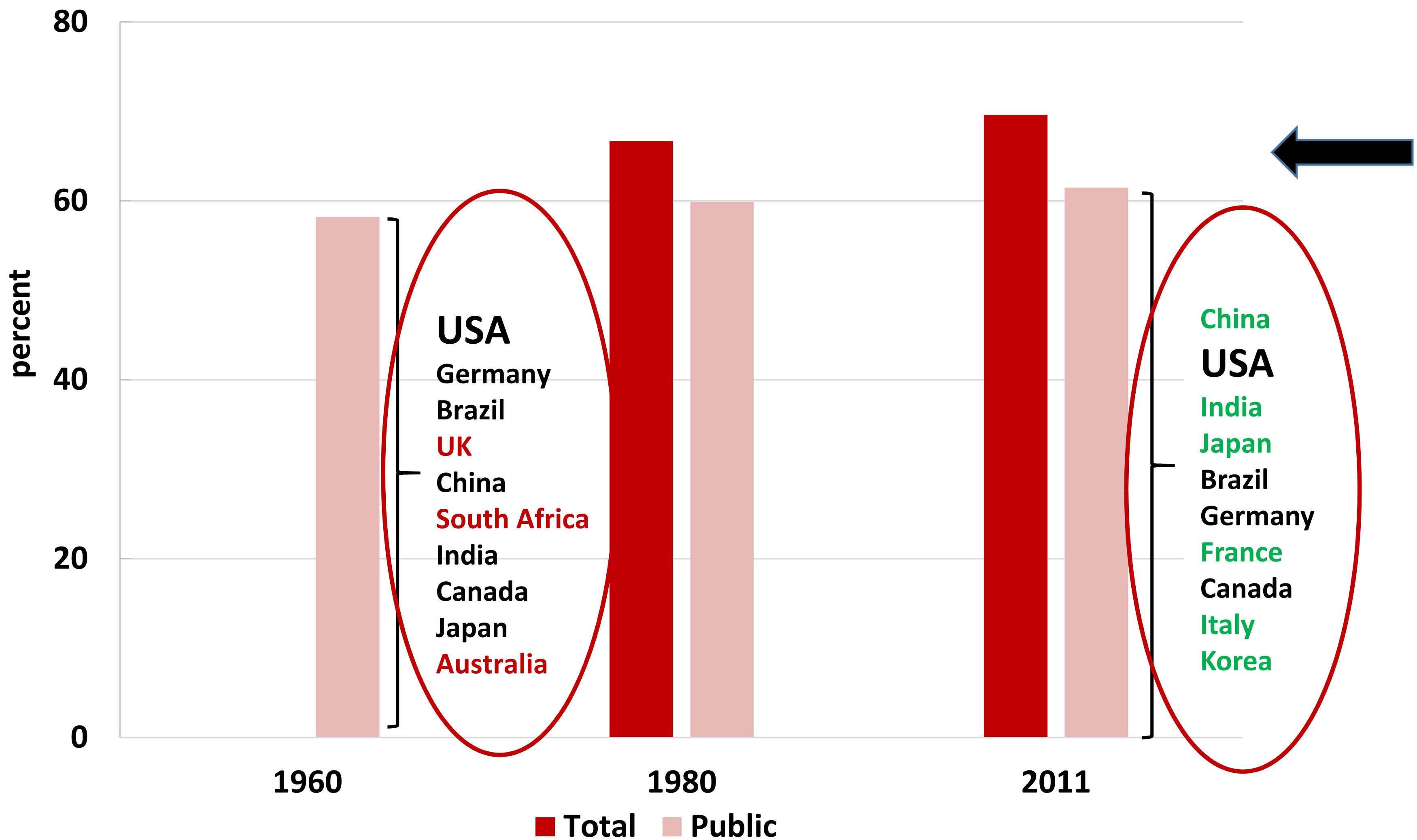
The Global Food and Agricultural R&D Landscape

Global Public and Private Food & Agricultural R&D, 1960-2011

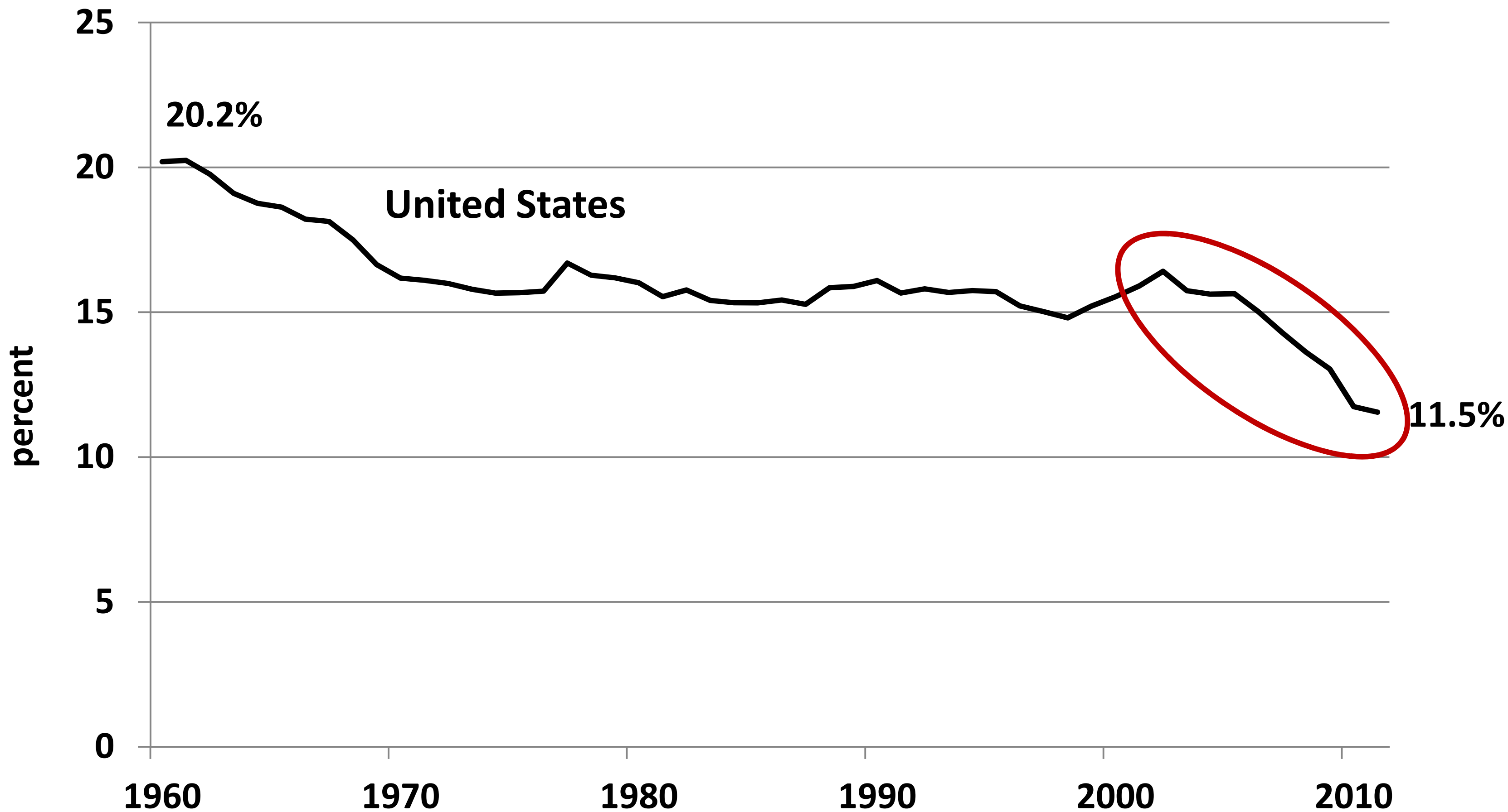


Source: Pardey, Chan-Kang, Beddow and Dehmer (2016, in process)

Spatial Concentration -- Top 10 Country Share and Rank



Shifting Global Shares of Public Food & Ag R&D, 1960-2011



Source: Pardey, Chan-Kang, Beddow and Dehmer (2016, in process)

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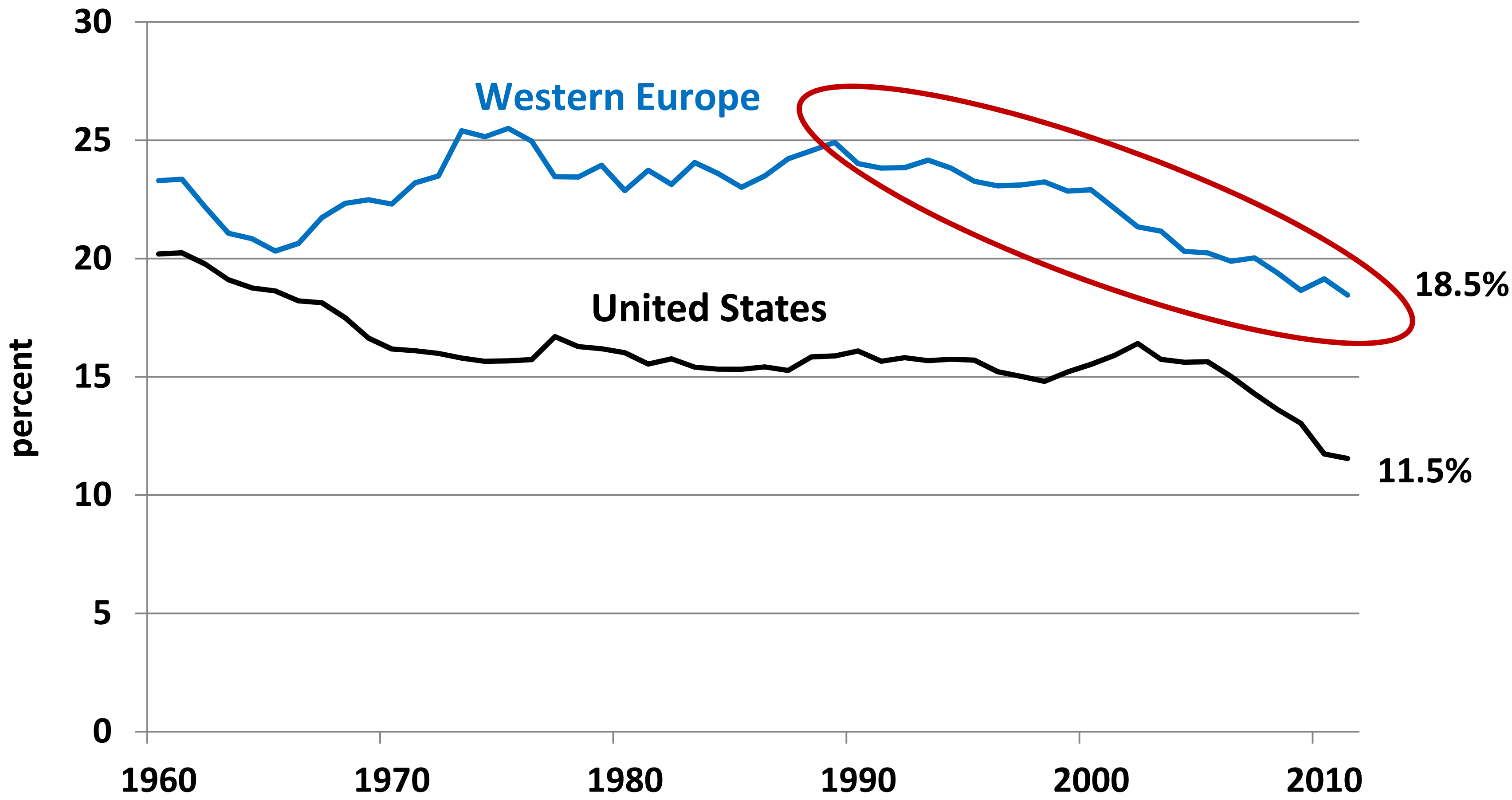

Source: Pardey, Chan-Kang, Beddow and Dehmer (2016, in process)

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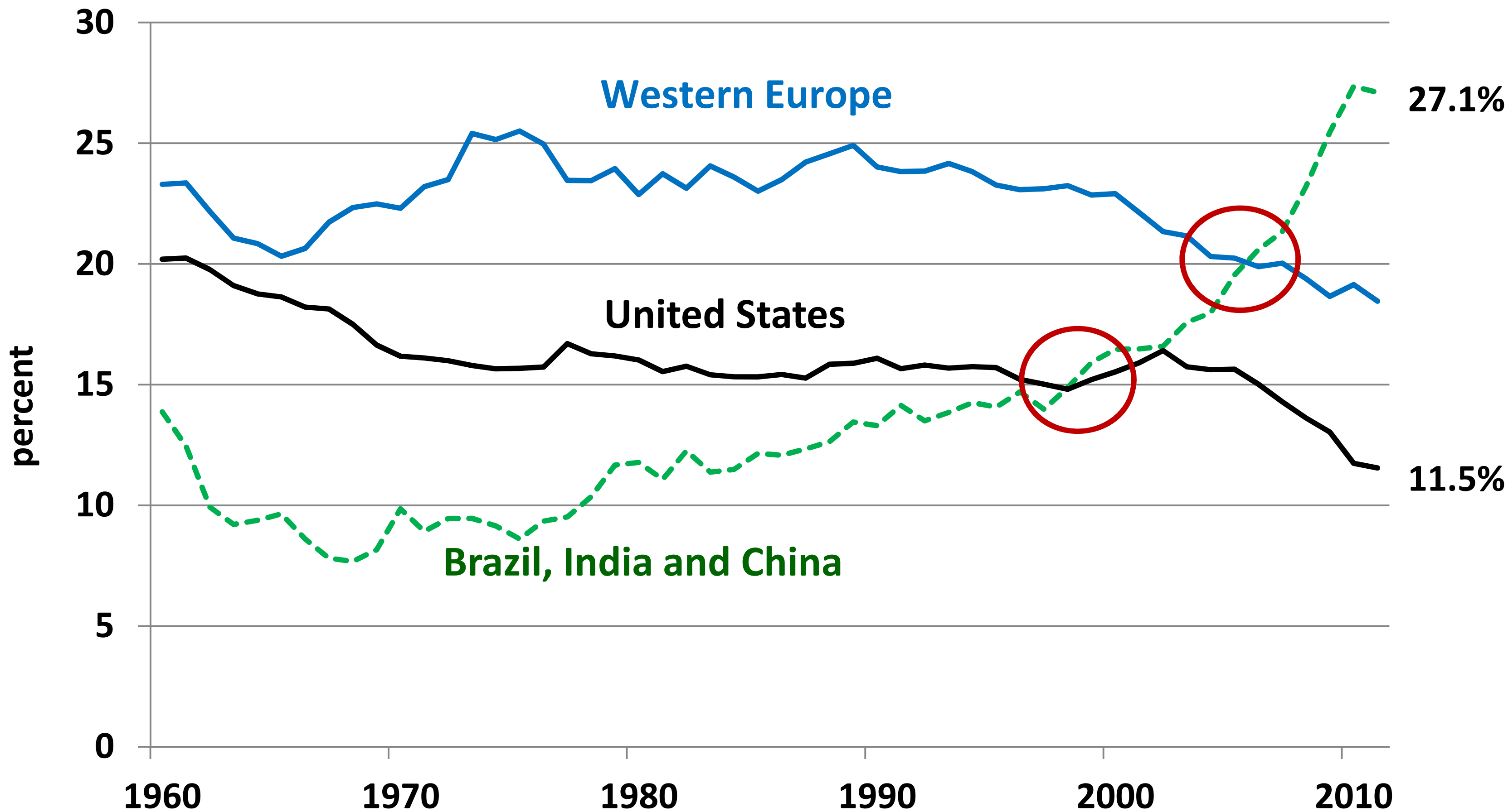


Source: Pardey, Chan-Kang, Beddow and Dehmer (2016, in process)

Agricultural R&D, Innovation and Adoption

Sustainable Productivity Performance

- Economic challenges
  - Comparative advantage and international competiveness

- Environmental challenges and changes
  - Climate (drought, heat stress, water logging etc)
  - Crop pest and diseases

Productivity Maintenance – The Case of Wheat Rusts

Running hard to stand still!

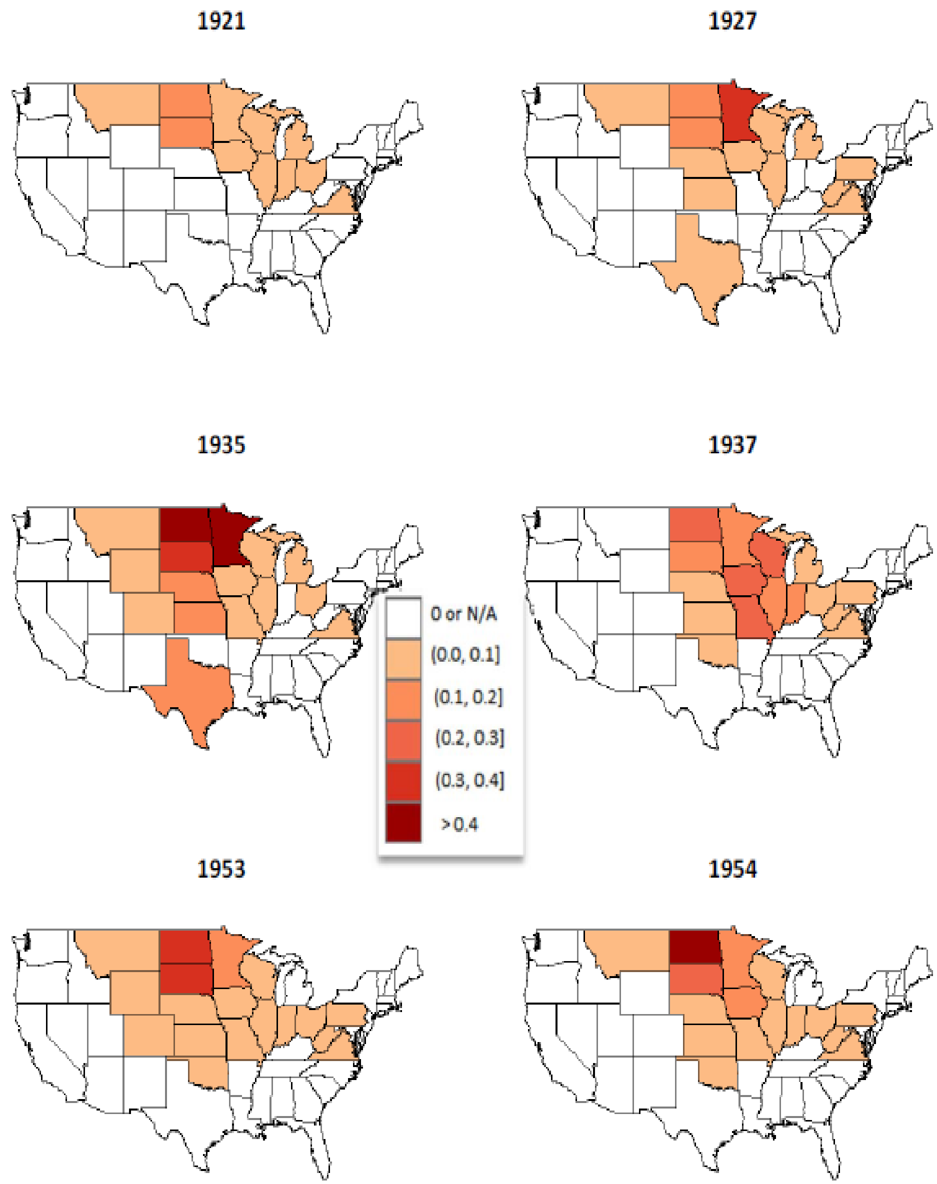
Stem Rust

Stripe Rust

Leaf Rust

Stem Rust

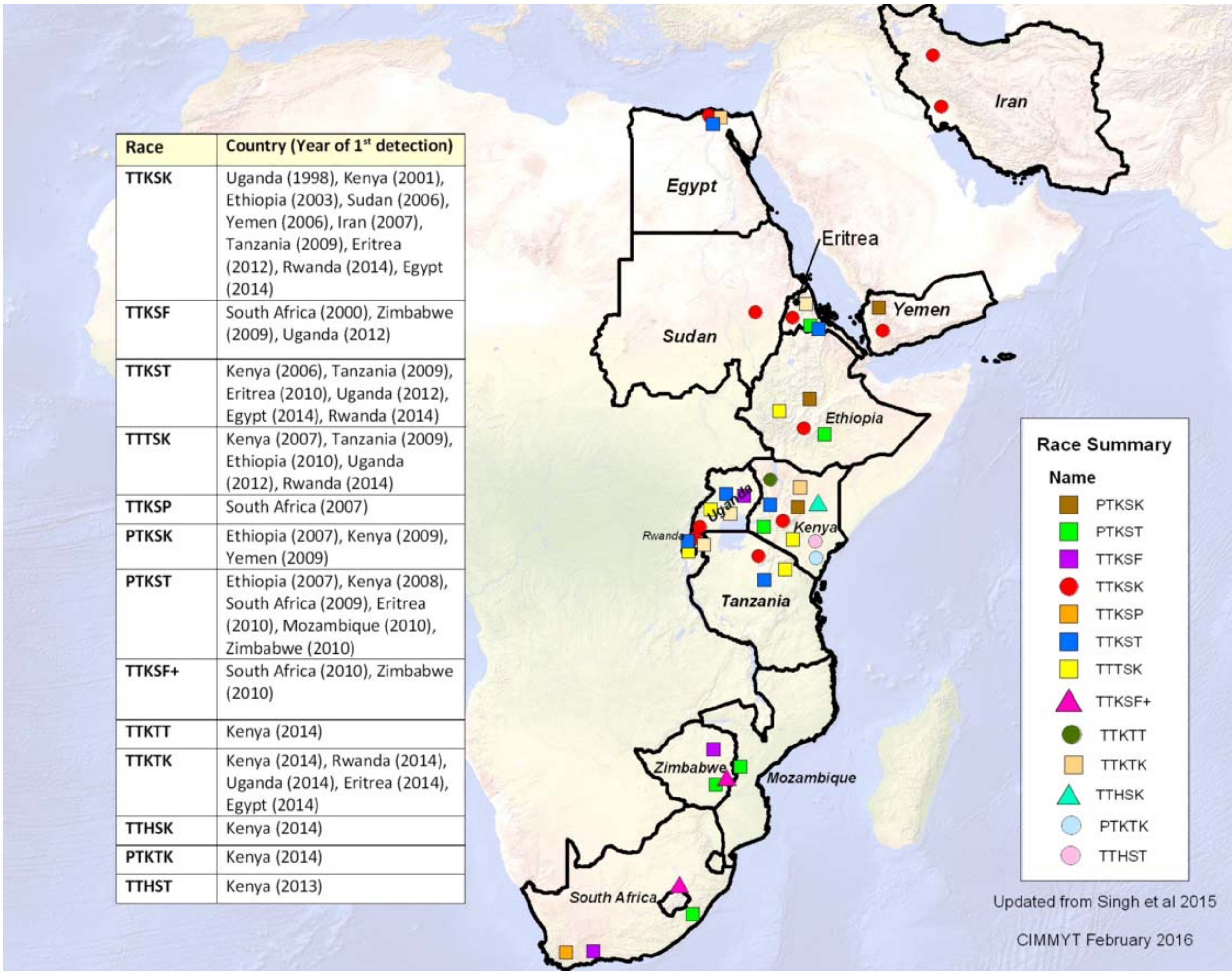
Appendix Figure 1: Reported State Losses (share) Due to Stem Rust in the U.S., Selected Years.



Source: Created by the authors using data from USDA, ARS (2011).

The Spread of Ug99 Stem Rust

Now 13 known variants spread across 13 countries



Race	Country (Year of 1st detection)
TTKSK	Uganda (1998), Kenya (2001), Ethiopia (2003), Sudan (2006), Yemen (2006), Iran (2007), Tanzania (2009), Eritrea (2012), Rwanda (2014), Egypt (2014)
TTKSF	South Africa (2000), Zimbabwe (2009), Uganda (2012)
TTKST	Kenya (2006), Tanzania (2009), Eritrea (2010), Uganda (2012), Egypt (2014), Rwanda (2014)
TTTSK	Kenya (2007), Tanzania (2009), Ethiopia (2010), Uganda (2012), Rwanda (2014)
TTKSP	South Africa (2007)
PTKSK	Ethiopia (2007), Kenya (2009), Yemen (2009)
PTKST	Ethiopia (2007), Kenya (2008), South Africa (2009), Eritrea (2010), Mozambique (2010), Zimbabwe (2010)
TTKSF+	South Africa (2010), Zimbabwe (2010)
TTKTT	Kenya (2014)
TTKTK	Kenya (2014), Rwanda (2014), Uganda (2014), Eritrea (2014), Egypt (2014)
TTHSK	Kenya (2014)
PTKTK	Kenya (2014)
TTHST	Kenya (2013)

Cereal Disease Laboratory

- Research Projects
- Publications
- People
- News
- Collaborations
- Careers

The

Cereal Rusts

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CEREAL DISEASE LABORATORY
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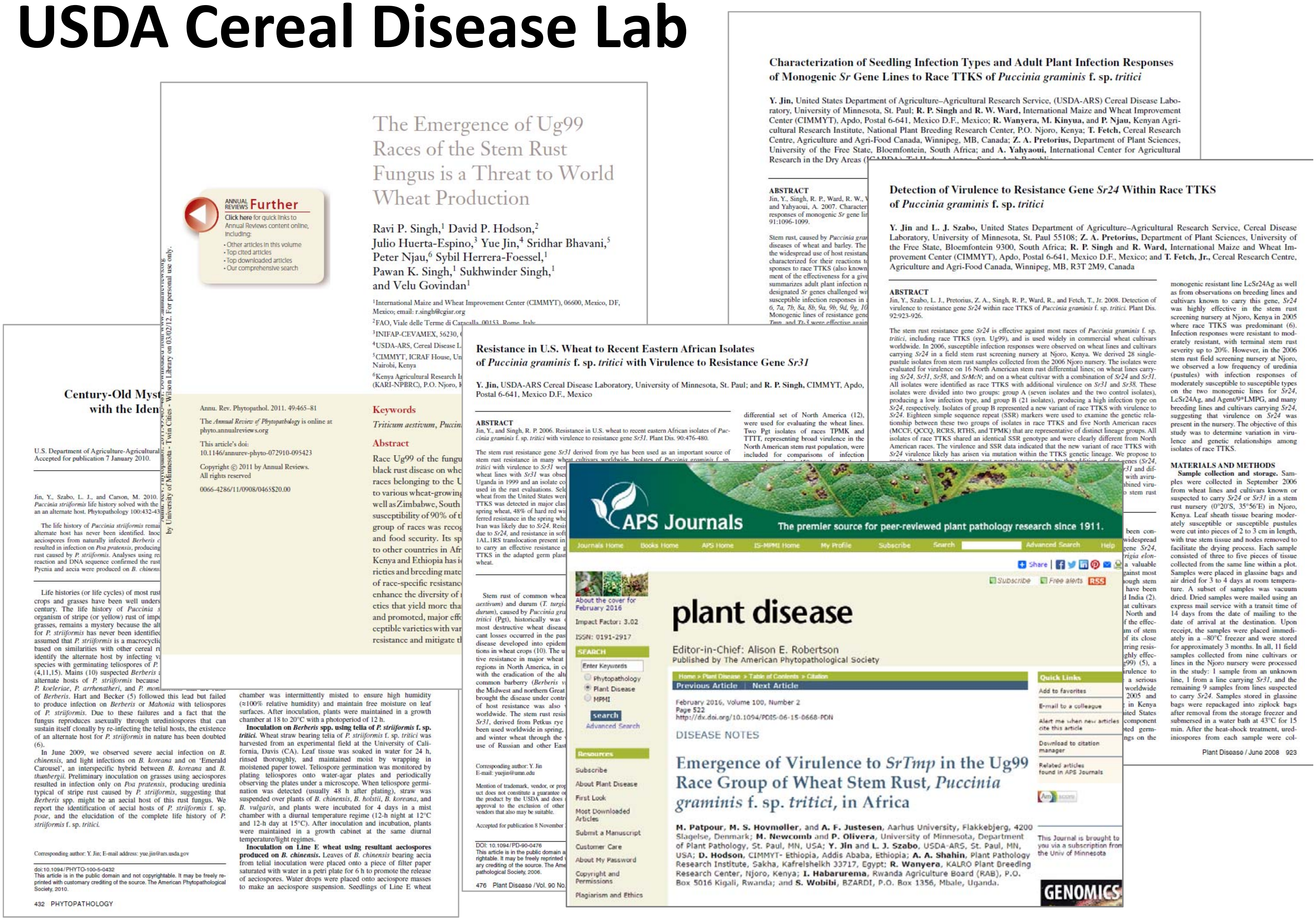
St. Paul MN 55108

Mission:
The mission of the Cereal Disease Laboratory is to reduce losses in wheat, oat, and barley to major diseases including leaf rust, stem rust, and Fusarium head blight. This mission is accomplished through research on the biology of the pathogens that cause these diseases and on methods to enhance disease resistance in small grains. Program objectives are to: (1) identify genes used by plants in defense against pathogens and determine their cellular and biochemical mechanisms of action; (2) elucidate molecular

- Barberry
- Bibliographies
- Cereal Rust Bulletins, rust reports, maps
- Cereal rusts
- Cooperator's page
- Fusarium head blight
- Germplasm evaluation
- Mail lists
- Monitoring of rust spores
- Publications
- Race analysis videos
- Race surveys
- Resistance genes
- Losses due to rust
- Staff
- Ug99 - emerging virulent races

- Directions to the lab
- University of Minnesota campus maps
- Health and Safety

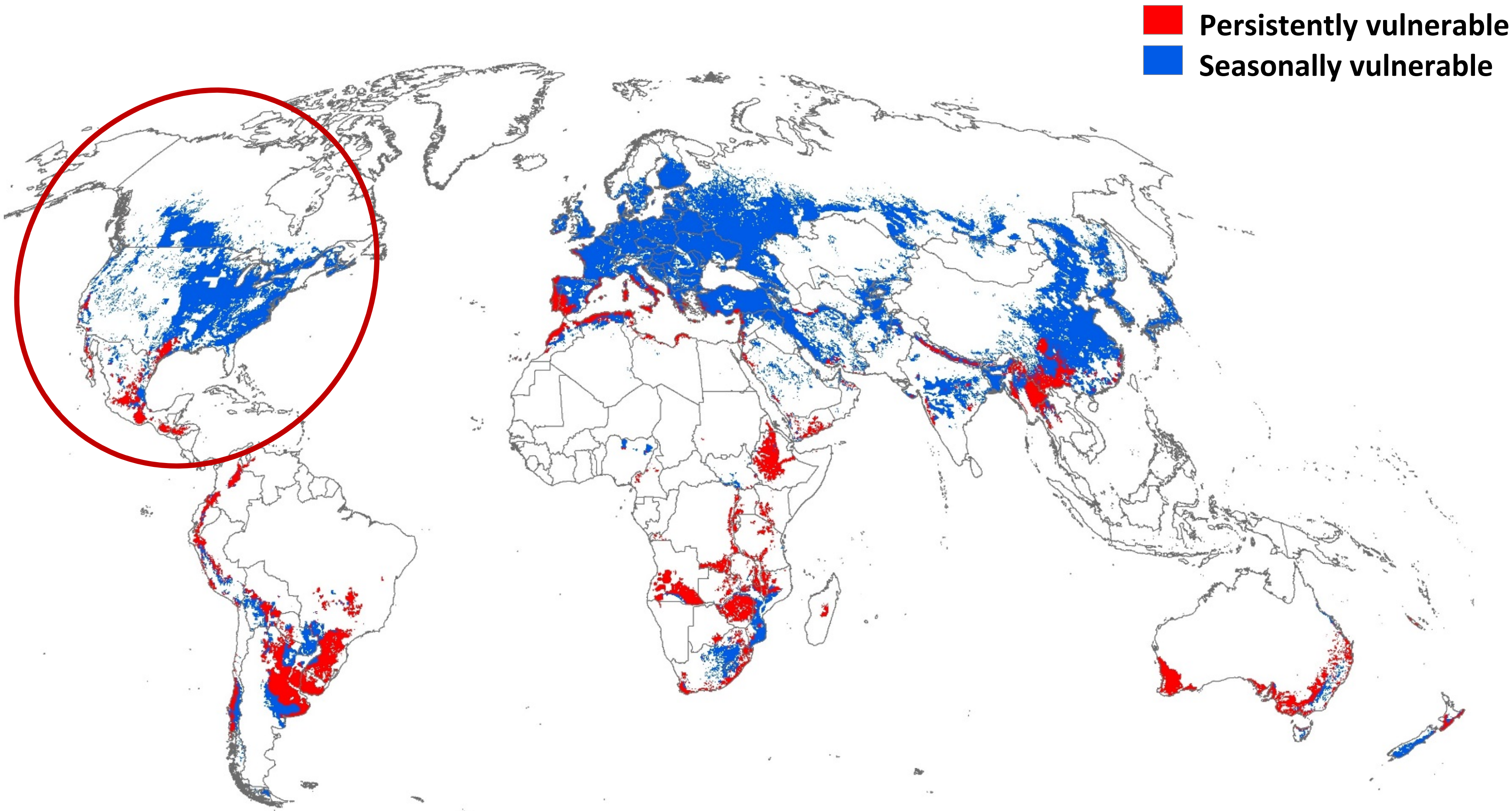
USDA Cereal Disease Lab



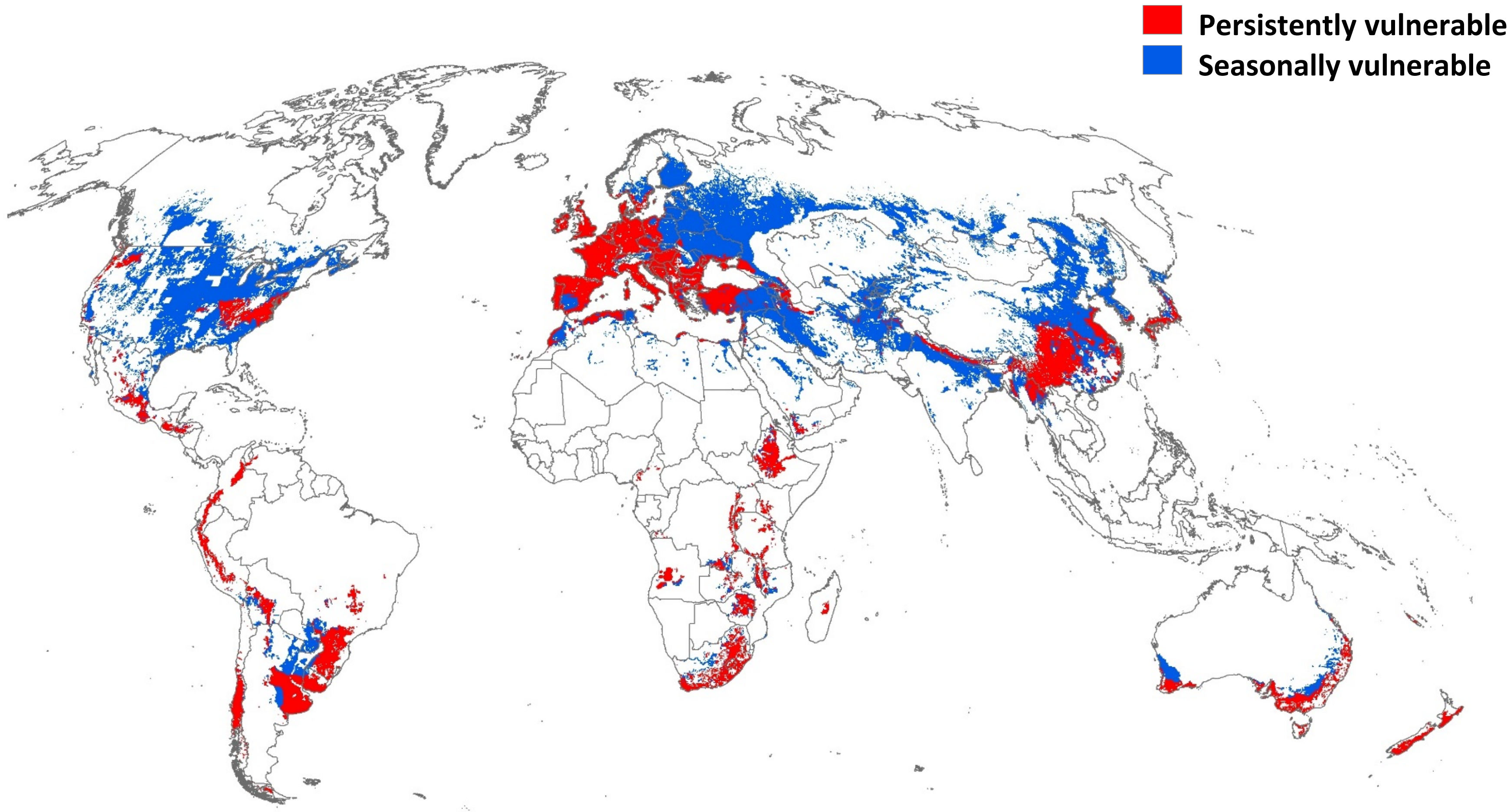
Doing Good by Doing Well

US Wheat Rust Research in a Global Setting

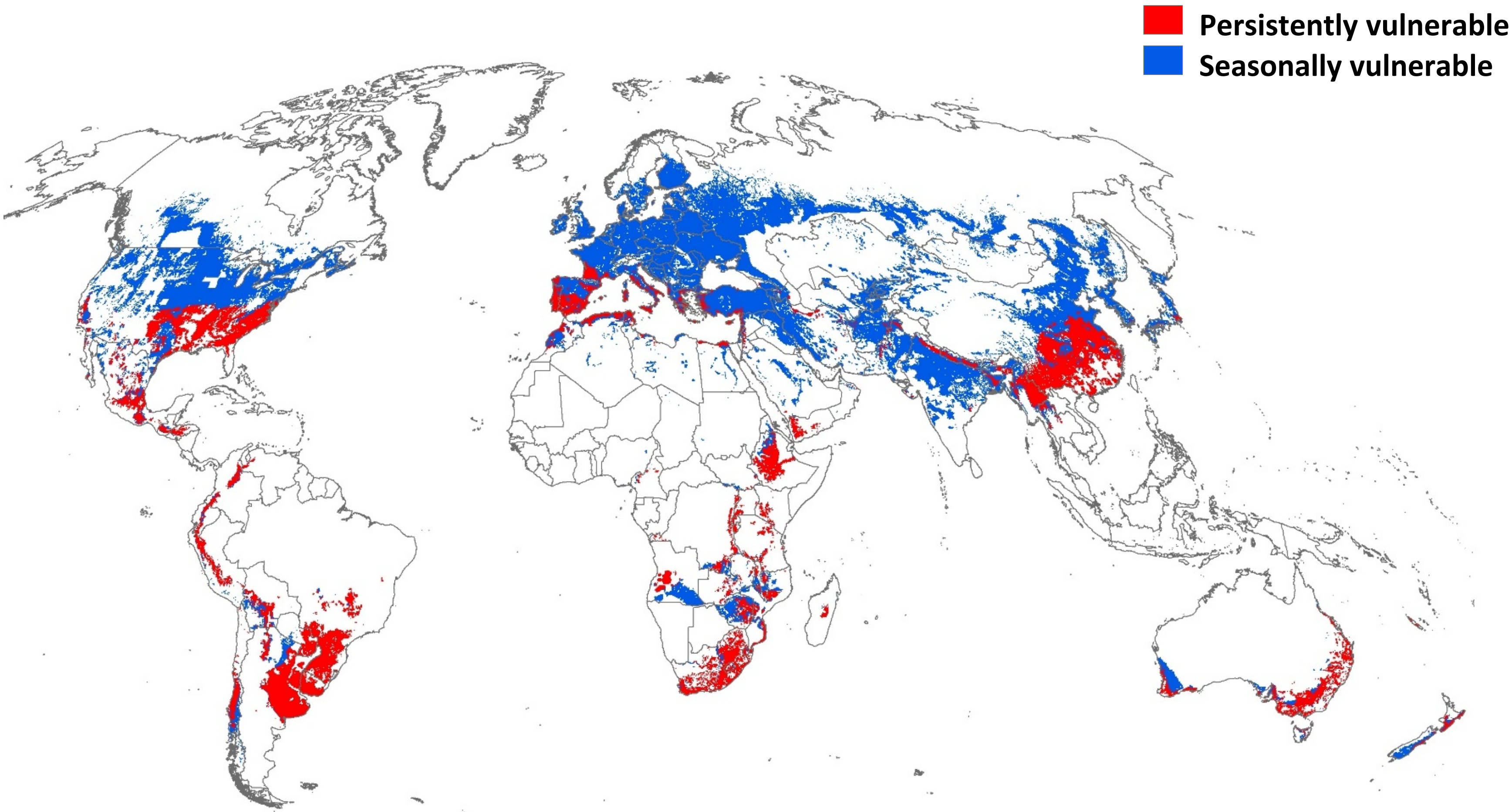
Stem Rust Climate Suitability



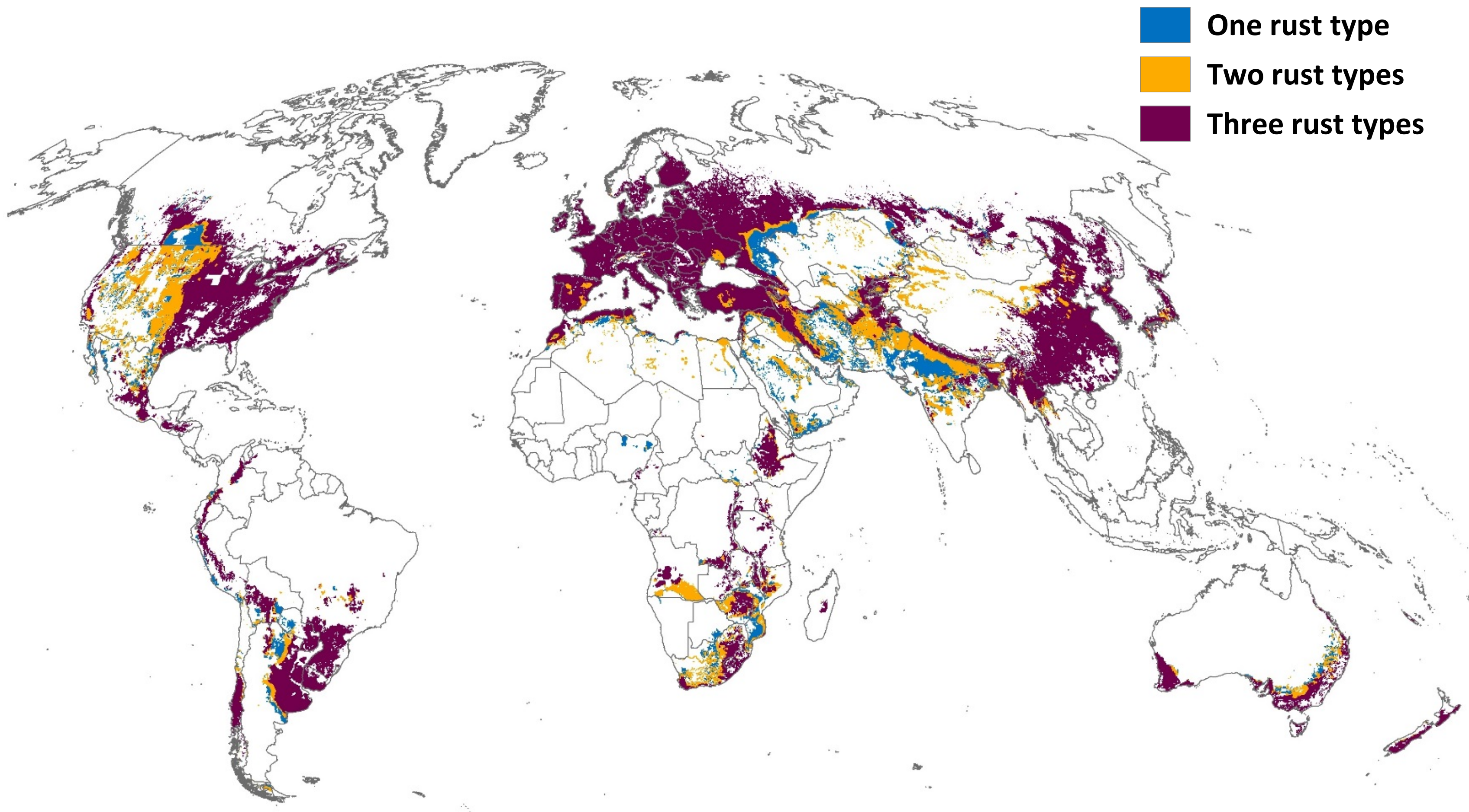
Stripe Rust Climate Suitability



Leaf Rust Climate Suitability



Three Rusts—Seasonally Vulnerable



Note: Suitability prediction based on growth index (GI) values from the CLIMEX model

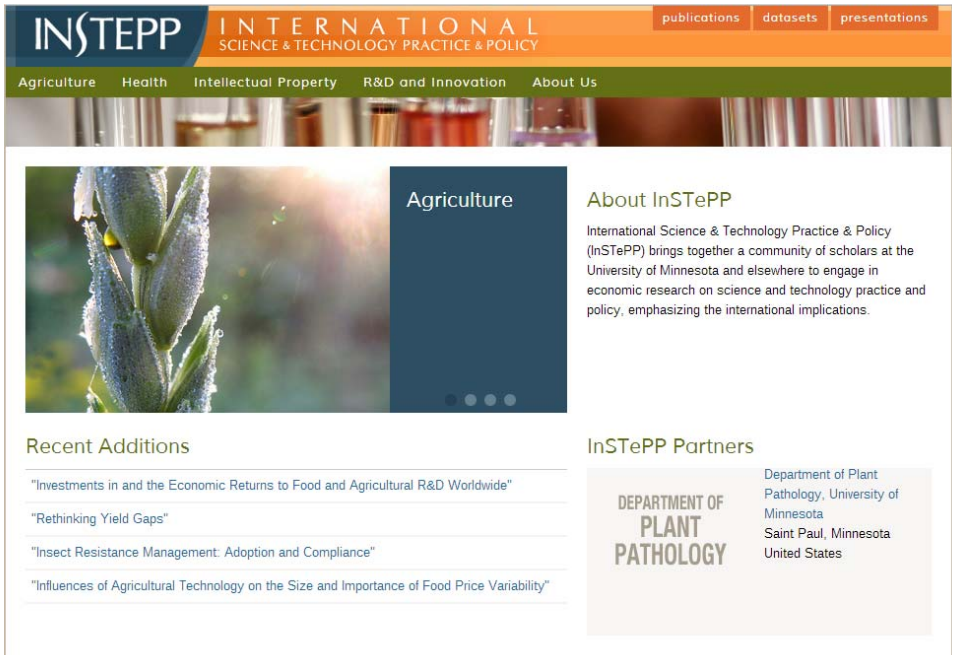
Vulnerability to Wheat Rusts Worldwide

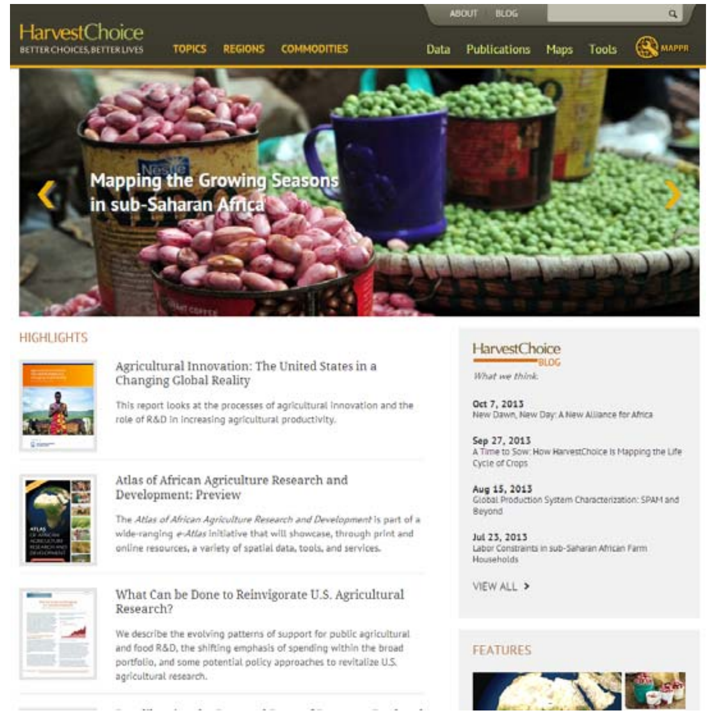
	Stem, Leaf and Stripe Rust Vulnerability			
	None	Only One	Only Two	All Three
	(Percentage of output, all farms)			
Western Europe	0.0	0.0	0.7	99.2
North America	2.2	12.5	37.1	48.3
Australia	0.0	10.3	17.8	71.9
Sub-Saharan Africa	11.0	3.6	13.9	71.6
China	0.0	0.0	11.5	88.5
India	6.3	18.8	72.5	2.5
World	3.2	6.9	27.1	62.7

Concluding Remarks

- U.S. losing considerable global market share in terms of (public) R&D spending
- R&D likely to remain highly spatially concentrated
  - A growing disconnect between the geography of agricultural demand and the location of agricultural R&D performance
- Shift towards more contestable and project-oriented (often shorter-term) funding of public science
  - The problems are just as hard as they ever have been
  - The present returns are just as high (pointing to persistent underinvestment)
- Requires political will to think long term and reinvest and revitalize agricultural R&D in the U.S. and elsewhere in the world (especially among the poorer countries)

Thanks!





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