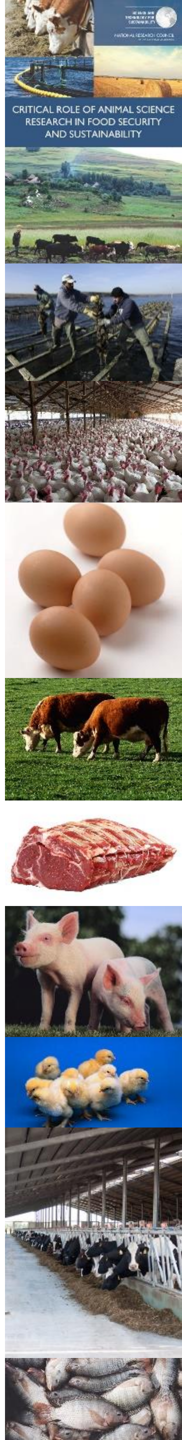
Challenges with funding of animal-source food production and consumption research

June 5, 2019

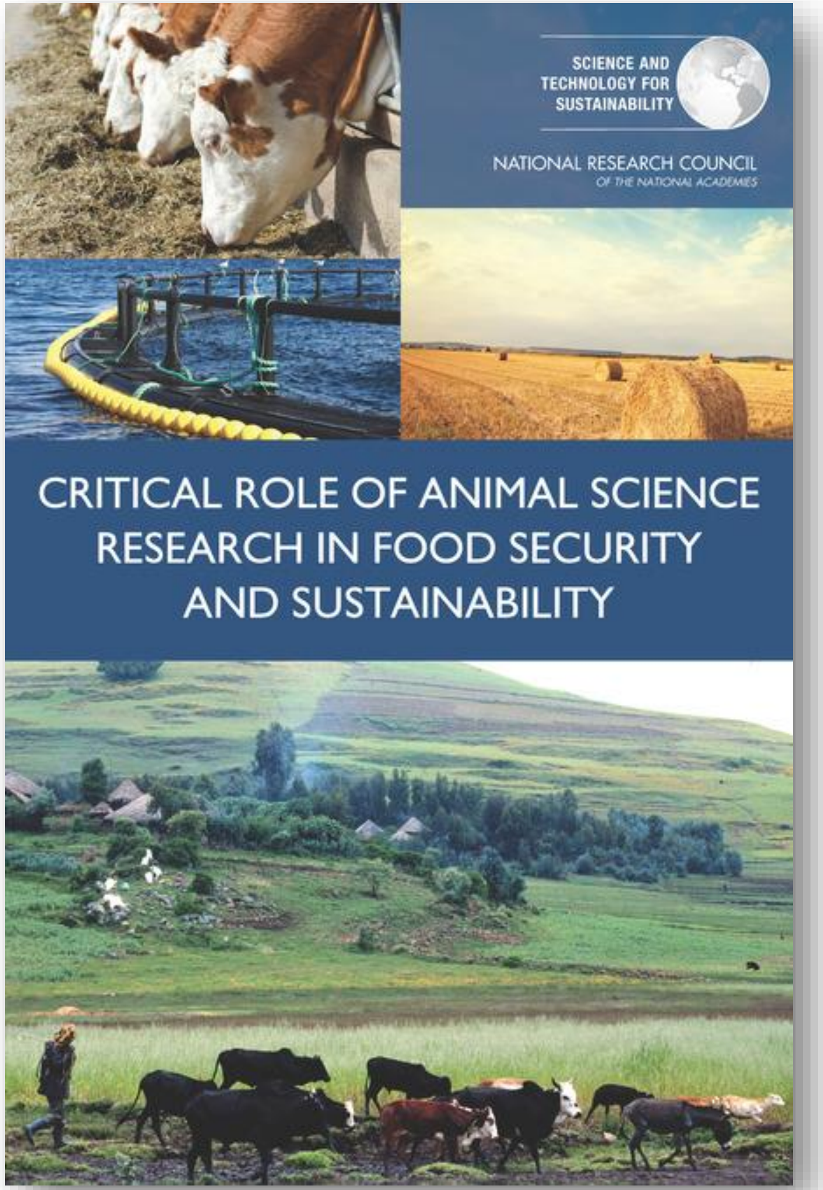
Washington, D.C.

Sara Place, Ph.D., Senior Director, Sustainable Beef Production Research, National Cattlemen's Beef Association



Outline

- NASEM 2015 study process/background
- Overarching recommendations
- Capacity building and research funding
- Research investment connection to productivity and sustainable intensification



Statement of task: Abridged version

- Identify critical R&D needs in US and globally for animal agriculture
- Evaluate how constraints of climate change and limited natural resources impact ability to sustainably meet future demand growth across production systems and geographic regions
- Identify US needs for trained human capital, product quality and safety, effective communication, and adoption of new knowledge

Statement of task: Abridged version

- Identify need for human capital development, tech transfer and info systems for emerging and evolving animal production systems in developing nations, including dissemination resources
- Describe evolution of sustainable animal production systems as relevant to production and production efficiency metric in US and developing nations

Study sponsors

- Association of American Veterinary Medical Colleges
- Bill and Melinda Gates Foundation
- Innovation Center for U.S. Dairy
- National Cattlemen’s Beef Association
- National Pork Board
- Tyson Foods, Inc.
- U.S. Department of Agriculture
- U.S. Poultry & Egg Association

5

Committee membership

- **Bernard D. Goldstein** (Chair) (IOM), Professor Emeritus, Department of Environmental and Occupational Health, University of Pittsburgh Graduate School of Public Health
- **Louis D'Abramo**, William L. Giles Distinguished Professor of Wildlife, Fisheries and Aquaculture, Mississippi State University
- **Gary F. Hartnell**, Senior Fellow, Chemistry Technology, Monsanto Company
- **Joy Mench**, Professor of Animal Science and Director of the Center for Animal Welfare, University of California, Davis
- **Sara Place**, Assistant Professor of Sustainable Beef Cattle Systems, Oklahoma State University
- **Mo Salman**, Professor of Veterinary Epidemiology, Colorado State University and Jefferson Science Fellow, U.S. Department of State
- **Dennis Treacy**, Executive Vice President and Chief Sustainability Officer, Smithfield Foods, Inc.
- **B. L. Turner II** (NAS), Gilbert F. White Professor of Environment and Society, Arizona State University
- **Gary W. Williams**, Professor of Agricultural Economics and Co-Director, Agribusiness, Food, and Consumer Economics Research Center, Texas A&M University
- **Felicia Wu**, John A. Hannah Distinguished Professor of Food Science and Human Nutrition and Agricultural, Food and Resource Economics, Michigan State University

6

Study process

- **Meeting 1**: Open, data-gathering session held March 10-11, 2014, in Washington, DC
- **Meeting 2**: Open, data-gathering session held May 13-14, 2014, in Washington, DC
- **Meeting 3**: Closed, discussion and writing session held July 7-10, 2014, in Washington, DC
- **Meeting 4**: Closed, discussion and writing session held September 8-9, 2014, in Washington, DC

Overarching recommendations

- Animal science research should move toward a systems approach that emphasizes efficiency and quality of production to meet food security needs
  - Transdisciplinary research collaborations
  - Public-private partnerships

Overarching recommendations

- There is a need to revitalize the research infrastructure (both human and physical) through a series of strategic planning processes
- Socioeconomic/cultural research is essential to guide and inform animal scientists and decision-makers on what research should be done (appropriateness and applicability) and communication and engagement strategies

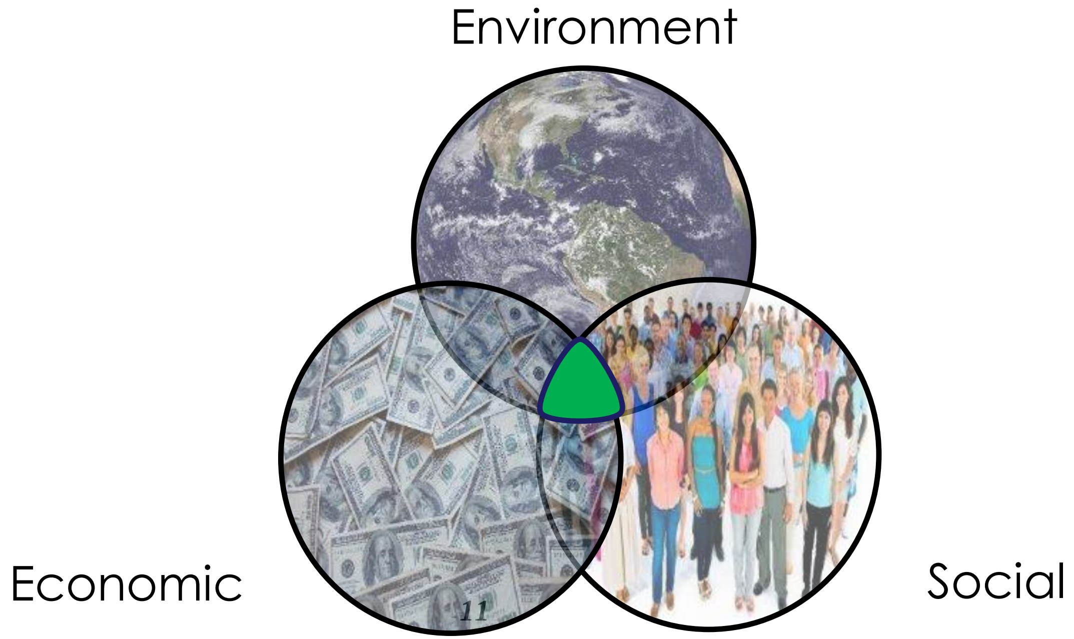
9

Overarching recommendations

- For research in sustainable intensification of animal agriculture to meet the challenge of future animal protein needs, **it is necessary to effectively close the existing broad communication gap between the public, researchers, and the food industries**

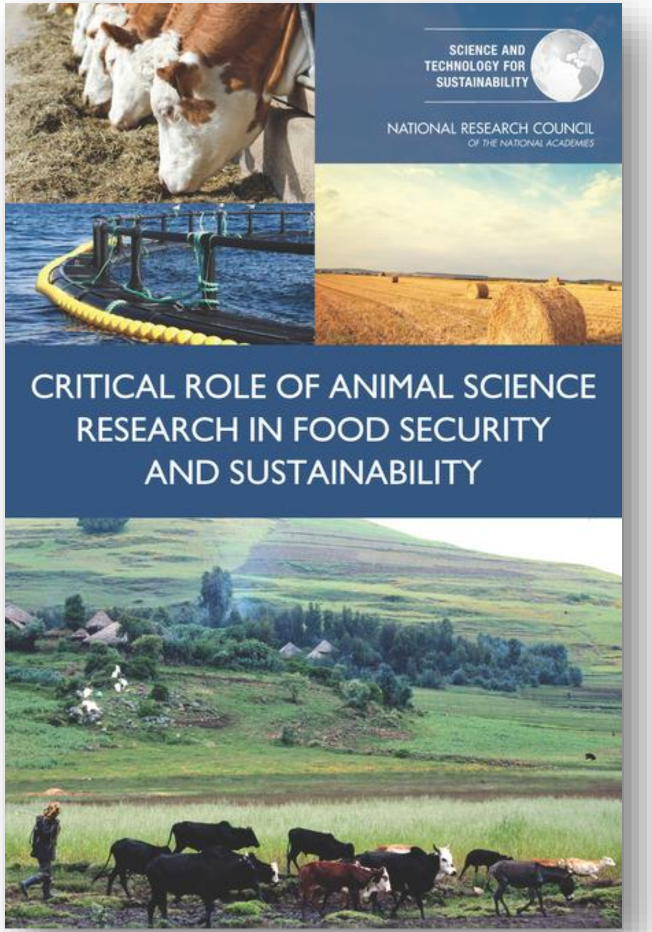
Overarching recommendations

- Continuing emphasis on animal productivity research is necessary; however, simultaneous research on economic, environmental, and social sustainability nexuses should also be enhanced



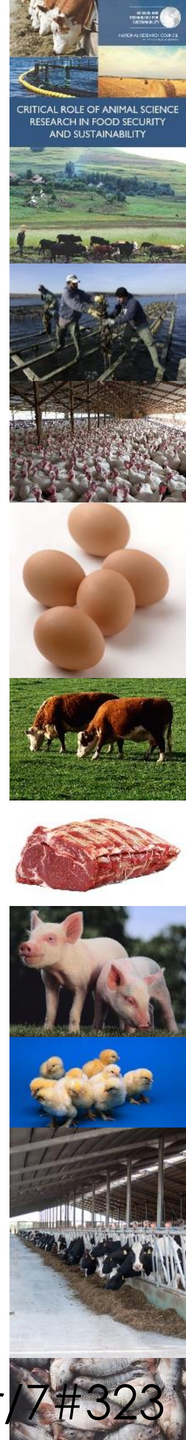
At the time of the report, few resources available to conduct a comprehensive global analysis

- “The committee recognizes the value of animal science training and research provided by non-land-grant institutions, as well as by non-U.S. institutions. Neither the committee’s mandate nor the areas of expertise of the committee members allowed comparisons of capacity-building activities in U.S. and non-U.S. institutions.”



Key recommendations from *Capacity Building and Infrastructure for Research in Food Security and Animal Sciences* chapter

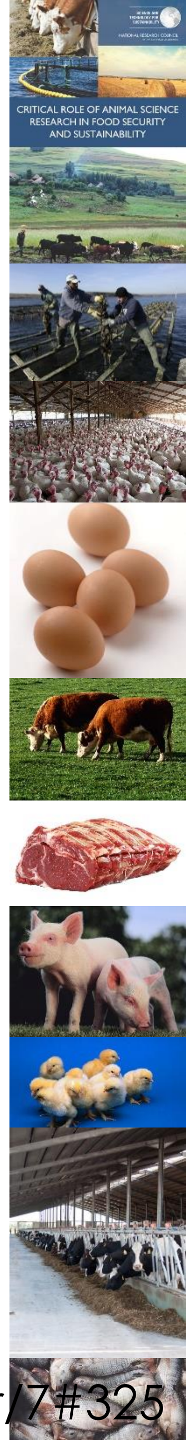
- Priorities for infrastructure for this area (*Research in Animal Sciences*) include:
  - There is an imminent need to revitalize animal agriculture research infrastructure (human and physical resources) through a series of strategic planning approaches.
  - The percentage allocation of public funding by agencies including USDA ARS, CSREES/NIFA, and ARS should be reprioritized by species, taking into account the long-term projected consumer demand for that animal product and the potential for reducing the environmental impact contributed by animal agriculture, with a focus on basic research.



Source: https://www.nap.edu/read/19000/chapter/7#323

Key recommendations from *Capacity Building and Infrastructure for Research in Food Security and Animal Sciences* chapter

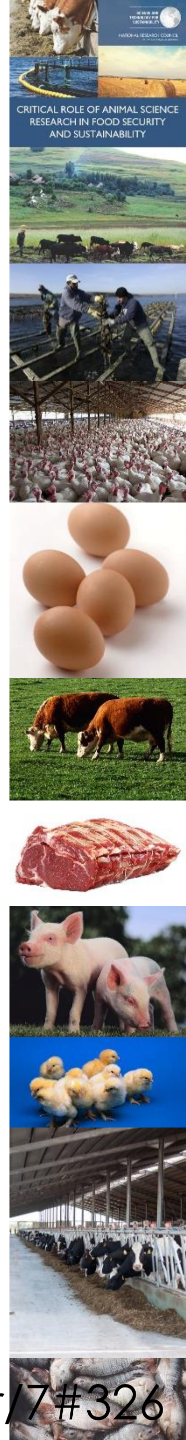
- One priority for infrastructure in this area (*Research Outreach in the Animal Sciences/Cooperative Extension; CE*) includes:
  - CE funding should increase to levels that are commensurate with animal science research and technology transfer needs. Its important communication role should be upgraded and improved to meet varied and changing demands of technology transfer.



Source: https://www.nap.edu/read/19000/chapter/7#325

Key recommendations from *Capacity Building and Infrastructure for Research in Food Security and Animal Sciences* chapter

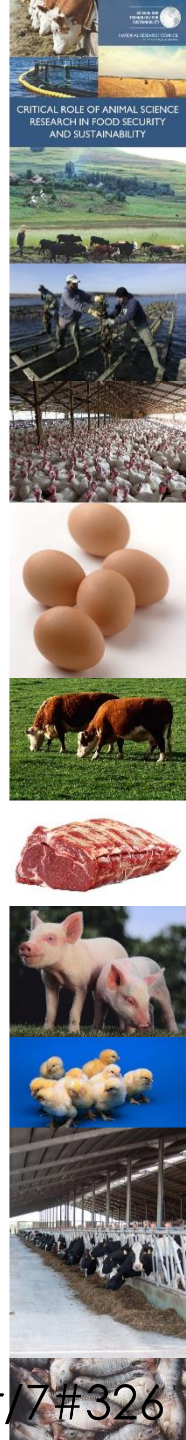
- One priority for infrastructure in this area (*Education in the Animal Sciences*) includes:
    - Funding for the USDA NIFA Food and Agricultural Sciences National Needs Graduate and Post-Graduate Fellowship Program should be increased, with periodic evaluation of the program to ensure that it is continuing to adequately address emerging research needs in animal science while developing the next generation of researchers.



Source: https://www.nap.edu/read/19000/chapter/7#326

Key recommendations from *Capacity Building and Infrastructure for Research in Food Security and Animal Sciences* chapter

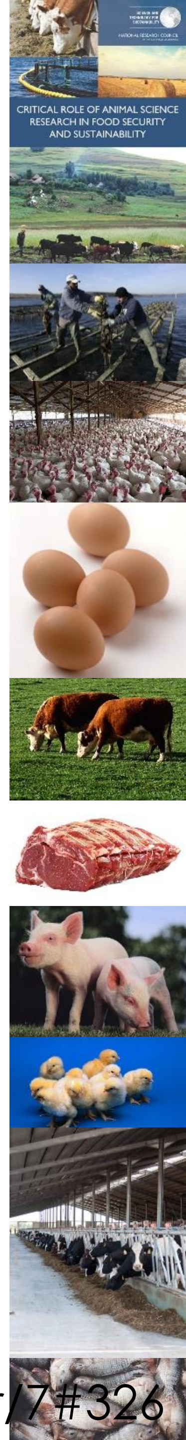
- In the area of *Capacity Building to Increase Diversity*:
  - The committee believes that paying attention to gender is not a matter of ideology but rather a matter of developmental effectiveness; incorporating gender issues more widely and systematically in agricultural research, development, and extension systems will contribute significantly to meeting the food needs of the future population or ensuring that productivity translates into the improved welfare of the poor.



Source: https://www.nap.edu/read/19000/chapter/7#326

Key recommendations from *Capacity Building and Infrastructure for Research in Food Security and Animal Sciences* chapter

- One priority for infrastructure for this area (*Partnerships for Research, Outreach, and Teaching to Leverage Resources*) includes:
  - Additional partnerships are needed to address animal agriculture research, teaching, and outreach to leverage dollar support. Ongoing engagement of partnerships among federal agencies (e.g., USDA, EPA, and NSF) and those that link animal health and public health, and public–private endeavors needs to be pursued.

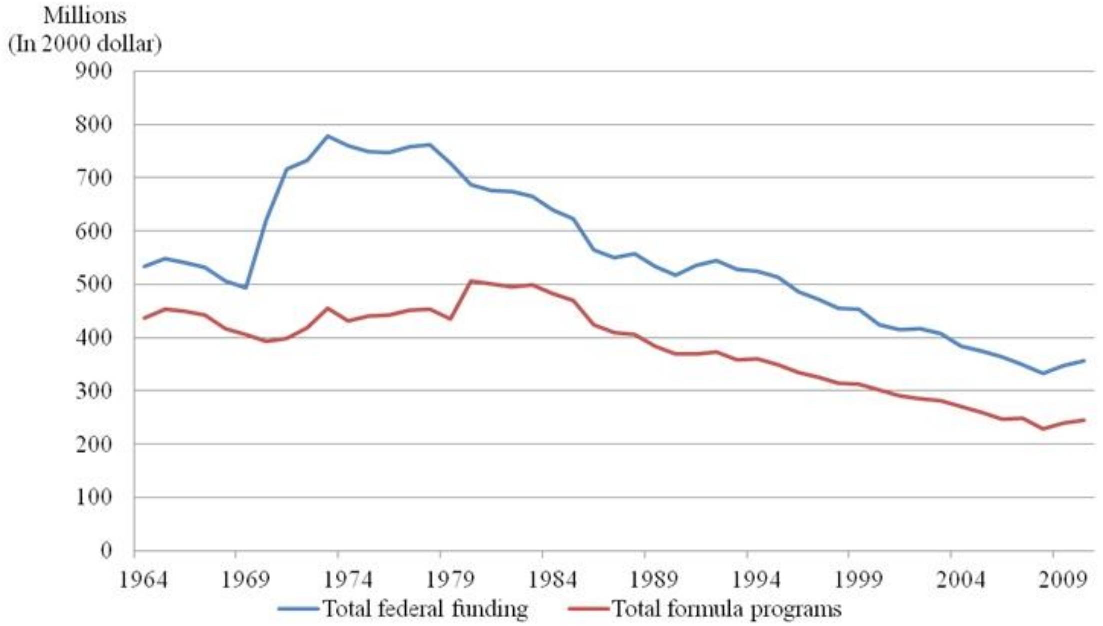


Source: https://www.nap.edu/read/19000/chapter/7#326

Federal funding trends in Cooperative Extension System

"Agricultural extension activities have a high rate of return, with literature estimates ranging from 16 to 110 percent. **Extension was estimated to contribute to 7.3 percent of annual agricultural productivity growth from 1949 to 2002 via improving farm production efficiencies**. The loss of extension capacity will impact the ability of CE not only to help animal agriculture address the upcoming challenges related to food production and food security nationally and globally, but to bridge the communication gap between producers and stakeholders about animal agriculture."

Figure 1. Historical Trend of NIFA Extension Activities Appropriation (in 2000 dollars)

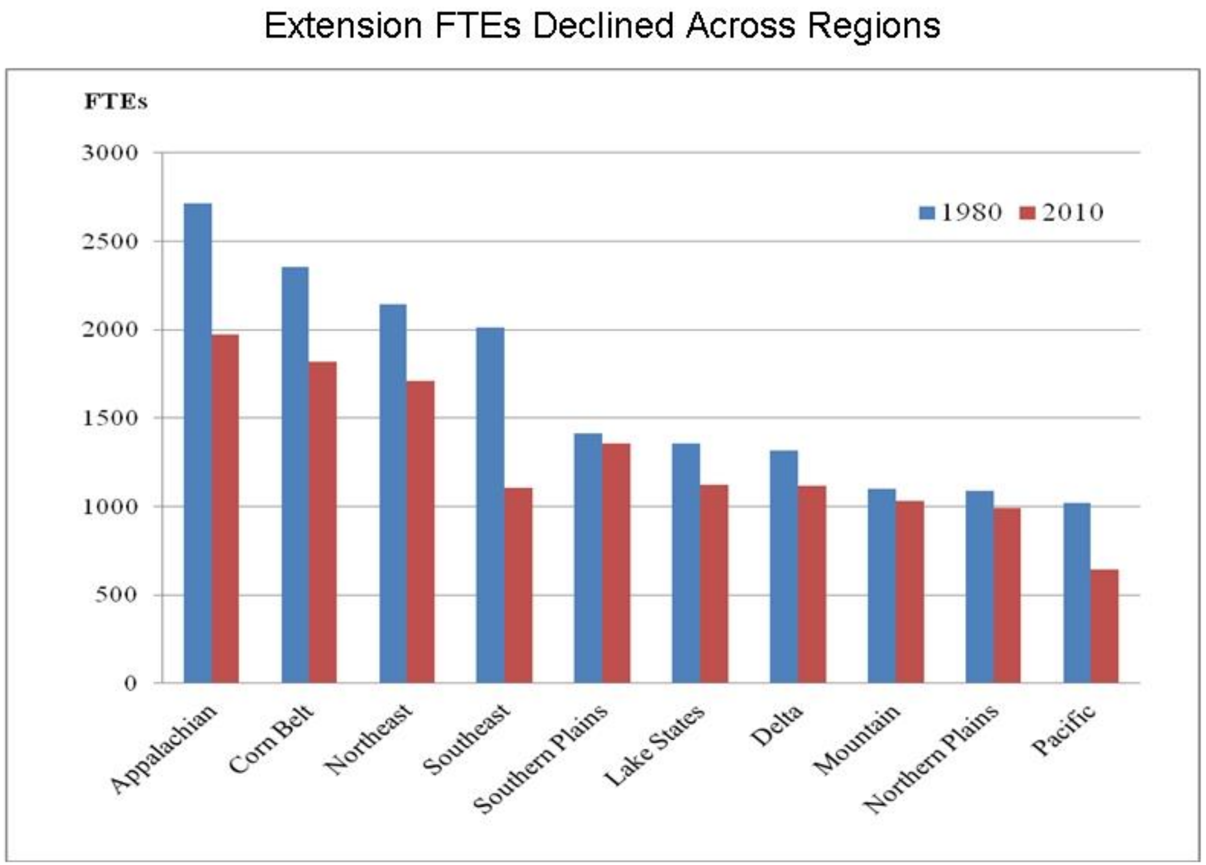


Notes: Total formula programs include Smith-Lever 3b&c, and 1890's and Tuskegee Funding is in real terms deflated by ERS' Agricultural Research Deflator (in 2000 dollar) following methodology by Pardey, Craig, and Hallaway (1989).

Source: Data is drawn from Extension activities appropriation history provided by USDA, Cooperative State Research, Education, and Extension Service (CSREES) for years 1965-2000, and USDA-National Institute of Food and Agriculture (NIFA) for years 2000-2010.

Sources: http://www.choicesmagazine.org/choices-magazine/submitted-articles/cooperative-extension-system-trends-and-economic-impacts-on-us-agriculture
https://www.nap.edu/read/19000/chapter/7#325

Trends in Cooperative Extension full-time equivalents across regions, 1980 - 2010



Note: Production regions are defined as the Northeast includes NH, PA, ME, MD, RI, MA, DE, CT, VT, NY, NJ; Lake States includes MN, MI, WI; Corn Belt includes OH, IA, MO, IN, IL; Appalachian includes WV, TN, NC, VA, KY; Southeast includes SC, AL, GA, FL; Delta includes LA, AR, MS; Northern Plains includes ND, SD, KS, NE; Southern Plains includes TX, OK; Mountain includes CO, UT, AZ, NM, WY, NV, ID, MT; and Pacific includes OR, CA, WA.
Source: Authors' classification based on USDA, NIFA, various years a.

Source: http://www.choicesmagazine.org/choices-magazine/submitted-articles/cooperative-extension-system-trends-and-economic-impacts-on-us-agriculture

Animal science is a popular undergraduate major

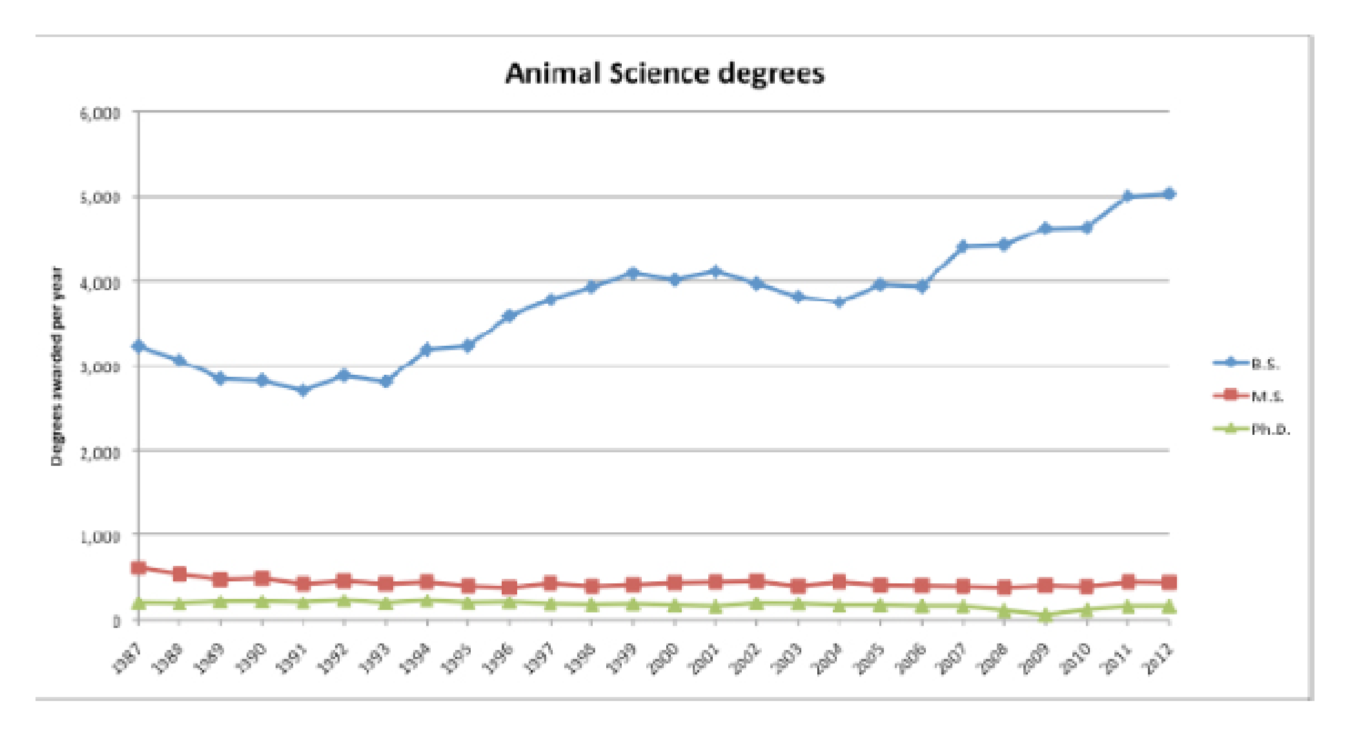


FIGURE 5-5 Number of B.S., M.S., and Ph.D. degrees awarded over a 25-year period.

SOURCE: Knapp, 2014. Summary of Animal Science degree data prepared for the National Research Council.

Source: https://www.nap.edu/read/19000/chapter/7#328

The number of M.S. and Ph.D. degrees conferred has declined over time

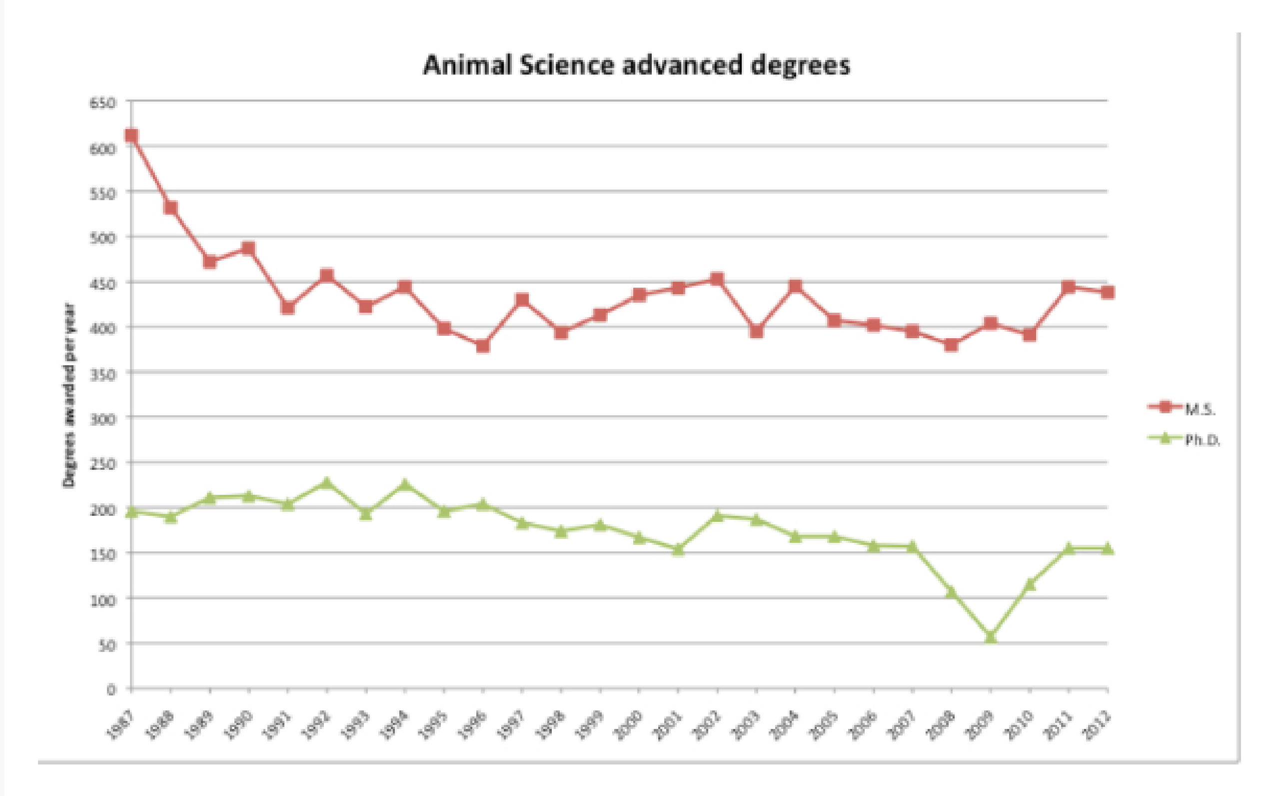


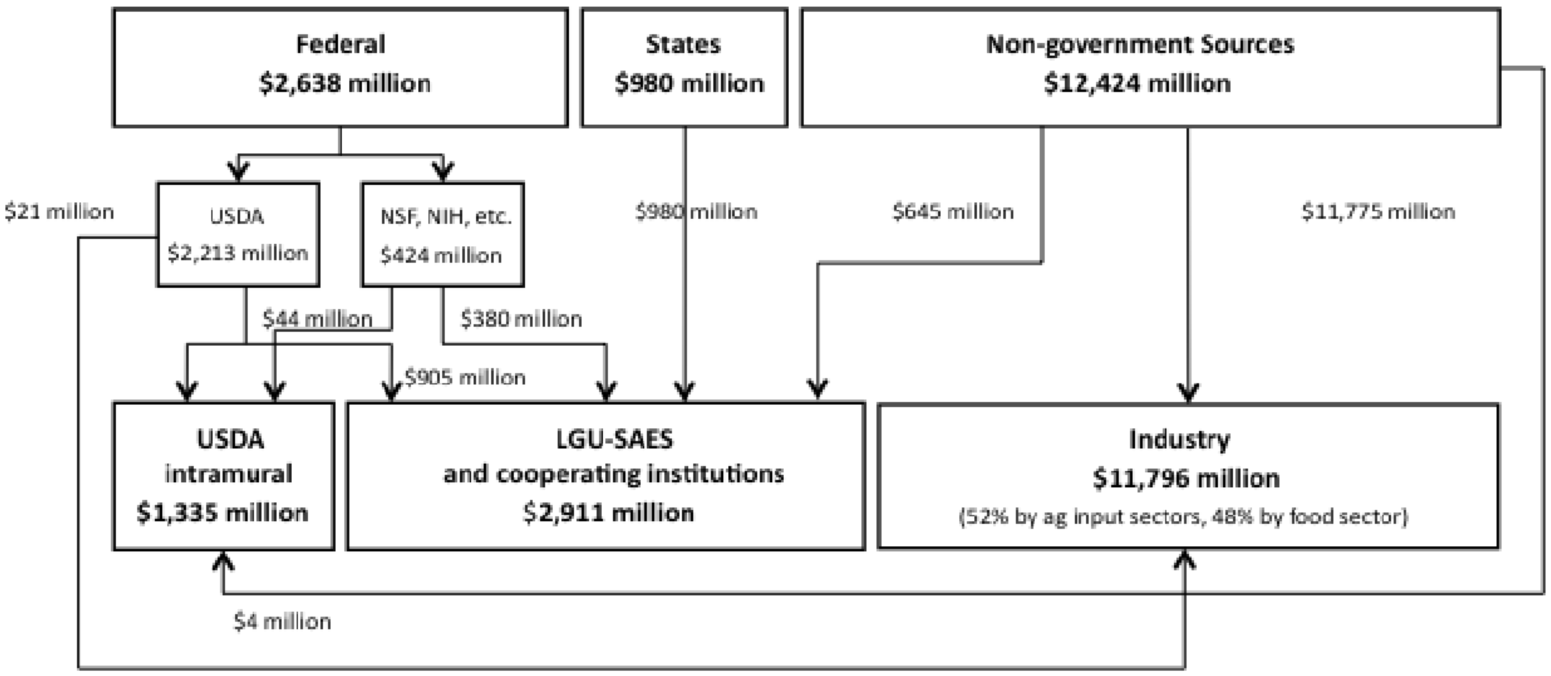
FIGURE 5-6 Trend over time in the number of M.S. and Ph.D. degrees awarded in animal sciences.
SOURCE: Knapp, 2014. Summary of Animal Science degree data prepared for the National Research Council.

Source: https://www.nap.edu/read/19000/chapter/7#328

Funders and performers of U.S. food and agricultural research, 2014

Figure 1.6.1

Funders and performers of U.S. food and agricultural research in 2014 (in 2012 dollars)



Note: All estimates are adjusted for inflation and expressed in 2012 dollars using the ERS research deflator. NSF = National Science Foundation; NIH = National Institutes of Health. LGU-SAES = Land Grant Universities/State Agricultural Experiment Stations.
Source: USDA, Economic Research Service based on data from the Current Research Information System; USDA, National Institute of Food and Agriculture; National Science Foundation Federal Funds for Research and Development; and Fuglie (2016).

Source: https://www.ers.usda.gov/webdocs/publications/93026/eib-208.pdf?v=9435.6

Strong rate of return for public funding of agricultural research & particularly for formula funds

"Hatch formula funding has a larger impact on agricultural productivity than federal competitive grant funding, and are allocation of Hatch formula funds to competitive grant funding would lower agricultural productivity."

Furthermore, from a cost–benefit perspective, our study shows that the social marginal **annualized real rate of return to public resources invested in agricultural research is 49–62%,** and to public agricultural extension, the rate is even larger

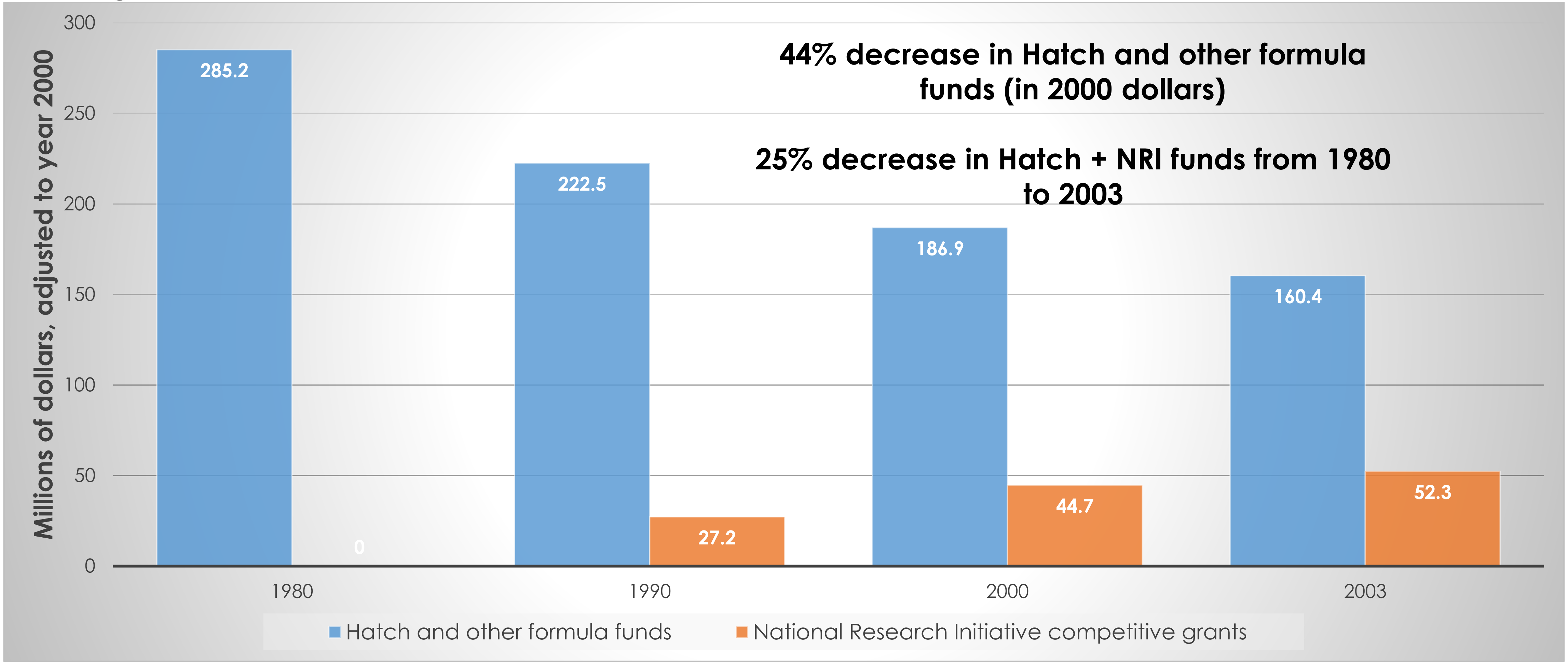
Do Formula or Competitive Grant Funds Have Greater Impacts on State Agricultural Productivity?

Wallace E. Huffman and Robert E. Evenson

This article examines the impact of public agricultural research and extension on agricultural total factor productivity at the state level. The objective is to establish whether federal formula or competitive grant funding of agricultural research has a greater impact on state agricultural productivity. A pooled cross-section time-series model of agricultural productivity is fitted to annual data for forty-eight contiguous states over 1970–1999. Our results show that public agricultural research and agricultural extension have statistically significant positive impacts on state agricultural productivity. In addition, Hatch formula funding has a larger impact on agricultural productivity than federal competitive grant funding, and a reallocation of Hatch formula funds to competitive grant funding would lower agricultural productivity. This seems unlikely to be a socially optimal policy. Furthermore, from a cost–benefit perspective, our study shows that the social marginal annualized real rate of return to public resources invested in agricultural research is 49–62%, and to public agricultural extension, the rate is even larger.

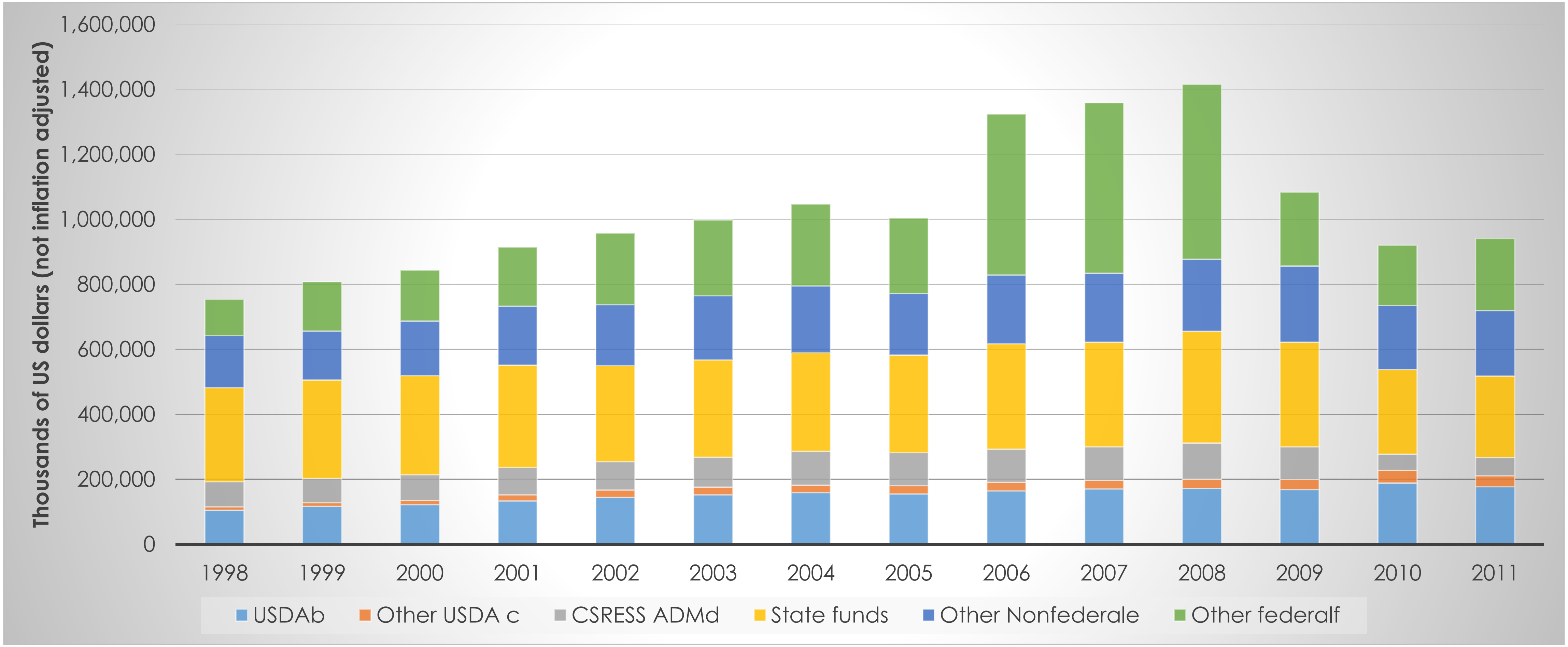
Key words: agricultural productivity, agricultural research funding, competitive grants, extension, formula funding, Hatch funds, pooled cross-section time-series model, productivity analysis, research, states.

USDA funds for Hatch and other formula funds and USDA competitive grants for agricultural research,1980 – 2003



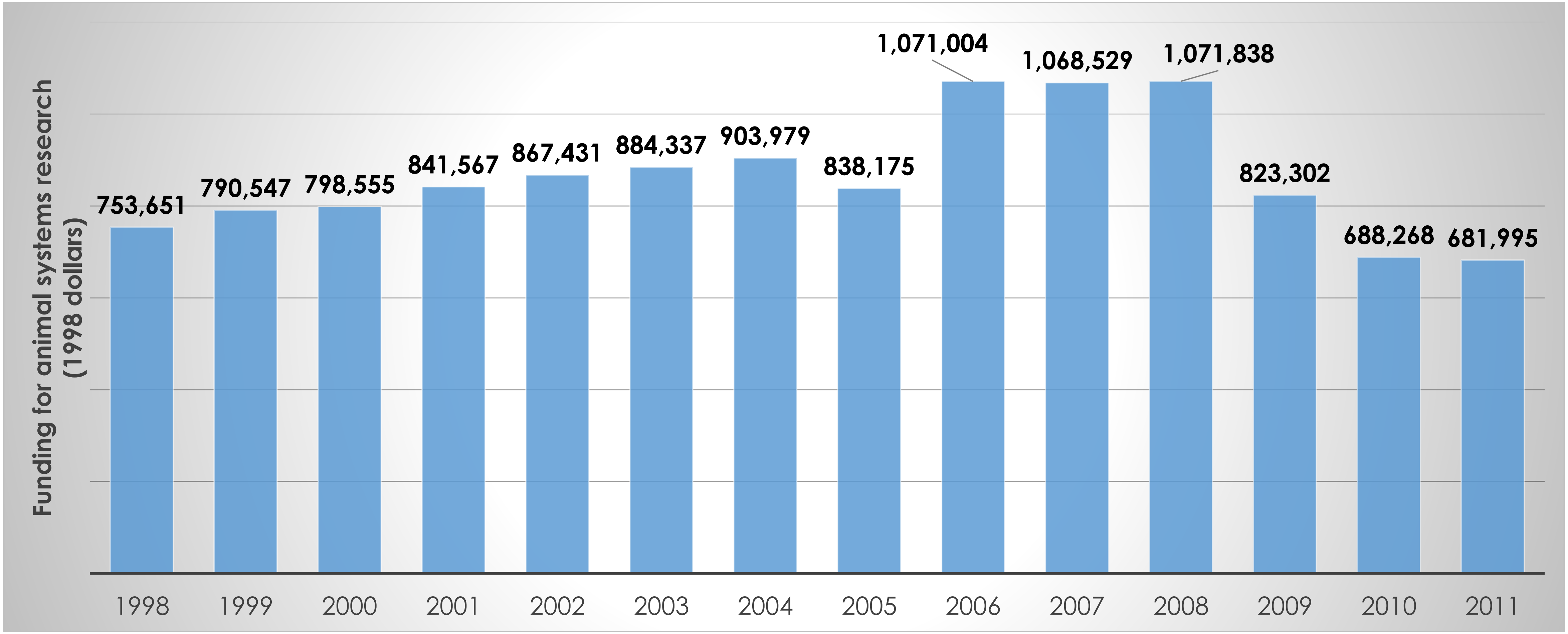
Source: Huffman and Evenson, Amer. J. Agr. Econ. 88(4) Nov. 2006: 783-798.

Trends in animal systems research funds by source (not adjusted for inflation), 1998 - 2011



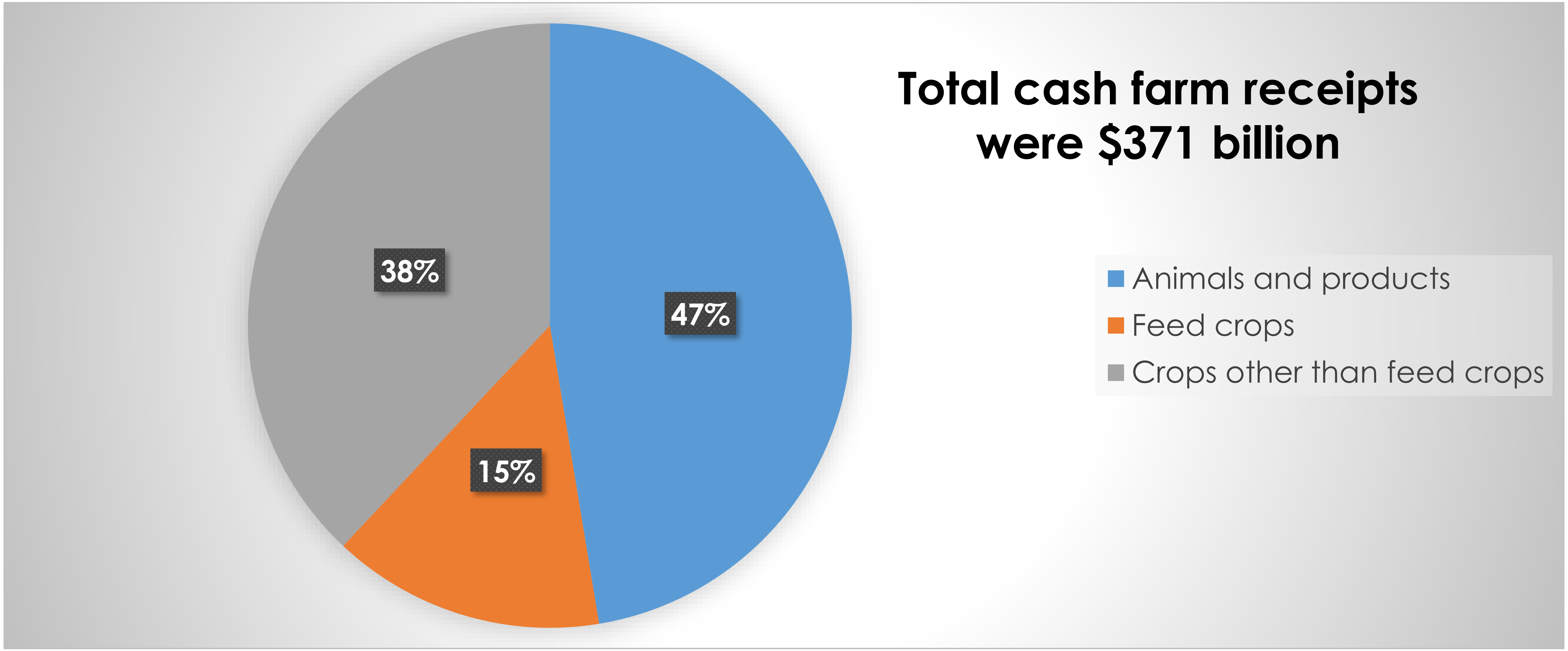
Source: https://www.nap.edu/read/19000/chapter/7#315

Trends in animal systems research funds* (real 1998 dollars)



*Current Research Information System (CRIS) reporting categories RPA 301-315 (reproduction, nutrition, genetics, animal genome, animal physiology, environmental stress, animal production and management, improved animal products, animal disease, external parasites and pests, internal parasites, toxicology, and animal welfare).

2017 cash farm receipts in the United States by commodity, thousands of dollars



Source: https://data.ers.usda.gov/reports.aspx?ID=17845

Animal-source foods are significant contributors to protein and essential micronutrients in the US food supply

"The higher energy intake to achieve adequate protein intake from plant foods needs to be considered, especially those with lower energy intakes and specific nutrient needs such as older adults… In addition, the bioavailability of some nutrients in plant-based dietary patterns or food sources of protein is generally lower than that of animal-based patterns, which needs consideration"

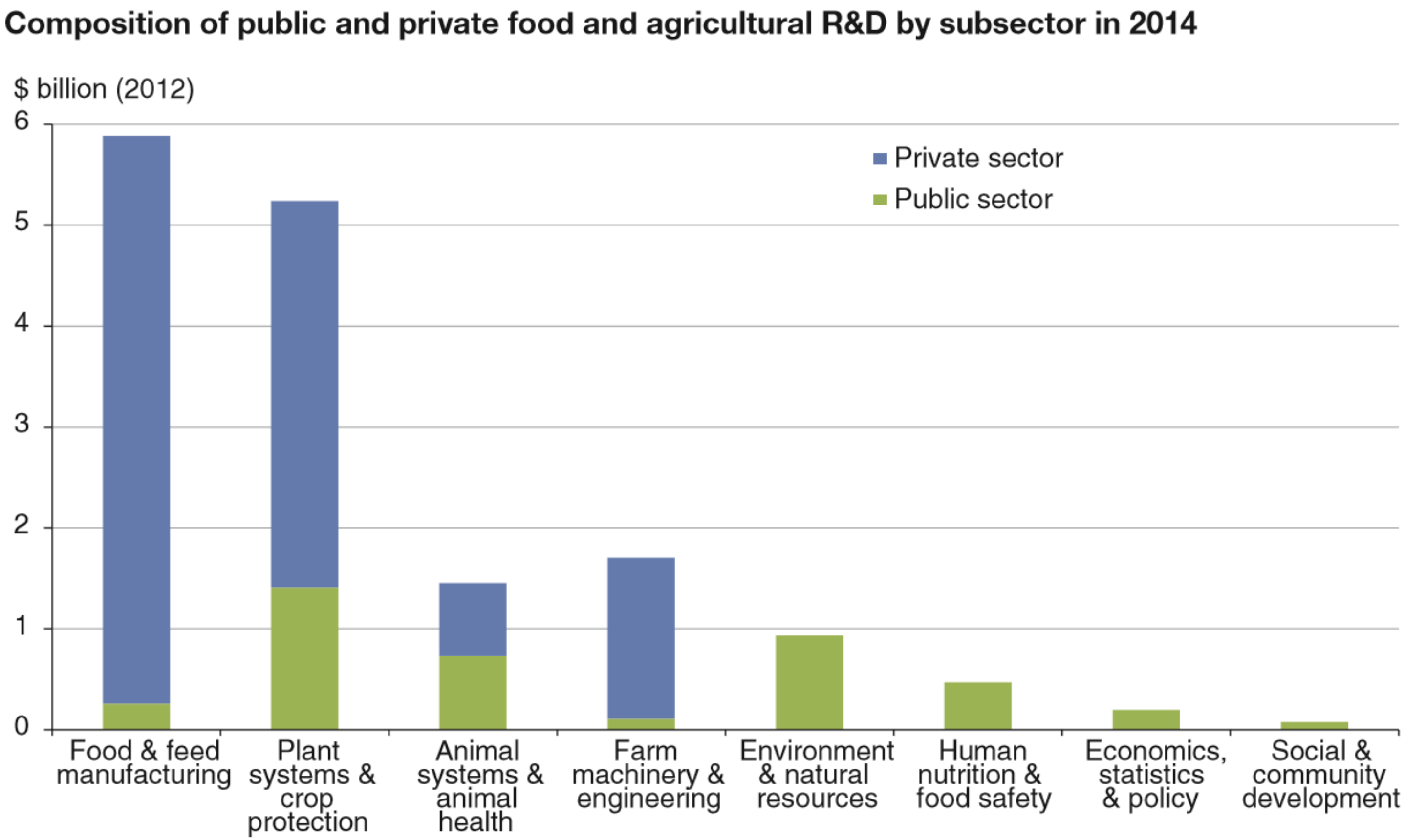
Table 2. Contribution of major animal-source food groups to selected nutrients in the U.S. food supply (2006) (USDA–ERS 2012a)

Nutrient	Meat, Poultry, and Fish (%)	Dairy Products (%)	Eggs (%)	Total (%)
Energy (calories)	13.4	8.6	1.4	23.4
Protein	40.3	19.0	4.0	63.3
Saturated fat	22.5	20.8	2.0	45.3
Vitamin A	32.0	17.5	6.4	55.9
Vitamin B_6	36.1	7.2	1.9	45.2
Vitamin B_{12}	75.5	19.9	4.5	99.9
Thiamin	18.2	4.7	0.7	23.6
Riboflavin	17.5	25.7	6.3	49.5
Niacin	36.6	1.1	0.1	37.8
Zinc	37.2	16.3	2.6	56.1

Phillips et al., 2015. Am. J. Clin. Nutr. 101(Suppl):1346S-52S

Source: CAST, 2013

Plant systems and crop protection research, both public & private, exceeds animal systems research



Note: Data are adjusted for inflation and expressed in 2012 dollars.
Source: USDA, Economic Research Service using data from USDA, National Institute of Food and Agriculture (NIFA), Research, Education, and Economics Information System; and Fuglie (2016).

Economic Studies Find High Social Returns to Investments in Agricultural Research

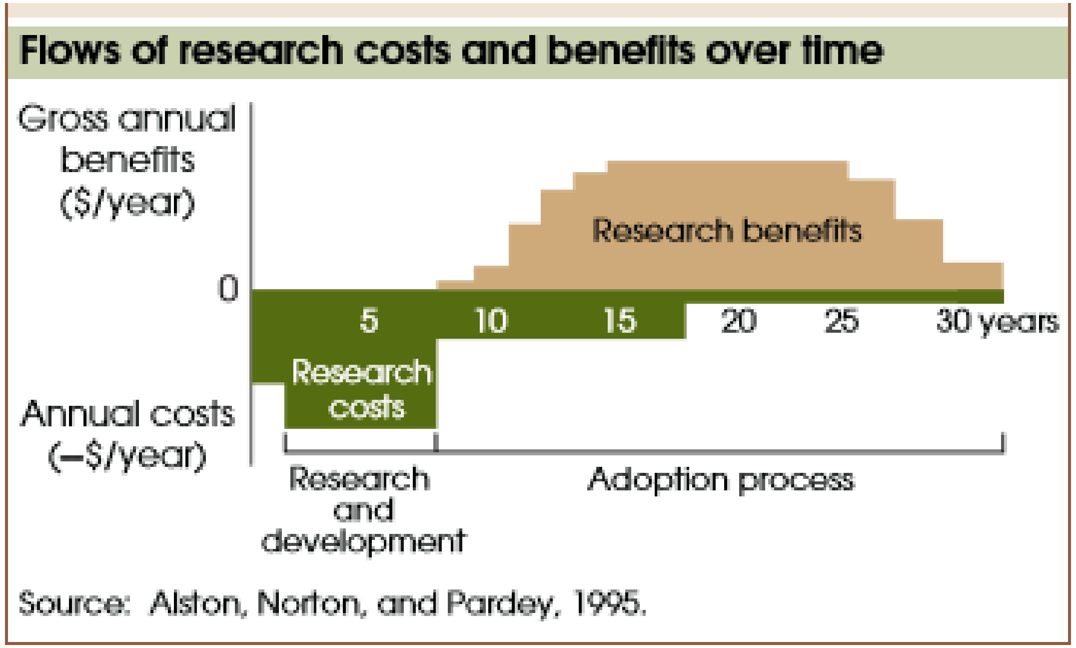


Table 1–Summary estimates of the rate of return to U.S. agricultural research

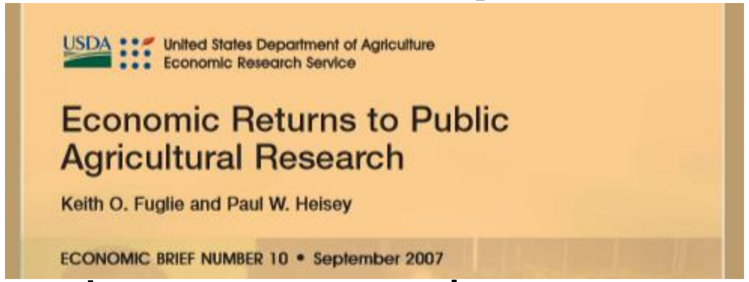
Item	Studies, 1965-2005	Mean estimate	Median estimate
Social rate of returns to public agricultural research	35	53	45
Social rate of returns to private agricultural research	4	45	45

Source: USDA, ERS, using data from Huffman and Evenson, 2006, and Fuglie et al.,1996.

Each $1 spent on agricultural research returns approximately $10 in benefits to the economy

Source: https://www.nist.gov/sites/default/files/documents/2017/05/09/Economic-Returns-to-Public-Agricultural-Research-2007.pdf

Key conclusions of Fuglie and Heisey (2007)


USDA United States Department of Agriculture
Economic Research Service

Economic Returns to Public Agricultural Research

Keith O. Fuglie and Paul W. Heisey

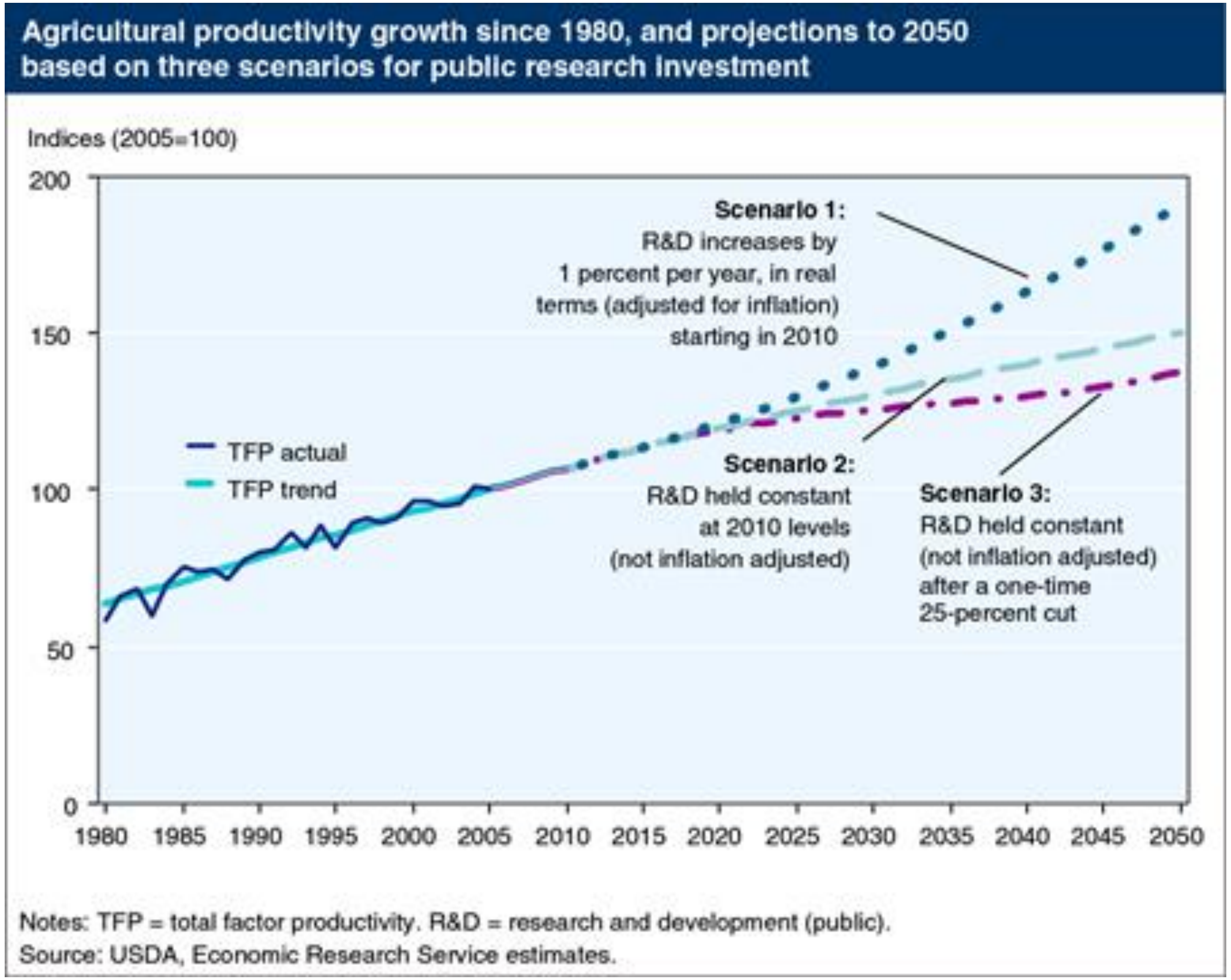
ECONOMIC BRIEF NUMBER 10 • September 2007

- Returns to research have been high for most crop and livestock commodities
- There appear to be significant social returns to private agricultural research
- Agricultural research generates long-term benefits
- Agricultural knowledge or research “spillovers” across State and national boundaries
  - Spillovers from **livestock research are generally greater than spillovers from crop research** because livestock production is less constrain by agro-ecological factors like soil and climate

Source: https://www.nist.gov/sites/default/files/documents/2017/05/09/Economic-Returns-to-Public-Agricultural-Research-2007.pdf

Sustained public investment in research supports long run agricultural productivity growth

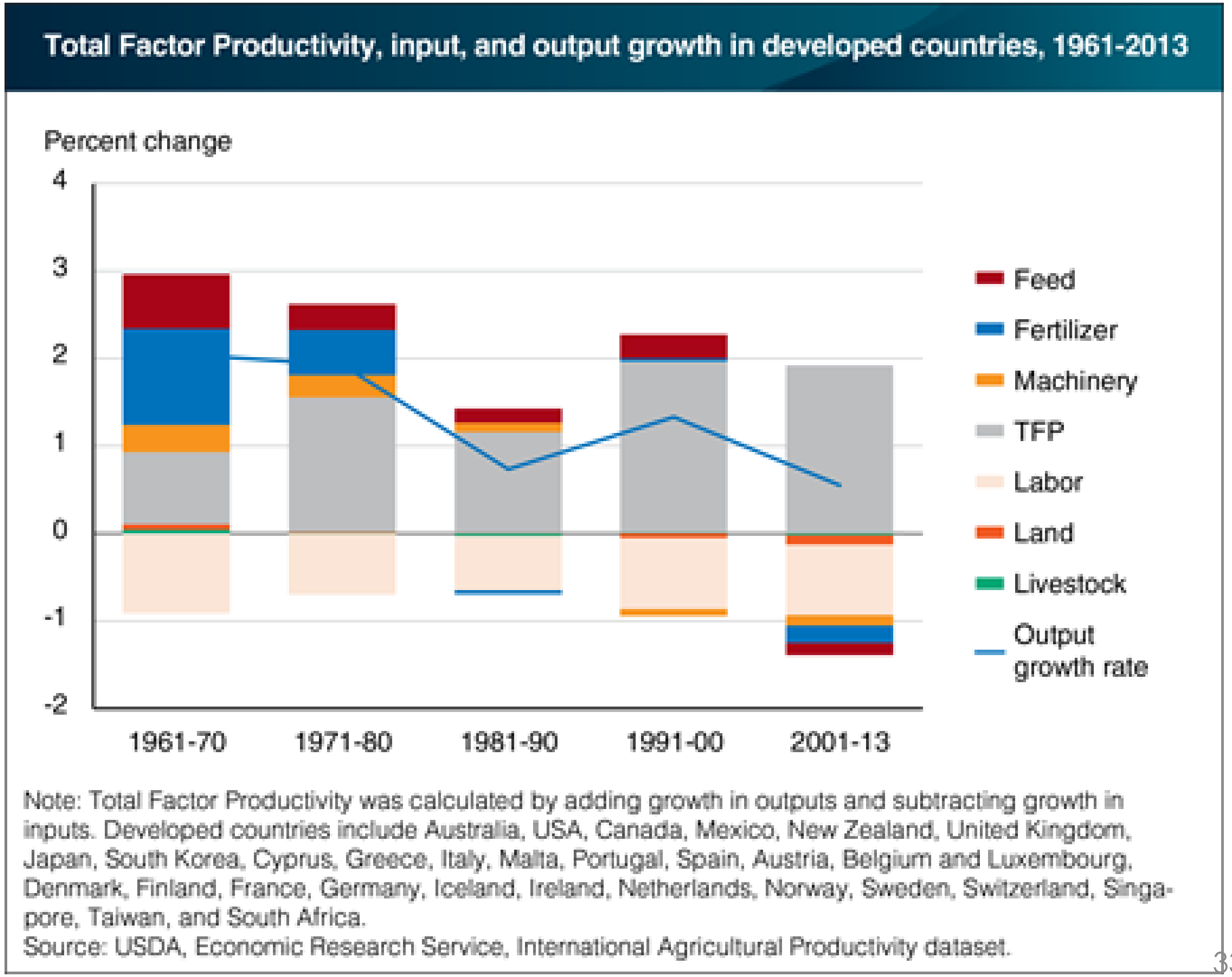
"Because R&D takes a long time to bear fruit, TFP growth differs little among the scenarios in the first decade, but then growth rates diverge. From 2010 to 2050, the annual rate of TFP growth is expected to increase/fall from the historical average of 1.42 percent per year to 1.46, 0.86, and 0.63 percent for Scenario 1, 2, and 3, respectively."



Source: https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=78466

Developed countries have increased outputs while slowing or decreasing input growth

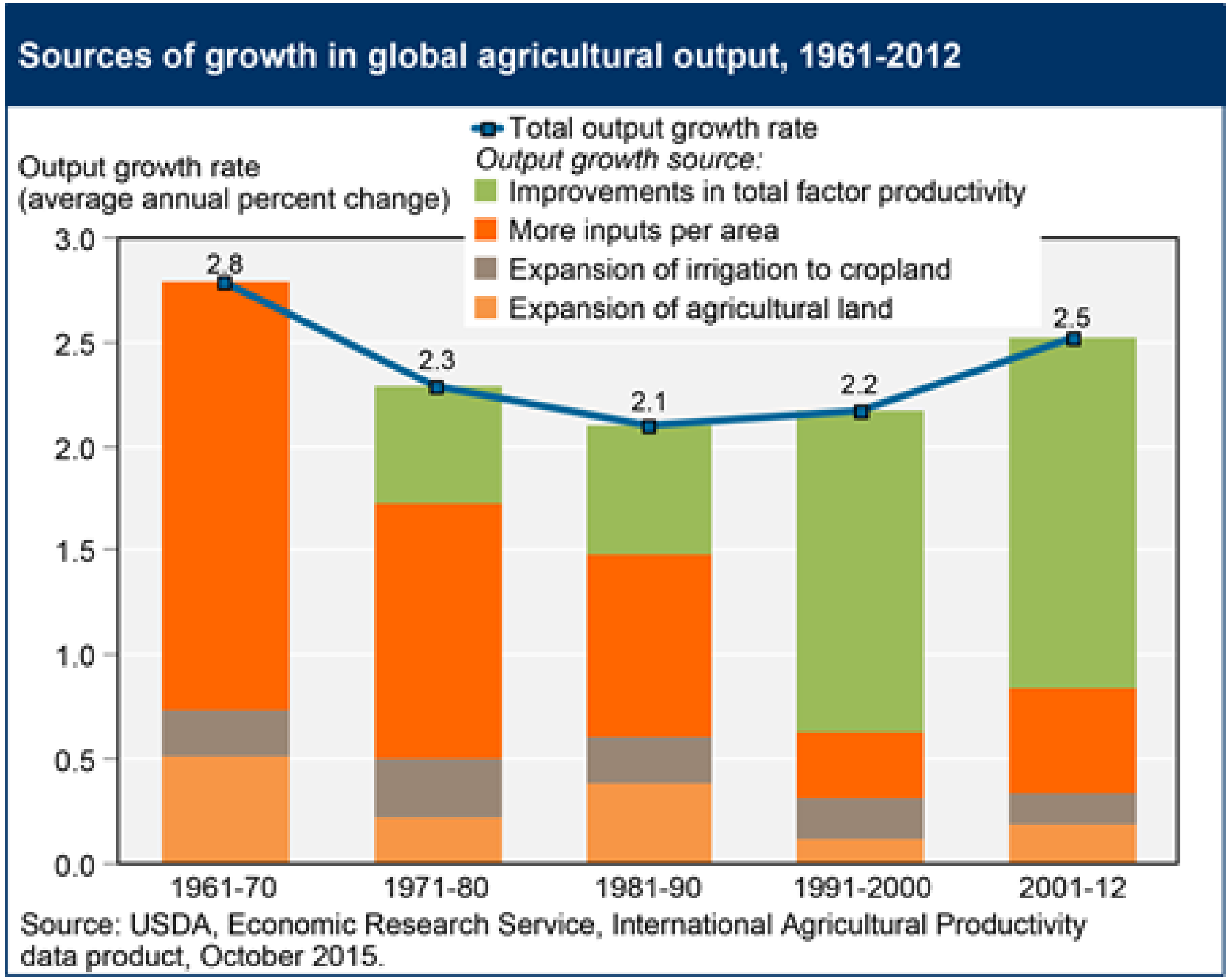
"Since the 1960s, agricultural TFP in developed countries has compensated for declining input use as output growth slowed. In more years, between 2001 and 2013, input growth in these countries declined across all factors of production for the first time."



Source: https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=80045

Increased productivity now the primary source of growth in world agricultural output

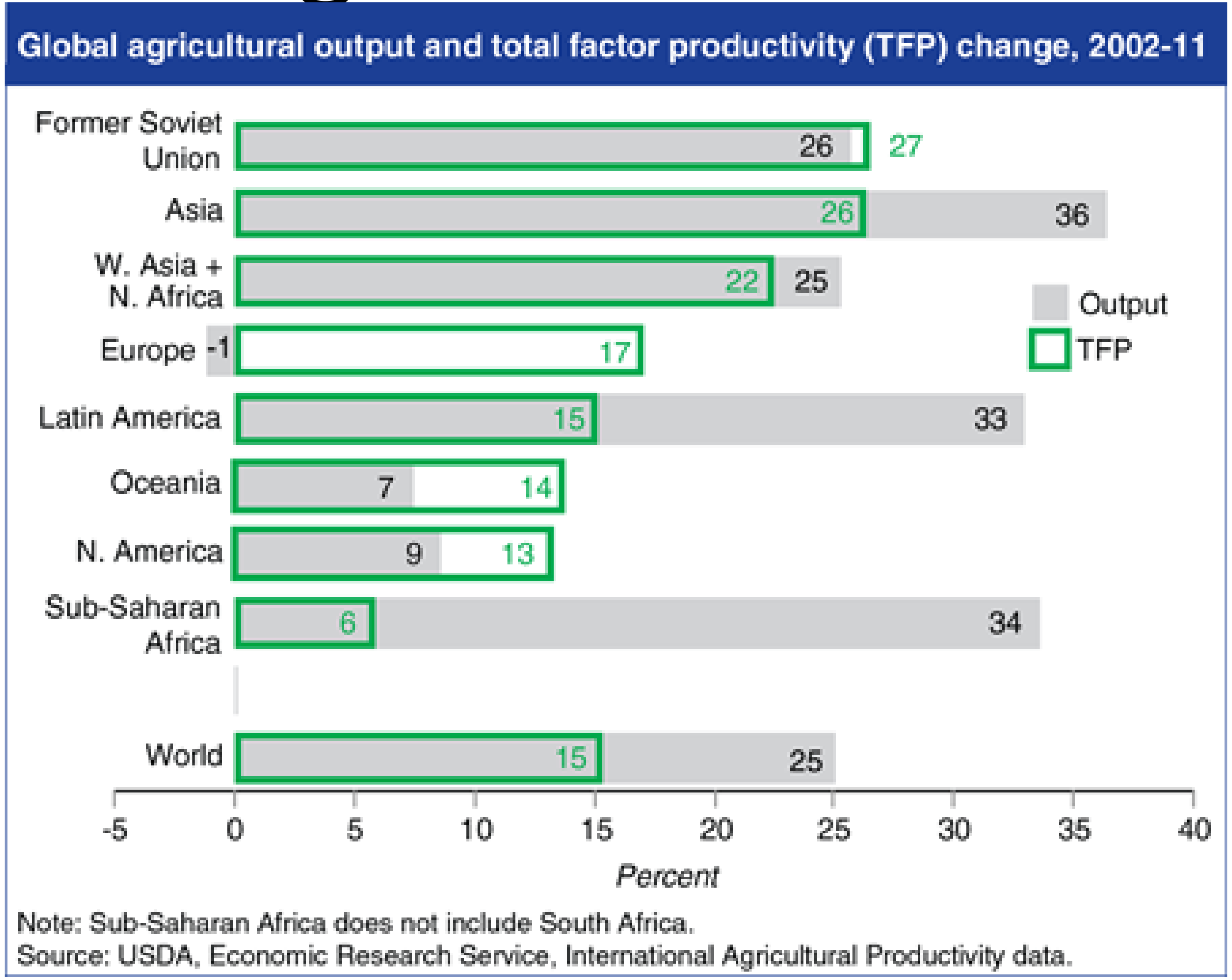
"In 2001-12, improvements in productivity—getting more output from existing resources—accounted for about two-thirds of the total growth in agricultural output worldwide, reflecting the use of new technology and changes in management practices by agricultural producers around the world."



Source: https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=78532

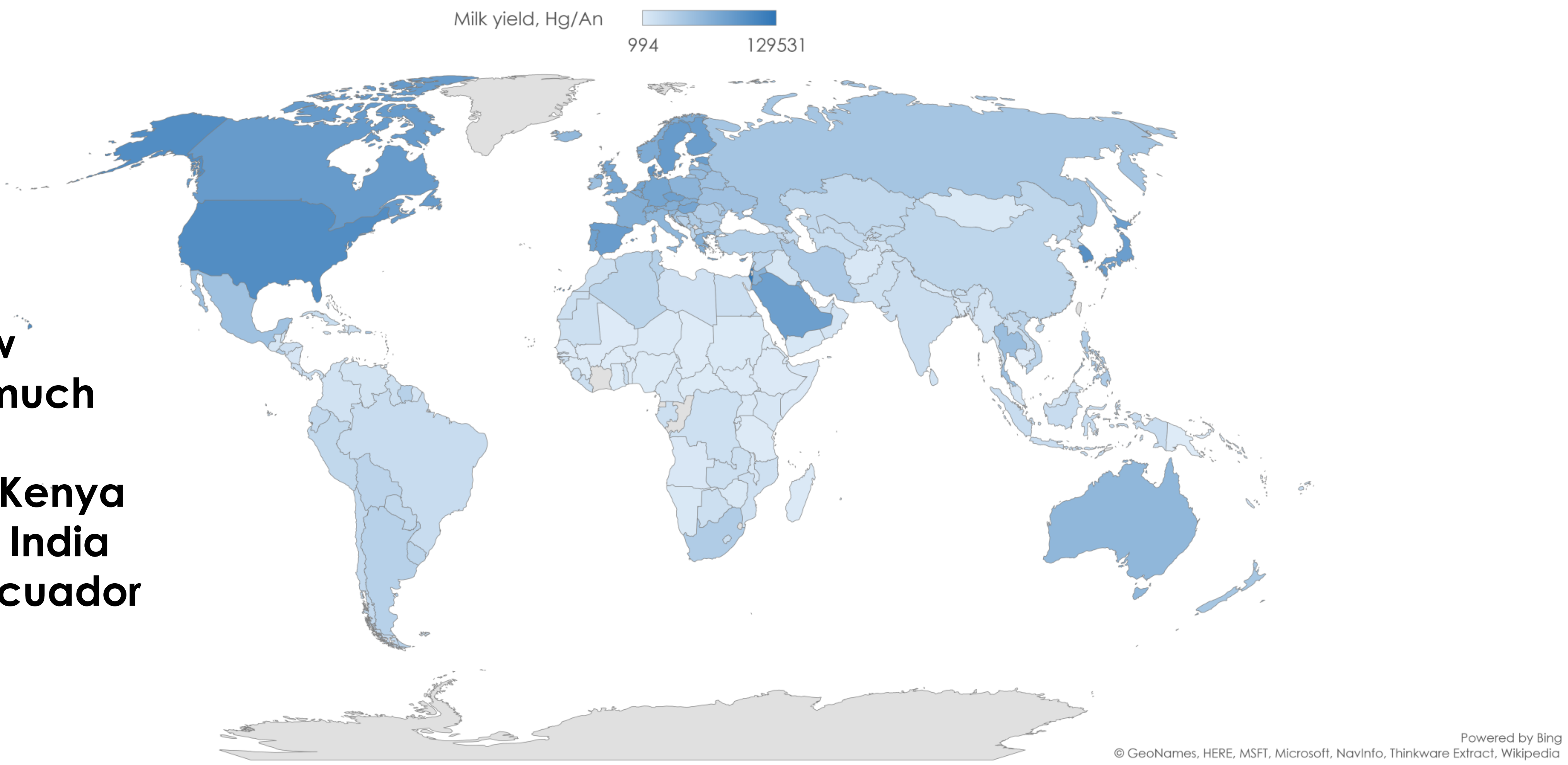
Agricultural productivity advances across all global regions

"Total factor productivity (TFP) in agriculture is an indicator of the rate of technical change based on a comprehensive measure of the amount of output attained from all of the land, labor, capital, and material resources employed in production. Over the 2002-2011 decade, agricultural TFP rose in every region of the world. In all regions **except Latin America and Sub-Saharan Africa**, gains in TFP accounted for most of the increase in agricultural output."



Source: https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=77749

Annual milk yield per cow in 2017



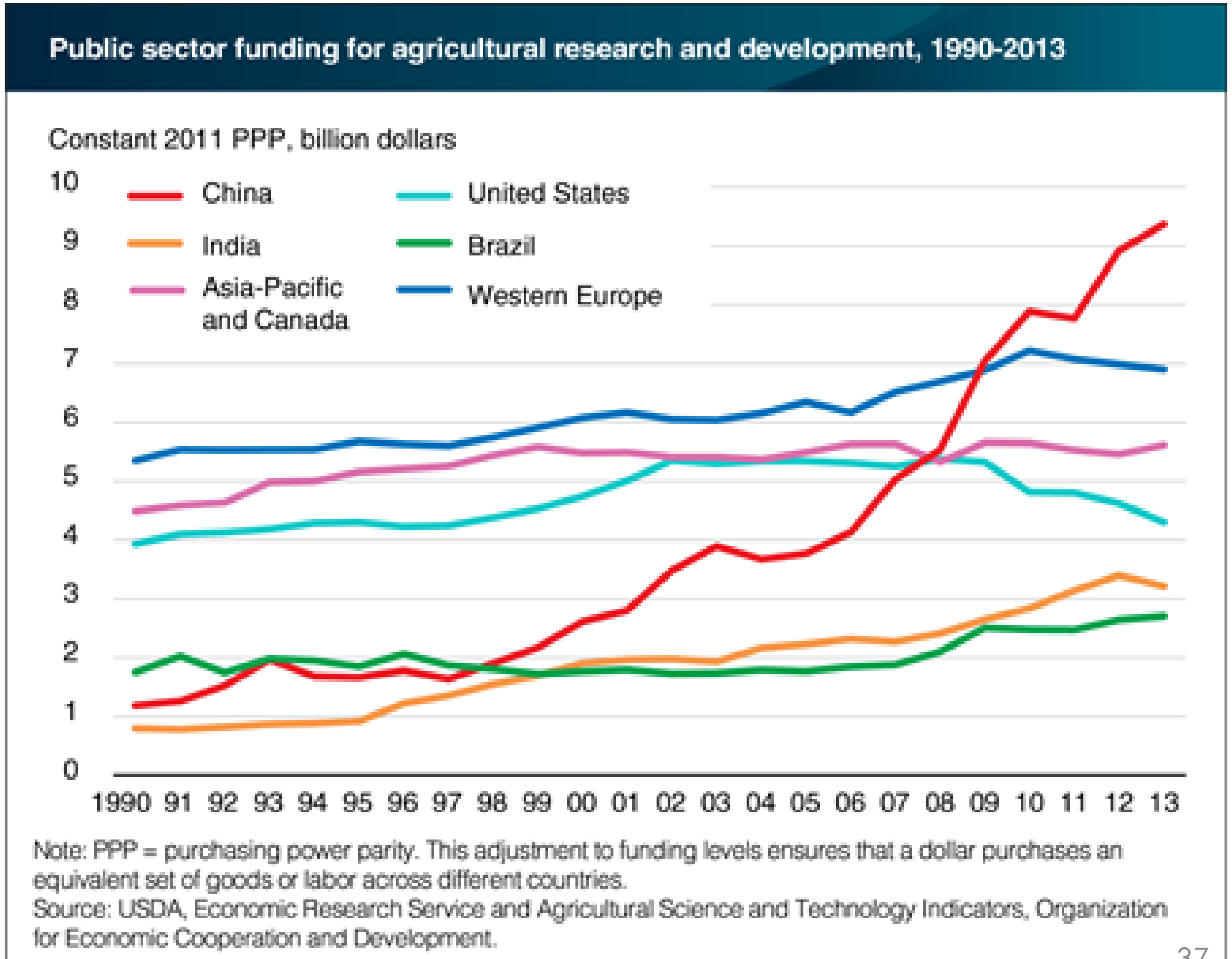
1 US dairy cow produces as much milk as:

- **16 cows in Kenya**
- **6.5 cows in India**
- **5 cows in Ecuador**

Source: UN FAOSTAT

Public sector funding trends for agriculture research & development

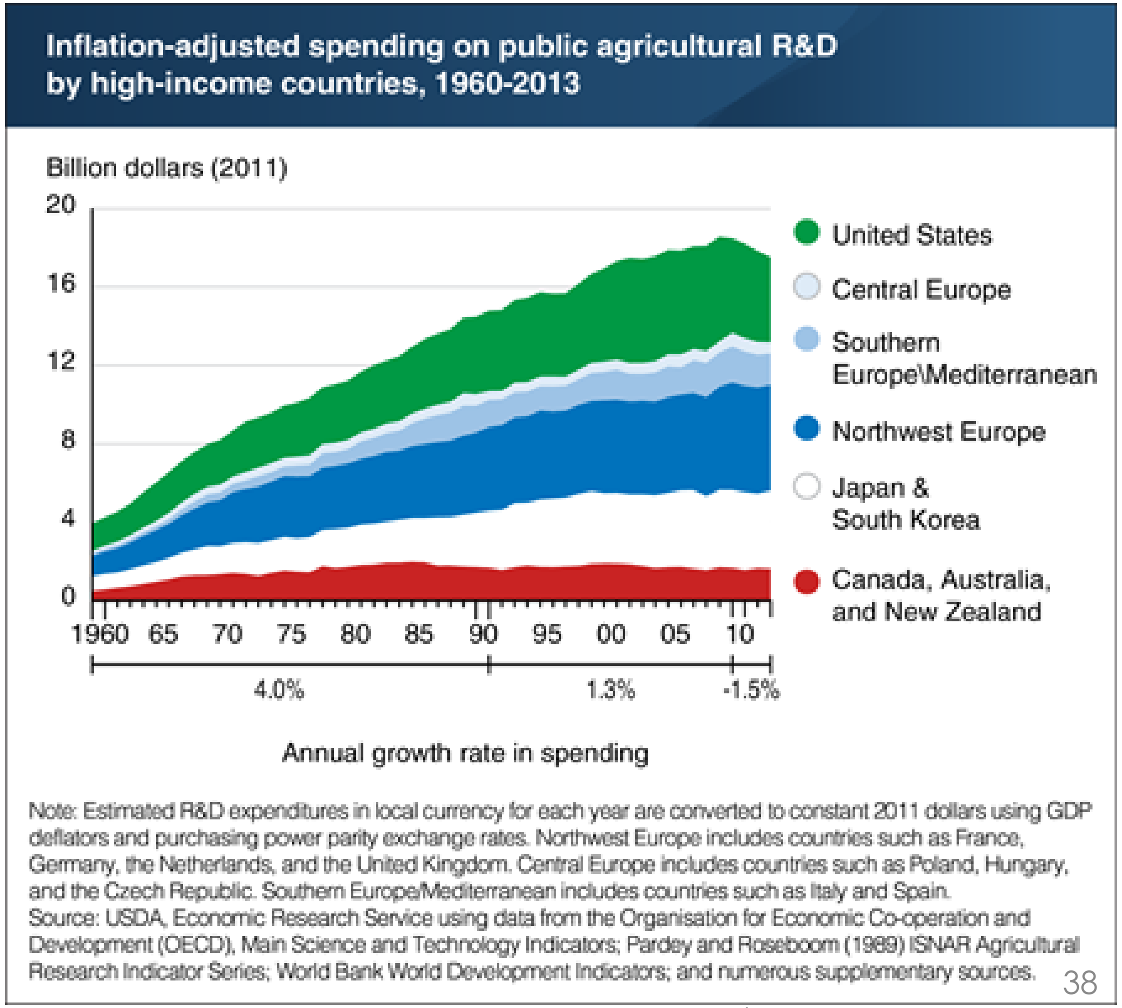
"Between 1990 and 2013, the U.S. share of spending among nations with major public agricultural R&D investments fell from about 23 to 13 percent. Chinese government spending on agricultural R&D rose nearly eightfold in real (inflation-adjusted) terms between 1990 and 2013, surpassing U.S. spending in 2008 and more than doubling it in 2013."



Source: https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=85038

Public spending on agricultural R&D by high-income countries grew after 1960, but is now in decline

"This decline in public R&D spending marked the first sustained fall in agricultural R&D investment by these countries in 50 years, and was most pronounced in the United States and Southern Europe. The United States continues to lead among high-income countries in public agricultural R&D spending, but the U.S. share of the total declined from 35 percent in 1960 to less than 25 percent by 2013."



Source: https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=89155

Africa Rice Center

Bioversity International

Center for International Forestry Research (CIFOR)

International Center for Agricultural Research in the Dry Areas (ICARDA)

International Center for Tropical Agriculture (CIAT)

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

International Food Policy Research Institute (IFPRI)

International Institute of Tropical Agriculture (IITA)

International Livestock Research Institute (ILRI)

International Maize and Wheat Improvement Center (CIMMYT)

International Potato Center (CIP)

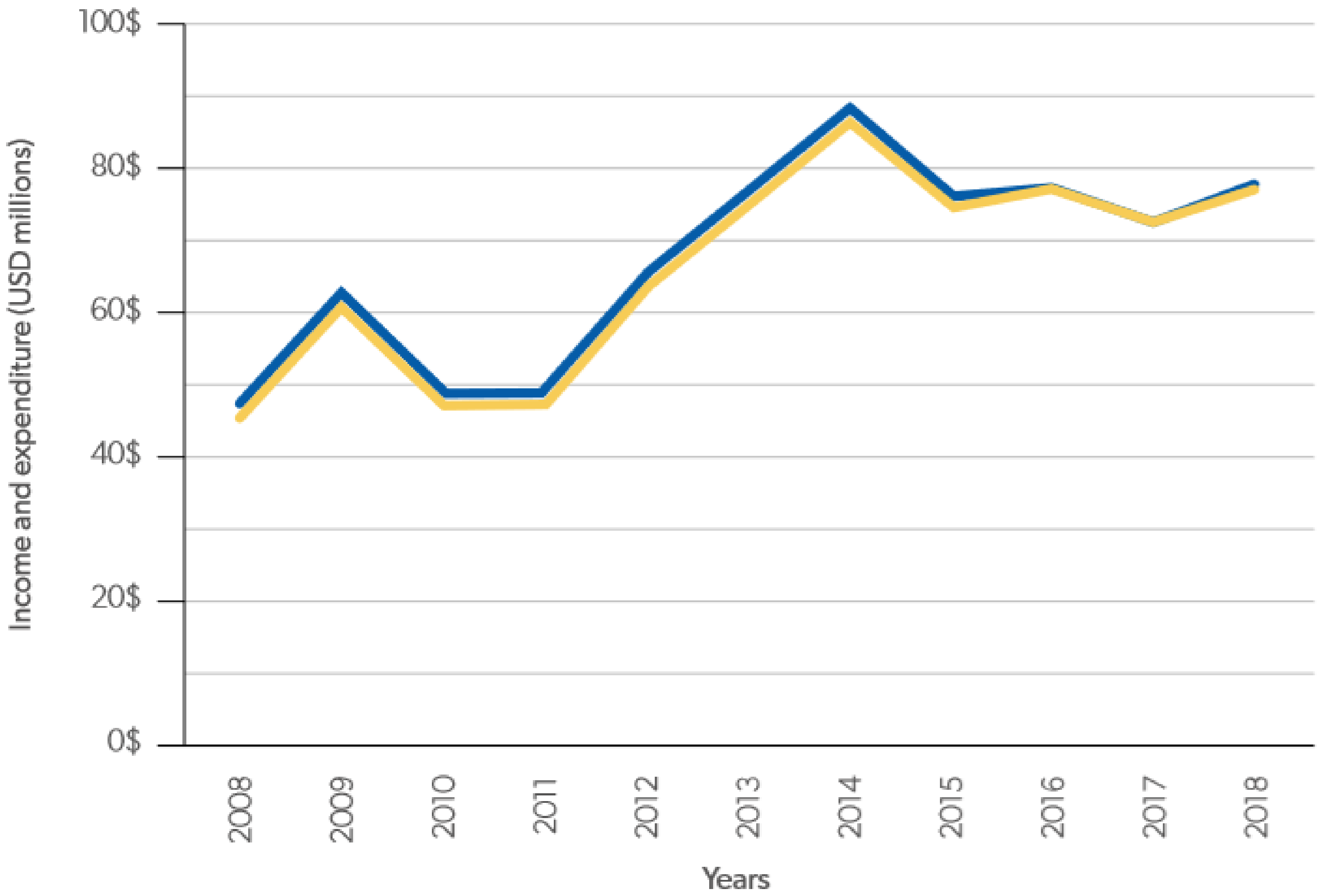
International Rice Research Institute (IRRI)

International Water Management Institute (IWMI)

World Agroforestry (ICRAF)

WorldFish

ILRI funding trends, 2008-2018

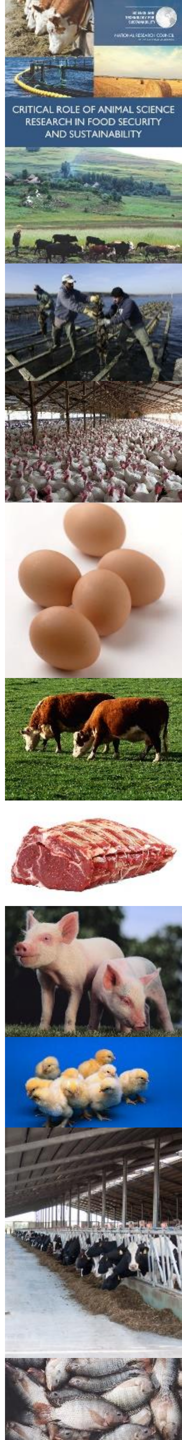


Source: ILRI 2018 financial statement

Source: https://www.ilri.org/publications/human-face-sustainable-livestock-development-annual-report-2018

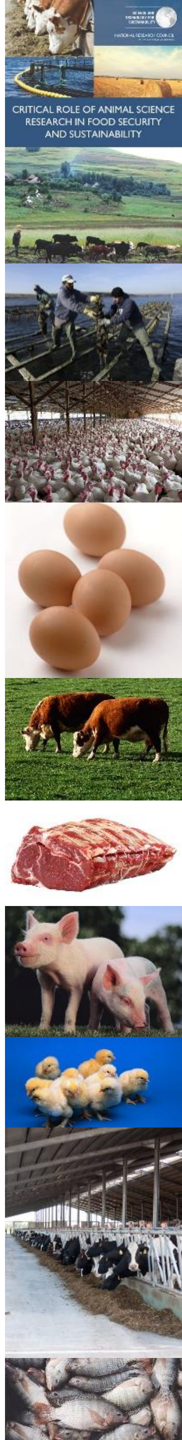
Conclusions

- Animal-source food demand will continue to increase for the next several decades
- Meeting increased demand via productivity, not major expansions of herds/flocks and expansions of agricultural land is critical
- Animal science research, education, and outreach are powerful tools to sustainably intensify production
  - Public & private funding both drive productivity
- Investments in animal science research have lagged compared to crops



Conclusions

- Investments in agriculture research in developed countries have stagnated or declined, investments in China, Brazil, and India have increased
- Yield gaps for animal agriculture are substantial
- Information gaps and lack of harmonization make analysis of the global impact of animal science research, education, and outreach difficult



Report is available for free download

- The National Academy Press (www.nap.edu)
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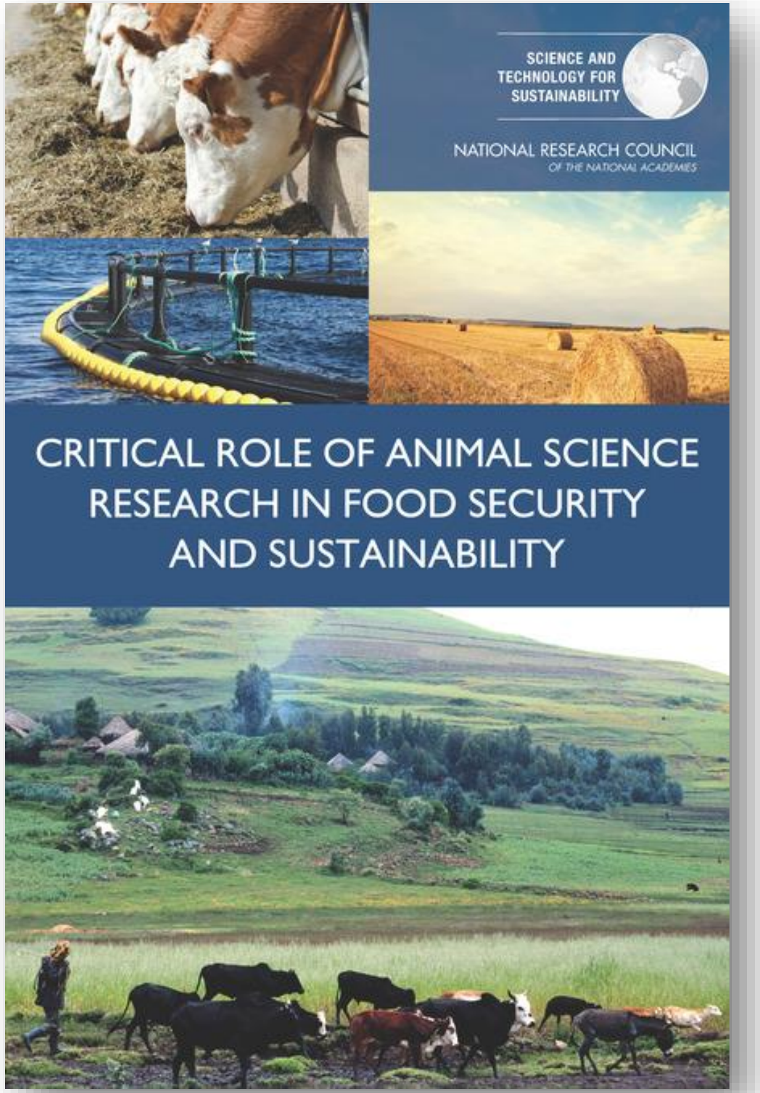

Thank you

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