Waste Not, Want Not

TRANSACTIONAL POLITICS, RESEARCH AND DEVELOPMENT FUNDING, AND THE US FARM BILL

Philip G. Pardey and Vincent H. Smith

NOVEMBER 2017

AGRICULTURAL POLICY IN DISARRAY

REFORMING THE FARM BILL

AMERICAN ENTERPRISE INSTITUTE

Executive Summary

In 1862 President Abraham Lincoln established the United States Department of Agriculture (USDA), which was conceived primarily as a federal government agency to promote innovation in US agriculture. As the 20th century dawned, more than half the department's total expenditures were directed to research and development (R&D) activites. As we approach the second decade of the 21st century, the department's spending priorities are now very different.

The share of USDA spending directed to food and agricultural R&D has fallen precipitously to just 1.6 percent of the agency's total budget in fiscal year 2017. As a consequence of these shifts in USDA spending priorities, the US has lost significant global R&D ground with large agricultural economies such as China, India, and Brazil, which are now collectively outspending the US by a large margin. Ostensibly temporary, emergency measures to shore up farm prices and US agricultural incomes introduced in the initial farm bills of the Great Depression and Dust Bowl era of the 1930s have grown inexorably over the subsequent decades, while government spending on R&D has stalled and is now declining.

The hard-nosed economic evidence is compelling. Failing to realign farm bill spending priorities and revive spending on (publicly performed) food and agricultural R&D will continue to compromise the productivity performance of US agriculture and undermine the sector's competitive position in growing but highly contested international markets. In contrast, realigning public funding for agricultural programs toward agricultural R&D, along with creative programs that increase incentives for private support of public interest focused on agricultural research, would benefit US agriculture, the US economy, and US consumers.

Waste Not, Want Not

TRANSACTIONAL POLITICS, RESEARCH AND DEVELOPMENT FUNDING, AND THE US FARM BILL

Philip G. Pardey and Vincent H. Smith

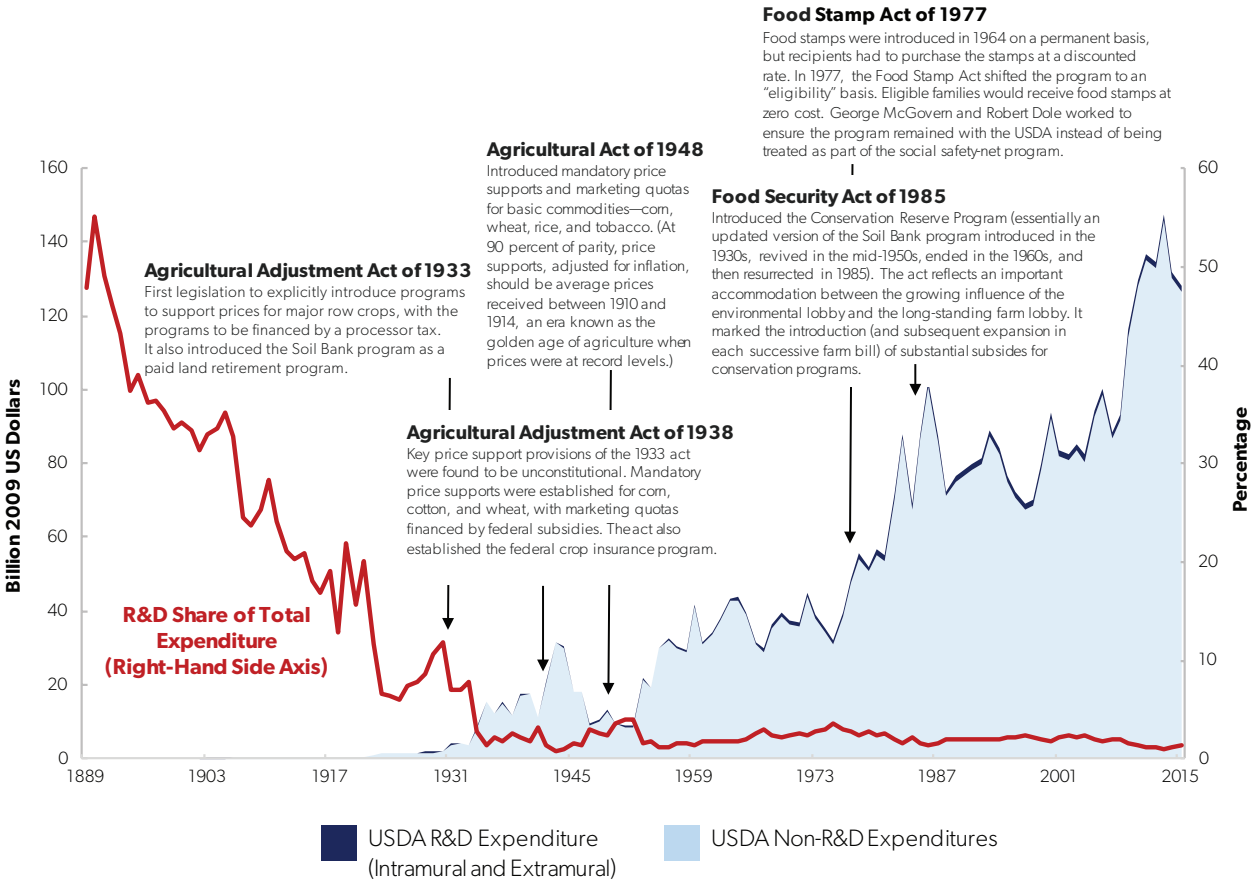
Doling out taxpayer dollars via the farm bill is transactional politics in its finest form, pitting the self-interests of agricultural lobbies against society's communitywide well-being. Many of the farm programs we know today have their roots in Franklin D. Roosevelt's 1930s New Deal legislation, which were emergency measures put in place to address the farm income implications of severely depressed farm prices during the Great Depression and as Dust Bowl droughts were ravaging parts of the United States. The Agriculture Adjustment Act of 1933 established the precedent for using federal resources to prop up farm prices and farm incomes, and the subsequent 1938 Farm Bill committed substantial federal funds for farm subsidy payments.[1]

The 1933 Farm Bill represented an explicit, radical expansion and shift in the US Department of Agriculture's (USDA) spending priorities, arguably the most dramatic change since President Abraham Lincoln signed an act to establish the Department of Agriculture in 1862 as the Civil War unfolded. The charge for the new fledgling federal department was "to acquire and to diffuse among the people of the United States useful information on subjects connected with agriculture in the most general and comprehensive sense of that word, and to procure, propagate, and distribute among the people new and valuable seeds and plants [Section 1]."[2]

The original research and innovation-centric vision of the USDA has been heavily diluted over the past 150 years. Figure 1 shows the USDA annual budget (in 2009 dollars) over the period 1889–2015 and the share of that budget allocated to research and development (R&D). In the early 1890s, expenditures on R&D accounted for more than half of total USDA spending. By 1929, at the onset of the Great Depression, that share had declined to about 11 percent as the USDA's extension, education, food safety, and other regulatory functions expanded.[3] However, subsequent to the passage of the 1933 and 1938 Agricultural Adjustment Acts, the share of the USDA budget allocated to research spending dropped sharply, averaging 4.6 percent in the 1930s. In the 1940s, R&D's share declined further to an average of around 2 percent, peaking at about 4 percent in 1952. Nevertheless, following the 1948 Agricultural Act, which introduced price supports at relatively high levels for some major commodities (e.g., wheat and corn), R&D's share dropped back to as little as 2 percent.

The USDA's budget rose sharply after the mid-1970s as the department's mission further expanded. In 1977, the Food Stamp Program, which is now known as the Supplemental Nutrition Assistance Program (SNAP), underwent major reforms, and participation in the progam jumped substantially. Then, through the 1985 Food Security Act, which in effect reintroduced a soil bank (now called the Conservation Reserve Program) and subsequent farm bills, spending on conservation programs was increased. The result was a further diminution of the share of USDA resources allocated

Figure 1. USDA Spending Priorities: From Promoting Productivity to Political Payments, 1889–2014



Note: Research spending represents intramural and extramural food and agricultural (exclusive of forestry) R&D spending by the USDA. Spending totals were deflated to 2009 prices using implicit gross domestic product (GDP) deflator from Louis Johnston and Samuel H. Williamson. See Louis Johnston and Samuel H. Williamson, "What Was the U.S. GDP Then?," MeasuringWorth, 2017, www.measuringworth.com/usgdp/.

Source: USDA spending was compiled from the US Treasury Department and the USDA reports. See US Treasury Department, Office of the Secretary, "Combined Statement of the Receipts and Disbursements Balances, etc., of the United States"; and US Department of Agriculture, *Budget Summary*, www.obpa.usda.gov/budsum/fy17budsum.pdf. R&D spending was compiled from the International Science and Technology Practice and Policy (InSTePP) Innovation Accounts version 3.5. See Philip G. Pardey and Jason M. Beddow, "Revitalizing Agricultural Research and Development to Sustain US Competitiveness," Farm Journal Foundation, February 28, 2017, www.farmersfeedingtheworld.org/assets/7/6/revitalizingagresearch_print.pdf.

to R&D, the department's original raison d'etre, to an average of less than 1.5 percent of its budget over the past decade.

The 19th and 20th centuries each had pivotal moments in terms of how federal funds would be spent on US agriculture. At some point, it will be time to revisit and realign USDA spending priorities to deal with 21st-century realities. With increasing concerns about trade deficits, the rate of growth of agricultural exports, the impact of US direct subsidies to farmers on US trade relations with other countries, access to overseas markets, and a decline in US agricultural productivity, is this the time to consider reallocating resources toward publicly funded R&D? Or does the near "rounding error" that, at about $20 billion a year, farm subsidies represent in an overall federal

government budget of $3.65 trillion (about 0.5 percent) once again spare that part of farm bill spending from any serious scrutiny?

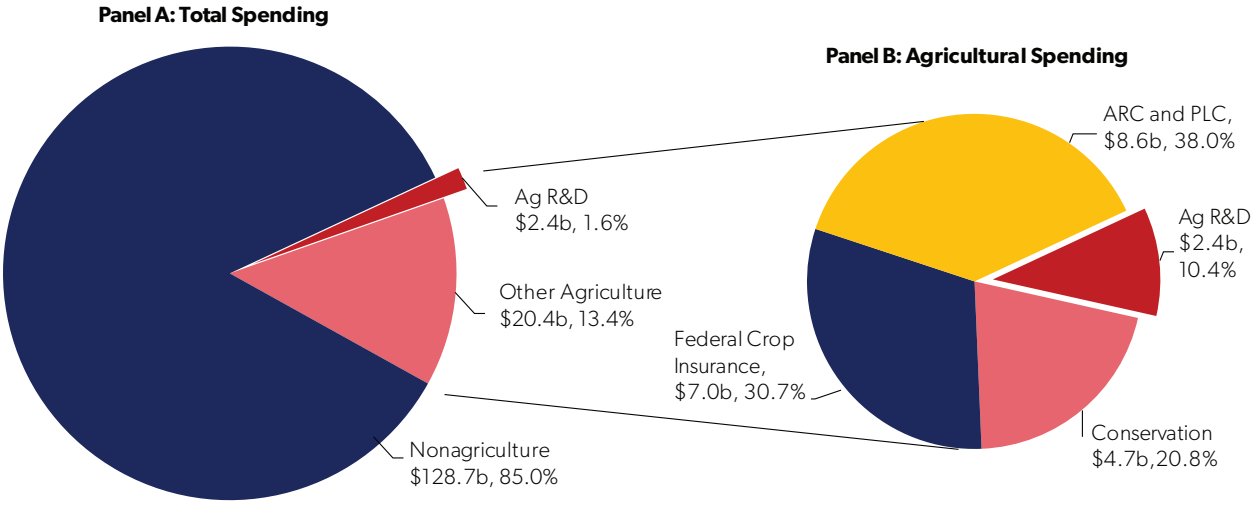
Slicing up the Farm Bill Pie

Historically, much of the federal government's public funding for agricultural R&D has been directly authorized through the farm bill, which includes a plethora of policy initiatives. Those initiatives range from nutrition assistance programs, such as SNAP and the Women and Infant Children (WIC) nutrition program, to direct farm subsidies, subsidized federal agricultural insurance, and conservation programs.

From a budget perspective, federal spending on farm bill initiatives can be divided between programs that are not focused on agriculture and programs that directly focus on the farm and farming operations. Total federal spending on USDA programs was around $151 billion in fiscal year 2017 (Figure 2). The bulk of this spending, more than 85 percent, is for nonagricultural programs (about $129 billion in 2017). Most of these funds are allocated to the major nutrition assistance programs, including SNAP and WIC. These initiatives are a major component of the US federal antipoverty, low-income household economic safety net and in 2017 served more than 42 million people who live in households with incomes below the federal poverty line (13 percent of the US total population). Rural housing and rural development programs for infrastructure and nonfarm-based economic development account for less than 0.5 percent of the total USDA budget (about $440 million a year). About $1.4 billion a year is allocated for emergency food aid programs, and a similar amount is allocated to extension and outreach education programs. Other funds are allocated for USDA personnel and administration costs.

The remaining $22.7 billion in the USDA's annual budget is spent on farm subsidies ($20.4 billion in 2017) and publicly funded agricultural R&D (about

Figure 2. Farm Bill Spending, 2017



Note: Data are forecast fiscal year 2017 expenditures or outlays except for federal crop insurance, which is budget authority given the considerable year-to-year variation. In this figure. "ARC" stands for the Agricultural Risk Coverage and "PLC" stands for Price Loss Coverage programs.

Source: US Department of Agriculture, *Budget Summary*, www.obpa.usda.gov/budsum/fy17budsum.pdf; US Department of Agriculture, National Institute for Food and Agriculture, "2018 President's Budget," October 2017, 19–31, https://nifa.usda.gov/archived-budget-information; and Congressional Budget Office, "June 2017 Baseline for Farm Programs," August 2017, 3–26, www.cbo.gov/sites/default/files/recurringdata/51317-2017-06-usda.pdf.

$2.4 billion in 2017) (see Figure 1, Panel B). The farm subsidy portion of the annual federal farm bill budgets is almost completely allocated among three major programs: the federal crop insurance program (on average approximately $7 billion), two major direct farm subsidy programs called Agricultural Risk Coverage and Price Loss Coverage (totaling $8.6 billion), and conservation programs ($4.7 billion). Approximately $600 million of federal money is spent on a suite of four livestock-oriented disaster aid programs.

The evidence with respect to the value to society of crop insurance subsidies is unambiguous. Numerous analyses have demonstrated that, from an economic efficiency perspective, the US crop insurance program represents a waste of scarce economic resources. For example, by giving farmers incentives to adopt more risky production practices, such subsidies have encouraged them to use relatively inefficient production methods.[4] They have also had complex environmental effects, many of which are adverse.[5] For example, crop insurance subsidies have incentivized farmers to plant crops on fragile lands previously used for grazing, with adverse effects on soil erosion and wildlife habitat. Further, subsidy payments largely flow to landowners and owners of farm businesses with relatively high incomes and average levels of wealth that are substantial.[6]

Farmers benefit from the crop insurance program through premium subsidies that enhance their average incomes, estimated by the Congressional Budget Office to average about $5.5 billion annually over the next 10 years.[7] However, the sector that arguably benefits most from the program, to the extent of about $2.4 billion a year in income from federal subsidies, consists of crop insurance companies and independent crop insurance agents. Effectively, that industry exists largely because of the federal crop insurance subsidies provided to farmers.[8] It is noteworthy that federal spending on subsidies to crop insurance companies is similar to spending on agricultural R&D.

A similar case can be made for waste with respect to the $8.6 billion a year currently being spent on the two programs, Agricultural Risk Coverage and Price Loss Coverage, which now serve as major sources of direct subsidies. These payments also flow mainly to the wealthiest and largest farm operations and enhance farm incomes in a sector that, by any reasonable measure, is on average in good financial condition.[9]

Conservation programs are often classified into two broad categories: working-lands programs, through which farmers are paid to adopt or continue farming practices that reduce pollution and less adversely affect environmental amenities, and land retirement programs, through which farmers receive federal funds when they remove land from crop production and place it into conservation uses. Some of these programs, as Erik Lichtenberg points out, do generate environmental benefits of value to society as a whole, but some do not, and many are poorly targeted.[10] Working-lands initiatives such as the Conservation Stewardship Program (CSP), which are budgeted at an annual average of about $1.8 billion over the next 10 years, are especially questionable. The reason is that the CSP is designed largely to pay farmers to continue using practices they have already adopted for other reasons.

Public investments in agricultural R&D are the one farm-oriented set of farm bill–authorized outlays that have consistently generated broad-based social benefits for both innovative farmers and consumers.[11] However, public spending on agricultural R&D has atrophied since the late-1990s. The question is why, given that agricultural R&D is one of the rare places in the agriculture-oriented programs authorized by the farm bill in which federal funds generate high social rates of return and are substantially underfunded. The answer is relatively straightforward. Much like teachers unions that primarily (albeit, not exclusively) exist to serve the interests of their members (teachers, not students), farm and agribusiness interest groups primarily exist to serve the interests of their members (farmers and agribusinesses, not consumers). They lobby Congress most heavily for programs that generate the most, and most immediate, benefits for their members.

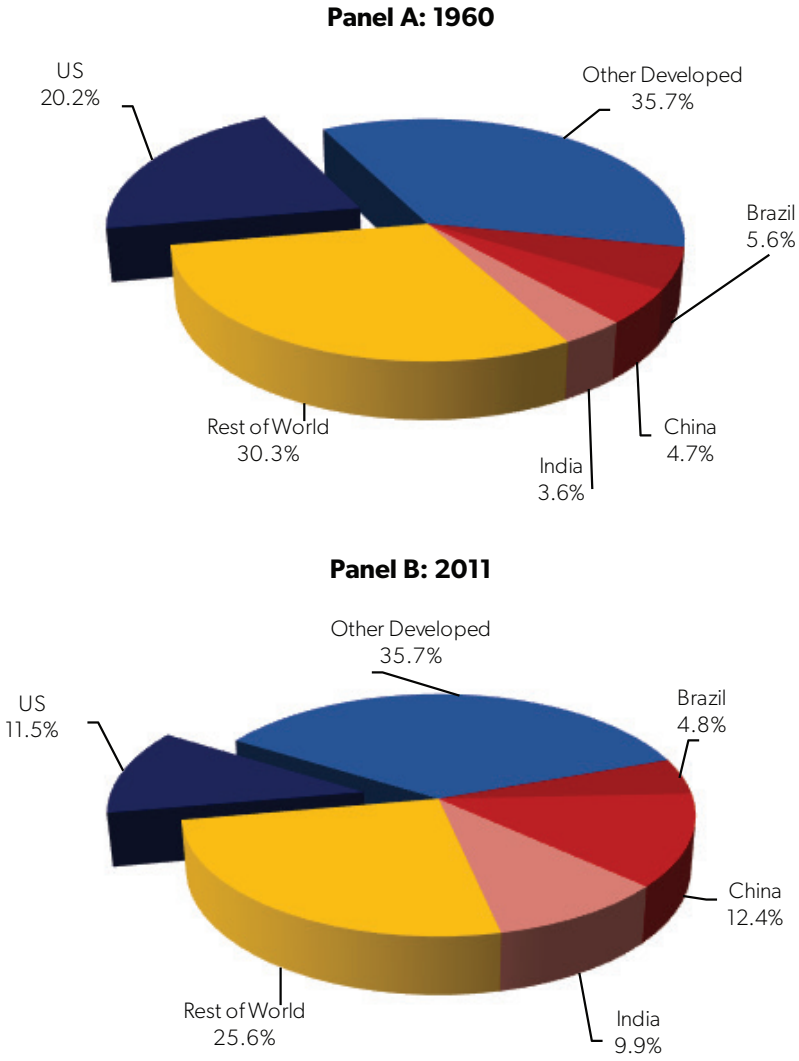
The benefits that flow from public agricultural R&D investments are (1) diffuse and shared with consumers and (2) occur only after a relatively long delay, and typically not in the short term. By contrast, the

benefits that flow from direct subsidy programs such as Price Loss Coverage, Agricultural Risk Coverage, federal crop insurance, and most conservation programs flow almost completely to a small set of farm owners and landowners and arrive almost immediately (the annual check shows up in the mail). If the choice is between spending a federal dollar on publicly funded R&D or more direct subsidies, farm interest groups will likely prefer the latter and therefore lobby more intensively for more direct subsidies. A third concern for the farm lobbies is also that because USDA agencies have increasingly responded to pressures from other interest groups, they have shifted a larger share of authorized R&D funds to research areas such as human nutrition and the environment that have less (and likely little) impact on agricultural productivity.

US Agricultural R&D Realities

The global agricultural R&D landscape is changing rapidly, and the US is losing ground as US policymakers have scaled back their support while policymakers in agriculturally important economies elsewhere in the world have opted to ramp up their pace of investment in agricultural innovation.

Figure 3. US Versus Rest-of-World Public Agricultural R&D Spending, 1960 and 2011

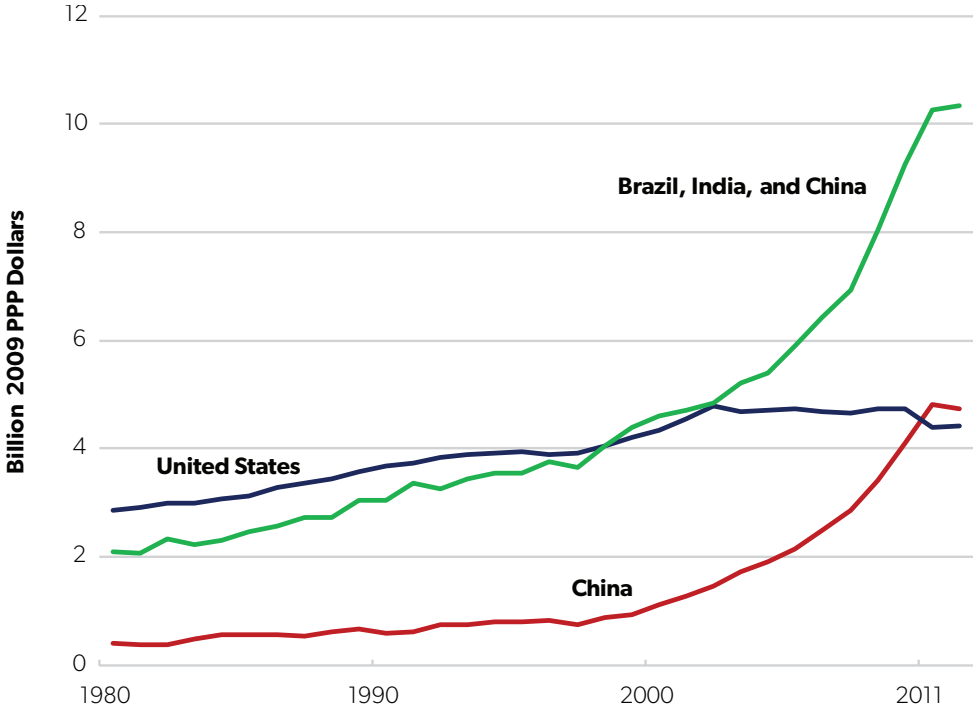


Source: Philip G. Pardey et al., "Agricultural R&D Is on the Move," *Nature* 15, no. 537 (September 2016): 301–03.

R&D Spending Trends. In 1960, the US accounted for 20 percent of global investments in public agricultural R&D, most of which was carried out by agencies such as the USDA and the land-grant universities. Fast forward to 2011—the latest year of available global data—and the picture is different (Figure 3). The US share of the global public-sector total has fallen to just 11.5 percent, second to the 12.4 percent share of global R&D contributed by China. In fact, collectively, China, India, and Brazil—three agriculturally large, middle-income countries—overtook US spending in 1998 and by 2011 together spent $2.35 on public agricultural research for every $1 invested in US public agricultural R&D (Figure 4).

How did this happen? Since at least the middle of the 20th century, real (inflation-adjusted) spending on US public agricultural research has grown at an ever-declining rate (Figure 5). Even more

Figure 4. China, India, and Brazil Outspend the US on Public Agricultural Research



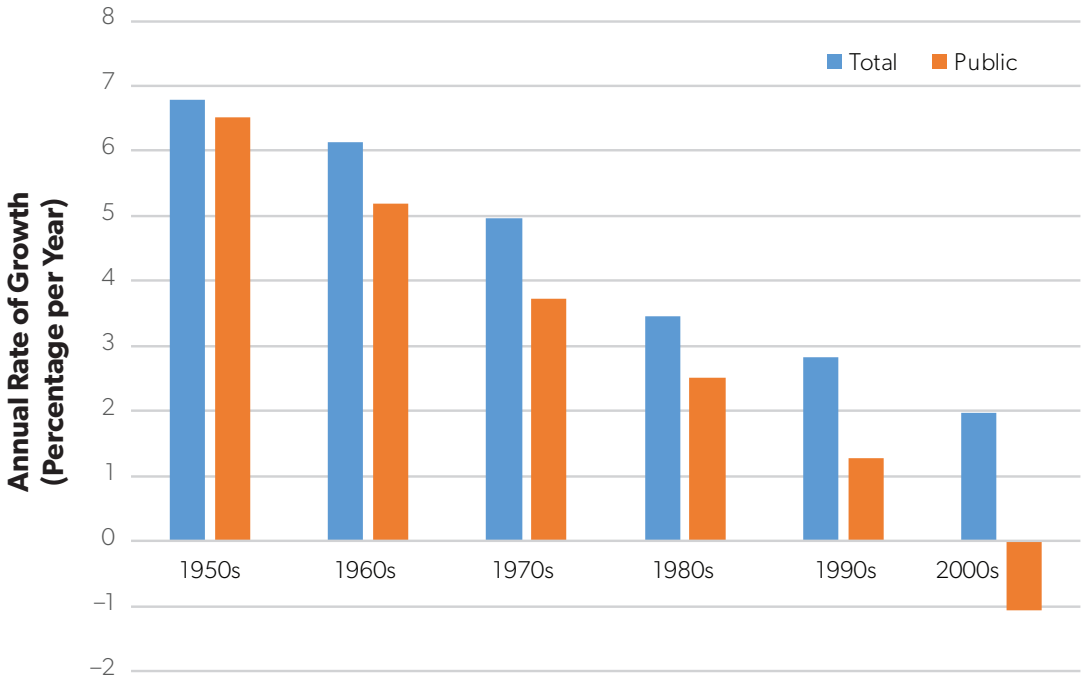
Note: "PPP" indicates purchasing power parity rate of currency exchange.
Source: Developed from data summarized in Philip G. Pardy et al., "Agricultural R&D Is on the Move," *Nature* 15, no. 537 (September 2016): 301–03.

critically, starting around 2002 the US began cutting back, not just slowing down, the rate of growth of spending on public agricultural R&D investments. By 2015, aggregate US spending had retreated to the inflation-adjusted levels that prevailed in 1992. In marked contrast to the US retreat from investments in public agricultural R&D, Brazil, India, and in particular China have been doubling down on their investments in public agricultural R&D, especially in the decades after 1990.

Do these changing cross-country research relativities matter? Certainly, and in potentially profound ways. The US agricultural economy now heavily relies on exports, shipping abroad more than 20 percent of its total agricultural production (by volume) in recent years.[12] For three commodities (cotton, walnuts, and almonds), at least two-thirds of US production is exported, and for six commodities (nonfat dry and powder milk, wheat, soybeans, grapes, and rice), more than one-third of production is exported.[13] Gaining and then sustaining international markets is inextricably linked to the quality and unit cost of production of US agricultural output relative to agricultural competitors elsewhere in the world. Improving product quality and lowering production costs is driven by improvements in agricultural productivity that in turn rely heavily on investments in agricultural R&D.[14] As the US slips further behind regarding investments in agricultural R&D, so too will it undercut its competitive advantage, the more so if other countries continue to sustain or even further ramp up their investments in productivity promoting R&D.

Public Versus Private R&D. Why not leave it to the private sector? One oft-told line of argument suggests that the private sector will fill the R&D void left

Figure 5. Whittling Away at US Public Agricultural R&D Investments



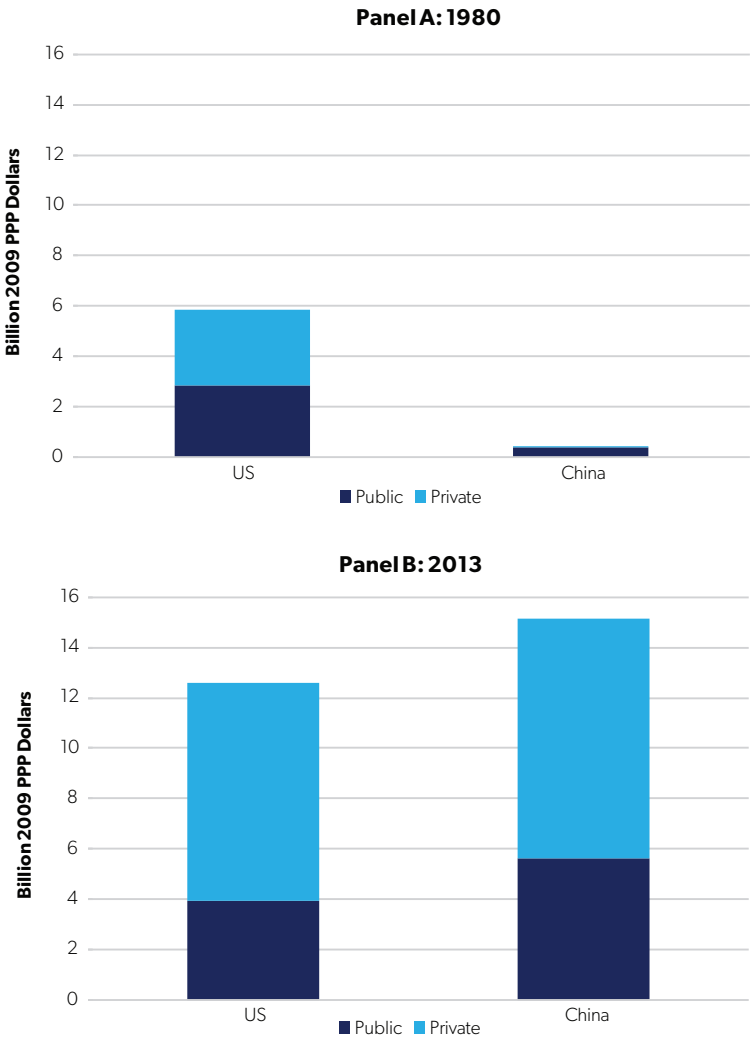
Note: Annual average growth rates for each period derived by a log linear regression method. The 2000s include data for 2000–14. Growth rates represent real growth rates as agricultural R&D series were deflated using the implicit GDP deflator from Louis Johnston and Samuel H. Williamson, "What Was the U.S. GDP Then?," MeasuringWorth, 2017, https://www.measuringworth.com/usgdp/.
Source: Philip G. Pardey et al., "Agricultural R&D Is on the Move," *Nature* 15, no. 537 (September 2016): 301–03; and US Department of Agriculture, Current Research Information System, unpublished annual data files, 1970 to 2015.

by scaling back public research. Certainly the private sector has increased its presence in agricultural innovation markets, now spending more than $2 (specifically $2.35 in 2014) on food and agricultural R&D for every public dollar invested in research.[15] But there are limits to what the private sector will find economical to do.

Consider, for example, the US health sector, where large public-sector investments in health research administered by federal agencies such as the National Institutes of Health (NIH) and National Science Foundation (NSF) provide the basic and applied science that is socially valuable in areas such as pharmaceuticals, medical devices, and cancer treatements but which private-sector health care–oriented firms find hard to make privately profitable. Patient and persistent support for public science provides the essential scientific building blocks for the more developmental, nearer-market, and typically shorter-term research that is more readily commercialized, and which the private sector does best. This public-private division of scientific labor helps solve the "market failure" problem that bedevils R&D by funding valuable growth preserving and promoting R&D that would not happen if left entirely to the private (inclusive of farmers) sector.[16] Moreover, the public science helps drive forward the private R&D it enables.

Just as the US has lost its preeminent global position regarding investments in public agricultural R&D, so too it is ceding ground on the private research front. In 1980, private agricultural R&D conducted in the US accounted for 33 percent of the world total. By 2011, that share had slipped by nearly a quarter. This

Figure 6. China Versus the US, 1980 and 2013



Source: Yuan Chai et al., "Passing the Agricultural R&D Buck? The United States and China" (working paper, International Science and Technology Practice and Policy Center, University of Minnesota and China Center for Agricultural Policy, Peking University, forthcoming 2018).

shift also reflects an increase in domestic spending on private agricultural R&D elsewhere in the world, along with recent decisions by some multinational agribusiness firms headquartered in the United States (and other high-income countries) to shift some of their R&D investments to locations in the agriculturally large and growing middle-income countries.[17] For example, China now outspends the US in both public *and* private agricultural R&D (Figure 6).[18]

Does It Pay to Invest Public Dollars in Agricultural R&D? Most of the farm bill dollars dedicated to agriculture simply slice up the agricultural pie, redistributing dollars from taxpayers to farmers, insurance intermediaries, and various agribusinesses.[19] In stark contrast, farm bill dollars dedicated to food and agricultural R&D expand the overall size of the agricultural pie to benefit not only innovative farmers and agribusinesses but also taxpaying consumers who foot the bill. R&D-induced productivity growth lowers the cost of production (to the benefit of innovative farmers and other agribusinesses) and lowers the price of food (to the benefit of all consumers, especially low-income consumers who spend a sizable share of their meager household incomes on food purchases). In the jargon of economists, there are both economic efficiency *and* poverty-targeted distributional or equity benefits from investing in food and agricultural R&D—a rare win-win outcome.

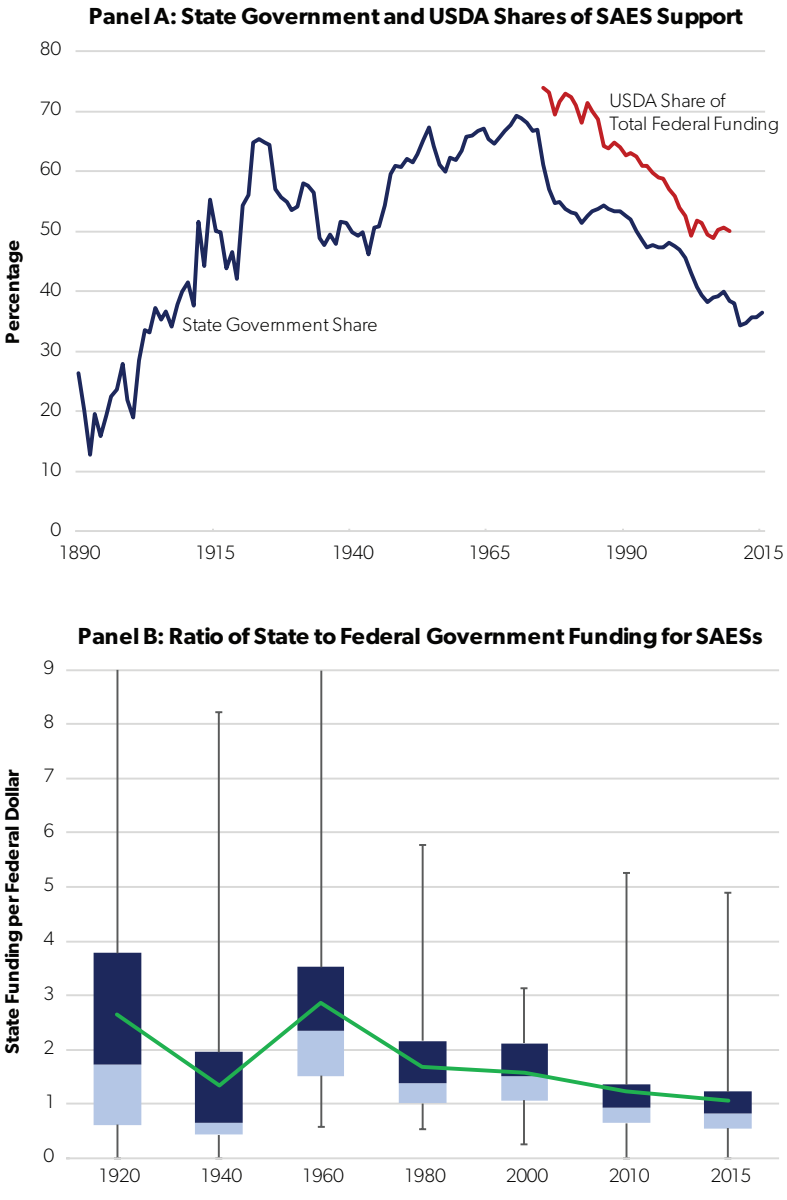
The overall economic gains from investing in agricultural R&D are especially large. Research is intrinsically risky. However, in practice, the big (and not so big) R&D winners pay for those that do not pan out commercially. In line with the compelling evidence gleaned from a large body of literature, Alston et al.[20] (in their Table 4) estimated that every dollar invested in US food and agricultural R&D on average generates $32 of benefits. Importantly, recent evidence also shows that the returns to more recent research investments are as large as the returns to distant past research.[21] In other words, the payoffs to agricultural R&D are as high as they have ever been.

Who Foots the Public Agricultural R&D Bill? Research by USDA agencies has long relied on federal funding allocated through the farm bill. However, over

time, USDA agencies have shrunk as a share of the total pool of public funds directed to agricultural R&D. The state agricultural experiment stations (SAESs)—typically colocated on the campuses of the land-grant universities—now conduct the lion's share of US public agricultural R&D: 73 percent in 2015, substantially larger than their 61 percent share in 1950.

The sources of financial support for SAES research are more diversified and have changed dramatically over time. The state government share of funding for SAES research fell dramatically: from 69 percent in 1970 to just 37 percent in 2015 (Figure 7, Panel A). Federal funding picked up much of the shortfall and now accounts for 40 percent of overall SAES funding, almost double its share in 1970. Subtly, but importantly, farm bill funding the USDA made available to the SAESs declined as a share of total federal funding to the SAESs over the past several decades. The decline was substantial, from around three quarters of total federal funding to the SAESs in the mid-1970s to just 39 percent in 2011 (Figure 7, Panel A). The increase in federal funding to the SAESs—from a 28 percent share of total SAES funding in 1975 to 40 percent in 2015—stemmed from a substantial increase in (mainly competitive, grant-allocated) funds coming from agencies such as the NIH, NSF, Department of Energy, Department of Defense, United States Agency for International Development, and others. A modest rebound in National Institute of Food and Agricultural Research (NIFA) funding in more recent years has seen the USDA share of total federal funding rise to 50 percent in 2009 (the last year data

Figure 7. Shifting State Versus Federal Government Support for SAES Research



Note: In Panel A, "USDA Share of Total Federal Funding" is the share of USDA funding in total federal funds provided to SAESs. In Panel B, the green line plots are respective ratio averages for the SAESs. Dark and light blue meet at respective ratio medians. Upper bound of the box indicates the 75th percentile, while lower bound indicates the 25th percentile. Upper bound of the whisker indicates maximum value, and lower bound indicates the minimum value observed across the SAESs. For plotting purposes, upper bounds were truncated in 1920 and 1960.
Source: Updated InSTePP Innovation Accounts (US agricultural R&D spending series) version 3.5. See Philip G. Pardey and Jason M. Beddow, "Revitalizing Agricultural Research and Development to Sustain US Competitiveness," Farm Journal Foundation, February 28, 2017, http://www.farmersfeedingtheworld.org/assets/7/6/revitalizingagresearch_print.pdf.

were available to credibly estimate this share), but it is still well below historical norms.

Coincident with the reduction in state-government- and USDA-sourced federal funding, SAES research priorities also shifted. Most notably, there was a sizable and sustained reduction in research aimed at preserving or promoting farm productivity.[22] Instead, the SAES research agenda has increasingly focused on food safety, food security, and environmental concerns, programs of research that have little if any impact on enhancing or maintaining farm-level productivity. No doubt these other areas of research have social value, but their expansion has been at the expense of, not in addition to, productivity-related R&D, putting at increasing risk the competitiveness of US agriculture in highly contested international markets.

What Is to Be Done?

In short, the familiar adage "waste not, want not" applies directly to federal spending on agricultural R&D as opposed to farm subsidies. From a society-wide perspective, the economically sensible strategy is to cut back on wasteful farm bill spending and instead significantly increase funding for public investments in agricultural R&D.[23] This realignment of spending priorities can readily be accommodated while also reducing overall farm bill outlays. Shifting farm bill policy from a "spending" and "income transfer" program to an "investment" strategy is much more than mere political rhetoric.

For example, crop insurance subsidies, at a minimum, waste more than $2 billion of society's resources every year in deadweight costs.[24] More than 80 percent of price support program payments have consistently been distributed to the largest 20 percent of farm businesses owned by households with levels of wealth that are many times larger than the average American household.[25] In contrast, investments in US agricultural R&D yield a 32-fold increase in economic benefits (to producers and consumers) for every taxpayer dollar invested.[26] With global population growth projected to result in two billion more mouths to feed by 2050, ensuring US agriculture remains internationally competitive to meet the anticipated massive growth in global food, feed, and fiber demand is self-evidently a strategic economic and national security imperative given the expanded market opportunities this presents, coupled with increased political instabilities from failing to address food shortages around the world.[27]

While the economic payoffs to agricultural R&D are profound, they take considerable time to materialize. Developing and deploying new crop varieties and animal breeds require decades of research effort. This gives a genuine sense of urgency to realigning 2018 Farm Bill spending priorities, particularly if we are serious about shifting the present production and productivity trajectories of US agriculture to better address emerging global food security and US competiveness concerns over the decades ahead.

Increased farm bill funding for food and agricultural R&D can also be done in ways that improve the effectiveness and accountability of public research. Accountable block grants to SAES institutions would inject some longer-term stability into the funding of intrinsically longer-term research processes, albeit periodically reviewed, reassessed, and, if required, reallocated funding. An increase in programmatic (or block) funding, with decisions on how best to allocate that funding being taken closer to the (typically more informed) research action, would reinvigorate forms of funding that were the hallmark of success of the SAESs during the past century. It would also better align funding timelines to the longer timelines it takes to actually do the funded research. As part of a larger farm bill commitment to agricultural research, further expanding NIFA's competitive funding program, the Agriculture and Food Research Initiative (AFRI), would also ensure the growth of a balanced portfolio of less volatile (5–10 year) programmatic (block) funding and more variable and contestable (3–5 year) AFRI project funding.

More federal funds is one important way of refinancing US public agricultural R&D. But farm bill legislation can also reshape and revitalize the incentives for others to coinvest in publicly performed agricultural R&D. Matching federal funds with state government

funds has long been a feature of SAES financing modalities. However, funds provided through the 1887 Hatch Act, the 1937 Bankhead-Jones Farm Tenant Act, and other acts as subsequently amended require a state match and have shrunk as a share of total (and federal) funding to the SAESs. Thus, for instance, in 2015 state governments committed just $1.07 on average for every dollar of federal funding made available for SAES research, well below the $2.87 of state funding per federal dollar in 1960 (Figure 7, Panel B). Expanding the amount of state matching requirements—either by increasing the amount of USDA-sourced funds subject to a matching requirement or increasing the required rate of state match for every federal dollar—is one likely effective strategy.

State governments are not the only source of additional SAES support. Innovative farmers and agribusinesses also benefit from public agricultural R&D, so putting efficient public financing principals into practice—whereby research costs are borne in proportion to research benefits—would argue in favor of Title VII farm bill statutes that incentivize farms and agribusinesses to also increase their support for SAES research. US farmers already engage in collective action to fund activities that benefit agricultural producers.

In recent years, these collective "check-off" arrangements have garnered annual funding of around $1 billion, and although some of the funds support R&D—typically less than 20 percent, but it varies substantially across various marketing programs—most of these funds are used for short-term promotional activities.[28] Legislation that provides enabling (not obligatory) incentives for the industry to impose a research-levy scheme—where the funds are focused specifically on R&D and managed outside existing US check-off programs in ways that optimize the innovative "bang for the buck"—would be a straightforward way to enable (and induce) producers to collectively cofinance the research that benefits their enterprises. The federally matched, research-levy scheme the Australian government introduced decades ago is an example of a successful and now significant source of funding for public research carried out by universities and other government institutions in that country.[29]

Giving producers incentives to implement such a research levy would likely require more than arguments about the effectiveness of collective action. To make such a program palatable to grower groups, one option (used to great effect in the Australian scheme) is for the government to offer matching funds (up to some predetermined limit), thus splitting the R&D burden between the research-levy program and general tax revenues. Including other industries that benefit from agricultural R&D in the scheme (such as input suppliers and food processors) would allow for even more agricultural R&D and, if implemented wisely, substantially correct the persistent underinvestment problem that has long bedeviled US agricultural R&D.[30]

Farm bill legislation can also reshape and revitalize the incentives for others to coinvest in publicly performed agricultural R&D.

The Foundation for Food and Agriculture Research (FFAR) provided in the Agricultural Act of 2014 is a potentially game-changing institutional innovation that is beginning to find its operational legs. Congress awarded the FFAR $200 million of startup funds to underwrite public agricultural R&D, with the requirement that the farm bill funds be dispensed via a one-to-one match with nonfederal funds. The arguments above speak in favor of renewing this venture-capital form of funding for public agricultural R&D. Expanding or even perhaps shifting this funding model to a matched research-levy approach could substantially expand the base of support for public agricultural R&D in the US while splitting the bill for that research among the taxpayers, farmers, and agribusinesses who benefit most from it.

About the Authors

Philip G. Pardey is a professor in the department of applied economics at the University of Minnesota, director of global research strategy for the university's College of Food, Agricultural and Natural Resource Sciences, and director of the university's International Science and Technology Practice and Policy (InSTePP) Center (www.instepp.umn.edu). **Vincent H. Smith** is Professor of Economics in the Department of Agricultural Economics and Economics at Montana State University (MSU), director of Agricultural Policy Studies at the American Enterprise Institute, and director of the Initiative for Regulation and Applied Economic Analysis at MSU.

Acknowledgments

The authors thank Connie Chan-Kang and Mason Hurley for their assistance in preparing this brief and Joseph Glauber for his excellent feedback on a prior draft. The authors are entirely responsible for the content of this brief.

Notes

1. Douglas E. Bowers, Wayne D. Rasmussen, and Gladys L. Baker, *History of Agricultural Price Support and Adjustment Programs, 1933-84*, US Department of Agriculture, Economic Research Service, 1984, https://www.ers.usda.gov/publications/pub-details/?pubid=41994; and Bruce L. Gardner, *American Agriculture in the Twentieth Century: How It Flourished and What It Cost* (Cambridge, MA: Harvard University Press, 2002).

2. Wayne D. Rasmussen and Gladys L. Baker, *The Department of Agriculture* (New York: Praeger, 1972), 6.

3. Ibid. For example, food safety activities increased with the 1906 passage of the Food and Drugs Act and the Meat Inspection Act—the latter attributable in part to the outcry stemming from Upton Sinclair's 1906 novel, *The Jungle*—while extension activities were given a boost with the passage of the Smith-Lever Act in 1914.

4. Barry K. Goodwin and Vincent H. Smith, *The Economics of Crop Insurance and Disaster Aid* (Washington, DC: AEI Press, 1995); Bruce A. Babcock and David A. Hennessy, "Input Demand Under Yield and Revenue Insurance," *American Journal of Agricultural Economics* 78, no. 2 (1996): 416–27, https://www.jstor.org/stable/1243713; Vincent H. Smith and Joseph W. Glauber, "Agricultural Insurance in Developed Countries," *Applied Economic Perspectives and Policy* 34, no. 3 (2012): 363–90, https://academic.oup.com/aepp/article-abstract/34/3/363/8759?; Barry K. Goodwin and Vincent H. Smith, "What Harm Is Done by Subsidizing Crop Insurance?," *American Journal of Agricultural Economics* 95, no. 2 (2013): 489–97, https://academic.oup.com/ajae/article-abstract/95/2/489/71210?; and Brian Davern Wright, "Multiple Peril Crop Insurance," *Choices* 29, no. 3 (2014): 1–5, http://www.choicesmagazine.org/UserFiles/file/cmsarticle_388.pdf.

5. Vincent H. Smith and Barry K. Goodwin, "The Environmental Consequences of Subsidized Risk Management and Disaster Assistance Programs," *Annual Review of Resource Economics* 5, no. 1 (2013): 35–60, http://www.annualreviews.org/doi/abs/10.1146/annurev-resource-110811-114505.

6. Bruce A. Babcock, "The Concentration of U.S. Agricultural Subsidies," *Iowa Ag Review* 7, no. 4 (2001): 8–9, www.card.iastate.edu/iowa_ag_review/fall_01/IAR.pdf; Michael J. Roberts and Nigel Key, "Who Benefits from Government Farm Payments?," *Choices* 3 (2003): 7–14, http://www.choicesmagazine.org/2003-3/2003-3-02.htm; and Anton Bekkerman, Eric J. Belasco, and Vincent H. Smith, "Does Size Matter? Distribution of Crop Insurance Subsidies and Government Program Payments Across U.S. Farms" (working paper, Montana State University Initiative for Regulation and Applied Economics Research, Bozeman, MT, September 2017), https://www.agri-pulse.com/ext/resources/pdfs/Smith-distributions-paper-october-2017.pdf.

7. Congressional Budget Office, "June 2017 Baseline for Farm Programs," August 2017, www.cbo.gov/sites/default/files/recurringdata/51317-2017-06-usda.pdf.

8. Smith and Glauber, "Agricultural Insurance in Developed Countries"; Wright, "Multiple Peril Crop Insurance"; and Vincent H. Smith, Joseph W. Glauber, and Barry K. Goodwin, "Time to Reform the US Federal Agricultural Insurance Program," American Enterprise Institute, October 2017, https://www.aei.org/publication/time-to-reform-the-us-federal-agricultural-insurance-program/.

9. Vincent H. Smith et al., "Agricultural Policy in Disarray: Reforming the Farm Bill—An Overview," American Enterprise Institute, October 13, 2017; and Bruce A. Babcock, "Covering Losses with Price Loss Coverage, Agricultural Risk Coverage, and the Stacked Income Protection Plan," American Enterprise Institute, October 13, 2017, https://www.aei.org/publication/time-to-reform-the-us-federal-agricultural-insurance-program/.

10. Erik Lichtenberg, "The Farm Bill, Conservation, and the Environment," American Enterprise Institute, November 13, 2017, http://www.aei.org/publication/the-farm-bill-conservation-and-the-environment/.

11. Xudong Rao, Terrance M. Hurley, and Philip G. Pardey, "Are Agricultural R&D Returns Declining and Development Dependent?" (working paper, InSTePP Center, University of Minnesota, St. Paul, MN, 2017); and Xudong Rao, Terrance M. Hurley, and Philip G. Pardey, "Recalibrating the Reported Returns to Agricultural R&D: What If We All Heeded Griliches?" (working paper, InSTePP Center,

University of Minnesota, St. Paul, MN, 2017).

12. US Department of Agriculture, Economic Research Service, "How Important Are Exports to the U.S. Agricultural Sector?," 2017, www.ers.usda.gov/faqs/#Q12.

13. Walt Gardiner, "U.S. Agriculture Exports: Recent Trends and Commodity Exposure to International Trade," US Food and Drug Administration, Office of Regulatory Policy, 2016, www.fca.gov/Download/EconomicReports/5%20USAgricultureExports-RecentTrendsAndCommodityExposure.pdf.

14. Philip G. Pardey and Jason M. Beddow, *Agricultural Innovation: The United States in a Changing Global Reality*, Chicago Council on Global Affairs, 2013, https://www.thechicagocouncil.org/sites/default/files/Agricultural_Innovation_Final%281%29.pdf.

15. Kyuseon Lee et al., "Private R&D Investment in the U.S. Food and Agricultural Sectors, 1950–2014" (working paper, InSTePP Center, University of Minnesota, St. Paul, MN, 2017), http://ageconsearch.umn.edu/record/259112?ln=en.

16. Failing to comprehend the nature of the market failure problem in agricultural R&D has a long history. As Rasmussen and Baker observed, "The chairman of the House Committee on Agriculture, J. W. Covert of New York, displayed his complete misunderstanding of the role the Department could play in scientific research when he claimed on February 18, 1881: 'The controlling idea involved in the creation of the department is that our wide domain should be tested, to ascertain what can be most successfully produced in its various sections. Experiments in this direction cannot be profitably conducted forever. Sooner or later the work of the department should be closed, and meanwhile I cannot see why the farmer should not, like other men engaged in other pursuits, learn to experiment for himself and act for himself without reference to governmental aid.'" Rasmussen and Baker, *The Department of Agriculture*.

17. Philip G. Pardey and Jason M. Beddow, "Revitalizing Agricultural Research and Development to Sustain US Competitiveness," Farm Journal Foundation, February 28, 2017, http://www.farmersfeedingtheworld.org/assets/7/6/revitalizingagresearch_print.pdf.

18. Y. Chai et al., "Passing the Agricultural R&D Buck? The United States and China" (working paper, InSTePP Center, University of Minnesota, St. Paul, MN, and Chinese Center for Agricultural Policy, Peking University, Beijing, 2017).

19. Smith, Glauber, and Goodwin, "Time to Reform the US Federal Agricultural Insurance Program"; and Smith et al., "Agricultural Policy in Disarray: Reforming the Farm Bill—An Overview."

20. Julian M. Alston et al., "The Economic Returns to U.S. Public Agricultural Research," *American Journal of Agricultural Economics* 93, no. 5 (2011): 1257–77.

21. Rao, Hurley, and Pardey, "Are Agricultural R&D Returns Declining and Development Dependent?"

22. Philip G. Pardey, Julian M. Alston, and Connie Chan-Kang, *Public Food and Agricultural Research in the United States: The Rise and Decline of Public Investments, and Policies for Renewal*, AGree, 2013, http://foodandagpolicy.org/content/public-food-and-agricultural-research-united-statesthe-rise-and-decline-public-investments-a.

23. As Pardey et al. noted, "Although no one really knows much quantitatively about the nature of diminishing returns to public agricultural research investments, it seems safe to say that the total U.S. public agricultural research enterprise could double in size without exceeding the national economic optimum—and certainly in the 'longer run,' after allowing appropriate time for building up the stocks of human and physical capital inputs to take efficient advantage of increases in operating funds." Pardey et al., *Public Food and Agricultural Research in the United States.*

24. Smith, Glauber, and Goodwin, "Time to Reform the US Federal Agricultural Insurance Program."

25. Bekkerman, Belasco, and Smith, "Does Size Matter?"

26. Alston et al., "The Economic Returns to U.S. Public Agricultural Research," 1257–77.

27. Marc F. Bellemare, "Rising Food Prices, Food Price Volatility, and Social Unrest," *American Journal of Agricultural Economics* 97, no. 1 (2015): 1–21, https://academic.oup.com/ajae/article/97/1/1/135390/Rising-Food-Prices-Food-Price-Volatility-and.

28. Julian M. Alston, Richard S. Gray, and Katarzyna Bolek, *Farmer-Funded R&D: Institutional Innovations for Enhancing Agricultural Research Investments,* Canadian Agricultural Innovation and Regulation Network, March 27, 2012; and Hyunok Lee et al., *Mandated Marketing Programs for California Commodities*, Giannini Foundation, 1996.

29. Alston, Gray, and Bolek, *Farmer-Funded R&D*; and John C. Kerin, *The Way I Saw It; The Way It Was: The Making of National Agricultural and Natural Resource Management Policy* (Melbourne: Analysis and Policy Observatory, 2017).

30. Pardey, Alston, and Chan-Kang, *Public Food and Agricultural Research in the United States.*