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Agricultural Research: Background and Issues

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SUMMARY

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Agricultural Research: Background and Issues

The U.S. Department of Agriculture (USDA) Research, Education, and Economics (REE) mission area funds billions of dollars annually for biological, physical, and social science research that is related to agriculture, food, and natural resources. Four agencies carry out REE responsibilities: the Agricultural Research Service (ARS), the National Institute of Food and Agriculture (NIFA), the National Agricultural Statistics Service (NASS), and the Economic Research Service (ERS). The Under Secretary for REE, who oversees the REE agencies, holds the title of USDA Chief Scientist and is responsible for coordinating research, education, and extension activities across the entire department. The Office of the Chief Scientist (OCS)—a staff office within the Office of the Under Secretary for REE—supports this coordination role. Discretionary funding for the REE mission area totaled approximately $3.4 billion in FY2020, and mandatory funding from the 2018 farm bill adds another $177 million per year on average.

USDA administers federal funding to states and local partners through its extramural research agency: NIFA. NIFA administers this extramural funding through *capacity grants* (allocated to the states based on formulas in statute) and *competitive grants* (awarded based on a peer-review process). USDA also conducts its own research at its intramural research agencies: ARS, NASS, and ERS.

Debates over the direction of public agricultural research and the nature of how it is funded continue. Ongoing issues include whether federal funding is sufficient to support agricultural research, education, and extension activities; the different roles of extramural versus intramural research; and the implications of allocating extramural funds via capacity grants versus competitive grants.

Many groups believe that Congress should increase support of U.S. agriculture through expanded federal support of research, education, and extension programs, whereas others believe that the private sector, not taxpayer dollars, should be used to support these activities.

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The federal government funds billions of dollars of agricultural research annually. The U.S. Department of Agriculture (USDA) Research, Education, and Economics (REE) mission area has the primary federal responsibility to advance scientific knowledge for agriculture. REE programs and activities include the biological, physical, and social sciences related broadly to agriculture, food, and natural resources.

The Under Secretary for REE, who oversees the REE agencies, holds the title of USDA Chief Scientist and is responsible for coordinating research, education, and extension activities within REE and across USDA. The Office of the Chief Scientist (OCS)—a staff office within the Office of the Under Secretary for REE—supports this coordination role (7 U.S.C. §6971).

Other USDA agencies and other federal agencies also conduct research relevant to agriculture. For example, within USDA, the Natural Resources Conservation Service, the Animal and Plant Health Inspection Service, and the U.S. Forest Service conduct some research activities. Outside of USDA, the National Science Foundation funds fundamental and applied research relevant to agriculture. This report focuses on USDA's REE mission area and does not directly address research activities or research funding outside of the mission area.

USDA's Research, Education, and Economics Mission Area

Figure 1. Overview of USDA's Research, Education, and Economics (REE) Mission Area

(FY2020 discretionary budget authority)

Function	Agency or Office
Intramural Federal funding of research conducted by federal personnel	**Agricultural Research Service** $1.607 billion **National Agricultural Statistics Service** $180.3 million **Economic Research Service** $84.8 million
Extramural Federal funding of research and related activities conducted by non-federal personnel at state and other institutions	**National Institute of Food and Agriculture** $1.527 billion
Policy and Coordination USDA scientific leadership and coordination	**Office of the Under Secretary for REE** $800,000 **Office of the Chief Scientist** (funds contributed by the REE agencies)

Source: Congressional Research Service (CRS), using U.S. Department of Agriculture (USDA) and appropriations committee information. Amounts are FY2020 budget authority. For program details, see USDA's Congressional Budget Justification, at http://www.obpa.usda.gov.

REE consists of four agencies (see **Figure 1**): the Agricultural Research Service (ARS), National Agricultural Statistics Service (NASS), Economic Research Service (ERS), and National Institute of Food and Agriculture (NIFA). All four agencies are headquartered in the Washington, DC,

metro area.[1] Their mission area includes intramural and extramural roles in agricultural research, statistics, extension, and higher education. Most REE activities are funded through annual discretionary appropriations. In FY2020, the REE discretionary budget totaled approximately $3.4 billion. Mandatory funding authorized in the 2018 farm bill adds approximately $177 million per year on average.[2]

Agricultural Research Service

ARS is USDA's chief *intramural* scientific research agency: it employs federal scientists to conduct research and is responsible for leading the national agricultural research effort. It operates approximately 90 research facilities in the United States and abroad, many of which are co-located with land-grant universities (**Figure 2**). ARS also operates the National Agricultural Library located in Beltsville, MD, the world's largest agricultural research library and a primary repository for food, agriculture, and natural resource sciences information.

ARS has about 5,000 permanent employees, including approximately 2,000 research scientists.[3] It is led by an administrator, who is a member of the Senior Executive Service. ARS organizes its research into 15 national programs to coordinate the nearly 700 research projects that ARS scientists carry out. This research spans efficient and sustainable food and fiber production, development of new products and uses for agricultural commodities, development of effective pest management controls, and support of USDA regulatory and technical assistance programs.

National Institute of Food and Agriculture

NIFA is USDA's principal *extramural* research agency: it leads and funds external research, extension, and educational programs for agriculture, the environment, human health and well-being, and communities. NIFA leadership includes developing and implementing grant programs that fund extramural activities. NIFA provides federal funding for projects conducted in partnership with land-grant universities in all 50 states and several U.S. territories, affiliated State Agricultural Experiment Stations (SAESs), schools of forestry and veterinary medicine, the Cooperative Extension System (CES), other research and education institutions, private organizations, and individuals.[4] The land-grant university (LGU) system includes three types of institutions: the 52 original colleges (known as the 1862 Institutions) established through the Morrill Act of 1862, the 19 historically black colleges (known as the 1890 Institutions) established through the Second Morrill Act of 1890, and the 36 tribal colleges (known as the 1994 Institutions) that gained land-grant status in 1994 (**Figure 3**).[5] NIFA awards federal funds through

[1] National Institute of Food Agriculture (NIFA) and Economic Research Service (ERS) staff and principal operations were moved to Kansas City in 2019; however, their administrative headquarters remain in Washington, DC.

[2] *Mandatory funding* is not only authorized, but also actually provided via budget enforcement rules. *Discretionary funding* may be authorized in a bill but is not actually provided until provided through annual appropriations bills. For more information, see "Types of Spending Authorizations" in CRS Report R45425, *Budget Issues That Shaped the 2018 Farm Bill*.

[3] More than 200 scientists are located at the Agricultural Research Service (ARS) headquarters in Beltsville, MD. For more information, see ARS, "About ARS," at https://www.ars.usda.gov/about-ars.

[4] The Cooperative Extension System (CES) is a nationwide, noncredit educational network. Each U.S. state and territory has an office at its land-grant university and a network of local or regional offices. The purpose of CES is to deliver knowledge gained through research and education directly to farmers and other residents for practical use.

[5] See CRS Report R45897, *The U.S. Land-Grant University System: An Overview*.

capacity grants—distributed to the states based on formulas in statute—and *competitive grants*—awarded to eligible applicants following a peer-review process.

NIFA is authorized to have 412 permanent full-time employees.[6] Its headquarters are located in Washington, DC, and most NIFA staff positions are located in Kansas City, MO.[7] It is led by a director, who is appointed by the President to serve a six-year term.[8] NIFA organizes its programs into four institutes led by deputy directors. National program leaders within the institutes manage NIFA programs in partnership with LGUs and other stakeholders.

National Agricultural Statistics Service

NASS conducts the five-yearly Census of Agriculture, and it provides official statistics on agricultural production and indicators of the status of the farm sector. NASS is one of the 13 principal statistical agencies of the Federal Statistical System of the United States.[9] NASS headquarters are in Washington, DC, and it has offices in 45 states and Puerto Rico. The NASS workforce consists of about 1,000 full-time employees and is led by an administrator, who is a member of the Senior Executive Service.

Economic Research Service

ERS supports economic and social science analysis about agriculture, rural development, food, commodity markets, and the environment. It also collects and disseminates data concerning USDA programs and policies. Like NASS, ERS is one of the 13 principal statistical agencies of the Federal Statistical System of the United States. ERS headquarters are located in Washington, DC, and the majority of ERS staff positions are located in Kansas City, MO.[10] In recent years, it has been authorized to have about 330 full-time employees.[11] ERS is led by an administrator, who is a member of the Senior Executive Service.

[6] USDA, "Explanatory Notes—National Institute of Food and Agriculture," *President's Budget Request—FY2021*, 2020, p. 19-5.

[7] USDA relocated most NIFA staff positions to Kansas City, MO, from Washington, DC, in October 2019. For further information, see CRS In Focus IF11527, *Relocation of the USDA Research Agencies: NIFA and ERS*.

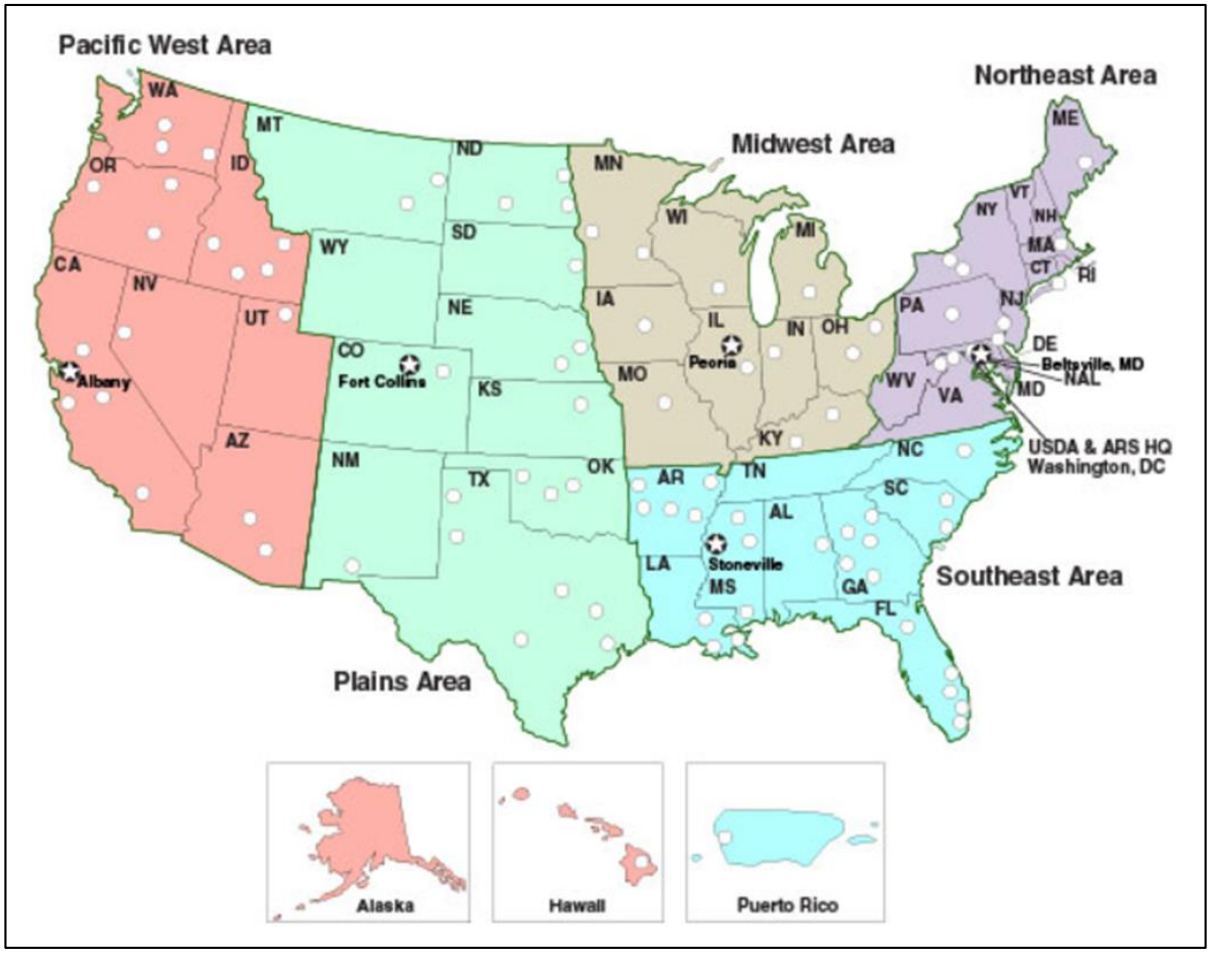
[8] The 2008 farm bill required that the NIFA director be a distinguished scientist appointed by the President (7 U.S.C. §6971(f)(3)(A)). This appointment does not require Senate confirmation. In contrast, the administrators of the other Research, Education, and Economic (REE) mission area agencies are career civil servants in the Senior Executive Service (SES). For information on the SES, see CRS Report R45635, *Categories of Federal Civil Service Employment: A Snapshot*.

[9] National Academies of Sciences, Engineering, and Medicine, *Principles and Practices for a Federal Statistical Agency*, 2017, p. 20.

[10] USDA relocated most ERS staff positions to Kansas City, MO, from Washington, DC, in October 2019. For further information, see CRS In Focus IF11527, *Relocation of the USDA Research Agencies: NIFA and ERS*.

[11] For example, ERS was authorized to have 329 full-time employees in FY2020 and 330 in FY2019. See USDA, "Explanatory Notes—Economic Research Service," *President's Budget Request—FY2021*, 2020.

Figure 2. USDA Agricultural Research Service Locations in the United States



Source: USDA, Agricultural Research Service (ARS), "Find a Location," at https://www.ars.usda.gov/people-locations/find-a-location.

Figure 3. Land-Grant Colleges and Universities

Source: USDA, National Institute of Food Agriculture (NIFA), "Land-Grant Colleges and Universities Map," at https://nifa.usda.gov/sites/default/files/resource/LGU-Map-03-18-19.pdf.

Office of the Under Secretary of REE and Office of the Chief Scientist

The Office of the Under Secretary of REE reports to the Secretary of Agriculture. This administrative office consists of the Under Secretary for REE and a few staff members.

OCS is a component of the Office of the Under Secretary of REE. In 2008, Congress created OCS when it established the dual role of the Under Secretary for REE as the USDA Chief Scientist (7 U.S.C. §6971(c)). OCS supports the USDA Chief Scientist in coordinating USDA research programs, setting priorities, and aligning scientific capacity across the four REE agencies and the department. Congress identified six OCS divisions to be led by division chiefs:

- Renewable energy, natural resources, and environment;
- Food safety, nutrition, and health;
- Plant health and production;
- Animal health and production;
- Agricultural systems and technology; and
- Agricultural economics and rural communities.

The division chiefs (in practice, known as *senior advisors*) hold their roles for a period of time and may be appointed by means of a flexible hiring authority, including term, temporary, or other appointment; detail; reassignment from another civil service position; and assignment from the states under the Intergovernmental Personnel Act (IPA, 7 U.S.C. §3374).[12] Other OCS staff, who may be hired on a permanent basis, implement additional OCS leadership duties described in statute (7 U.S.C. §6971(e)(4)). In recent years, these positions have included the OCS director and deputy director, the departmental scientific integrity officer, the veterinary science policy officer, and the senior advisor for international affairs.

Since its establishment, OCS has not received an independent appropriation. Rather, the four REE agencies have funded it via interagency agreement. The FY2021 President's budget request for the Office of the Secretary includes the first separate request for OCS, in the amount of $6 million and 29 staff years.[13]

Extramural Research Funding

Extramural research that NIFA sponsors is administered by a relatively small cadre of employees who are funded by a small portion of NIFA's appropriation for salaries and expenses. The vast majority of the NIFA appropriation is available for extramural research grants that are made primarily through two types of funding: capacity grants and competitive grants (see **Figure 4**). The following sections introduce some USDA extramural funding concepts. For more detailed information on federal funding of the LGU system, see CRS Report R45897, *The U.S. Land-Grant University System: An Overview*.

[12] 7 U.S.C. §6971(E)(3)(a).

[13] USDA, "Explanatory Notes—Office of the Secretary," *President's Budget Request—FY2021*, 2020, pp. 1-9 to 1-10. The House-passed FY2021 Agriculture appropriations bill (H.R. 7608, Div. B) did not include the funding requested for the Office of the Chief Scientist (OCS). As of September 2020, the Senate has not yet marked up its FY2021 bill.

Capacity Grants

Capacity grants for research, education, and extension are distributed to land-grant colleges (1862, 1890, and 1994 Institutions), schools of forestry, and schools of veterinary medicine using formulas that are set in statute. The amounts provided to each institution are determined by census-based statistics that change infrequently. Each recipient institution determines the research priorities for the capacity funds it receives. Two accounts provide most of the capacity grant funding: Hatch Act funding and Smith-Lever funding.[14]

Capacity Grants for Research

The Hatch Act of 1887 (7 U.S.C. §301) authorizes research funding at the state agricultural experiment stations (SAESs) associated with the 1862 Institutions. In 1955, Congress amended the Hatch Act to distribute the appropriation according to a formula based on each state's farm and rural population. The Hatch Act requires one-to-one nonfederal matching funds, generally provided from state budgets, and it requires each state to use 25% of Hatch Act funds to support multistate or regional research. The 1890 Institutions get similar funding through Evans-Allen Act research funding (7 U.S.C. §3222). These grants also require one-to-one nonfederal matching funds. Unlike the Hatch Act, the Evans-Allen Act allows states to apply for a waiver for up to 50% of the matching requirement.[15]

Additional capacity grant programs support forestry, veterinary, and other research at land-grant institutions. Similar to the Hatch Act and Evans-Allen Act, these funds are distributed among states with eligible institutions according to formulas in statute. These criteria are specific to each program. Further, interest from the Tribal College Endowment Fund (7 U.S.C. §301 note) is distributed to eligible institutions according to formulas in statute. The Hispanic-Serving Agricultural Colleges and Universities Fund (7 U.S.C. §3243), designed in a similar way, has yet to be funded by Congress.

Capacity Grants for Extension

The Smith-Lever Act (7 U.S.C. §341) authorizes cooperative extension funding to the states using statutory formulas and requiring nonfederal matching funds. Smith-Lever Act funds support state participation in the Cooperative Extension System through the 1862 Institutions.[16] The 1890 Institutions get similar extension funding through Section 1444 funding (7 U.S.C. 321-329), with distribution based on a formula in statute, and a nonfederal matching funds requirement.[17]

[14] Additional details are available in the USDA *Budget Summary* and *Explanatory Notes* for NIFA, available at http://www.obpa.usda.gov.

[15] While granting a waiver may allow federal funding to continue to flow to a historically Black college or university (HBCU) if a state does not meet the matching requirement, such waivers reduce the resources available to these historically Black institutions. See Association of Public and Land-Grant Universities, *Land-Grant But Unequal: State of One-to-One Match Funding for 1890 Land-Grant Universities*, September 2013, at http://www.aplu.org/library/land-grant-but-unequal-state-one-to-one-match-funding-for-1890-land-grant-universities/file.

[16] NIFA, "Cooperative Extension System," at https://nifa.usda.gov/cooperative-extension-system.

[17] *Section 1444* refers to Section 1444 of the National Agricultural Research, Extension, and Teaching Policy Act of 1977 (Title XIV of P.L. 95-113), which established these grants.

Competitive Grants

NIFA awards competitive grants using a peer-reviewed merit selection process. It makes awards to fund fundamental and applied research, extension, and higher education activities, as well as projects that integrate these activities. Competitive programs are designed to enable USDA to attract a wide pool of applicants to work on agricultural issues of national or regional interest and to select the best quality proposals submitted by highly qualified individuals, institutions, or organizations (7 U.S.C. §450i(b)). Competitive grants are primarily funded with discretionary appropriations, but some also receive mandatory funding from the farm bill (**Figure 4**). The many NIFA competitive grant programs focus on aspects of agricultural research, extension, and education.[18]

The Agriculture and Food Research Initiative (AFRI) is NIFA's flagship competitive grants program. It funds basic and applied research, education, and extension to colleges and universities, agricultural experiment stations, and other organizations conducting research in priority areas that are established partially in the farm bill. The 2008 farm bill (P.L. 110-246) mandated that AFRI allocate 60% of grant funds for basic research and 40% for applied research.[19] Further, at least 30% of total funds must be used to integrate research with education and/or extension activities.[20]

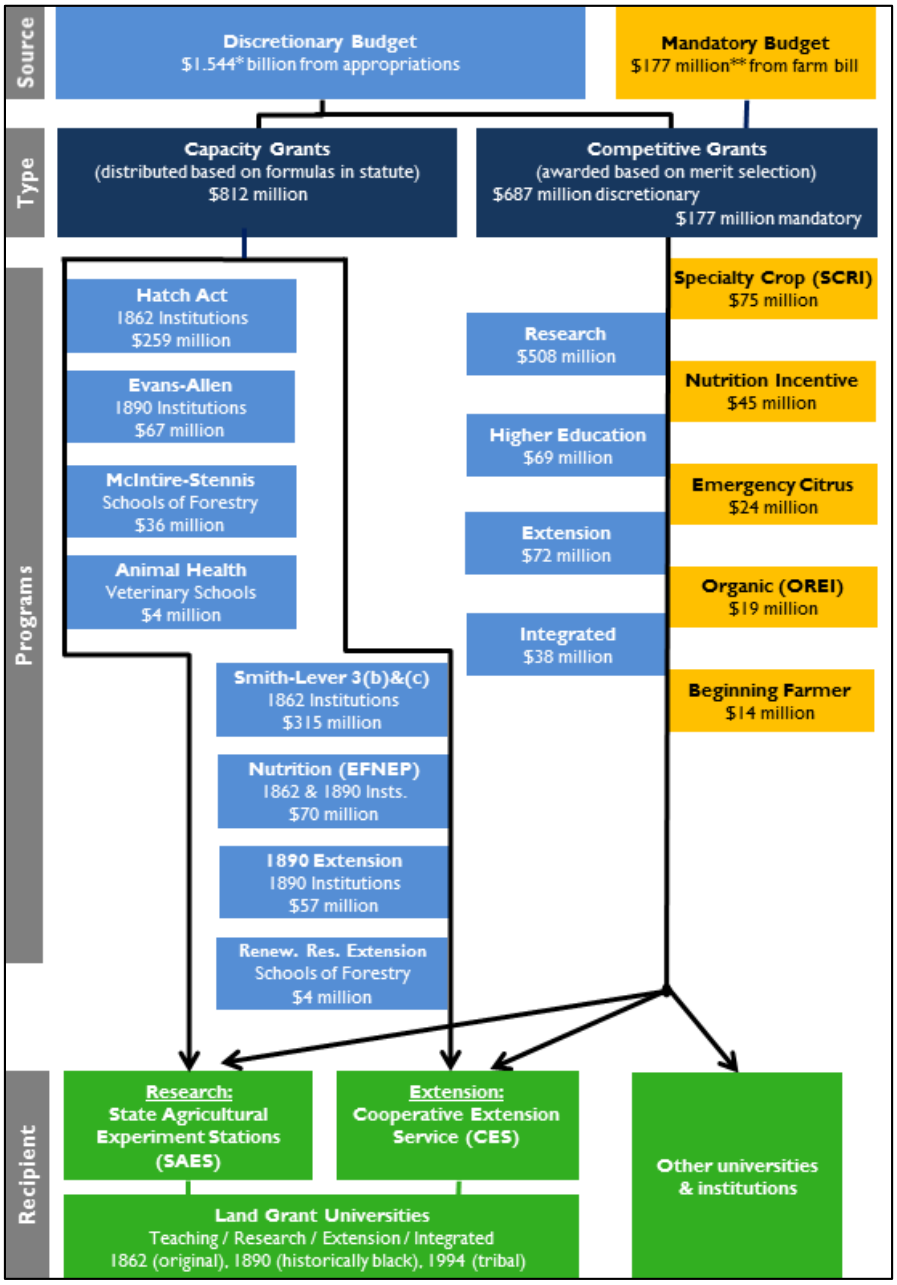
[18] For a listing of NIFA's competitive grants, see NIFA, "RFA List," at https://nifa.usda.gov/rfa-list.

[19] 7 U.S.C. §3157(b)(5).

[20] 7 U.S.C. §3157(b)(11)(A)(i).

Figure 4. National Institute of Food and Agriculture (NIFA) Budget

(FY2020 budget authority)



Source: CRS, based on USDA FY2021 Budget Request, NIFA Congressional Justification.

Notes: *Total NIFA discretionary funds include funds appropriated directly to NIFA and via General Provisions in annual appropriations legislation. These total funds include $28 million in administrative funds not reflected in program totals and $17 million in General Provisions funding. **Mandatory funds presented do not include the Extension Risk Management Education Program—a USDA Risk Management Agency program administered by NIFA. Nor does it include Scholarships for Students at 1890 Institutions or Urban, Indoor, and Other Emerging Agricultural Production, which received mandatory funds for a single year, to be available until expended. Renew. Res. Extension=Renewable Resources Extension Act Capacity Grant; Specialty Crop (SCRI)=Specialty Crop Research Initiative; Emergency Citrus=Emergency Citrus Disease Research & Extension Initiative; EFNEP=Expanded Food and Nutrition Education Program; Organic (OREI)=Organic Agriculture Research and Education Initiative; Beginning Farmer=Beginning Farmer and Rancher Development Program.

Intramural Research Funding

About 55% of annual discretionary funding that Congress appropriates for REE is for the intramural research agencies that conduct federal research: ARS, ERS, and NASS.[21] Decisions about how to spend these funds are made in accordance with congressional direction and include decisionmaking at the department, mission area, and individual agency levels. The *USDA Science Blueprint*, released in 2020, presents a five-year vision for USDA science, including the REE agencies and science units of other USDA agencies outside of REE.[22] The multiyear strategic plans that individual agencies develop and publish provide an introduction to their research and agency operations. These plans identify goals, objectives, and performance measures for research and agency operations. In recent years, these plans include the ARS *2018-2020 Strategic Plan*,[23] the ERS *Strategic Plan: FY2013-2018*,[24] and the NASS *Strategic Plan: FY2020-2025*.[25]

Research Funding Considerations

Changing environmental, economic, and social conditions affecting our food system constantly challenge its ability to deliver abundant, high-quality, and safe foods to consumers. Agricultural research is designed to address questions of importance to consumers, farmers, ranchers, and other participants in the broader food system (e.g., food processors, exporters, manufacturers of farm machinery).

The way that the federal government funds agricultural research can influence who conducts research, where they conduct it, and what issues they address. Furthermore, the federal government is not the only funder of agricultural research. Research investments of the states, the U.S. private sector, and other countries also contribute to scientific discoveries. Collectively, these investments affect our ability to address food system challenges in the United States and the competitiveness of U.S. agriculture in a global context. How much and the type of funding the federal government provides can shape the U.S. agricultural research enterprise. Congress may choose to consider the amount of agricultural research funding it provides and the balance of funding among available options (e.g., capacity vs. competitive grants, intramural vs. extramural funding).

Capacity Grants Versus Competitive Grants

A topic of ongoing debate among policymakers and stakeholders is the balance of capacity grant funding of the LGU system versus competitive grant funding available to land-grant and other institutions and individuals. Those wanting to focus on agricultural research efficiency in the context of limited federal resources often call for more competitive grants. In contrast, those more concerned with sustained funding for institutions and a broad geographic distribution of research funding often prefer capacity grants.

[21] In FY2020, the intramural agencies received about $1.9 billion of the total $3.4 billion appropriated for REE.

[22] USDA, *Science Blueprint: A Roadmap for USDA Science from 2020-2025*, 2020, at https://www.usda.gov/sites/default/files/documents/usda-science-blueprint.pdf.

[23] ARS, *2018-2020 Strategic Plan*, at https://www.ars.usda.gov/ARSUserFiles/00000000/Plans/2018-2020%20ARS%20Strategic%20Plan.pdf.

[24] ERS, *Strategic Plan: FY2013-2018*, at https://www.ers.usda.gov/media/9361/strategic-plan-2013-18.pdf.

[25] NASS, *Strategic Plan: FY2020-2025*, at https://www.nass.usda.gov/About_NASS/Strategic_Plan/pdf/USDA_NASS_SP_FY20-25.pdf.

The current balance of USDA capacity and competitive grants has evolved over time. In 1972, the vast majority of USDA-funded extramural research was conducted at LGUs using capacity funds, compared with about 53% today. The National Academy of Sciences (NAS) published an influential report that year, arguing that the agricultural research of the prior several decades had become overly focused on applied research rather than cutting-edge basic research.[26] The report recommended shifting to more competitive funding, with the primary goals of increasing the scientific merit of federally funded agricultural research and increasing the flow of ideas between researchers and USDA. Congress authorized a competitive research grants program in the 1977 farm bill and authorized annual appropriations to increase annually, from $25 million in FY1978 to $50 million in FY1982 (P.L. 95-113, §1414). Enacted annual appropriations for this competitive grants program reached about $40 million in FY1989.

Following a series of advisory reports, Congress established NIFA in the 2008 farm bill (P.L. 110-246, §7511) as a newly reorganized agency to manage USDA's extramural programs. A 2000 NAS report examined the efficacy of the National Research Initiative Competitive Grants Program (NRI)—at the time, USDA's flagship competitive grants program.[27] USDA's Cooperative State Research, Education, and Extension Service (CSREES) administered NRI and all of USDA's competitive and capacity grant programs. Among the NAS report's recommendations was the creation of a new agency that would be solely responsible for administering USDA's competitive grants programs. A second report—released by a USDA task force in 2004—reiterated this recommendation. In the 2002 farm bill, Congress required USDA to convene a task force to "evaluate the merits of establishing one or more National Institutes focused on disciplines important to the progress of food and agricultural science."[28] This task force's report advocated for establishing a new USDA grant-making agency modeled on the National Institutes of Health and the National Science Foundation.[29] The report expressed that this agency should accomplish its mission primarily through administering competitive grants to support high-caliber, fundamental agricultural research.

In recent years, the debate over the optimal balance of competitive versus capacity-funded research has continued. In 2012, the President's Council of Advisors on Science and Technology (PCAST) recommended a continued focus on increasing the proportion of research funds awarded competitively, for both extramural and intramural research.[30]

Some view the choice of funding mechanism as important because it can influence who conducts the research, where it takes place, and what type of research is performed. On the one hand, some believe that the competitive, peer-reviewed process is advantageous because it draws on a wider pool of eligible candidates (e.g., grant recipients are not limited to land-grant institutions or

[26] National Academy of Sciences (NAS), *Report of the Committee on Research Advisory to the U.S. Department of Agriculture* (Washington, DC: National Academy Press, 1972).

[27] NAS, *National Research Initiative: A Vital Competitive Grants Program in Food, Fiber, and Natural-Resources Research* (Washington, DC: National Academy Press, 2000), at http://www.nap.edu/catalog/9844.html.

[28] P.L. 107-171, §7404. The task force was also required to review ARS.

[29] USDA, Research, Education, and Economics Task Force, *National Institute for Food and Agriculture: A Proposal*, July 2004, at http://www.ars.usda.gov/sp2userfiles/place/00000000/national.doc.

[30] President's Council of Advisors on Science and Technology (PCAST), *Report to the President on Agricultural Preparedness and the Agriculture Research Enterprise*, December 2012, at https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/pcast_agriculture_20121207.pdf. PCAST is an advisory board composed of individuals and representatives from sectors outside the federal government with diverse perspectives and expertise that advises the President on science, technology, education, and innovation policy. For more information on PCAST, see CRS Report R43935, *Office of Science and Technology Policy (OSTP): History and Overview*.

SAESs) and can engage the "best and brightest minds" in addressing challenges facing the agriculture sector, irrespective of their home institutions.

At the same time, others argue that capacity grants provide stable funding to institutions and allow for long-term research and planning that can yield needed agricultural insights.[31] Census-based formulas and nearly constant appropriations have meant that states receive a predictable allocation every year. Although federal capacity grants may provide a fraction of the total funding for the SAESs, SAESs traditionally use them to support staff salaries and the core ongoing research programs that underpin academic programs at many universities (**Figure 6**).[32]

Studies comparing capacity and competitive grants have shown that competitive grants tend to favor basic research, reach more nonland grant universities, and be concentrated among fewer states.[33] Generally, states with large agricultural production and top-ranked academic programs in biology and agricultural sciences are more competitive and receive larger shares of competitively allocated federal grants.

Other studies have indicated that federal capacity funding has a larger positive impact on agricultural productivity over the long-term than federal competitive grants.[34] These studies assert that the steady funding that capacity grants provide support core and foundational research and facilitate high-risk and long-term projects of national importance. They also assert that research addressing multidisciplinary problems and local, state, and regional concerns is typically underfunded in a national competitive-grant process. Many consider that such research areas are of critical concern and that research addressing them may yield a large net social payoff to the agricultural sector.

Extramural Versus Intramural Funding

Another consequential policy consideration is the balance of USDA extramural vs. intramural research funding. In recent years, approximately 45% percent of funds appropriated for the REE agencies has gone to NIFA, USDA's extramural funding agency. About 47% of the total has gone to ARS, USDA's principal in-house scientific research agency.

Many believe that intramural research at ARS allows the federal government to fill an important niche that is not met by industry or other institutions. Specifically, they believe that intramural research is best to address research problems of national and long-term priority. Such topics include adaptation to climate change and extreme weather events; conservation and improvement of plant and animal genetic resources; research and vaccine development for foreign animal diseases; and soil and water resource management. Addressing some of these topics, ARS

[31] For a NIFA-commissioned external evaluation of NIFA capacity funding, see S. Tripp et al., *Quantitative and Qualitative Review of NIFA Capacity Funding*, TEConomy Partners, LLC, March 2017, at https://www.nifa.usda.gov/resource/nifa-capacity-funding-review-teconomy-final-report.

[32] See Donald A. Holt, "Agricultural Research Management in US Land-Grant Universities – The State Agricultural Experiment Station System," in Gad Loebenstein and George Thottappilly (eds), *Agricultural Research Management*, 2007, Springer, Dordrecht.

[33] Kelly Day Rubenstein et al., "Competitive Grants and the Funding of Agricultural Research in the United States," *Applied Economic Perspectives and Policy*, vol. 25, no. 2 (2003), pp. 352-368.

[34] See Wallace E. Huffman et al., "Winners and Losers: Formula versus Competitive Funding of Agricultural Research," *Choices*, vol. 21, no. 4 (2006); and Wallace E. Huffman and Robert E. Evenson, "Do Formula or Competitive Grant Funds Have Greater Impact on State Agricultural Productivity," *American Journal of Agricultural Economics*, vol. 88, no. 4 (November 1, 2006), pp. 783-798.

manages the Long-Term Agroecosystem Research Network (LTAR)[35] and national collections of plant, animal, microbial germplasm (i.e., genetic resources).[36] ARS is to also manage the National Bio and Agro-Defense Facility (NBAF).[37]

On the other hand, some believe that ARS scientists have an unfair competitive advantage over other agricultural scientists who do not have an endowed source of support like the federal budget for core research expenditures. The intramural statistical and social science agencies—NASS and ERS—may not raise the same concerns, with their more limited budgets, staffing, and scopes.

Public Versus Private Funding

A recurring policy issue is whether the federal government is providing sufficient funding for agricultural research. A related concern is the role of publicly funded research within the context of all agricultural research performed with public and private funding.

Public funding for agricultural research—including funding from USDA, other federal agencies, and the states—has changed over time. It grew steadily from the 1950s to the late 1970s, when adjusted for inflation, and then remained relatively constant into the 1980s (**Figure 5**). Public funding rose from 1998 through 2001, at a time of budget surplus. In the wake of the terrorist attacks of September 11, 2001, supplemental funding for anti-terrorism activities added to federal funding of agricultural research in FY2002 (P.L. 107-117) and FY2003 (P.L. 108-11), although total public funding declined from previous years.[38] Overall public funding of agricultural research declined each year from 2002 to 2014, with the steepest declines from 2009 to 2010 and from 2012 to 2013, as Congress eliminated earmarks and cut federal spending through budget sequestration and other means.[39] As a result of a relatively flat or declining USDA research budget, funding from other federal agencies, such as NIH and NSF, has accounted for an increasing portion of federal support for agricultural research.

Research and development funds from private industry for agricultural research and food have grown since the 1970s, more than doubling between 2003 and 2014 (**Figure 5**). This funding includes investments in public-private partnerships that facilitate technology transfer and at the same time help to supplement federal and state research support. Over the long term, private-sector spending on agricultural research has continued to grow, while public spending has stagnated or declined in constant dollars.

[35] ARS, "The LTAR Network," at https://ltar.ars.usda.gov.

[36] ARS, "Genetic Resource Collections," at https://www.ars-grin.gov/Pages/Collections.

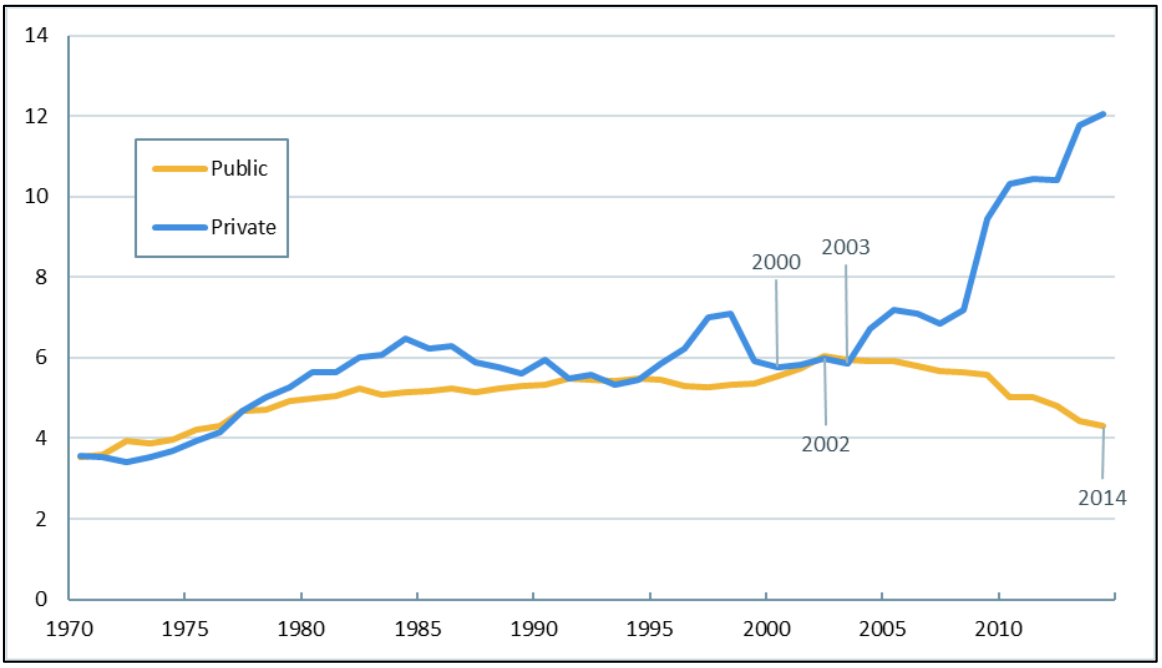
[37] USDA, "National Bio and Agro-defense Facility," at https://www.usda.gov/nbaf.

[38] P.L. 107-117 transferred funds from the Emergency Response Fund created in 2001 (P.L. 107-38) to various agencies, including USDA, in FY2002.

[39] Universities reported that sequestration negatively impacted their research, due to widespread delays and reduced activities. See Association of American Universities, Association of Public and Land-Grant Universities, and The Science Coalition, *Survey on Sequestration Effects—Selected Results from Private and Public Research Universities*, November 11, 2013, at https://www.aau.edu/key-issues/survey-sequestration-effects-selected-results-private-and-public-research-universities. Earmarks (congressionally directed spending) also were a common means of targeting agricultural research appropriations to specific universities or projects (see "Earmarks" in CRS Report R40721, *Agriculture and Related Agencies: FY2010 Appropriations*). Congressional Rules eliminated these after FY2010.

Figure 5. Inflation-Adjusted U.S. Public and Private Agricultural Research and Development Expenditures

1970-2014, in 2013 constant US$ (billions)



Source: CRS, from data provided at Economic Research Service (ERS), "Agricultural Research Funding in the Public and Private Sectors," accessed June 5, 2020, at https://www.ers.usda.gov/data-products/agricultural-research-funding-in-the-public-and-private-sectors.

Notes: ERS notes these data derive from the National Science Foundation, USDA's Current Research Information Systems, and various private sector data sources. Data are adjusted for inflation using an index for agricultural research spending developed by ERS. Data as of February 2019.

A chief concern some have about privately funded research is the extent to which novel research discoveries are shared. Another common concern is whether private funders would choose to fully develop research discoveries with the potential for large social benefits, but limited near-term profit potential.

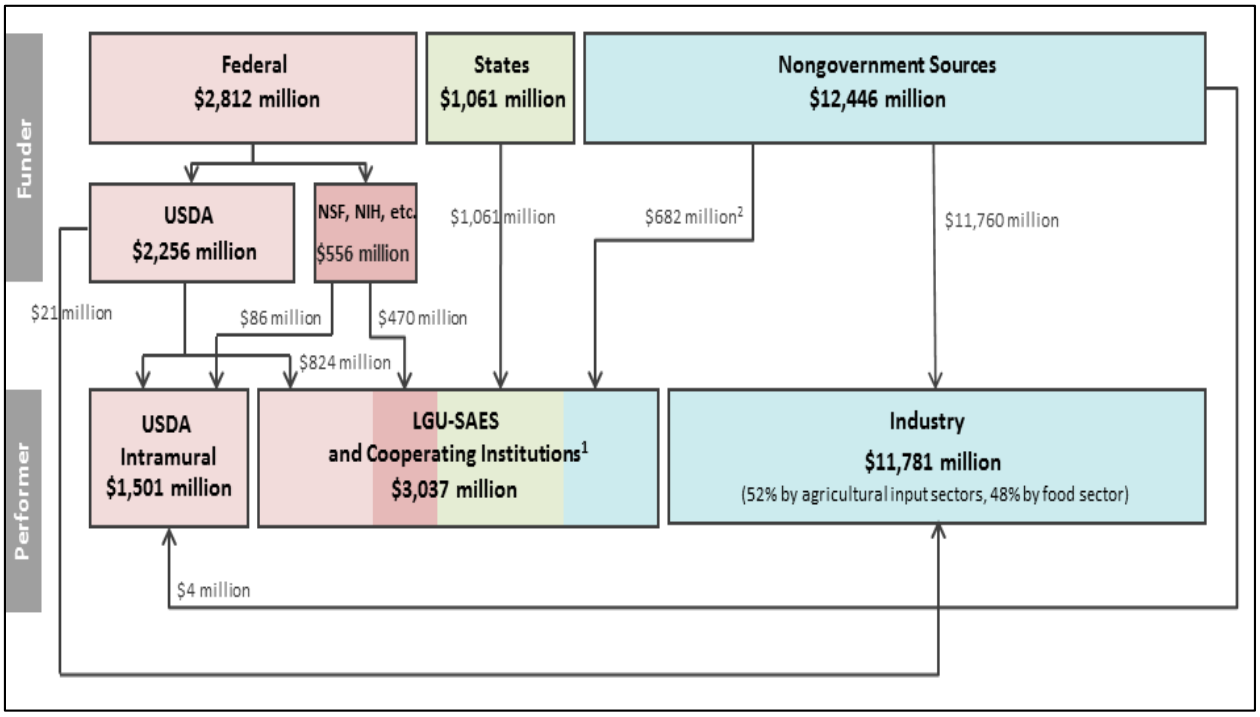
Figure 6 shows the many funders of agricultural research, the scale of their contributions, and the destinations for that funding, using 2013 data. In 2013, of the $16.3 billion of agricultural research funding, about 76% came from nongovernmental sources ($12.4 billion) and about 72% of the research and development performed with these funds was performed by industry ($11.8 billion). State governments passed through $1.1 billion to LGUs and SAESs.[40] The LGUs and SAESs received about 42% of their funding ($1.3 billion) from federal sources, including USDA, NSF, and NIH.[41] USDA intramural research by ARS, ERS, and NASS accounted for about 9% of total agricultural research spending in 2013.

[40] This is less than the $1.4 billion they provided in 2009.

[41] This accounting is for the research function only and excludes funding for extension and education.

Figure 6. Funders and Performers of U.S. Food and Agricultural Research in 2013

(dollars in millions)



Source: CRS, from Matthew Clancy, Keith Fuglie, and Paul Heisey, "U.S. Agricultural R&D in an Era of Falling Public Funding," *Amber Waves*, November 10, 2016, at https://www.ers.usda.gov/amber-waves/2016/november/us-agricultural-rd-in-an-era-of-falling-public-funding.

Notes: Funding data are for calendar year 2013. Includes research and development funding only; it does not include extension or education funding.

1. This category includes the 1862 and 1890 land-grant universities (LGUs) and State Agricultural Experiment Stations (SAESs); veterinary schools, forestry schools, and other U.S. colleges and universities receiving agricultural research funding from USDA. Data are based on 2013 state-level reporting (state reporting standards changed in 2010).
2. This amount ($682 million) consists of research grants and contracts from private companies; research grants from farm commodity groups, philanthropic foundations, individuals and other organizations; and revenue and fees from the sale of products, services, and technology licenses.

Some observers are concerned that both the increase in non-USDA public funding (e.g., NSF, NIH) and the increase in private funding might cause the focus of agricultural research to shift away from what some have traditionally considered the U.S. agricultural sector's highest priorities and needs.[42] They assert that such a shift could hamper the nation's ability to remain at the cutting-edge with regard to new innovations; to be competitive in a global market; and to cope with long-term challenges such as pest and disease outbreaks, climate change, and natural resource management. Some observers are also concerned about the decline in state funding of agricultural research. This decline has contributed to the overall decline in the share of public funding of U.S. agricultural research.[43]

[42] For an analysis of the different roles of public and private agricultural research, see John King, Andrew Toole, and Keith Fuglie, *The Complementary Roles of the Public and Private Sectors in U.S. Agricultural Research and Development*, ERS, Economic Brief (EB) 19, September 2012.

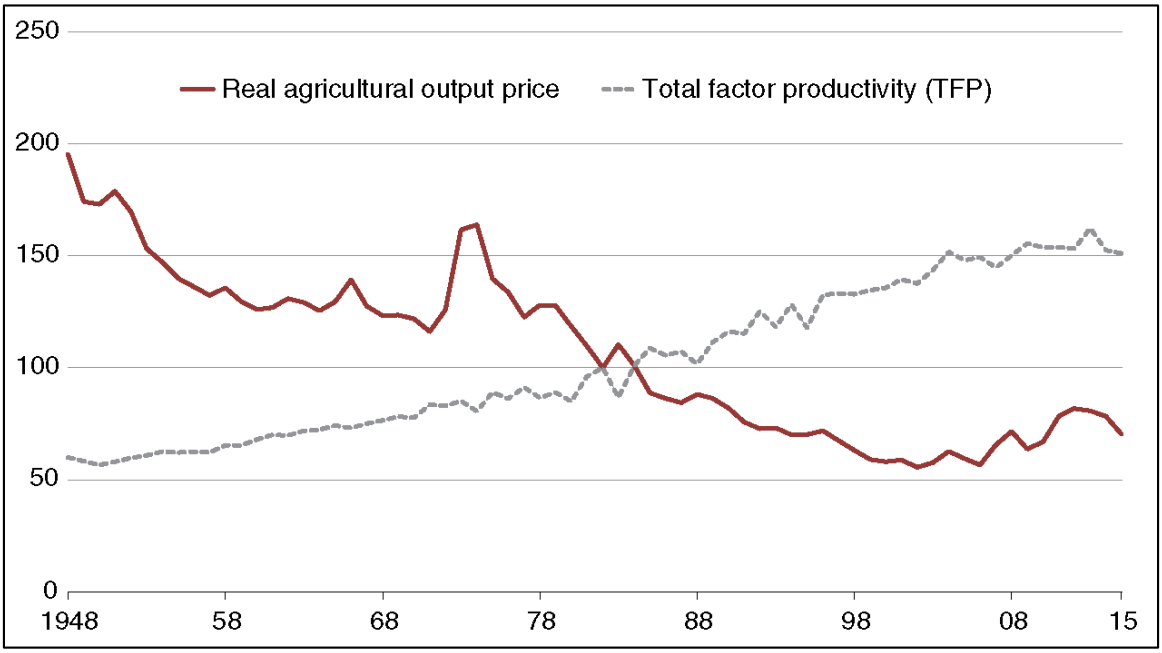
[43] See Matthew Clancy, Keith Fuglie, and Paul Heisey, "U.S. Agricultural R&D in an Era of Falling Public Funding,"

Irrespective of the amount of agricultural research funding, some analysts have noted that USDA's increased engagement with the private sector on research and technology transfer since the 1980s may fuel innovation and reduce redundancies.[44]

Agricultural Research Supports Productivity

Public investment in agricultural research has been linked to productivity gains and economic growth.[45] Studies have consistently reported high social rates of return on public agricultural research investments—on the order of 20%-60%.[46] The rate of return may depend on the type of research conducted (basic vs. applied), the duration of the research investment, and the specific topic under study.

Figure 7. U.S. Agricultural Productivity: 1948-2015



Source: Sun Ling Wang et al., *Agricultural Productivity Growth in the United States: Measurement, Trends, and Drivers*, ERR-189, Economic Research Service, July 2015.

Notes: Data are expressed with an index that is calculated relative to the data in 1982, where data in 1982 are set to equal 100. As shown, from 1948 to 2015, U.S. agricultural productivity continued to grow, while the real price of agricultural outputs tended to decline.

Amber Waves, November 10, 2016, at https://www.ers.usda.gov/amber-waves/2016/november/us-agricultural-rd-in-an-era-of-falling-public-funding/.

[44] Keith O. Fuglie and Andrew A. Toole, "The Evolving Institutional Structure of Public and Private Agricultural Research," *American Journal of Agricultural Economics*, vol. 96, no. 3 (January 20, 2014) pp. 862-883.

[45] Keith O. Fuglie and Paul W. Heisey, *Economic Returns to Public Agricultural Research*, ERS, EB-10, September 2007, at https://www.ers.usda.gov/publications/pub-details/?pubid=42827.

[46] *Social rates of return* compare the benefits (including economic benefits and gains to consumers and society at large) to public costs. Matthew Clancy, Keith Fuglie, and Paul Heisey, "U.S. Agricultural R&D in an Era of Falling Public Funding," *Amber Waves*, November 10, 2016, at https://www.ers.usda.gov/amber-waves/2016/november/us-agricultural-rd-in-an-era-of-falling-public-funding.

Agricultural economists assert that advances in agricultural research and extension were critical to the huge productivity gains in the United States after World War II.[47] *Total factor productivity* (TFP) is a key measure for overall agricultural productivity; it measures outputs (e.g., crop yields, labor productivity) per total unit of inputs (e.g., land, labor, fertilizers). ERS has estimated TFP of U.S. agriculture has increased an average of 1.38% annually from 1948 through 2015, compared to 0.1% annual growth of total inputs (**Figure 7**).[48]

Advances in basic and applied agricultural sciences—such as disease-resistant crop varieties, efficient irrigation practices, and improved marketing systems—are widely considered fundamental to increasing agricultural yields, farm sector profitability, competitiveness in international agricultural trade, and improvements in nutrition and human health.

Funding Agricultural Research: Looking Ahead

In a constrained budget environment, agriculture competes for federal funding against other federal priorities. Within the funding allocated for agriculture, agricultural research competes for funding against other agricultural programs, such as conservation, farm income and risk management programs, food safety inspection, rural development, and domestic and foreign food aid programs.[49] Historically, Congress has not solely prioritized funding for agricultural research, education, and extension activities but has also prioritized funding for programs designed to provide more immediate benefits to farmers, such as income support and crop insurance.

Stakeholders have varying perspectives on the needs for federal investments in agricultural research. Some want more public spending on agricultural research to maintain U.S. competitiveness and to increase agricultural productivity and innovation in the face of growing food demand and increasing agricultural challenges (e.g., pests, natural disasters).[50] Some argue that the stagnant growth in inflation-adjusted USDA funding for agricultural research, education, and extension over the past few decades has hindered the ability of the U.S. agricultural sector to stay productive and competitive.[51]

New innovations and technologies related to production, processing, marketing, and natural resource management are widely acknowledged as essential for continued productivity gains and economic growth of the sector. Some argue that agriculture has not achieved the same priority level with policymakers as other sectors, such as health, and that U.S. agriculture will suffer over the long term because of a lack of new innovations. These critics argue that the lack of public investment in new agricultural innovations will have dire consequences in the future, especially given new and varied challenges, such as rising production costs; new pest and disease outbreaks; increasing frequency of extreme weather events, such as droughts and floods; and climate change.

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[47] Sun Ling Wang et al., *Agricultural Productivity Growth in the United States: Measurement, Trends, and Drivers*, ERS, Economic Research Report (ERR) 189, July 2015, at https://www.ers.usda.gov/webdocs/publications/45387/53417_err189.pdf.

[48] Sun Ling Wang et al., ERR-189, 2015.

[49] See CRS Report R46437, *Agriculture and Related Agencies: FY2021 Appropriations*.

[50] For example, see Charles Valentine Riley Memorial Foundation and Iowa State University, *A Unifying Message: Pulling Together: Increasing Support for Food, Agricultural and Natural Resources Research*, 2018, at https://rileymemorial.org/files/files/RMF A Unifying Message Pulling Together June 2018.pdf; Supporters of Agricultural Research Foundation, "Why Support Ag Research," at https://supportagresearch.org/about/why-support-ag-research; and ERS, *Public Agriculture Research Spending and Future U.S. Agricultural Productivity Growth: Scenarios for 2010-2050*, EB-17, 2011, at http://www.ers.usda.gov/media/118663/eb17.pdf.

[51] See footnote 50.

In a step toward increasing innovation for agricultural research, the 2018 farm bill authorized a new Agriculture Advanced Research and Development Authority (AGARDA) pilot program (P.L. 115-334, §7132) at USDA to carry out innovative research and to develop and deploy advanced solutions to agricultural threats.[52] As of September 2020, this pilot program has not received appropriations.

In contrast to those calling for increased funding, some stakeholders argue that the federal government should have a limited role in funding agricultural research and that taxpayer dollars should not be used to support what they believe should be a private sector endeavor. Others believe that the states and the private sector should fill the research funding gap left by the federal government.

At the same time, while private sector funding has increased over time, some have expressed concerns that private sector funding focuses primarily on bringing existing technologies to market (i.e., more applied research) and does not focus on basic research to address challenges that the agricultural sector may face in the future, such as environmental sustainability or adaptation to climate change.

Finally, some advocates have argued that some of USDA's research portfolio duplicates private sector activities on major crops, including corn, soybeans, wheat, and cotton.[53] They argue that funding should be reallocated to basic, noncommercial research to benefit the public good that is not addressed through private efforts. Others point out that the major crops are economically important to the food, feed, and energy sectors and should continue to receive significant amounts of public funding, especially for emerging threats such as new pests and pathogens, limited water availability, and impacts of agriculture on human and environmental health.

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[52] See CRS In Focus IF11319, *2018 Farm Bill Primer: Agricultural Research and Extension*.

[53] PCAST, *Report to the President on Agricultural Preparedness and the Agriculture Research Enterprise*, December 2012, at https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/pcast_agriculture_20121207.pdf.

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