

Accelerating Economic Recovery Through Agricultural Innovation

Summary

- American agricultural innovation, which generates tens of thousands of jobs, is threatened by COVID-19, the economic downturn, and longstanding public underinvestment in research and development.
- Research labs and companies developing novel crop varieties, fertilizers, livestock feeds, alternative proteins, and other technologies are also essential to mitigating climate change and ensuring American leadership in emerging industries.
- Government support for basic and applied research efforts and early-stage startups at risk of failure, would accelerate innovation, protect existing jobs, and lead to new job growth.
 - \$300M for ongoing publicly funded R&D to cover COVID-related costs: 3.6+ thousand jobs
 - \$9.4B to cover the agricultural R&D facility maintenance backlog: 140+ thousand jobs
 - \$190M for new interagency research initiatives: 3.7+ thousand jobs
 - \$50M+ for mission-driven research at AGARDA: 600+ jobs
 - \$74M to incentivize private sector R&D through FFAR and SBIR: 650+ jobs

“The federal government should support agricultural R&D in order to continue rapid innovation and job growth in areas with large financial and environmental potential.”

AUTHOR



Dan Blaustein-Rejto

COVID-19 threatens to slow or halt agricultural innovation in the US.

Agricultural Research and Development (R&D) has improved the productivity, global competitiveness, and environmental sustainability of American farms. For example, since the 1960s, productivity advances have enabled farmers to reduce land use by 9% and cut the carbon footprint per pound of milk and chicken over 50%.¹ There are many opportunities for innovation to further reduce agricultural emissions. Beef production, nitrogen fertilizer, and dairy production — the largest sources of agricultural emissions — account for 2.1%, 2.1%, and 1.2% of total US greenhouse emissions, respectively.²

Yet state and federal funding for agricultural R&D has recently been stagnant or, by some measures, declining. On average, annual funding grew 2% between 1970 and 1995, but has since fallen about 1% annually.³ While privately funded R&D is also key for innovation and has grown enough to compensate for the decline in public funding, private R&D is not a substitute for public R&D.⁴ The private sector focuses on shorter-term, lower-risk R&D and on different topics than the public sector.⁵

COVID-19 is exacerbating the decline in public R&D and threatening private sector R&D as well. Research at universities, government labs, and companies has slowed down as labs have closed or downsized. In addition, venture capital funding for startups is falling, though lab, salary, and other expenses remain.

To ensure that promising research efforts, companies, and infant industries do not fail, it is critical to increase public R&D funding as well as incentives for private R&D investments.

ECONOMIC AND ENVIRONMENTAL IMPORTANCE OF AGRICULTURAL INNOVATION

Recent years have seen a boom in food and agricultural startups and research contributing to *sustainable intensification* — aiming to raise agricultural productivity while reducing environmental impacts. Particularly promising efforts have developed or seek to develop:

- Crops and livestock varieties that are higher yielding⁶ and more resilient to extreme weather.⁷
- Crop varieties that sequester at least 50% more carbon in soils than current varieties.⁸
- Microbial seed treatments and soil amendments that can increase yields on the order of 10%,⁹ reduce fertilizer application rates,¹⁰ and reduce both nitrate leaching and greenhouse gas emissions.¹¹
- Fertilizers made from clean energy¹² and fertilizer products that reduce fertilizer greenhouse gas emissions as much as 44%.¹³
- Alternative proteins such as plant-based and cell-cultured meat that pose less zoonotic disease, antibiotic-resistant bacteria, and food safety risks than conventional meat products, while also reducing greenhouse gas emissions.¹⁴
- Cattle feed supplements that could cut US beef and dairy methane emissions as much as 23% and 19%, respectively, while increasing animal yields.¹⁵

Startups working on these and other production-focused technologies attracted over \$1.5 billion (B) in investment in the US in 2019,^{16,17} contributing to the creation of tens of thousands of science and technology jobs related to agriculture and food.¹⁸ The sector is anticipated to continue growing. The agricultural biotechnology market, for instance, is projected to grow about 7-11% annually in coming years,¹⁹ while the precision farming industry is expected to nearly double in size.²⁰

COVID-19 IMPACT ON AGRICULTURAL INNOVATION

R&D, innovation, and industry growth related to sustainable intensification is slowing due to the pandemic.²¹

Research efforts at universities, government agencies, and companies have stalled, and some companies have laid off large shares of their employees.²²

- Many labs, ranging from those that develop microbe-based fertilizers to those breeding crops to sequester more carbon, have reduced staffing or shut down.²³
- Shortages of research equipment that are also used for healthcare have further delayed research projects.
- Startups are facing new difficulties in raising funds,²⁴ and Venture Capital (VC) funding is anticipated to further fall.^{25,26}
- If US VC funding drops as much as seed stage funding has globally,²⁷ it could wipe out \$550 million in investment for startups that are making products critical for sustainable intensification such as seeds, alternative proteins, fertilizers, farm software, and sensors.^{28,29}

Unless R&D funding and support is expanded labs may need to cancel research projects that could otherwise have given rise to innovative new technologies and companies. In addition, without expanding support for the private sector, including for R&D, companies may shut down and would-be entrepreneurs may not start new businesses. There are several ways the federal government should support agricultural R&D in order to continue rapid innovation and growth in areas with large financial and environmental potential.

STABILIZE AND STRENGTHEN EXISTING PUBLIC RESEARCH CAPACITY

Spend: \$9.7B
Jobs: 143,600-144,700³⁰

Publicly funded extramural research efforts were hamstrung by stagnant funding levels and deteriorating facilities before the crisis. Without additional funding, COVID-related research delays and shutdowns are further undermining research.

Providing supplemental appropriations of at least

\$300M to USDA research agencies would enable grant and contract-funded researchers to cover current expenses and restart projects. Multi-month lab closures have led to delays and potential cost-overruns in projects with a fixed amount of funding. Supplemental funds should be used to extend grant and contract funding, covering additional personnel and lab costs. Funds should also provide emergency relief to core facilities to maintain base operations, particularly in regions expected to re-open more slowly.³¹ This level of funding could support about 3,600-4,700 jobs in research and related roles. Many research efforts, such as those funded by AFRI's Plant and Livestock Production and Protection programs, are also key to enhancing agricultural productivity and environmental sustainability.

It is also important to fund the \$9.4B maintenance backlog for USDA Agricultural Research Service (ARS) facilities and agricultural schools at land-grant universities.³² Funding the backlog would:

- Reduce future research delays.
- Increase the effectiveness of other public R&D spending.
- Create over 140,000 jobs.³³

DEVELOP NEW INTERAGENCY RESEARCH INITIATIVES

Spend: \$190M
Jobs: 3,700-4,200

Developing new R&D initiatives focused on individual technologies would address long-standing research shortfalls, mitigate new COVID-related research slowdowns, and advance long-term sustainable intensification. New R&D efforts should target fields with long-standing research gaps that have been exacerbated recently, and that have high long-term economic and environmental potential.

Interagency research is necessary to effectively fund research in many fields given the wide range of scientific disciplines involved. Many agencies — particularly USDA, DOE, and NSF — fund and conduct active research on sustainable intensification. Coordinated interagency efforts, as the successful National Nanotechnology Initiative has shown, could reduce redundancy, cut costs, and improve agency productivity, while targeting research capacity toward promising industries.³⁴ New initiatives could include, among others:

1. **A \$50M “Alternative Protein Initiative” to build and maintain US leadership in the rapidly growing alternative protein industry.** By 2030 the industry could grow nearly ten-fold, generating as many as 1 million jobs globally. Public R&D investment would help ensure that nascent research efforts in the US continue, that a large portion of industry job growth occurs in the US, and that farmers who grow the crops used in new products benefit. Canada recently invested nearly \$110M USD, with a 1-to-1 private sector match, into a university-industry consortium focused on plant-based proteins. If a \$50M US effort had the same economic impact per dollar invested as the Canadian effort is projected to have, it would create over 2,000 jobs and add nearly \$1.5 billion to the US economy over 10 years.³⁵
2. **A \$50M “Cow of the Future Initiative” to establish US leadership in the nascent industry of products that can increase livestock productivity and reduce GHG emissions.** Many of the technologies are still under research, receive little public or private funding, and now are receiving less private funding due to the economic downturn.³⁶ Congress has previously appropriated funding for one particular cattle feed supplement — it should dramatically expand funding to explore additional feed and other livestock mitigation technologies. In addition to ensuring the nascent industry survives and substantially expands in the long-term, this would generate about 600-800 jobs in the near-term.³⁷
3. **A \$40M “Agricultural Nitrogen Initiative” to bring down the cost of new technologies that increase crop yields, reduce farmers’ fertilizer costs, and reduce nitrogen pollution.**

Despite promising advances and increasing demand from farmers for products that will help them cut fertilizer costs and more easily comply with environmental regulations, the fertilizer industry only spends about 0.2% of its \$20.5B revenue on R&D, orders of magnitude less than the seed industry’s 10-20%.³⁸ While there is currently relevant federal research funding, it is minimal and potentially duplicative.³⁹ For example, NSF, DARPA, and USDA have funded overlapping research on microbes that can deliver more nutrients to crops, and crops that fix their own nitrogen from the air, among other topics. Increasing annual federal R&D funding to \$40M, approximately matching current industry spending, would support foundational research in emerging fields. Besides benefits to farmers and the environment, this would generate about 500-600 jobs in the near term⁴⁰ and help position the US as a leader in the specialty fertilizer market, which is expected to grow globally by 50% from \$23B in 2018 to over \$38B in 2026.⁴¹

4. **A \$50M “Enhanced Root Systems Initiative” to enhance crop productivity and soil carbon sequestration.** New research efforts to enhance crop roots, if successful, could increase farmers’ soil quality and sequester hundreds of millions of tons of carbon dioxide-equivalent, enough to offset the majority of greenhouse gas emissions from US agriculture. A 2019 National Academies of Sciences, Engineering, and Medicine report estimated that \$40 to \$50M in additional funding is needed annually for approximately 20 years. This funding is all the more important now after COVID-19 has stalled efforts and threatened funding to private sector efforts. In addition to establishing the US as a leader in a potentially multi-billion industry, \$50M in funding would generate about 600-800 jobs in the near-term.⁴²

PURSUE MISSION-DRIVEN RESEARCH THROUGH AGARDA

Spend: \$50-400M, part of or in addition to new interagency initiatives

Jobs: 600-6,300, part of or in addition to new interagency initiatives

In addition to, or as part of, any large-scale inter-agency R&D initiative, Congress should appropriate at least \$50M for the Agriculture Advanced Research and Development Authority (AGARDA). The 2018 Farm Bill established AGARDA and authorized appropriations of \$50M per year between 2019 and 2023. AGARDA can fund grants and collaborative research between private and public entities, with the goal of spurring long-term, high-risk R&D that the private sector is unlikely to undertake.

The success of R&D efforts similar to AGARDA illustrate why a new agency is necessary. The Defense Advanced Research Projects Agency (DARPA) and the Advanced Research Projects Agency-Energy (ARPA-E), after which AGARDA is modeled, have been credited with laying the groundwork for the internet, GPS, systems for advanced nuclear reactors, and other innovative technologies. Like these agencies, AGARDA should be administered to be mission-driven — focused on achieving specific advances that require broader coordination and longer-term support than other agencies can support.⁴³

AGARDA's targets for R&D could include, among others:

- Developing carbon-neutral beef and dairy production systems that achieve cost parity with conventional systems.
- Developing crops that sequester 50% more carbon in the soil.
- Halving the average amount of nitrogen lost through crop nutrient management.
- Achieving price parity between conventional meats and plant-based products developed to be similar in taste, texture, and other characteristics.

To offset the slowdown in research at universities and private labs due to COVID-19 and to stimulate creation of new companies and jobs, Congress should consider providing additional one-time funding on the order of \$400M for AGARDA. In 2009, in the wake of the financial crisis, Congress appropriated one-time funding of \$400M to ARPA-E, infusing new funds into the clean energy industry when private capital availability had declined.

Congress could address the current drop in financing for R&D similarly, but should consider one adjustment: retaining equity in companies that receive particularly large support for R&D. This not only would help the government recoup spending, but also ensure that the public benefits from companies' success.⁴⁴

While the payoff from agricultural research investments today is unpredictable, past experience suggests funding AGARDA would have outsized job-created benefits. Government investment in mission-oriented innovation increases GDP approximately ten times more than non-R&D government spending, creating about \$9 in GDP per dollar spent.⁴⁵ Ultimately, funding of \$400M would generate about at least 4,900-6,300 new jobs for researchers, support staff, suppliers of scientific equipment, and others — a short-term estimate not accounting for the long-run economic benefits from R&D investment.⁴⁶

INCENTIVIZE PRIVATE SECTOR RESEARCH

Spend: \$74 M
Jobs: 650-750

To further restore and stimulate R&D spending, Congress should also create stronger incentives for the private sector to invest in R&D. Private sector spending on agricultural input R&D typically exceeds public agricultural R&D spending, making

it key to spurring innovation that in turn helps achieve many societal goals including agricultural decarbonization.⁴⁷

An effective way to incent greater private investment would be to authorize additional funding for the Foundation for Food and Agriculture Research (FFAR). FFAR, created in the 2014 Farm Bill, spurs development of public-private partnerships and consortia. By requiring at least a 1-to-1 match for all funding, FFAR leverages substantial non-federal funding — about 1.2 non-federal dollars for every 1 federal dollar — and ensures that R&D activities are commercially relevant.⁴⁸ Its funding has spurred the development of four new public-private consortia working on key long-term challenges livestock antibiotic use and has supported cutting-edge research demonstrating how to improve crop photosynthesis.⁴⁹ While FFAR was authorized \$185M in the 2018 Farm Bill, many agricultural economists argue that the country should double agricultural R&D funding in general.⁵⁰ Doubling FFAR funding would raise its average annual funding from \$37M to \$74M, generating 450-600 jobs in the short-term, and more if it induced new non-federal funding.⁵¹

In addition, doubling funding for food and agriculture companies through the National Food and Agriculture Initiative (NIFA) Small Business Innovation Research (SBIR) program, an increase of \$37M, would spur innovation and market expansion for the small businesses most impacted by COVID-19. SBIR acts as the federal government's seed fund for technology-intensive companies, providing early-stage grants through NIFA and other R&D agencies to small businesses to conduct R&D that has high potential for commercialization.

SBIR is highly effective in spurring innovation. Across NIFA and the other agencies that provide SBIR grants, grantees file about 10 patents per day,⁵² about 70% of projects likely would not have started without SBIR funding,⁵³ and 40-70% of projects reach the market.⁵⁴ The programs have a high ROI — upwards of \$19.50 in economic activity per \$1 invested.⁵⁵ There is good reason to increase program funding for all industries given the general downturn in seed funding and the program's high oversubscription rate — only 17% of Phase I grants are funded for instance. But

doubling agriculture-related SBIR funding alone could address the R&D financing gap for nearly 100 startups that might otherwise shutter,⁵⁶ and protect or create about 200 jobs in the near-term.⁵⁷ Related legislation proposed to increase small business R&D funding is the Small Business Innovation Voucher Act (S. 3289, H.R. 5348).⁵⁸

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