Why Fund Science?

The Science Coalition (TSC) is a nonprofit, nonpartisan organization of more than 50 of the nation's leading public and private research universities. Collectively, TSC members are dedicated to sustaining federal investment in fundamental scientific research as a means to stimulate the economy, spur innovation, and ensure that America continues to lead the world in innovation.

In a divisive political environment, investment in research is something everyone, regardless of party affiliation, can endorse. Our country's scientific enterprise has for decades been a powerhouse for innovation and economic prosperity. Importantly, it is not just research universities who understand this – voters agree. TSC polling shows nearly all voters (94 percent) believe the United States should be the global leader in scientific research and technology, and the majority (82 percent) approve of the federal government providing public funds to achieve this.

TSC members appreciate – as do the American people – that federal research investment can uniquely help solve society's most pressing problems. Cutting-edge advances in health care, energy innovation/sustainability, agriculture, and national security are underpinned by the special relationship between America's research universities and federal research agencies. What's more, there are few investments more catalytic for new industries, more jobs, and expanded economic growth than the basic science that enables discovery and development.

In short, protecting stable, predictable investment in fundamental research is one of the most impactful ways to secure America's continued leadership. During the upcoming campaign TSC urges candidates from all parties and ideologies to remember that fundamental science is central to progress on the issues most important to voters.

For more information on The Science Coalition, please contact tsc@sciencecoalition.org.

THE SCIENCE COALITION

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What is Fundamental Research?

Fundamental research, also known as basic research, is the foundation of all scientific and technological inquiry. It is curiosity-driven, meaning researchers are seeking to answer theoretical questions for the sake of building knowledge. Fundamental research is a precursor to applied research, which relies on knowledge gained from fundamental research to identify solutions for existing problems. In a nutshell, fundamental research generates new and unpredictable understanding about the world that can be pulled off the shelf – whether in one year or in 50 years – and plugged in to address contemporary challenges. Fundamental research is also synonymous with innovation – driving the creation of new industries, jobs, and economic activity that keeps the United States competitive.

Why Fundamental Research Matters

The importance of fundamental research cannot be overstated; it has led to discoveries with practical and groundbreaking applications in every field and sector. Here are just a few examples of modern technologies that have resulted from fundamental research:

- Global Positioning System (GPS)
- Baby Formula
- Lithium-Ion Battery
- Magnetic Resonance Imaging (MRI)
- Lasers
- Touch Screens

What begins as a broad research hypothesis often results in a discovery that underpins innovative new industries — ones that create jobs, improve daily life, and promote the workforce of the future. Beyond its capacity to enable life-improving discoveries across a variety of disciplines, federal investment in fundamental research has resulted in short- and long-term economic benefits by contributing to hundreds of thousands of jobs each year, which in turn generates billions of dollars in wages, taxes, and GDP growth.

What is the Federal Government's Role in Funding Fundamental Research?

Investment from the private sector in fundamental research is nominal because fundamental research does not immediately result in tangible outcomes and often requires a long timeline. Therefore, the vast majority of U.S. fundamental research is publicly funded through the federal government. Congress annually determines how federal appropriations are allocated among research agencies, who in turn use that investment to decide which projects at universities and colleges to finance – a process which effectively determines the scope and agenda for American science.

Federal research agencies, including the National Science Foundation, National Institutes of Health, and the Department of Energy, award millions of dollars in grant funding to university-based researchers conducting promising work on a variety of topics. History shows us innovation is not achieved by accident overnight; robust, predictable, and consistent annual federal investment in research is irreplaceable to sustain these projects, get new ones off the ground, and bolster the innovation ecosystem.

How Federal Government Funding Plays a Role in University Research

The partnership between federal research agencies and universities, fueled by robust federal research investment, is the linchpin that ensures fundamental research continues year after year and leads to discoveries that serve as the backbone of innovation. Overall, research universities perform more than half of U.S. fundamental research, making them the second-largest contributors to U.S. research and development. The majority of university research is fundamental (64%), compared to applied (26%), which is more typically funded by the private sector.

THE SCIENCE COALITION

THE LIFECYCLE OF A RESEARCH CAREER

Innovative discoveries, technological advancements, lifesaving treatments, and more all rely on a robust and sustained research workforce pipeline.

Whether a researcher chooses to enter academia, the private sector, or start their own company, funding for federal research agencies — which is decided by Congress on an annual basis — is key to attract, sustain, and maintain a research workforce that advances the boundaries of science while inspiring the next generation to follow in their footsteps. In fact, funding predictability is essential for future researchers to envision STEM as a viable career path.

But where do future scientists get started? The pathway to a career in STEM can begin as early as elementary school and continues to take shape through hands-on undergraduate, graduate, and postdoctoral experiences. Let's take a look at the many ways public-university partnerships play a role in advancing STEM careers and in turn support the more than 560,000-strong research workforce.

1 Exposure to STEM in elementary, middle, and high school plays an important role in cultivating future researchers and getting students excited about the possibility of a career in STEM. Once enrolled in a college or university, undergraduate research programs allow interested students to gain hands-on experience and explore areas of interest while demonstrating the variety of career opportunities in STEM.

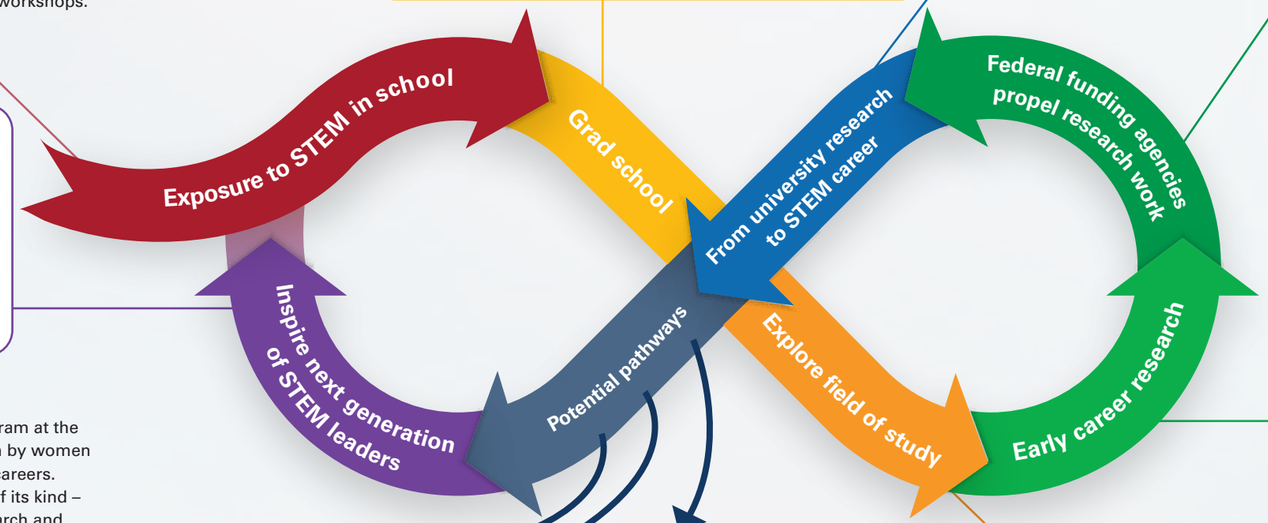
NIU Northern Illinois University's **Research Rookies** program is a yearlong opportunity tailored to undergraduate students interested in exploring a topic of research while gaining technical research skills and experience. Students serve as research assistants, establishing a working relationship with a faculty mentor, and participate in professional development workshops.

2 Next up – graduate school! In pursuing an advanced degree, future researchers get their first taste of a research career, crafting a compelling research question that will propel their course of study under the guidance of a faculty member. Graduate researchers will develop a proposal for a grant from a federal research agency and use the funding to conduct original research, establishing enduring relationships with federal agency partners that will benefit them throughout their careers.

6 Pathways from univerity research to STEM career include spinoff companies, private sector research, and building an academic career.

5 As researchers' careers progress, federal funding agencies continue to play an important role in propelling researchers forward and sustaining their work.

- NSF's **Mid-Career Advancement** program "enables a more diverse STEM workforce by facilitating research productivity and creativity from mid-career scientists and engineers."
- NIH's **Research Project Grant Program (R01)** is intended to "support a discrete, specified, circumscribed project to be performed by the named investigator(s) in an area representing the investigator's specific interest and competencies, based on the mission of the NIH."



7 Propelled by support and expertise from federal research agencies, the outcome of a research career — whether it's a groundbreaking discovery, mentoring a new generation of students interested in the STEM fields, or a spinoff company that underpins a local economy — makes funding from federal agencies an important contribution to the vitality and competitiveness of the American research enterprise.

4 Early career research programs sponsored by federal research agencies are crucial in easing the transition from graduate researcher to career researcher while strengthening the relationship between researcher and agency.

- The National Science Foundation's (NSF) **Faculty Early Career Development (CAREER) Program** supports "early-career faculty who have the potential to serve as academic role models in research and education and to lead advances in the mission of their department or organization."
- NASA's **Early Career Initiative** is "focused on professional development for early career scientists, engineers, and technologists."
- The Department of Energy's (DOE) **Early Career Research Program** "supports the individual research programs of outstanding scientists early in their careers and stimulates research careers in the disciplines supported by the DOE Office of Science."

3 At the end of grad school, graduate researchers publish the results of their work in peer-reviewed publications and, in some cases, apply for patents for their inventions or software. For those interested in gaining further experience in their field of study, some may enter a postdoctoral fellowship.

UNIVERSITY OF MICHIGAN

The **Women in Science and Engineering (WISE)** program at the University of Michigan works to increase the participation by women and gender minorities in STEM academic programs and careers. WISE – one of the first university programs in the world of its kind – received a Recognition Award for the Integration of Research and Education (RAIRE) from NSF.

A. Launch a spinoff company from research: Universities are a hotbed for innovation, and oftentimes, researchers will use the proprietary insights gained through their work to launch a spinoff company. The Science Coalition's **Sparking Economic Growth** reports chronicle a collective 355 spinoff companies born from federally funded university research, which together have generated billions of dollars in economic impact and support thousands of jobs nationwide.

UNIVERSITY of WASHINGTON

Dr. Josh Smith, the co-founder of **Jeeva Wireless**, a University of Washington spinoff, says NSF funding was "essential" to initiate the research that now underpins the company's ultra-low power communication technology. Between 2015 and 2019, Jeeva contributed over $20 million to U.S. GDP and supported more than 100 jobs across the supply chain.

B. Enter the private sector research workforce: Research experience is critical in the private sector, wherein trained STEM professionals drive advances in industry, contribute to the development of cutting-edge technology, and propel new innovations forward across disciplines.

Northeastern University · DARTMOUTH · UNIVERSITY of ROCHESTER

After completing his undergraduate degree at Northeastern University, PhD at Dartmouth College, and post-doctoral work at the University of Rochester, **Dr. Robert Perni** funneled his research expertise into his role as Vice President of Research and Development at IMTherapeutics, a company that develops oral drug molecules for autoimmune conditions. Over the course of his career, he has received grants from NIH and authored or co-authored more than 170 research publications.

C. Build an academic career: For those interested in conducting research in their field of choice for the long-term, academia is a natural fit. Principal investigators conduct their own research, much of which is funded by federal research agencies, instruct undergraduate, graduate, and postdoctoral researchers, and foster an intellectual environment on campus, inspiring the next generation of STEM talent.

HARVARD UNIVERSITY

Dr. Joanna Aizenberg is a pioneer in the fields of biomineralization and biomimetics and leads the Aizenberg Lab at Harvard University, where dozens of undergraduate and graduate students, post-docs, and research fellows conduct research on bioinspired materials design with support from numerous federal research agencies, including the Department of Defense, DOE, and NSF.

PRINCETON UNIVERSITY

With funding from the National Institutes of Health (NIH), Zemer Gitai, a Professor in the Department of Molecular Biology at Princeton University, oversees the **Gitai Lab**, which brings together undergraduate, graduate, and postdoctoral researchers from diverse backgrounds. They are studying how the cell biology of bacteria affects host-pathogen interactions to drive innovations in novel antibiotics.

CONCLUSION

Universities, federal research agencies, and Congress all play vital roles in increasing diversity in STEM fields to cultivate a robust talent pipeline to protect the legacy and promise of the American scientific enterprise.

When Congress passes robust and reliable annual appropriations for federal research agencies, it is an investment in economic growth, our country's global competitiveness, and the people who put the U.S. at the cutting edge (and keep us there).

THE SCIENCE COALITION

A Year of Innovation:
Catalyzing Research to Combat COVID-19

Since day one, member institutions of The Science Coalition have been working to combat the COVID-19 crisis from every angle. Using fundamental research as their foundation, university scientists and researchers jumped into action. With the aid of federal research agency partners and key federal investments, these researchers are forging new treatments, finding creative solutions to ever-changing problems, and working alongside public health officials to understand the long-term effects of the virus.

Boosting Testing Capacity

A team at **Indiana University** is developing a breathalyzer-like test to quickly detect COVID-19 by identifying the scent in breath altered by the virus. Using breath samples from people who have tested positive and negative for COVID-19, the researchers, who received funding through the National Science Foundation, are developing technology to test many individuals in a short amount of time, significantly curbing the spread of the virus.

A **UC Santa Cruz** researcher spearheaded the development of a new COVID-19 test that can provide results in less than 20 minutes. Using an optical biosensor to measure antibody levels in the blood, the test is quicker than other methods but maintains the "gold standard" of accuracy associated with slower tests. While the test cannot diagnose active infections, understanding antibodies in the immune system may help to establish a minimum baseline of antibody levels in order for an individual to be considered protected and assess the prevalence of infections across communities.

Supplying Medical Equipment

In response to the high demand for nasal swabs, a team of researchers at the **University of South Florida** designed, tested, and produced a 3D-printed nasal swab to be used for COVID-19 tests. The swabs have been shown to work just as well as regular nasal swabs in diagnosing the virus and were designed using FDA-approved surgical grade material. They could serve as a standard model for 3D printed swabs tests as health care systems across the country work to increase their testing capacities.

Mitigating the Spread

Princeton University scientists helped to conduct the largest COVID-19 contact tracing study, monitoring more than 500,000 people in India to understand the factors most affecting the virus's spread. The research found superspreaders, who represent only a small portion of total infections, posed the greatest risk, and children and young adults may be driving transmission. Additionally, the research found shutdown orders help to curb mounting cases, providing public health insights to inform future policy decisions. The work was supported by the National Science Foundation.

THE SCIENCE COALITION

Innovating Treatments

Stanford University researchers are developing a single-dose vaccine for COVID-19 that could be more easily stored and transported than current options. Pivoting their research from vaccines for HIV, Ebola, and influenza, the lab added the coronavirus spike protein to nanoparticles to form the basis for their vaccine. Some nanoparticle formulations can be kept at room temperature, so the potential vaccine could eliminate a significant barrier in delivering doses to low and middle income countries, curbing the pandemic worldwide.

With a funding grant from the National Institutes of Health (NIH), a team of researchers at **West Virginia University** will lead an eight-state consortium to broaden the National COVID Cohort Collaborative. The member states will provide patient registry data to create a large, granular dataset from which patient outcomes from various treatments can be assessed. The eight states selected to participate represent a cross section of patients varying in age, weight, socioeconomic status, and health care access. The resource will provide critical insights to curate personalized, lifesaving care protocols as NIH works to develop treatment regimens for COVID-19 across patient populations.

Designing Preventative Technology

Scientists at **Massachusetts Institute of Technology** transitioned their work on diagnostic algorithms to create an artificial intelligence model to distinguish asymptomatic individuals infected by COVID-19 from their healthy peers based on the sound of their cough. The model accurately identified 100 percent of people known to have COVID-19. The team is working to scale the technology into an app that people could use at home as a first step in identifying a potential infection.

Addressing Social Outcomes

Researchers at **Columbia University** conducted a study that analyzed New Yorkers' mobility during exponential growth periods of the COVID-19 pandemic, finding that low income populations and communities of color used the subway most often, increasing their risk of infection. The research, funded by the National Science Foundation, demonstrates how early mitigation efforts, including social distancing, compounded pre-existing health disparities among essential workers. Their findings will be an important consideration in future health policy as decision makers work to balance transmission risk with socioeconomic burdens.

Urban vegetation could slow the spread of COVID-19 by improving air quality and keeping people socially distanced, according to **Auburn University** researchers. Their study found areas with higher amounts of green space were associated with lower cumulative cases of COVID-19, suggesting smart planning for urban vegetation could be an important factor in mitigating future public health crises. The researchers also found urban vegetation had a positive impact on mental health.

April 2021 • Volume IV

SPARKING ECONOMIC GROWTH

How Fundamental Research Drives Economic Growth and Innovation

Analysis Conducted for
The Science Coalition
by FTI Consulting

THE SCIENCE COALITION

OVERVIEW

Fundamental research is where innovation begins. It is the foundation of all scientific progress — the pursuit of original, first-level knowledge that catalyzes advancements in science, technology, medicine, energy, and national security. For decades, federal agencies have led the way in fundamental research, awarding grants to innovative projects at colleges and universities, where much of this research takes place. Through this competitive process, federal dollars have supported — and continue to support — advances across industries, from chemical manufacturing to telecommunications to behavioral sciences and myriad others.

To understand the economic impact of fundamental research investment, FTI Consulting (FTI) analyzed the research expenditures of members of The Science Coalition (TSC), a non-profit, nonpartisan organization of more than 50 of the nation's leading public and private research institutions between 2015 and 2019. FTI also examined the impact of select "spinoff" companies rooted in the federally funded research conducted at TSC universities. FTI found that as a result of the long-term federal investment in fundamental research, new innovations, businesses, and jobs are created, all of which transform daily life for millions of people in communities across the country.

Spinoff companies have vast supply chains that have resulted in economic footprints beyond the states they are based in. The surveyed companies contributed more than $1.3 billion toward the U.S. Gross Domestic Product (GDP) between 2015 and 2019 and supported nearly 100,000 jobs across the nation. An important note: this work represents just a fraction of the economic benefits created through federal funding for fundamental research. What begins as a broad research hypothesis often results in a discovery that underpins innovative new industries — ones that create jobs, improve daily life, and promote the workforce of the future. The return on investment in fundamental research has also been made abundantly clear over the last year as the world grappled with the COVID-19 pandemic. Thanks to decades of work conducted by universities and their federal research agency partners, innovations like vaccines, treatments, and emergency medical equipment were created at a breakneck pace. As the U.S. economy recovers from subsequent economic fallout of the pandemic, fundamental scientific research will continue to play a pivotal role, sparking economic growth in countless ways and at every level of the supply chain.

Much of today's fundamental scientific research would be impossible without strong federal investment. And if we have learned anything over the past year, it is that good things take time. Now is the time to redouble our commitment to federal investment in fundamental research to ensure the American scientific enterprise, and the workforce that serves as its backbone, remains strong, capable, and ready to address the nation's most pressing issues.

KEY FINDINGS

- The 53 companies highlighted in this report **contributed more than $700 million** to the U.S. Gross Domestic Product (GDP) between 2015 and 2019.
- These companies **attracted more than $830 million in research grants** from both public and private sources.
- Research grants enabled these companies to **support 9,300 direct jobs nationally**, contribute $729 million to the U.S. GDP, and pay $115.3 million in federal taxes and $42.9 million in state taxes, all while conducting innovative research and developing new products.
    - **The 49,240 operations jobs and 48,080 research jobs** created or supported by the research expenditures **translates to $1.3 billion in federal tax revenues and $430 million in states tax revenues.**

Research grants enabled these companies to support 9,300 direct jobs nationally, contribute $729 million to the U.S. GDP, and pay $115.3 million in federal taxes and $42.9 million in state taxes, all while conducting innovative research and developing new products.

- The companies are based across the country and vary in size, operating with as few as one to as many as 252 direct employees.
- **The 53 companies in the sample were based in 12 states but provided direct and indirect employment throughout all 50 states**. The companies provide opportunities for economic growth and development both in the states where they are based and across the country. They are only a snapshot of the almost incalculable contributions that fundamental research makes to the U.S. economy and society.
- **These companies span industries**, including science, technology, engineering, and math (STEM) fields like advanced manufacturing, as well as industries like education, language, energy, environmental remediation, and more. There is truly no limit to science's ability to solve problems and spur economic growth.
- These companies help to **create and bring to market the next generation** of therapeutics, electronic devices and services, software, analytics, trainings, education, and other professional services.

CONCLUSION

Federal fundamental research investment enables universities and research institutions to make discoveries that serve as the backbone of all critical innovations.

By performing close analysis of the economic outcomes of the fundamental research supported by public and private research institutions and related companies, FTI found that fundamental research also leads to millions of dollars in economic activity, thousands of jobs, and boosts economies across the country. In short, federal sponsorship of fundamental research is an investment that provides returns many times over.

The economic benefits of fundamental research are routinely undercounted and the prevailing wisdom that fundamental research has lesser short-term economic benefits is often erroneous. Over just a five-year period, the 53 spinoff companies sampled here have attracted over $830 million in research grants which in turn supported more than 9,000 jobs nationally and contributed $729.0 million to the U.S. GDP, with some companies contributing hundreds of millions in GDP individually. The companies have also paid $115.3 million in federal taxes and $42.9 million in state taxes and, through both indirect and induced effects, many of them created jobs and supported the economies of states they were not based in.

Our findings regarding the economic impact of this sample of companies further prove that federally funded fundamental research has a phenomenal return on investment—both short- and long-term—and that it will be key to revitalizing the economy. By increasing investment in R&D, the federal government could catalyze job growth and increase tax revenues, two outcomes critical to recovering from the economic fallout of the COVID-19 pandemic. According to an analysis by Breakthrough Energy, if the U.S. increased R&D spending to about $315 billion per year by 2030, federal R&D spending could support 3.4 million jobs, $301 billion in labor income, and $81 billion in tax revenue.[34]

As our society and economy recover from the COVID-19 pandemic, it is crucial we prioritize the long-term fundamental research that has allowed us to not only support local economies through job and company creation, but also has supported innovations to combat the pandemic. Thanks to decades-long federal investment in fundamental research, the groundwork was laid for innovations to combat the pandemic, including vaccines and treatments, at a record pace. We cannot let up now. Congress must redouble its commitment to providing predictable, sustained, and robust federal investment in fundamental research to support economic recovery and growth and secure our position as a leader in innovation on the global stage.

THE SCIENCE COALITION

The National Science Foundation:

70 Years of STEERING THE FUTURE of Fundamental Science

70th PLATINUM ANNIVERSARY

WHAT DOES NSF DO?

In 2020, the National Science Foundation (NSF) celebrates its 70th anniversary, also known as the "platinum anniversary." As platinum is a catalyst in chemical reactions, NSF is a catalyst for scientific innovation as it is the only federal agency to support fundamental research in all fields of science and engineering.

Since its founding in 1950, the independent federal agency has promoted the progress of science, advanced the country's prosperity, welfare, and health, and secured the nation. The agency's focus to **advance knowledge and unearth discoveries for the benefit of society** has charted the course of American innovation.

NSF invests in the studies that underpin our economy, including **"high-risk, high pay-off"** ideas, novel collaborations, and numerous projects that may seem like science fiction today, but will shape our future in meaningful ways.

WHY DOES NSF MATTER?

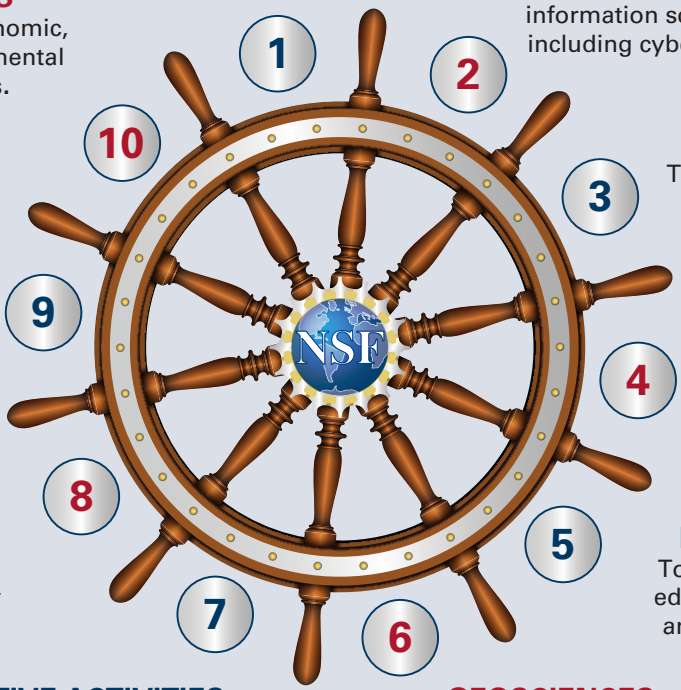
Since its inception, NSF has been a unique federal agency in the way it operates from the bottom up. Officials work closely with the research community to identify cutting-edge opportunities and monitor the areas of research most likely to result in progress.

WHAT SCIENCE DOES NSF FUND?

BIOLOGICAL SCIENCES
To enable discoveries for understanding life.

COMPUTER & INFORMATION SCIENCE & ENGINEERING
To investigate computer and information science and engineering, including cybersecurity and big data.

SOCIAL, BEHAVIORAL & ECONOMIC SCIENCES
To understand how social, economic, political, cultural, and environmental forces affect people's lives.



EDUCATION & HUMAN RESOURCES
To achieve excellence in U.S. science, technology, engineering, and math (STEM) education at all levels.

MATHEMATICAL & PHYSICAL SCIENCES
To harness the collective efforts of the math and physical sciences communities to address the most compelling scientific questions, educate the future workforce, and promote discoveries to meet the needs of the nation.

ENGINEERING
To enrich the understanding of natural systems, enhance electronics, and fortify the nation's infrastructure.

INTERNATIONAL SCIENCE & ENGINEERING
To promote innovation through access to international knowledge, infrastructure, and capabilities.

ENVIRONMENTAL RESEARCH & EDUCATION
To advance environmental research, education, and scientific assessment, and to determine the best means of implementing related activities.

INTEGRATIVE ACTIVITIES
To lead and coordinate strategic programs and opportunities across disciplinary boundaries.

GEOSCIENCES
To expand our knowledge about the processes that affect the global environment including the atmospheric, earth, ocean, and polar sciences.

THE SCIENCE COALITION

A Majority of American Voters Support Federal Investment in Science

KEY TAKEAWAYS FROM TSC'S 2018 POLL

A majority of Democratic and Republican voters believe that investment in scientific research should be a priority for the U.S. federal government.

82% of voters approve of the federal government **investing taxpayer funds** in scientific research.

- 77%
- 87%
- 79% I

Since 2015, more women and Republican voters have increased their support for federal investment in scientific research.

- 36% more stay-at-home moms
- 34% more midwestern voters
- 32% more Republican base voters

60% of voters feel strongly that the federal government should **invest more** in scientific research.

- 45%
- 75%
- 56% I

72% of voters feel that scientific research **helps grow** the U.S. economy.

- 69%
- 78%
- 62% I

94% of voters believe it is important for the United States to be the **global leader** in science and technology.

- 95%
- 96%
- 89% I

Voters' views about the importance of the United States being the global leader in scientific research and technology are on the rise. Today, 61% of voters say it is "very important" compared to 48% in 2015.

The most important contributions science makes to the U.S. economy and society are:

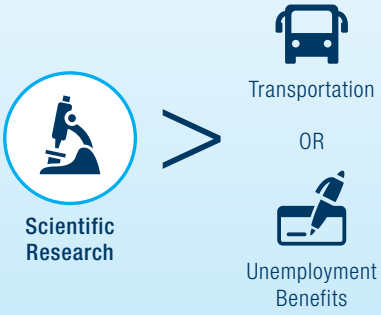
(when ranked by personal importance)

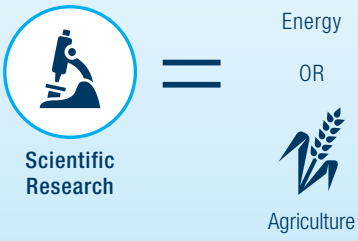
1. developing **new medicines** and curing diseases
2. developing **new energy technologies**
3. identifying the best ways to protect our **environment**
4. developing new **national security technologies**
5. creating new technologies for **business/job growth**
6. keeping America competitive in a **global economy**
7. exploring and better **understanding the world** in which we live
8. exploring **space**

WHEN RANKING

FEDERAL FUNDING PRIORITIES,

VOTERS THINK...





The Science Coalition (TSC) is a nonprofit, nonpartisan organization based in Washington, D.C., comprised of more than 50 of the nation's leading public and private research universities. Serving as a public affairs organization, we are dedicated to promoting the need for sustained federal investment in basic or fundamental scientific research. To learn more about public support for federal investment in scientific research, visit **www.sciencecoalition.org.**

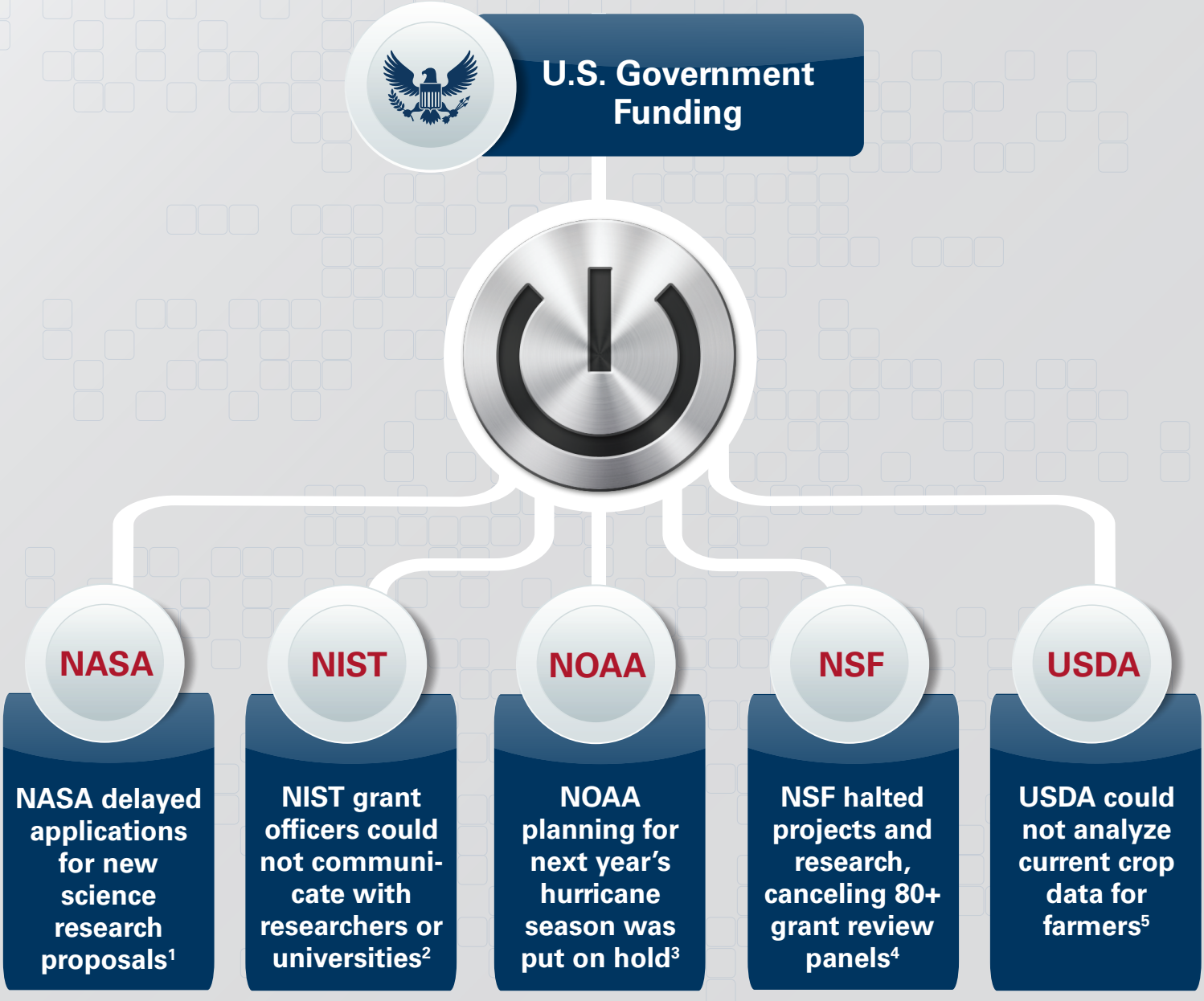
THE SCIENCE COALITION

THE SCIENCE COALITION

Funding Instability Hurts Scientific Research

At least $1.3 BILLION* in funding for fundamental science research and projects was on hold because of the government shutdown.

Even though the shutdown has ended for now, its lingering costs to research are still being felt. Federal research agencies will take time to get back up to speed, halting university projects for weeks or even months to come.



*Based off FY18 estimates for January

To learn more about the real cost to science, visit sciencecoalition.org

Universities Caught in the Middle

Bloomberg

Shutdown Damage Will Persist Long After U.S. Government Reopens

January 28, 2019 – "The government may be reopening, but the consequences of the longest federal shutdown in U.S. history are likely to linger for national parks, forests, the federal workforce and cutting-edge scientific research. Some may even be permanent…The shutdown forced a weeks-long closure of the National Science Foundation, a hub for research grants. The NSF canceled more than 80 review panels, in which specialized scientists grade applications and decide what research grants to fund, covering everything from molecular biology to cyber infrastructure. Because the upcoming calendar is jam-packed, rescheduling the sessions and clearing the mounting backlog could take months..."

Science

End of U.S. Shutdown Won't Mean Return to Business as Usual for Research Agencies

January 25, 2019 – "The agencies that conduct or fund research that have been mostly closed since 22 December 2018 include NASA, the National Science Foundation (NSF), the U.S. Department of Agriculture, the Food and Drug Administration, the National Oceanic and Atmospheric Administration, and the National Institute of Standards and Technology…Once their doors are open, however, there will be a staggering amount of work waiting to be done."

POLITICO

Shutdown Forces Universities to Scramble for Absent Research Dollars

January 25, 2019 – "Colleges across the country are fronting the money — in some cases, millions — to keep federally funded research projects running. And some may soon have to think about pulling the plug as the longest-ever shutdown drags on, shuttering many of the key agencies that fund university research, including the National Science Foundation, NASA and the U.S. Department of Agriculture. The damage could be long lasting, potentially including job cuts."

TwinCities BUSINESS

The University of Minnesota is Losing More Than $500K Every Day During Government Shutdown

January 21, 2019 – "The expenses derive from the nearly 1,300 awards that University of Minnesota researchers rely on for projects. These awards come from different agencies, including the National Science Foundation, NASA, the U.S. Department of Transportation, the Environmental Protection Agency, and more."

Daily Camera

Concern Over Shutdown Mounting at CU Boulder, Where Majority of Research Funding Comes from Federal Government

January 18, 2019 – "Last year CU received about $369 million, or 72 percent, of its research funding from the federal government, according to the university…Graduate students working in joint programs with federal labs are among those affected, as well as CU researchers who are funded through federal grants."

abc

Web Exclusive: Government Shutdown Disrupting University Research

January 17, 2019 – "The university receives 50-60% of its research funding from the federal government. Rulli [Associate Vice President for Research at Notre Dame] says that 30% of all research funding is impacted by the shutdown, specifically from agencies including the National Science Foundation, NASA, and the National Endowment for the Humanities."

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[1] https://www.theverge.com/2019/1/29/18202071/nasa-government-shutdown-recovery-backpay-contractors
[2] https://www.commerce.gov/sites/default/files/2018-12/DOC%20Lapse%20Plan%20-%20OMB%20Approved%20-%20Dec%2017%2C%202018.pdf
[3] https://www.miamiherald.com/news/local/environment/article224016445.html
[4] https://www.bloomberg.com/news/articles/2019-01-28/shutdown-damage-will-persist-long-after-u-s-government-reopens
[5] https://www.foodingredientsfirst.com/news/us-government-shutdown-fda-and-usda-feel-the-squeeze-as-key-services-come-under-threat.html

EVERYDAY TECHNOLOGIES FROM **FUNDAMENTAL RESEARCH**

Federal funding for fundamental research has led to humankind's most groundbreaking discoveries, from the Internet to DNA fingerprinting. Fundamental research touches our lives in a myriad of ways. Here are some ubiquitous technologies – thanks to decades of fundamental research – that make our everyday lives better.

LASER:

Building off work funded by the **Air Force Office of Scientific Research (AFOSR)**, researchers at **Columbia University** drew from Albert Einstein and Wolfgang Paul to create the "maser," laying the groundwork for the laser itself in 1960.[1] Since its inception, the laser has been the basis for a long list of modern technologies, from the DVD player[2] to life-saving medical treatments.[3]

GLOBAL POSITIONING SYSTEM (GPS):

After Sputnik's launch, researchers at the **Massachusetts Institute of Technology (MIT)** and **Johns Hopkins University** determined the satellite's exact location through the Doppler effect.[4] With this observation, and the creation of atomic clocks at the **National Institute of Standards and Technology (NIST)**,[5] the **Department of Defense (DOD)** and Johns Hopkins University developed Transit, the first global satellite navigation system and precursor to the modern GPS.[6]

BABY FORMULA:

While prepping for a Mars mission, research funded by the **National Aeronautics and Space Administration (NASA)** uncovered algae rich in omega-3 fatty acid, a nutrient in breast milk that helps brain function. That ingredient has since been added to more than 90% of infant formula brands on the market as an enriched supplement.[7]

LITHIUM-ION BATTERY:

Based on fundamental research in the 1950s in lithium chemistry,[8] and supported by advances in the **Department of Energy's (DOE) Office of Basic Energy Sciences (BES)**, lithium-ion batteries now power everyday machinery and act as a viable solution to grid-scale energy storage.[9]

MAGNETIC RESONANCE IMAGING (MRI):

Researchers at **Stanford University** and **Harvard University** laid the groundwork for the MRI in 1946 when they discovered the phenomenon of nuclear magnetic resonance. Through the 1990s, the **National Science Foundation (NSF)** and the **National Institutes of Health (NIH)** committed substantial funding to ensure the MRI could be developed into the widely used diagnostic tool it is today.[10]

TOUCH SCREEN:

Originally used for air traffic control, the first touch screen was invented in the 1960s with indium tin oxide – a compound crucial to electric conductivity.[11] Today's touch screen emerged years later from a **National Science Foundation (NSF)**-funded project at the **University of Delaware**, when researchers searched for a no-pressure keyboard.[12]

THE SCIENCE COALITION

Learn more about America's investment in fundamental research at our website:
www.sciencecoalition.org

RESOURCES

1. http://www.au.af.mil/au/awc/awcgate/ndu/spawned_by_basic_research.pdf
2. http://www.innovationtaskforce.org/NewSite/wp-content/uploads/2012/08/scientific_research_2012.pdf
3. http://www.nasonline.org/publications/biographical-memoirs/memoir-pdfs/townes-charles.pdf
4. https://www.nap.edu/read/9479/chapter/4
5. https://www.nist.gov/pml/time-and-frequency-division/time-services/brief-history-atomic-clocks-nist
6. https://www.darpa.mil/about-us/timeline/transit-satellite
7. https://spinoff.nasa.gov/Spinoff2008/ch_8.html
8. https://physicstoday.scitation.org/doi/pdf/10.1063/PT.3.3296
9. https://science.energy.gov/~/media/bes/pdf/BESat40/BES_at_40.pdf
10. https://www.nsf.gov/about/history/nifty50/mri.jsp
11. https://arstechnica.com/gadgets/2013/04/from-touch-displays-to-the-surface-a-brief-history-of-touchscreen-technology/
12. http://www1.udel.edu/udaily/2014/may/nai-fellows-052714.html

THE SCIENCE COALITION

From the surface of the sun to the depths of the ocean floor

THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

WHAT NOAA DOES:

The National Oceanic and Atmospheric Administration (NOAA) was established in 1970 to understand and predict changes in climate, weather, oceans, and coasts, share that knowledge and information with others, and conserve and manage coastal and marine ecosystems and resources.

WHY NOAA MATTERS:

Our physical world is rapidly changing, and the research conducted at NOAA is vital to predict, protect, manage, and mitigate changes in the environment affecting our daily lives.

Through weather, climate, and storm forecasting, NOAA researchers provide reliable information to people, planners, and emergency personnel so they have the most up-to-date data when making crucial decisions.

Along with cutting-edge research and technology, NOAA's research supports marine commerce and coastal restoration, and its products and services affect more than one-third of the United States' GDP.

NOAA AND FUNDAMENTAL RESEARCH:

NOAA has strong partnerships with our nation's universities, providing grants to support research across a variety of physical sciences, including climate, weather, and marine ecosystems.

Some programs include:

CLIMATE PROGRAM OFFICE: Advances our understanding of the planet's climate system and fosters application for risk management and adaptation efforts.

Example: Researchers at Northeastern University studied the effects of climate change on fisheries to better inform decision-making and plan for future coastal sustainability.[1]

SEA GRANT: Supports research to create and maintain a healthy coastal environment and economy.

Example: The Ohio State University researchers are reducing and mitigating harmful algal blooms to protect Lake Erie.[2]

NATIONAL OCEAN SERVICE: Supports our coasts and oceans through science-based solutions to address economic, environmental, and societal pressures.

Example: The University of Washington houses the Northwest Association of Networked Ocean Observing Systems, which maintains a fleet of real-time sensors, monitors, radars, and buoys across the Northwest to track ocean conditions that benefit the commercial fishing industry, first responders, shellfish growers, native tribes, and more.[3]

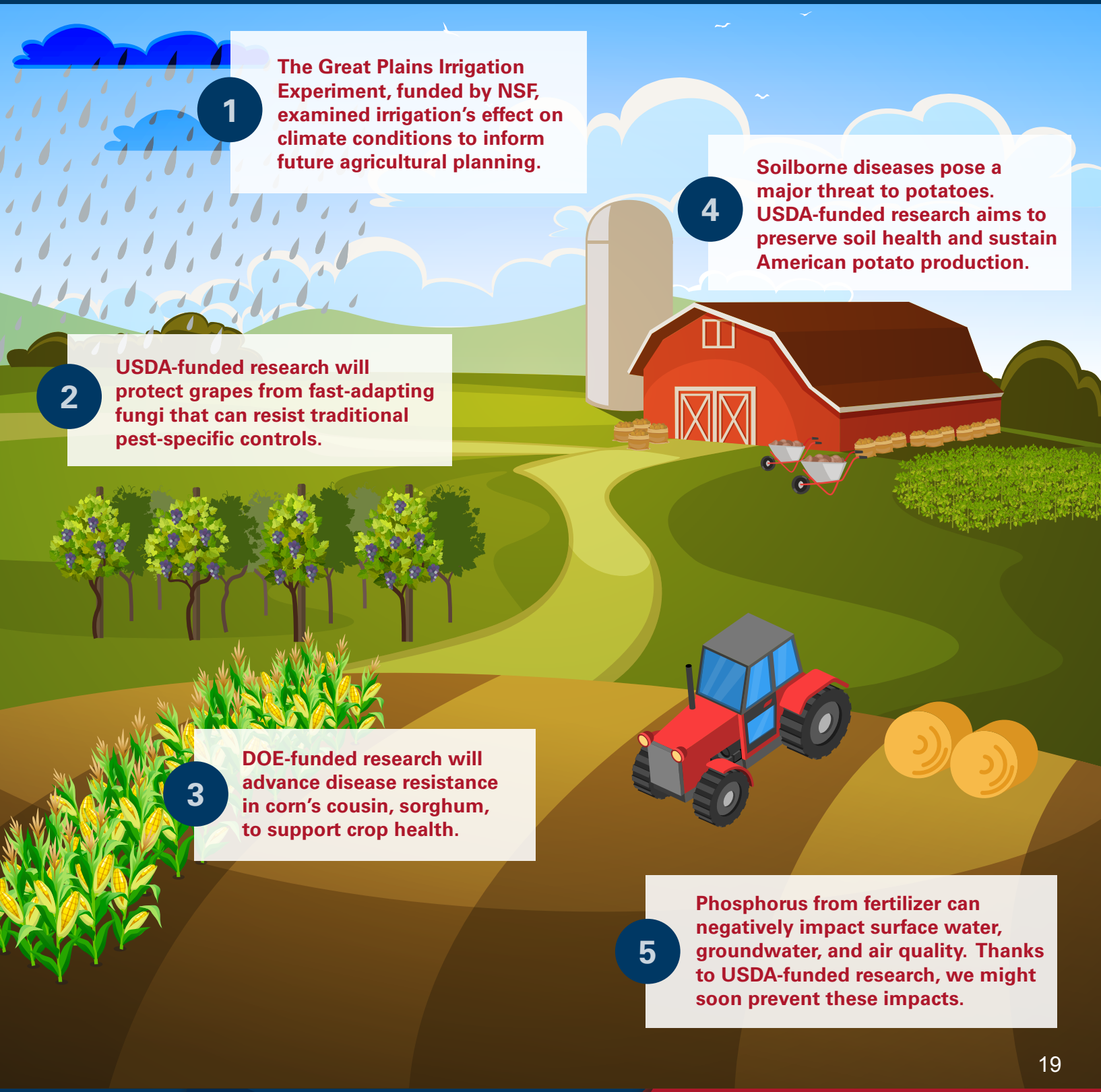
1 https://cpo.noaa.gov/Meet-the-Divisions/Climate-and-Societal-Interactions/COCA/Climate-Fisheries/Funded-Projects?udt_7674_param_orderby=Lead_x0020_PI&udt_7674_param_direction=descending
2 https://ohioseagrant.osu.edu/research/issues/habs
3 http://nvs.nanoos.org

THE SCIENCE COALITION

THE FUTURE OF FARMING

How Federally-Funded Fundamental Research Is Planting The Seeds For Innovation In Agriculture

November 2018



1. The Great Plains Irrigation Experiment, funded by NSF, examined irrigation's effect on climate conditions to inform future agricultural planning.

2. USDA-funded research will protect grapes from fast-adapting fungi that can resist traditional pest-specific controls.

3. DOE-funded research will advance disease resistance in corn's cousin, sorghum, to support crop health.

4. Soilborne diseases pose a major threat to potatoes. USDA-funded research aims to preserve soil health and sustain American potato production.

5. Phosphorus from fertilizer can negatively impact surface water, groundwater, and air quality. Thanks to USDA-funded research, we might soon prevent these impacts.

SCIENCE MATTERS

To learn more about how federally-funded fundamental research improves lives, visit **www.sciencecoalition.org**.

1 UNIVERSITY OF NEBRASKA

The Great Plains Irrigation Experiment at the University of Nebraska-Lincoln—funded by the National Science Foundation (NSF)—will help Americans better understand how irrigation affects climate conditions and will inform future agricultural planning and weather forecasting.

2 WASHINGTON STATE UNIVERSITY

With support from the U.S. Department of Agriculture's (USDA) National Institute of Food and Agriculture (NIFA) Specialty Crop Research Initiative, researchers at Washington State University will seek to improve how we detect and predict how harmful fungi develop resistance to traditional pest-specific controls. Based on the results, these findings could be applied to all specialty crops—from apples and cherries to hops and potatoes—and prevent damage from fungi.

3 UNIVERSITY OF ILLINOIS

Corn is an American staple, but research into its cousin—sorghum—might hold the key to more stable crops in the future. At the University of Illinois, researchers are investigating how genes in sorghum confer resistance to harmful fungi. This research, funded by the U.S. Department of Energy (DOE), could lead to greater stability and yields in both crops.

4 UNIVERSITY OF MINNESOTA

The USDA's NIFA Specialty Crop Research Initiative funded research to better understand the complex factors affecting soil health and potato soilborne diseases, a major threat to the crop. Led by investigators at the University of Minnesota, this research will enhance environmental quality and sustain the economic production of potato operations in the U.S.

5 AUBURN UNIVERSITY, UNIVERSITY OF WISCONSIN-MADISON, AND THE UNIVERSITY OF CALIFORNIA, RIVERSIDE

Researchers at Auburn University, the University of Wisconsin-Madison, and the University of California, Riverside are investigating how to prevent poultry and dairy waste—and the phosphorus they contain—from negatively impacting surface water, groundwater, and air quality, thanks to funding from the USDA's NIFA Agriculture and Food Research Initiative.