USDA Research, Education, and Economics
U.S. DEPARTMENT OF AGRICULTURE

USDA SCIENCE AND RESEARCH STRATEGY, 2023 - 2026:

Cultivating Scientific Innovation

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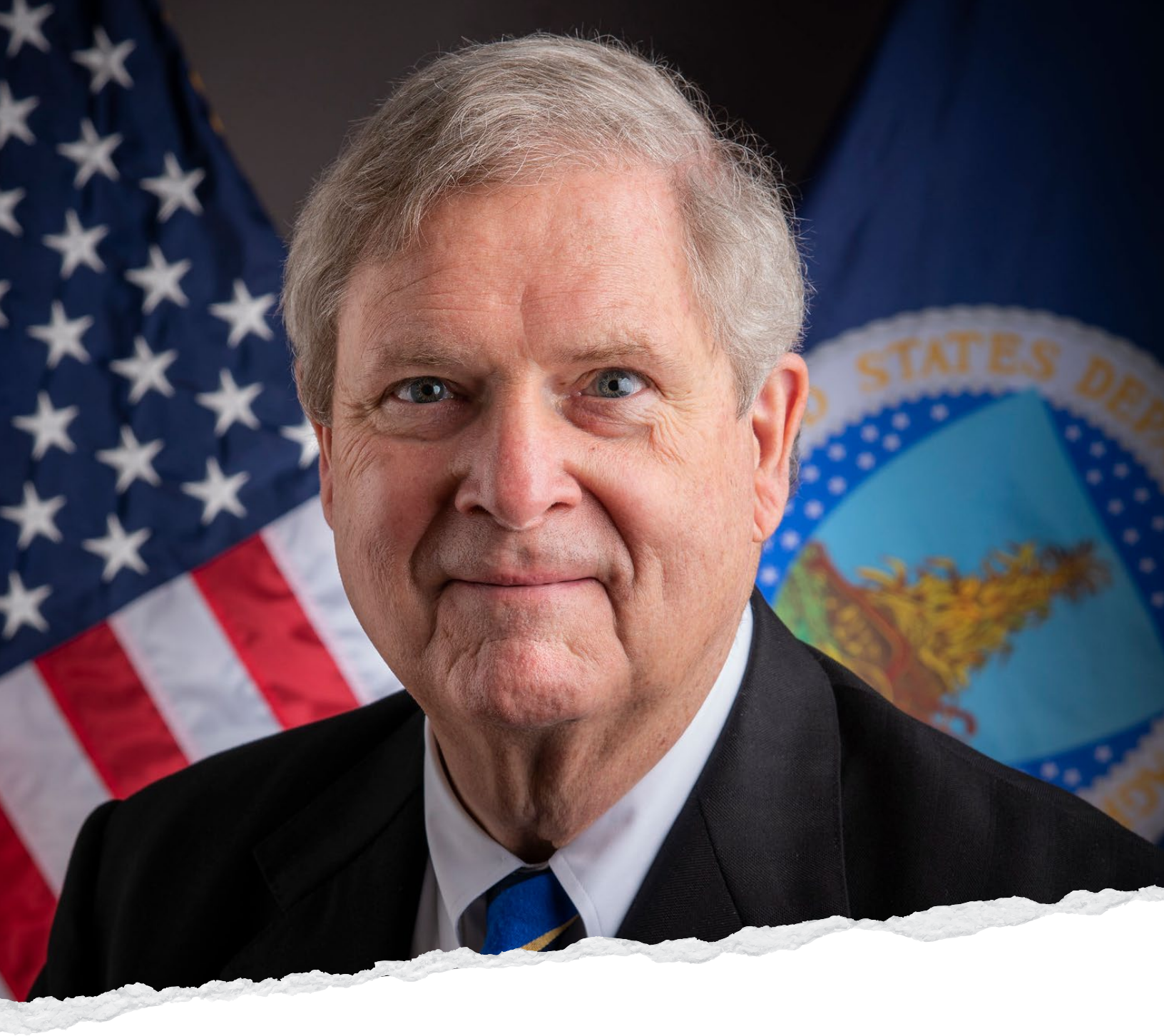
Contents

3 Contents
4 A Message From the Secretary of Agriculture
6 A Message from the USDA Chief Scientist and Under Secretary for Research, Education, and Economics (REE)
8 About USDA Science
8 The U.S. Department of Agriculture
10 Foundational Principles of USDA Science
13 Research Impact
14 About This Plan
14 Our Partners / Join Us
17 **Priority 1:** Accelerating Innovative Technologies & Practices
17 Inclusive Innovation Culture
18 Technology-Enabled Decision Support Systems
19 Collaborative Intelligence Tools
20 Bioengineered Traits and Customizable Management Practices
21 Diversified Future Systems
23 **Priority 2:** Driving Climate-Smart Solutions
23 Climate Change Impacts
24 Climate Change Mitigation
25 Adaptation to a Changing Climate
26 Decision Support Tools
27 Bioeconomy
29 **Priority 3:** Bolstering Nutrition Security & Health
29 Inclusive Food Systems
30 Data Transparency
31 Predictive Analytics
32 Pathogen Virulence Factors
33 Food Systems Understanding and Impact
35 **Priority 4:** Cultivating Resilient Ecosystems
35 Genomics and Genome Editing
36 Microbiome Research
37 Sustainable Agro- and Aquatic Ecosystems
38 Infectious Diseases and Pests
39 Biodiversity
41 **Priority 5:** Translating Research Into Action
41 Communication
42 Education and Workforce Development
43 Data Assets
44 Ag Science Policy



A Message from the Secretary of Agriculture

We are at a pivotal moment in U.S. agriculture. We face urgent challenges of addressing climate change, ensuring the prosperity and health of our rural, Tribal, and agricultural communities and bolstering our food supply chains so they are resilient to future shocks. When I think about the challenges we face, including the fact that despite recent record farm incomes most farmers rely on off-farm income to support their families, I think about one of my favorite quotes from President Lincoln who established the U.S. Department of Agriculture in 1862. At that perilous time in our country's history, the President said: "The dogmas of the quiet past are inadequate to the stormy present. The occasion is piled high with difficulty, and we must rise with the occasion. As our case is new, so we must think anew."

I believe that these challenges offer tremendous opportunities to shape the future of U.S. agriculture and forestry to ensure they are prosperous and profitable for the many and the most, instead of just the few. USDA's FY 2022 – 2026 Strategic Plan outlines how we plan to meet this moment. It is guided by five crosscutting priorities that inform our work: addressing climate change via climate-smart agriculture, forestry and renewable energy; advancing racial justice, equity and opportunity; creating more and better markets for producers and consumers at home and abroad; tackling food and nutrition security while maintaining a safe food supply; and making USDA a great place to work for everyone.

Science and innovation must underpin our work to advance these priorities, as they consistently have to improve agricultural production in the modern era. In my lifetime, American farm sector labor productivity has improved by 17 times largely due to advancements of technology and innovation that enable farmers to produce more output with less input. Now, we can use research, data, and technology to create new opportunities throughout agriculture and forestry systems, to support rural communities and emerging urban agriculture opportunities.

We have already begun this work. Through implementing the Infrastructure Investment and Jobs Act, we have stood up the Bioproducts Pilot Program to lower commercialization risks associated with bringing biobased products developed from agricultural commodities – such as bioplastics and other biomaterials – to market. This Research and Development (R&D) effort, in conjunction with USDA's BioPreferred program, is enabling the creation of a more circular economy where agricultural resources are harvested, consumed, and regenerated sustainably. In turn, this ensures wealth and other economic benefits are created in, and stay in, rural and agricultural communities.

USDA established a historic partnership program to expand markets for climate-smart agriculture commodities. This effort is already improving our understanding of sustainable agricultural practices so that markets can tell their customers that what they are purchasing in terms of their food products have, in fact, been produced in a sustainable way. We have also been a vital partner in execution of the President's Executive Order on Advancing Biotechnology and Biomanufacturing for a Sustainable, Safe and Secure American Bioeconomy, which touches on all parts of USDA, underpinned by technologies developed by our research agencies.

I am excited to build on USDA's latest Strategic Plan by releasing our *Science and Research Strategy, 2023-2026*. This first-ever Department-wide plan outlines our highest research priorities for the next 3 years and represents the input of both our stakeholders and all 8 of the USDA's Mission Areas. As such, the content in this document will serve to spur innovation and collaboration across the USDA Science R&D landscape as we seek to solve the future's greatest challenges by partnering with the communities we serve. I hope you will join with us in this important endeavor as we continue to push the boundaries of possibility for agriculture and forestry, using science to develop new opportunities for developing prosperous, profitable, and sustainable systems.

Sincerely,

Tom Vilsack
USDA Secretary

Photo courtesy of AAAS and the IF/THEN® Collection (ifthencollection.org)

A Message from the USDA Chief Scientist and Under Secretary for Research, Education, and Economics (REE)

As the Department's Chief Scientist, I am honored to advance and support USDA's first-in-class, innovative, and momentous research each day. Our scientists, researchers, and partners strive to improve nutrition quality and security for all Americans, cultivate new sources of food and develop new bioproducts to contribute to a more circular U.S. economy, and enhance the sustainability and resilience of our food, forestry, and agriculture production systems.

In short, we come to work each day to provide the U.S. agriculture sector the research, information, and products it needs to feed and clothe the world sustainably and safely - no small task.

Despite the incredible scientific advances across the agricultural sector since the Green Revolution, serious challenges remain. The global population is expected to exceed 9 billion by 2050 – nearly 2 billion more mouths to feed over the next 25 years. Emerging pests and diseases continually threaten and can result in billions of dollars of losses for agricultural producers. Americans increasingly face nutrition security challenges and need more science and information to make health-promoting diet and lifestyle choices. We are facing the indisputable effects of climate change: unpredictable growing seasons, drought and sea level rise, and a myriad of other threats to our Nation's natural resources. It has never been more crucial that we work together to confront the significant questions and complications facing our world today and into the future.

Fortunately, American farmers, ranchers, and producers are incredibly resilient. Production agriculture requires constant innovation and adaptation as farmers and ranchers pursue climate-smart solutions to extreme weather, rural businesses seek new markets to remain profitable, and underserved communities seek trusted partners to tackle systemic issues. Access to information and new technologies undergirds each of these objectives, and when appropriately resourced, USDA Science has a proven track record in providing timely research, data, training, Extension services, and economic analysis to support farmers, ranchers, and producers.

The *USDA Science and Research Strategy, 2023-2026* conveys how agriculture science and innovation can drive us successfully and cooperatively into the next generation of sustainable and resilient agriculture and forestry systems. Within this strategy, we identify five research priorities of focus to address the complex challenges of today:

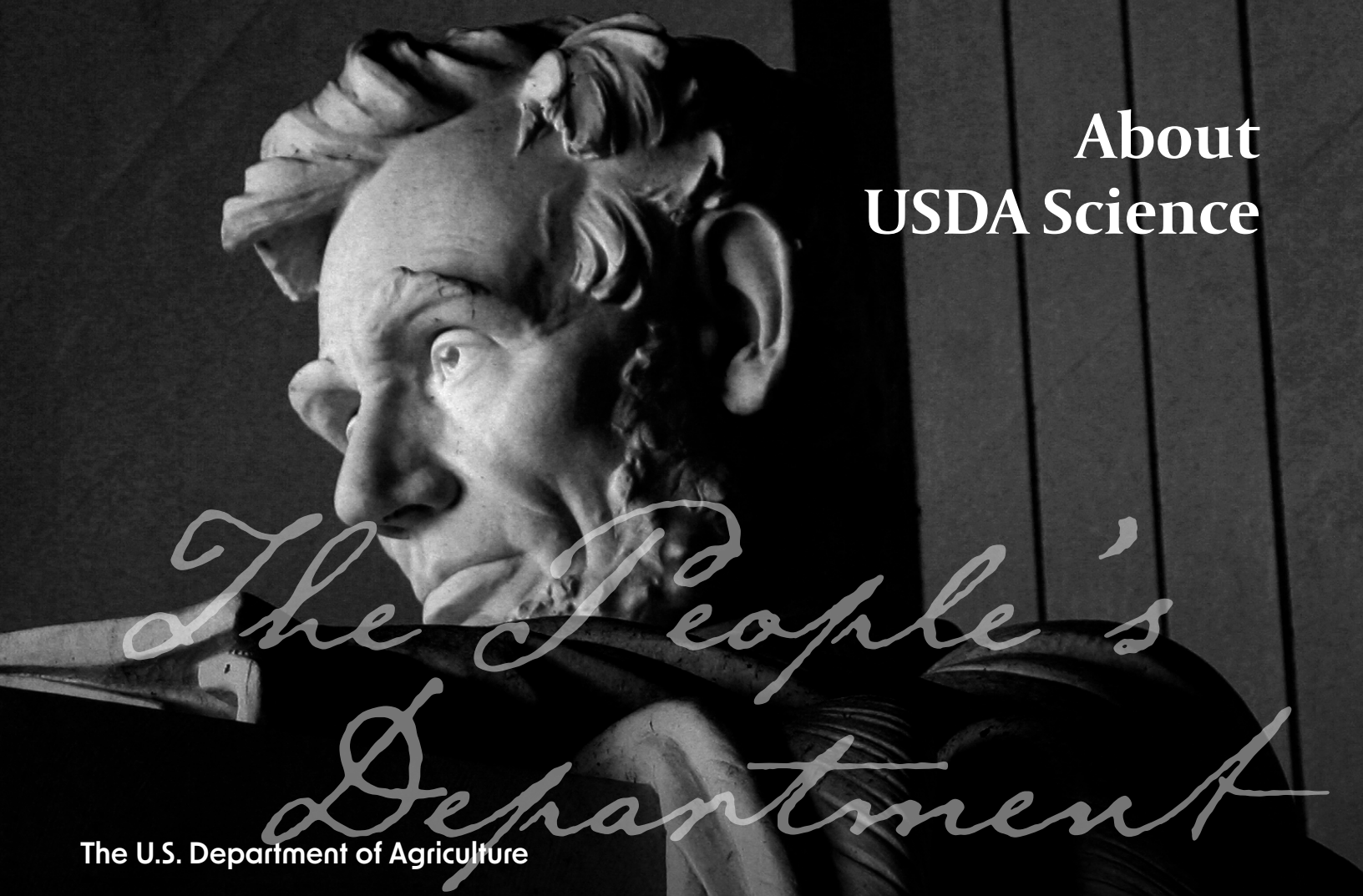
1. Accelerating Innovative Technologies & Practices
2. Driving Climate-Smart Solutions
3. Bolstering Nutrition Security & Health
4. Cultivating Resilient Ecosystems
5. Translating Research Into Action

As you read the content of this strategy, we invite you to join us in this effort. Moving from intention to implementation requires we cooperate deeply and often. To learn more about how you can be a part of this solution, please visit www.USDA.gov/topics/research-and-science today.

Sincerely,

Dr. Chavonda Jacobs-Young
USDA Chief Scientist and Under Secretary for REE

Chavonda Jacobs-Young



About USDA Science

The U.S. Department of Agriculture

On May 15, 1862, President Abraham Lincoln signed legislation to establish the United States Department of Agriculture (USDA or the Department). Two and a half years later in his final message to Congress, Lincoln called USDA "The People's Department." At that time, about half of all Americans lived on farms, compared with about 2 percent today. But through our work on food, agriculture, economic development, science, natural resources conservation, and a host of other issues, USDA continues to fulfill Lincoln's vision—serving millions of Americans every day. The agriculture and food industry contributes $1.1 trillion to the U.S. domestic product and represents nearly 11 percent of total U.S. employment.

Furthermore, over the years USDA has expanded its support not only for production agriculture but for vibrant rural communities and the environment, along with the underlying infrastructure that gives all producers better access to markets and supports diets and nutrition for a healthy population.

In October 2021, Secretary Vilsack outlined in the *USDA Strategic Plan Fiscal Years 2022-2026* five bold, cross-cutting strategic priorities that inform the entire Department's work. The objectives within this document are designed to carry forward these priorities while simultaneously supporting the science and research needs in the Department's Strategic Plan. We hope as you read through the objectives below, you get a sense of the immediate and central role that science and research will play in contributing to the progress of the Secretary's priorities.

The following table is a summarized cross-walk of how the *USDA Science and Research Strategy, 2023-2026* priorities and objectives support the overarching USDA strategic priorities. Each objective within the contents of the document will restate the alignment by displaying the linked icons after each objective title.

USDA's Strategic Priorities

	Addressing Climate Change via Climate Smart Agriculture, Forestry and Renewable Energy	Advancing Racial Justice, Equity & Opportunity	Creating More & Better Market Opportunities for Producers and Consumers at Home and Abroad	Tacking Food & Nutrition Insecurity While Maintaining a Safe Food Supply	Making USDA a Great Place to Work for Everyone
Priority 1: Accelerating Innovative Technologies & Practices					
1.1 Inclusive Innovation Culture		●			●
1.2 Technology-Enabled Decision Support Systems	●	●	●	●	
1.3 Collaborative Intelligence Tools		●	●	●	
1.4 Bioengineered Traits and Customizable Management Practices	●		●	●	
1.5 Diversified Future Systems		●	●	●	
Priority 2: Driving Climate-Smart Solutions					
2.1 Climate Change Impacts	●		●	●	
2.2 Climate Change Mitigation	●	●	●		
2.3 Adaptation to a Changing Climate	●	●		●	
2.4 Decision Support Tools	●	●			
2.5 Bioeconomy	●		●		
Priority 3: Bolstering Nutrition Security & Health					
3.1 Inclusive Food Systems		●		●	
3.2 Data Transparency		●		●	
3.3 Predictive Analytics	●			●	
3.4 Pathogen Virulence Factors				●	
3.5 Food Systems Understanding & Impact		●		●	
Priority 4: Cultivating Resilient Ecosystems					
4.1 Genomics & Genome Editing	●		●	●	
4.2 Microbiome Research	●		●	●	
4.3 Sustainable Agro- & Aquatic-Ecosystems	●		●		
4.4 Infectious Disease & Pests			●	●	
4.5 Biodiversity	●	●	●		
Priority 5: Translating Research into Action					
5.1 Communication		●			●
5.2 Education & Workforce Development		●			●
5.3 Data Assets		●			●
5.4 Ag Science Policy		●			●

Foundational Principles of USDA Science

The USDA upholds "Scientific Leadership" as one of its five core values and bases decisions and policy on science and data that are reliable, timely, relevant, and free from political interference." To accomplish this, USDA Science is driven by five foundational principles interwoven throughout the priorities, objectives, and strategies of this document.

Equity & Inclusion:

We apply an equity lens when designing our research, programs, trainings, and outreach. Our goal is to recognize and unlock the talents of employees of all backgrounds to ensure our science and data are inclusive of and accessible to all Americans.

Sustainability & Resiliency:

We put agricultural research and extension at the center of solutions to the climate crisis by connecting science and practice. We develop and deploy tailored tools, technologies and practices that help producers mitigate and adapt to climate change and protect our natural resources and the ecosystems that surround them.

Bold & Transformational Thinking:

We seek to challenge the status quo by investing in a diversified science portfolio that accelerates food systems transformation inclusive of many and not just a few. We embrace the necessity of high-risk, high-reward transdisciplinary research to challenge ourselves to do what is right rather that what is easy.

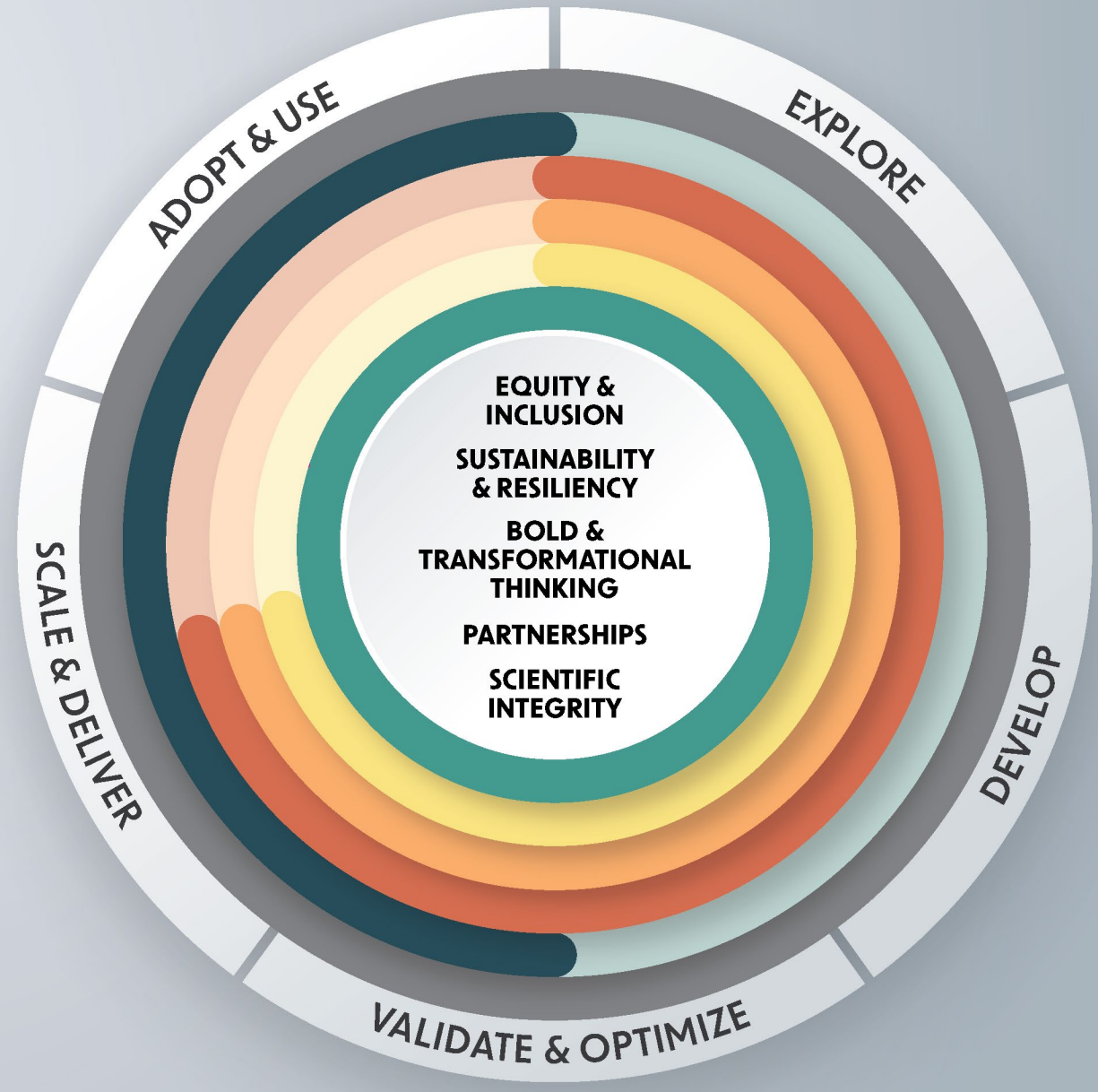
Stakeholder Partnerships:

We value building relationships across the research, education, and extension communities and seek to listen to and understand the needs of the people impacted by our research and data. We proactively seek partnerships that will generate lasting and profound outcomes across all communities, particularly those who have been historically underserved.

Scientific Integrity:

We ensure our policies and actions are based on science that is honest, accessible, and objective and data that are reliable, timely, and relevant. We are committed to building the public's confidence in USDA science and working in a manner that is deserving of its trust.

USDA Science
Research to Impact Framework



PRIORITY 1
ACCELERATING INNOVATIVE TECHNOLOGY & PRACTICES

PRIORITY 2
DRIVING CLIMATE-SMART SOLUTIONS

PRIORITY 3
BOLSTERING NUTRITION SECURITY & HEALTH

PRIORITY 4
CULTIVATING RESILIENT ECOSYSTEMS

PRIORITY 5
TRANSLATING RESEARCH INTO ACTION

Centered on our five "Foundational Principles," the *USDA Science and Research Strategy* includes five Priority Areas that collectively address all phases of the Research to Impact cycle. This integrative framework illustrates which parts of the cycle each research priority advances. In many cases, priorities will overlap and influence the cycle in both directions. Employing the above "Research to Impact Framework", USDA demonstrates its commitment to strategically addressing the complete Research to Impact cycle ensuring agricultural science and innovation successfully translate into real-world impact.

Research Impact

USDA Science supports a strong and prosperous agricultural sector that is essential to the well-being of the U.S. economy. Public sector agricultural R&D investments have been the key to moving our Nation boldly forward. USDA's Economic Research Service found that between 1948 and 2019, total agricultural output in the United States grew by 175 percent. This rise cannot be attributed to increases in agricultural land or labor - both inputs declined over the period - but stem instead from the adoption of a whole suite of innovations in crop and livestock breeding, nutrient use, and pest, farm, and field management. These new practices have yielded significant dividends; public agricultural research and development investments from 1900 to 2011 generated, on average, $20 in benefits to the U.S. economy for every $1 of spending.

To drive the greatest impact into the future, our research must be inclusive, equitable, accessible, innovative, and competitive. We must be able to move rapidly from concept to reality to implementation. Extending the reach of USDA Science leverages public investment and has the potential to expand inclusion in advances generated from Department programs. The process of individual adoption of new practices and widespread use across communities is complicated, requiring ideas from multiple sources to successfully deliver solutions. Explicit consideration of behavioral factors along with economic and technical feasibility considerations throughout the research process can accelerate adoption and success of innovation as a driver of the U.S. economy.

The USDA is putting forth five key science priority areas to address societal challenges and to capture opportunities to make significant advances in food, agriculture, and natural resource sectors. The five priority areas are:

1. Accelerating Innovative Technologies & Practices
2. Driving Climate-Smart Solutions
3. Bolstering Nutrition Security & Health
4. Cultivating Resilient Ecosystems
5. Translating Research Into Action

This *USDA Science and Research Strategy, 2023-2026* reflects the challenges and opportunities we face and outlines how USDA Science plans to meet this moment. The objectives include innovative and forward-looking goals while also identifying foundational needs for these and future priorities. The priority areas are not meant to be exclusive; just as societal needs are multifaceted and complex, there are cross-cutting themes that emerge. Accelerating Innovative Technologies & Practices sets the stage by taking a look far into the future and the science needed to support what might emerge. The next three priority areas (Driving Climate-Smart Solutions; Bolstering Nutrition Security & Health; Cultivating Resilient Ecosystems) take a deeper dive into significant areas of societal need. The final priority area (Translating Research Into Action) focuses on policy and foundational needs to translate science into realized action and outcomes.

The United States has a distinguished history as a world leader in science and research. For example, the USDA Science Framework ensures that R&D moves effectively across all phases of research to real-world impact. Centered around the Foundational Principles and underpinned by an ever-evolving culture of innovation, the five priority areas introduced in the *USDA Science and Research Strategy, 2023-2026* work in harmony to ensure a comprehensive approach to science. As we join together to think creatively about effective options to provide the world a safe supply of food, feed, fuel, and fiber through these five research priorities, we'll foreshadow how the United States can successfully move science into practice for the good of society on a global scale.

About This Plan

The USDA has established a systems approach to embrace multifaceted solutions to the complex societal challenges that we face. Progress depends on diversity of ideas, perspectives, and methods. Thus, in developing this plan, our goal was to maximize the diversity of viewpoints and inputs. Today, USDA is composed of 29 agencies organized under 8 Mission Areas and 16 Staff Offices, with nearly 100,000 employees serving the American people at more than 6,000 locations across the country and abroad. A cross-Department team of scientists was convened for each Science and Research Strategy priority area. All mission areas of the Department were represented to draw on widespread perspectives and expertise. Each team member was encouraged to think beyond their own project or immediate duties and to draw in relevant knowledge gleaned from those outside the team including the private and academic sectors.

USDA regularly consults and engages with a wide range of diverse stakeholders, including Congress; private citizens; State, local, and Tribal government, producers, cooperatives, landowners, policy experts, universities and trade schools, infrastructure sectors, lenders, foundations, technical assistance providers, environmental and social advocates, industry partners, and consumer groups. These activities were used to inform and validate the objectives and strategies.

Nested under each of the five science priority areas are strategic objectives and more granular strategies that serve as a call to action for both the USDA and for external researchers, the Cooperative Extension System, and the general population who are poised to join USDA in making the United States a leader in solving the world's most challenging problems. This is not the entirety of all things that should be done to respond to the needs of a changing world, but prioritized activities that USDA will pursue, fund, and track as we look towards the future. Interwoven throughout this strategy are important elements that highlight how USDA Science is "Supporting an Equitable and Just Science Enterprise" and demonstrating real world application through the "Science in Action" snapshots. We hope that as you read through this strategy, you find areas of intersection for your current and future USDA Science needs.

Our Partners / Join Us

Science is never static, and this is a living document. Impacts are only realized through deliberate inclusion of multiple perspectives throughout the innovation life cycle. The big societal issues are not simple problems to be easily understood, quantified, managed, or rectified. Moving USDA Science forward towards these goals requires the collective action of public and private sectors whose scope spans a variety of interested parties and stakeholders.

We invite you to join us in these discussions by connecting with us at

www.usda.gov/topics/research-and-science

"Understanding the decline in disruptive science and technology more fully permits a much-needed rethinking of strategies for organizing the production of science and technology in the future."

- Park, Leahey and Funk, Nature 613, 138–144 (2023)

Agriculture and forestry have historically embraced innovation to meet the ever-increasing demand for food, feed, fuel, and fiber in a world with limited resources. To maximize impact, science must be forward-looking and anticipate future needs. Knowledge development, dissemination and adoption are core to the USDA mission; the USDA science, research, and extension system is one of the most effective innovation impact models in translational science. Accelerating technological advancement is essential to sustaining agriculture and forestry production for our growing global population. Therefore, USDA must identify and develop transdisciplinary approaches to supporting innovative, resilience-focused, and commercially viable technologies and practices at a transformative pace to strengthen quality of life for all Americans now and into the future.

Priority 1:
Accelerating Innovative Technologies & Practices

Inclusive Innovation Culture

Objective 1.1

Establish a transformative innovation culture in USDA Science by building trust through diversity, equity and inclusion of people, scientific fields including social sciences, cultures, and ideas from across USDA and its partners.

Key Strategies:

- Launch a futurist approach to problem identification including training USDA staff and project reviewers on how to evaluate far-reaching big ideas (high risk, high reward) from across scientific disciplines (e.g., social science, natural science, data science).
- Create a rewarding environment for thought diversity and creativity that incentivizes and measures an increasing velocity of learning, that in turn enables pivots to highly innovative research directions.
- Enhance technology and information transfer efforts across USDA to promote co-development or adoption of taxpayer-funded tools and techniques to achieve USDA objectives.
- Convene dynamic, inclusive, and customer-driven stakeholder networks to spur and capitalize innovation, including public-private partnerships in support of innovation competitions and other opportunities for development.

Supporting an Equitable and Just Science Enterprise

USDA is committed to advancing diversity, equity, inclusion, and accessibility in its workforce and is establishing a permanent Diversity and Inclusion Office. In February 2022, USDA launched the Equity Commission to advise the Secretary of Agriculture and provide USDA with an analysis of how its programs, policies, systems, structures, and practices that contribute to barriers to inclusion or access, systemic discrimination, or exacerbate or perpetuate racial, economic, health and social disparities and recommendations for action.

- USDA Equity Commission, report released Feb 28, 2023

Technology-Enabled Decision Support Systems

Objective 1.2

Improve the health and well-being of all Americans through rapid assessment and shared communication of production risks, consumer demand, health needs, and market trends.

Key Strategies:

- Support seamless information sharing through technology-enabled decision support systems that integrate diverse data streams as a basis for more equitable and efficient supply chain response to short-run disruptions and long-run adjustments.

- Develop precision environmental management decision support tools that account for multiple factors (e.g., soil microorganism optimization, restoration, disease and pest detection and response including vaccines, soil-water-nutrient management, plant/animal genetics).

- Establish digital twin(s) as a test bed platform to mimic major agriculture, forestry, or food systems, enabling rapid customization by researchers evaluating the impact of potential new innovations.

- Integrate consumer biometric reads with food characteristics for individually precise nutrition and dietary recommendations to provide real time information on purchase behaviors for early assessment of future trends and consumer demand.

Collaborative Intelligence Tools

Objective 1.3

Automate or eliminate repetitive tasks through collaborative intelligence (e.g., Artificial Intelligence assisted support systems) and transition workers to high-quality jobs of the future.

Key Strategies:

- Combine Artificial Intelligence and autonomous robotic systems in programmable data-driven farming and forestry practices to maximize productivity and to reduce response time for production disruptions.

- Embed Artificial Intelligence into diagnostic applications and design systems for early detection of production stressors (e.g., pest, weed, weather, moisture) and disease (animals, plants, trees) to support rapid development and applications of response and assessment of relevant quality characteristics.

- Integrate a suite of collaborative intelligence tools and robotic systems in workforce development and technical education (e.g., using augmented reality to teach for real-world operations and settings) to prepare people for agriculture and food jobs of the future.

- Utilize additive manufacturing (e.g., 3D printing) for right-sizing equipment and parts across multiple production operations to increase accessibility and affordability for all growers.

Bioengineered Traits and Customizable Management Practices

Objective 1.4

Improve sustainable production by developing novel selectable plant and animal traits, as well as advanced and customized agricultural and forestry management practices.

Key Strategies:

- Create advanced microbial, thermochemical, and mechanical processing systems for efficient conversion of inedible biomass and waste into new materials, food, and fuels.
- Develop genome engineering, genetic technology, and other technological tools to deliver high yield crops and forest trees for rapid adaption to extreme environmental stresses (e.g., drought) and biological threats.
- Tailor bio-based materials through rapid genetic engineering and nanotechnology to minimize time needed to deliver desired end-use characteristics (e.g., cellulose, fiber, and oil structure/content to create advanced textiles, building materials, and biochemicals).
- Redesign agricultural production systems to use circular nitrogen economies in croplands and livestock management and shift the use of most inefficiencies in the agricultural nitrogen cycle.

Diversified Future Systems

Objective 1.5

Create technologies suitable for use across diverse scales, systems, types, and locations of farms.

Key Strategies:

- Expand the sources and modifications of proteins and other nutrients beyond traditional commodities to supplement the current food system.
- Develop platform chemicals and polymeric materials with unique properties that can only be derived from lignocellulosic feedstock (e.g., mycelium-based wood).
- Advance scalable production systems to support small and mid-size producers to supplement large-scale commercial production (e.g., varieties that work well in small-scale conditions).
- Identify and advance opportunities to develop production systems for alternative environments such as zero-gravity, desert, controlled environment, high altitude, etc.

Science in Action

Forest Service scientists and academic partners are developing ways to produce high-value chemicals from wood. For example, bioactive molecules that have application in cholesterol-lowering drugs and a compound that can be used in food flavoring, fuel additives, medicine, and other chemical products. These discoveries could provide green alternatives to conventional chemicals or those that are difficult to produce from crude oil and offer landowners broader and more balanced market opportunities.

"Scientists tell us that our powerful nature-based carbon sink—our farms and forests—could begin to degrade if we do not take action. With the right tools and partnerships, American agriculture and forestry can lead the world in solutions that will increase climate resilience, sequester carbon, enhance agricultural productivity, and maintain critical environmental benefits."

- Secretary of Agriculture, Tom Vilsack

Priority 2:
Driving Climate-Smart Solutions

Continuous scientific advances are foundational to ensure that agriculture and forest sectors are resilient to extreme weather and climate-related disasters. USDA Science can improve the mitigation and adaptation potential of agriculture and forestry systems, as well as support agriculture and forestry communities through development and deployment of tools and technologies through systems-focused, interdisciplinary, actionable science that spans many disciplines including biological, geospatial, physical, economics, and social sciences. In this way, USDA will advance research that is co-developed with the public, including underserved communities, to address risks from long-term and acute climate stressors, recognize potential to generate new climate-related revenue streams, and improve climate resilience supporting every American's health, nutrition, and food security while bolstering sustainable markets for bioproducts.

Climate Change Impacts

Objective 2.1

Bolster quantification and measurement systems to assess the extent of climate change impacts, contributions of the agriculture and forestry sectors as both sinks and sources of carbon and greenhouse gases (GHG) to climate change, and effectiveness of adaptation and mitigation responses.

Key Strategies:

- Improve quantitative analysis and modeling of agricultural emissions and sequestration in biomass and soils of forest, agricultural, and other ecosystems. Improve methods and models for estimation, measurement, and monitoring of GHG emissions and carbon storage in space and time and decrease uncertainty in climate mitigation practices to better inform conservation efforts.

- Continue development and application of biophysical and socioeconomic climate change indicators for agriculture and forestry to track the extent of climate change effects, underpin development of decision-support resources and monitor long-term effectiveness of climate adaptation responses.

- Enable long-term monitoring programs for GHG fluxes and carbon sequestration that generate low-cost methods for standardized data sampling, capture, management and visualization tools and technologies.

- Identify and quantify the effects of climate stressors – both acute (e.g., extreme weather) and chronic (e.g., long-term climate changes) on human, natural and managed systems relevant to the agriculture and forestry sectors including production, pricing, producer and consumer behaviors and trade of goods and services.

Supporting an Equitable and Just Science Enterprise

USDA Science is equipping producers with the tools and technologies needed to address climate change, especially those producers who are disproportionately affected. In 2023, the USDA, National Institute of Food and Agriculture (NIFA) launched its first Agriculture and Food Research Initiative (AFRI) program priority area focused on funding environmental justice research. This priority area will inform how public investment in research, education, and Extension can provide the greatest impact in supporting underserved producers most affected by climate change.

- NIFA Request for Applications, Agriculture and Food Research Initiative Competitive Grants Program Foundational and Applied Science Program, p. 64

Climate Change Mitigation

Objective 2.2

Enhance research and technology development and improve the technical GHG mitigation potential of agriculture and forestry sectors to reduce GHG emissions, sequester carbon, and generate low-carbon sources of energy.

Key Strategies:

- Improve understanding and quantification of major sources and sinks of agricultural GHG emissions and quantify abatement options and costs.

- Develop improved animal and crop systems and advance technologies and management practices that will mitigate GHG emissions and sequester carbon. For example, decreasing enteric methane emissions, advancing cover cropping, genome editing, evaluating innovative fertilizer technologies, and improving soil microbiomes.

- Evaluate the costs and benefits of greenhouse gas abatement options and assess the effectiveness of USDA programs to incentivize producers to adopt practices and technologies that mitigate climate change.

Adaptation to a Changing Climate

Objective 2.3

Position the agricultural sector to be resilient in the face of climate change. Expand equitable, climate-smart technologies, approaches and field-based practices to help producers, ranchers, and forest landowners adapt to the consequences of climate change.

Key Strategies:

- Improve understanding of adaptation potential of agriculture and forestry systems to climate-related stresses on natural resources (e.g., soil health, biodiversity, precipitation regimes and standing biomass) and biotic vulnerabilities (e.g., pest and pathogen infections, invasive organisms, and pollinator health).

- Identify and evaluate the efficacy of climate adaptation approaches that are regionally relevant and economically viable and conduct post-disaster assessments to inform development of approaches and resources to build adaptive capacity to future events.

- Continue to develop new crop germplasm, nursery seed stock, and animal breeds that are better adapted to climate-induced stresses.

- Advance understanding of the diverse needs of producers and land managers and incorporate these needs and Indigenous Traditional Ecological Knowledge (ITEK) into research to develop climate-smart management practices to adapt to climate change.

Decision Support Tools

Objective 2.4

Develop and expand availability and application of science-based, climate-informed decision-making tools and practices to equitably support all USDA stakeholders in adapting to climate-related risk to ensure that scientific knowledge is accessible, useful, usable, and used.

Key Strategies:

- Improve and expand existing tools for understanding crop production (ex. CropScape) and local and regional seasonal weather forecasting (ex. GrassCast) for agricultural and rural communities.
- Empower underserved communities by engaging and including them in tool development and application through listening and learning to ensure equitable development and delivery, as well as implementation and evaluation.
- Develop and improve Artificial Intelligence--assisted remote sensing climate-smart decision-support tools, including climate disaster monitoring and impact assessment.
- Expand impact of USDA's long-term research and science delivery networks (e.g., USDA Cooperative Extension System, USDA Agricultural Research Service's Long-Term Agroecosystem Research Network, Forest Service's Experimental Forest and Ranges, USDA Climate Hubs) by using research to address unique community and climate vulnerabilities and needs.
- Expand interdisciplinary and transdisciplinary funding opportunities within research, education, and extension programs that integrate environmental justice concerns with underserved communities' needs.

Bioeconomy

Objective 2.5

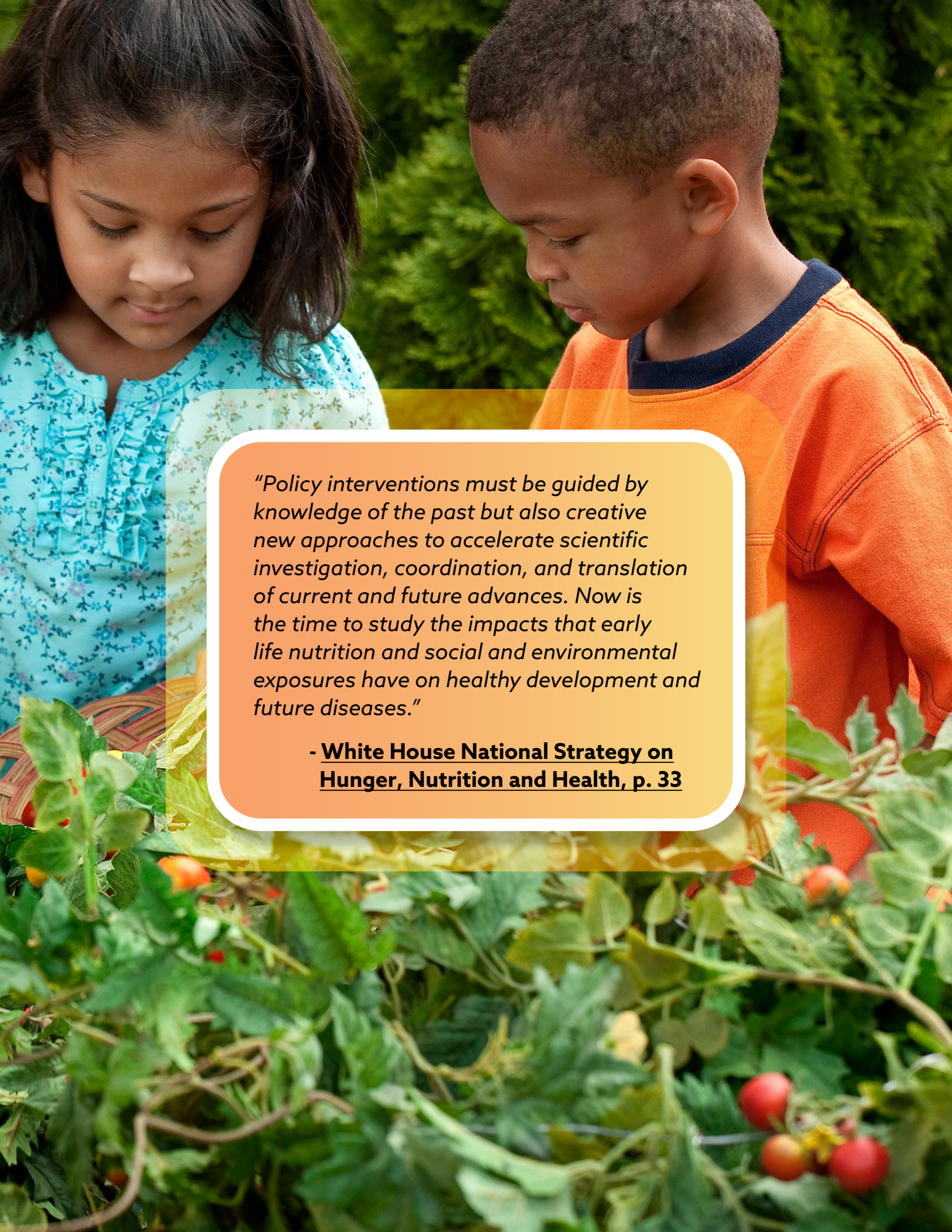
Conduct science that supports sustainable markets for agriculture and forest bioproducts and clean energy to identify potential for new revenue streams and drive sustainable economies and supply chains with reduced waste and GHG emissions.

Key Strategies:

- Support research on biotechnology and biomanufacturing capacity in food and agriculture to reach the bold societal goals for advancing the U.S. bioeconomy to support a sustainable circular economy.
- Improve understanding of consumers' bioproduct preferences to inform development and production of existing and new bioproducts that consumers demand.
- Advance research on technologies to evaluate, produce, and scale-up innovative bioproducts from biotechnology and biomanufacturing, including through the Sustainable Aviation Fuel Grand Challenge, BioPreferred Program, Wood Innovations Program, and the Bioproduct Pilot Program.
- Improve understanding of and ability to quantify the GHG mitigation potential and power generation benefits of renewable energy sources from agriculture and forestry systems, including agrivoltaics and anaerobic digestion.

Science in Action

USDA Science has a history of developing and deploying national research networks that focus on regional agriculture needs. The historical power and openness of GRACEnet, the Long-Term Agroecosystem Research (LTAR) network, and other greenhouse gas (GHG) emissions efforts are now being harnessed to establish a new partnership. The Agricultural Measurement and Monitoring Innovation Project focuses on sensor design and deployment and data integration across the USDA Agricultural Research Service field network to develop powerful data and Artificial Intelligence tools that will improve measurement and monitoring of GHG emissions in agriculture systems.



"Policy interventions must be guided by knowledge of the past but also creative new approaches to accelerate scientific investigation, coordination, and translation of current and future advances. Now is the time to study the impacts that early life nutrition and social and environmental exposures have on healthy development and future diseases."

- White House National Strategy on Hunger, Nutrition and Health, p. 33

Priority 3:
Bolstering Nutrition Security & Health

A safe and nutritious food supply is essential to human health, addressing food and nutrition security, and preventing (or minimizing) chronic diseases. Ensuring equity and inclusion within the food system is a foundational need to address foodborne illness and diet-related chronic diseases. Achieving these goals is predicated on managing the food and nutrition landscape using a systems approach to address diet-related chronic diseases (e.g. cardiovascular disease, diabetes, and certain cancers) in addition to food safety concerns that can be impacted by environmental changes (e.g., increased heat) or supply chain adjustments (e.g., increased concentration). Therefore, USDA will deliver science-based best practices and opportunities within the food system to support decisions related to food and nutrition security, dietary guidance, personalized food choices, food safety, nutrition and agriculture while continuing to drive innovative solutions.

Inclusive Food Systems

Objective 3.1

Enhance development, extension, and engagement of science for all populations with consideration to disparities associated with economic status, as well as demography, ethnicity, life-stage, disabilities, and location to improve understanding of factors influencing food and nutrition security.

Key Strategies:

- Translate research through engagement. USDA will bring together research, Extension and community leaders to develop products that are tailored for specific subpopulations, particularly in underserved communities. USDA will establish partnerships with target communities and recruit leaders from within the community to leverage their lived experience, existing relationships, and public trust.

- Provide support to local and regional food and farm businesses through grants and other financial assistance for food hubs, distribution, and processing as well as technical assistance particularly in support of underserved communities to provide nutritious food to schools, food banks and other nutrition assistance programs.

- Develop approaches to advance and measure equity more effectively within federal nutrition assistance programs, including across Tribes and among people with disabilities and build the evidence for these programs' impact on food insecurity, nutrition, and health.

- Partner with Department of Health and Human Services (HHS) to ensure that Dietary Guidelines for Americans utilize a health equity lens to deliver guidance that is inclusive of people from diverse racial, ethnic, socioeconomic, and cultural backgrounds.

Supporting an Equitable and Just Science Enterprise

USDA Science advances equitable access to food safety and nutrition information by strengthening partnerships to improve research translation to all communities and expanding educational materials to consider community knowledge including Indigenous Traditional Ecological Knowledge and Indigenous food items. For example, a new partnership between the ARS Grand Forks Human Nutrition Research Center and the University of North Dakota focuses on better understanding American Indians and Native Alaskans' diets and Indigenous foods.

Data Transparency

Objective 3.2

Improve transparency and sharing of nutrition and health data to develop a broad, understandable and inclusive picture of linkages between nutrition security and health and enable more rapid response to population needs.

Key Strategies:

- Integrate or align relevant USDA and partner databases across disciplines that consider all aspects of the food system to improve transparency and knowledge (e.g., connections between the National Nutrient Database and other important databases such as What We Eat in America and the school lunch program).

- Expand the National Nutrient database to include reports of the concentrations of nutrients in Native American and Native Alaskan foods to expand awareness of food and nutrition options and benefits. Integrate Indigenous Traditional Ecological Knowledge in the development of and sharing of nutrition and health data.

- Identify future data needs to support precision nutrition research, education, and Extension as well as systems-based analysis that considers economic, environmental, social and health-related outcomes across the entire food production value chain to enable research on emerging and evolving health needs.

Predictive Analytics

Objective 3.3

Increase data and analytics for predicting, developing, and disseminating appropriate intervention or management strategies to reduce and eliminate contamination in food production and processing, reduce food loss and waste, improve the nutritional value of food in a changing climate context, including considerations to adapt to various cultures and contexts.

Key Strategies:

- Build key relationships to connect climate change, food systems, nutrition security research, education, and Extension programs for more rapid and wholistic response to changing needs.
- Develop advanced analytic tools including machine learning and Artificial Intelligence for enhanced detection, metabolic modeling and forecasting capabilities for early identification and targeting of foodborne pathogens and chemical contaminants.
- Foster novel sensing technologies, hand-held devices and forecasting tools to protect alternative food sources from harmful food pathogens and contaminants.
- Design predictive modeling for infections of food crops by fungal contaminants and their subsequent production of mycotoxins.
- Improve predictive tools and increase mitigation approaches to ensure food is safe for consumers regardless of environmental and management shifts due to climate change.

Pathogen Virulence Factors

Objective 3.4

Increase support for risk-based analysis and research using cutting-edge technology to identify virulence factors in pathogens, including antimicrobial resistance, resulting in the development and deployment of innovations to reduce pathogen occurrence in food systems.

Key Strategies:

- Apply cutting-edge technology to detect pathogen virulence and fitness factors to improve real-time, rapid biomolecular identification of new and existing foodborne contaminants.
- Determine pathogen survival mechanisms that enhance virulence potential and pathogen survival.
- Develop novel mitigation strategies by applying systems-based, integrated research to investigate the effect of climate/environment/source/diet on pathogen virulence and emergence.
- Pioneer the application of cutting-edge tools to protect new and alternative food sources from food pathogens and toxins that might threaten their sustainability.
- Develop and apply an integrated food systems approach to address pre-harvest sources of foodborne pathogens.

Food Systems Understanding and Impact

Objective 3.5

Develop new evidence-based food systems that undergird and support decisions related to dietary guidance, food safety, agriculture, economics and Federal nutrition assistance.

Key Strategies:

- Facilitate engagement of intramural and extramural partners to conduct research, education, and Extension on diet-related chronic diseases, including cardiovascular disease, diabetes, and certain cancers.
- Identify validated biomarkers of nutrient intake and nutritional status to address personalized needs for specific foods and components.
- Create food safety models and approaches that address the novel needs of alternative and diversified food products and food delivery systems (e.g., home delivery, local/ regional farmers markets).
- Develop and implement an approach to track food purchase behaviors to identify consumer preferences and market trends (e.g., the National Household Food Acquisition and Purchase Survey (FoodAPS-2)).

Science in Action

The virtual Agricultural Science Center of Excellence for Nutrition and Diet (ASCEND) for Better Health brings together scientists, partner organizations and communities to deliver science-based solutions that promote and elevate food and nutrition security for all Americans. The goals of ASCEND will support President Biden's Cancer Moonshot initiative and will be accomplished through the synergy of research, data and engagement. Nutrition Hubs will bring together government, academic and community leaders to develop products that are tailored for specific subpopulations; leveraging existing knowledge into clear focus while serving as a spur to newer, even more innovative solutions.

"Farmers, ranchers, and forest owners have built vibrant rural economies that supply food and fiber to the world, while also developing strong and lasting stewardship traditions that are a proud cornerstone of America's conservation heritage."

- America the Beautiful Report, p. 8

Priority 4:
Cultivating Resilient Ecosystems

A healthy viable production ecosystem delivers food, feed, fuel and fiber for all and conserves natural resources for future generations. USDA seeks to balance the goals of satisfying human needs; enhancing environmental quality, the resource base and ecosystem services; sustaining the economic viability of agriculture; and enhancing the quality of life for farmers, ranchers, forest managers, workers, and society as a whole. USDA Science can address these place-and-scale-appropriate needs through science-based solutions targeting the multi-dimensional, simultaneous, and pressing goals to ensure agricultural productivity, sustainability, and resilience.

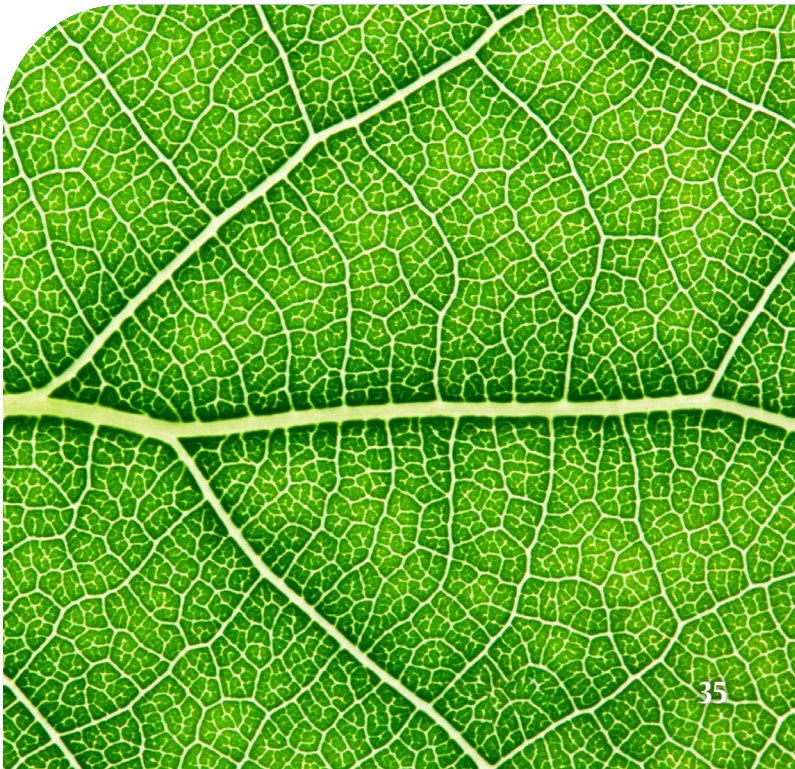
Genomics and Genome Editing

Objective 4.1

Determine the DNA sequences of plant and animal genomes and use this information to apply molecular biology techniques, such as genome editing and other advanced breeding methods to improve sustainability through research, including leveraging public-private partnerships and open science approaches.

Key Strategies:

- Genetically characterize plants and animals within the USDA's National Genetic Resources Program to better identify and catalog traits that enable future generations to adapt to climate change and to implement innovative solutions that improve sustainability.
- Develop plant regeneration methods, such as recovering viable plants from single cells or plant organs; for example, for specialty crops or rare/endangered species that have the potential to benefit from genome editing tools.
- Devise more effective genomic methods to identify and predict desired genetic changes that enable breeders to deliver specific phenotypes to sustainably meet economic, environmental and societal needs.



Supporting an Equitable and Just Science Enterprise

The 1890 Faculty Research Sabbatical Program (FRSP) provides faculty at 1890 land-grant universities with the opportunity to participate in a residency at an USDA, Agricultural Research Service laboratory to conduct cooperative research of mutual interest. In 2022, research programs included food and water science, anticancer drug discovery and development, molecular interactions between bacterial pathogens and their plant hosts, bioinformatics, how trees can be used to mitigate heat islands and improve stormwater management, and cell biology and wound healing in veterinary medicine. Faculty are able to harness the resources of both ARS and their university.

- 1890 Faculty Research Sabbatical Program (FRSP)

Microbiome Research

Objective 4.2

Accelerate the deployment of technology and practices that improve crop and animal production, transform feed efficiency, and increase resilience to weed, disease, pest, and environmental threats by promoting and advancing microbiome research for soil, plant, and animal health.

Key Strategies:

- Investigate and incorporate methodologies that protect and harness soil microbiomes and their impact on nutrient cycling and ecosystem services.
- Advance fundamental knowledge on the rhizosphere (below-ground) and phyllosphere (above-ground) microbiomes and their impact on plant physiology, health, and productivity.
- Encourage the development and integration of tailored gut microbiomes and feed formulations to improve nutrient-use-efficiencies and animal health while reducing enteric methane emissions.

Sustainable Agro- and Aquatic Ecosystems

Objective 4.3

Restore and improve resiliency of agro- and aquatic ecosystems by accelerating the adoption of sustainable agricultural systems that are transformative, diversified, and integrated (e.g., integrated crop-livestock, crop-aquaculture, perennial, and agroforestry systems), and recognizing the need for sustainable inputs.

Key Strategies:

- Build the capacity of land and water-based ecosystems at all scales to cope with both predictable and erratic natural disasters and other stress-inducing events.

- Encourage the adoption of practices along the entire supply chain to maximize sustainable productivity and quantify productivity, resiliency, and ecosystem services of diversified and integrated agricultural systems.

- Develop strategies to mitigate the impacts of terrestrial agriculture on freshwater and marine environments to preserve the health of aquatic ecosystems while supporting the responsible expansion of finfish, shellfish, and seaweed aquaculture.

- Identify and characterize inputs affected by exogenous factors to sustain a sufficient and predictable supply of pollinator services, nutrient sources, water resources and technological devices.

- Develop methods for anticipating and openly communicating changes in water quality and quantity (e.g., extreme drought and precipitation) in agricultural systems to improve resiliency and inform management decisions.

Infectious Diseases and Pests

Science in Action

USDA Science takes a One Health approach to maintain or reduce health risks to animals, humans, the environment, and society. Now, USDA Science is collaborating with the U.S. Department of Homeland Security to stand up the National Bio and Agro-Defense Facility (NBAF) in Manhattan, KS. This state-of-the-art facility is a national asset that will help protect the Nation's agriculture, farmers, and citizens against the threat and potential impact of serious animal diseases. The USDA's Agricultural Research Service and Animal and Plant Health Inspection Service will work together at NBAF to conduct foreign and emerging animal and zoonotic disease research, training, and diagnostics to achieve optimal health outcomes for animals and people.

Objective 4.4

Enhance agricultural production and resiliency by developing capabilities that identify, combat, respond to and eradicate plant and animal infectious diseases, including zoonotic diseases and pests.

Key Strategies:

- Implement systems approaches that inform infectious disease-related agricultural science and advance USDA's ability to protect the Nation's agriculture, farmers, and citizens against the threat and potential impact of animal and crop diseases.

- Enhance emergency preparedness at all governance levels by improving surveillance, early detection and rapid response and recovery, developing recovery plans and ensuring the availability of countermeasures, including acceleration of vaccine development, for transboundary, vector-borne, emerging/reemerging and costly endemic animal and plant diseases and pests through research, education, and extension and collaboration within the U.S. Government.

- Improve understanding of the economic impacts and develop targeted solutions to threats of domestic and transboundary animal and plant diseases and pests.

Biodiversity

Objective 4.5

Identify and enable the adoption of practices that demonstrably conserve or improve biodiversity, improve air quality, water quality and retention, enhance carbon sequestration, and protect pollinator populations.

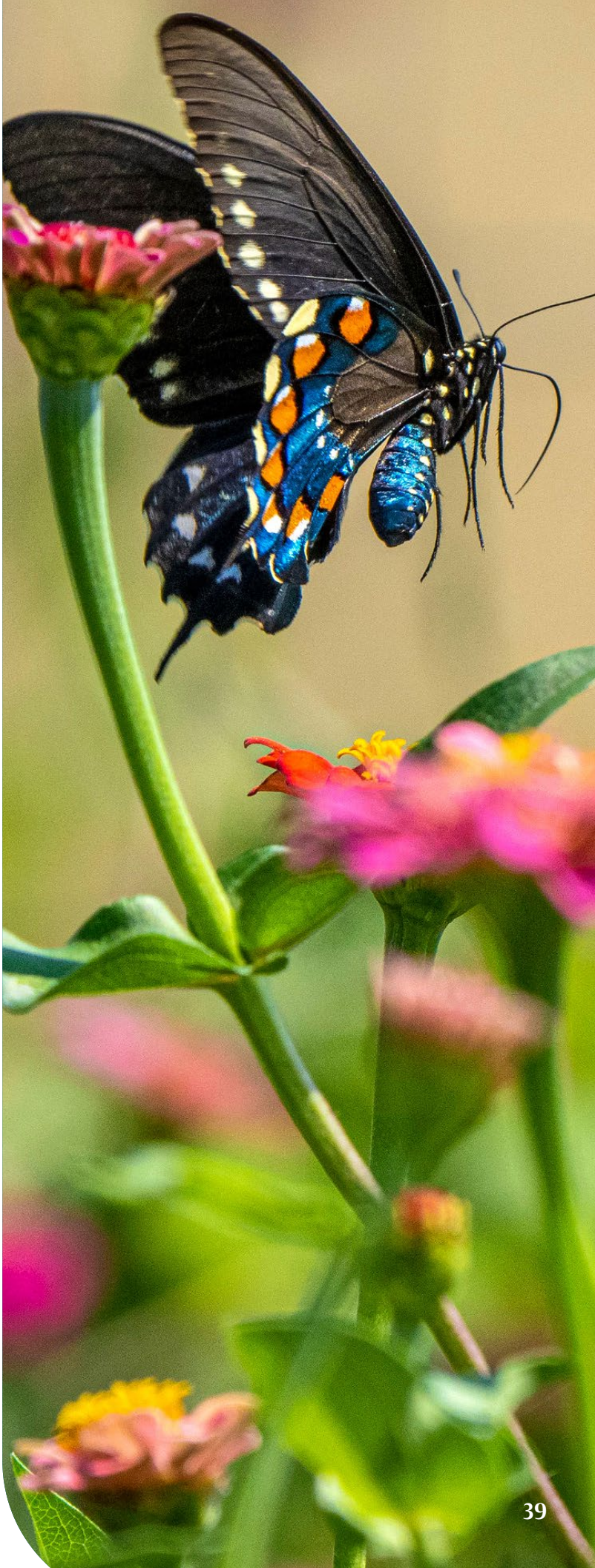
Key Strategies:

- Evaluate current genetic diversity of species in cropland, rangeland, and natural and planted forestland and develop means to maximize biodiversity and use natural diversity to increase resilience.

- Identify key factors influencing producer behavior change and successful technology adoption models that emphasize the need to conserve resources and minimize environmental impact.

- Incorporate precision agriculture technologies and techniques that, among other things, strengthen soil health and vitality to optimize resource use and enhance land stewardship.

- Build internal and external coordination across research, policies, and programs to safeguard pollinator health through monitoring and economic initiatives, pest management, genetics and breeding as well as environmental factors such as stressors, forage, habitat, and nutrition.



"USDA Science is mission driven. We begin with an end in mind, and that is formulated by a specific need or challenge identified through rich interactions with the people who use the information and technologies we produce. It is true knowledge is power, and we believe implementation means success."

- Dr. Chavonda Jacobs-Young, USDA Chief Scientist and Under Secretary for Research, Education, and Economics (REE)

Food, feed, fuel, and fiber systems rely on science and research to drive innovation that enhances optimal performance and responsible growth. However, gaps between science, data, and decision-making can limit the development and implementation of science-based solutions. It is imperative that the progress led by USDA's science and research enterprise be translated into actions that are communicated both domestically and internationally, to support the interconnectivity of science and research at a global scale while generating direct benefits for American producers and consumers. To cultivate a more innovative and sustainable global agricultural sector, USDA works to attract and employ a talented and diverse workforce that leads and empowers increasingly open, science-based, and data-driven activities, communicates solutions that promote understanding and action and fosters a culture where policy informs, encourages, and advances scientific innovation and adoption.

Priority 5:
Translating Research Into Action

Communication

Objective 5.1

Improve communication and awareness of scientific progress and agricultural science policy issues related to food, feed, fuel, and fiber systems.

Key Strategies:

- Employ communication tools, activities and strategies that empower internal and external stakeholders, including producers, consumers, and front-line workers, to access, understand, adopt, and implement scientific results and policies.
- Enable rapid responses that can provide effective, timely communications in targeted formats and languages to reach multiple, varied audiences in crisis situations that threaten the Nation's food, feed, fuel, and fiber systems.
- Convene dynamic, inclusive, and customer-driven stakeholder networks and engagement opportunities to ensure that science and policy is nimble and responsive to evolving needs.

Science in Action

USDA Science is focused on engaging communities to co-develop research that will address unique challenges in agriculture and forestry exacerbated by climate change. The 10 regional Climate Hubs across the United States are a source for practical, proactive thinking about climate change and work to link USDA Science and program agencies in delivery of timely and authoritative tools and information to agricultural producers and professionals. The Climate Hubs launched a Climate Hubs Fellows program to train post-doctoral and other fellows in regional hubs to connect climate science with local and regional communities.

Education and Workforce Development

Objective 5.2

Support the equitable development of a diverse, inclusive, nimble, and resilient workforce with the knowledge, skills, and abilities necessary to drive agricultural research forward.

Key Strategies:

- Proactively work with stakeholders to address barriers to using research products and data for decision-making and advance the value of science.
- Across research fields, foster the development of a wide range of integrated skill sets (e.g., computer, engineering, natural and social sciences) to improve the utilization of advanced technologies.
- Develop and expand degree, certificate, curriculum, and youth programs to integrate science, technology, engineering, and mathematics (STEM) with science policy, the research to impact lifecycle and translating science into solutions.
- Attract, retain, and empower diverse students to build careers in food, agriculture, and related disciplines – including at USDA – through meaningful, experiential learning opportunities, scholarship programs and outreach activities that inspire and prepare them for success.

Supporting an Equitable and Just Science Enterprise

USDA is cultivating a culture of innovation to advance food, agriculture, and forestry science by supporting a workforce that is reflective of the diversity of America through university and private partnerships and programs like NEXTGEN which will support students of diverse backgrounds in agriculture careers. The NEXTGEN Program is designed to enable 1890 institutions, 1994 institutions, Alaska Native-serving institutions and Native Hawaiian-serving institutions, Hispanic-serving institutions, and Institutions of Higher Education located in Insular Areas to build and sustain the next generation of the workforce. These efforts include student scholarship, meaningful internships and fellowships, job opportunity matching, and facilitating pathways for employment in the Federal sector. For more information, see:

www.usda.gov/youth/career

Data Assets

Objective 5.3

Ensure the collection, delivery, storage, interoperability and protection of high-quality data and results and leverage USDA data assets to inform science and research that leads to impactful positive changes.

Key Strategies:

- Develop standards and principles for scientific benchmarking of USDA programs and policies to effectively promote increasingly open robust research across the Department.
- Invest in innovative methods to collect, develop, maintain, analyze, and disseminate scientific data, and results to improve the efficiency and effectiveness of agricultural markets, domestic and foreign trade, regulatory policies, and future research.
- Strengthen links between research and technology transfer by providing objective, relevant, timely and accurate federally funded research, statistics, and economic analysis to foster co- development of novel tools and technologies and move innovations towards commercial applications.
- Maintain and advance scientific integrity principles and security protocols that safeguard people, systems, and data to mitigate predictable and unforeseen risks while promoting transparency and equitable access through open science.

Science in Action

USDA Science collects, analyzes, and translates robust data to provide relevant and timely information on the state of agriculture and forestry across the United States. For example, the USDA, National Agricultural Statistics Service's (NASS) Census of Agriculture surveys individuals from all agricultural communities. Another example is the three nationwide surveys conducted by the Forest Service, Forest Inventory and Analysis Program (FIA); a traditional national forest inventory, National Woodland Owner Survey, and Timber Products Output. In both examples, results provide the only source of statistically robust, consistent data on these topics for every State, county and U.S. territory.

Ag Science Policy

Objective 5.4

Support deployment of new innovations and enable risk-based and scientifically sound decision making and policymaking by promoting the production and appropriate use of science and data.

Key Strategies:

- Adapt agricultural science policies to better promote accessibility, equity and economic sustainability while advancing social, environmental, and human health priorities.
- Strengthen existing collaborations and create new research collaborations between governments, academia and industry to accelerate the translation of food, agriculture, and forestry science into action.
- Facilitate partnerships with other countries and international organizations that enable USDA-supported researchers to identify potential collaborations for aligning efforts that improve global food security and address other issues of global interest.
- Collaborate across regulatory agencies to promote the adoption of a transparent and predictable regulatory environment based on science that incentivizes investment in research and development and provides a clear path to market for innovations.

Science in Action

USDA Science is advancing research, new technologies, products, and approaches required to mitigate and adapt to climate change while supporting economic growth and job creation through leadership of the Agriculture Innovation Mission for Climate (AIM for Climate). Launched in 2021, AIM for Climate is a joint initiative by the United States and the United Arab Emirates that seeks to address climate change and global hunger by uniting participants to significantly increase investment in and other support for climate-smart agriculture and food systems innovation. Since its launch, AIM for Climate has enabled global investments of over $13 billion and enabled the creation of a network of over 500 global partners.

www.aimforclimate.org

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