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USDA Science
Research, Education, and Economics Action Plan
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Preamble

As the 21st century unfolds, America faces economic, social, and environmental challenges that require strong and innovative systems of food and agricultural science for answers and technology solutions. Agriculture and natural resources are at the crossroads of the world's most critical problems: establishing sustainable food production, providing clean and abundant water, responding to climatic variability, developing renewable energy, improving human health, and strengthening food safety. From fostering continued economic growth to adapting to the effects of climate change and addressing food security, the United States can continue to be a leader in global agriculture. Yet, the challenges facing agriculture, natural resources, and conservation are immense and need to be faced with a robust research enterprise and educational programs. The President's Council of Advisors on Science and Technology (PCAST) released the *Report to the President on Agriculture Preparedness and the Agriculture Research Enterprise* in December of 2012[1]. The report highlighted current challenges facing agriculture. The Research, Education, and Economics (REE) Mission Area considered the recommendations made by PCAST during revision of the REE Action Plan. Our continued global leadership and success depend upon a renewed and reinforced commitment to our world-class agricultural science and research capabilities, as well as training the next generation to carry these studies into the future. If we want to keep America at the forefront of global competition, we need to make smart investments in education and innovation, leveraging the diverse resources and talent we have, especially in the agricultural sciences. This education begins with supporting science, technology, engineering, and math (STEM) programs so that science and mathematics are woven seamlessly into students' skills and interests, while exposing students to the sources of their health and wellbeing – healthy food and clean water.

The framework for my role as Under Secretary for REE in this respect has been delineated by the 2008 Farm Bill and by "A Roadmap for USDA Science," produced by my predecessor in early 2010. During my tenure as Under Secretary, Prior to 2012, I held a series of informal and formal consultations with multiple stakeholders in U.S. Department of Agriculture (USDA) science,

[1] Report to the President on Agriculture Preparedness and the Agriculture Research Enterprise, Office of the President, President's Council of Advisors on Science and Technology, December 2012.

including the National Agricultural Research, Extension, Education, and Economics (NAREEE) Advisory Board, to assess REE's progress in achieving the vision set forth in these documents. I reviewed the reports prepared by REE staff in 2009 in gathering background for the "Roadmap" that examined USDA science in the context of other science agencies in the Federal Government. These sources, as well as lessons learned from implementation of Farm Bill provisions, especially related to the establishment of the National Institute of Food and Agriculture (NIFA), Agriculture and Food Research Initiative (AFRI), and the Office of the Chief Scientist, significantly informed our planning, going forward. The initial REE Action Plan was released to the public in February 2012.

Over the past two years, I have explored how the education and training of the next generation of scientists, and of the future of agriculture are being addressed. The important work done by the National Agricultural Statistics Service (NASS) and the Economic Research Service (ERS), for example, is much more visible than in the past. Also, this revision highlights the excellent work being done by the Natural Resources and the Environment mission area, particularly the Forest Service and the Natural Resource Conservation Service, and work by the Animal & Plant Health Inspection Service (APHIS). We still need to ensure the sustainability of our core programs and competencies, both intramural and extramural, in order for USDA-conducted and supported science to be able to deliver on the strategic goals and priorities of the Department. With this challenge at hand, as USDA's Chief Scientist and Under Secretary for REE, I am pleased to share the current REE Action Plan for USDA science and education. The revised plan has been updated for accuracy and relevancy, and links REE research, education, statistics, and economics programs to the Department's strategic plan. It includes measurable actions and outcomes to help coordinate our efforts to achieve the goals and priorities.

Now more than ever, careful planning is fundamental to global prosperity and security, and a dynamic and integrated strategic vision can be a guiding force for continued innovation, as well as the means to maximize the potential of our world-renowned system of agricultural science and education. In 2012, we celebrated the 150th anniversary of the historic partnership between the Federal Government and the States that formed the basis for the land-grant university system, which, along with local extension offices and experiment stations, not only revolutionized American education and agriculture, but together transformed the Nation's economic and social fabric. This year, as we celebrate the centennial of Cooperative Extension, we must renew our Nation's commitment to maintaining and growing a progressive and innovative system of agricultural science and education. The time is right to reinvent and reimagine a research and development partnership between the Federal Government and the States to face today's many challenges. And, we need to craft a new compact with America—it's States, its agricultural producers, its consumers, and its colleges and universities, and the private sector—to bring into existence a renewed agricultural enterprise capable of helping to feed the world and inventing new technologies and energy sources needed in the decades to come.

Revising the REE Action Plan has been an ongoing process of consultation, refining, and strategically structuring the core mission area elements that REE is best suited and most able to champion. The Action Plan is not designed to be a comprehensive compendium of all research, education, and extension programs within the mission area. Rather, the purpose is to identify and outline focused efforts in mission-critical core areas. This focus will enable a shared vision for USDA science and education across the Department.

The REE Action Plan is organized around the leading priority areas for USDA science. However, these priorities are clearly linked—in science, nature, and through the multitude of goods and services produced on our Nation's working lands. These linkages between priority areas reflect the inherent complexity of agricultural systems and highlight our need for even more interdisciplinary investigations as we move forward.

Collectively, we have—at USDA and with our many partners—a robust infrastructure to perform world-class science and to deliver classroom and community education. Instead of building separate and duplicative resources agency by agency, State by State, university by university, we should identify which agencies, Departments, and institutions have the critical skills to solve a problem, and focus that combined knowledge and capacity where it will do the most good. The rich and deep talent base at USDA and in our partner institutions is capable of addressing almost any problem we can put before it. With the right vision, we can figure out how those many problems relate to our most urgent issues and tackle the root causes rather than manage the symptoms.

As Under Secretary for REE, I intend to use the valuable resources in our agricultural research, education, and extension systems to implement an efficient and effective strategy for the diverse stakeholders in the public and private sectors to collaborate on our common concerns in an inclusive and integrated manner. Looking forward, yet facing the realities of today's economic climate, we must now simultaneously streamline and enhance our research, education, and extension capabilities while using our resources intelligently and efficiently. This will mean integrating our diverse capabilities into a collaborative and cohesive operational unit that will multiply our research yields, focus our vision, unify our voice, and enhance our chances of success. It also means laying the foundation for a strong economic future by attracting the next generation of students into the field of agricultural sciences—including a spectrum of biological, biochemical, biophysical, economic, food science, climatological, environmental, and soil sciences—to build a pipeline of talent that keeps America leading the world's agricultural innovation.

The immensity and diversity of the difficulties we face allow us an excellent opportunity to once again demonstrate our ability and capacity to rise and meet the greatest of challenges. There is not a moment to lose, and REE has a unique role in achieving these goals.

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I. Introduction

In June 2010, Secretary Thomas J. Vilsack released the *U.S. Department of Agriculture (USDA) Strategic Plan for 2010-2015*, which articulated a comprehensive agenda for USDA. Fundamental to accomplishing this agenda is ensuring an equally comprehensive approach to science, education, and information to support subsequent action. As requested in the 2008 Farm Bill, then Under Secretary Rajiv Shah tasked the Research, Education, and Economics (REE) mission area to develop *"A Roadmap for USDA Science"* in early 2010, which articulated a vision for delivering the research, tools, and statistical data needed to meet the needs of USDA agencies and the country. That vision also reflected the growing needs domestically and globally for a comprehensive approach to agriculture and working lands. In a world undergoing major economic challenges, it is not surprising that people turn to the basic provisioning factors of food, water, and shelter in order to understand how to build a sustainable environment. USDA science is central to providing these basic requirements of life. The REE Action Plan further develops the vision outlined in the Roadmap and provides focus, direction, and accountability.

> *"The 'Roadmap' presents an assertive and progressive approach to transforming USDA REE into a high-profile research organization." (NAREEE Advisory Board, December 2010)*

In "*A New Biology for the 21st Century*"[2] the National Academy of Sciences identified a set of challenges that integrate fundamental biological understanding with critical societal issues. One of the questions posed was "*how can Federal agencies more effectively leverage their investments in biological research and education to address complex problems across scales of analysis from basic to applied?*" In addition, the articulated principles of a New Biology emphasize integration–of disciplines and approaches–but perhaps most relevant to USDA is to ***purposefully*** organize research around problem-solving. These can readily be viewed as principles of USDA science.

The Department's plan reflects a vision to use the best available science to expand economic opportunity through innovation, to promote agriculture production sustainability that better nourishes Americans while also helping to feed others throughout the world, and to preserve and conserve our Nation's natural resources. Our commitment to sustainable agriculture is compatible with the recent National Research Council report, which defined sustainable agriculture as (1) producing enough to satisfy human needs, (2) enhancing environmental quality and protecting the natural resource base, (3) being profitable, and (4) increasing the quality of life for farmers, farm workers, and society as a whole. The use of sustainable agriculture as a

[2] A New Biology for the 21st Century. National Research Council. National Academies Press. 2009. Available at http://www.nap.edu/catalog/12764.html.

guiding framework is an underlying assumption throughout our plan, and is also an explicit component of many of the goals and strategies. Fully half of the organizations that provided formal input to the roadmap included this concept.

REE delivers the scientific discovery mission of USDA through:

The ***Agricultural Research Service (ARS),*** the largest intramural research agency of USDA. ARS has a workforce of approximately 8,000 employees, including 2,200 life and physical scientists, engineers, and veterinarians who represent a wide range of disciplines and work at more than 100 locations across the country and at 5 overseas laboratories. The ARS research agenda is broad, with about 1,200 research projects organized under 4 major program areas: Nutrition, Food Safety, and Food Quality; Animal Production and Protection; Natural Resources and Sustainable Agricultural Systems; and Crop Production and Protection.

The ***National Institute of Food and Agriculture (NIFA),*** USDA's primary extramural research, education, and extension funding agency. Its mission is to lead food and agricultural science to create a better future for the Nation and the world by funding research, education, and extension projects and programs, some of which are specific to the Land-Grant University System, and others open to participation by other partner organizations.

The ***Economic Research Service (ERS),*** USDA's primary source of economic information and analysis, and economic and social science research. The mission of ERS is to inform and enhance public and private decisionmaking on economic and policy issues related to agriculture, food, the environment, and rural development.

The ***National Agricultural Statistics Service (NASS),*** USDA's statistical agency. NASS conducts hundreds of surveys every year and prepares reports covering virtually every aspect of U.S. agriculture. NASS also conducts statistical science research on survey design, sampling, and other methodological issue areas. NASS works closely with the states in determining their agricultural profiles.

II. Strategic approaches

This action plan describes a set of strategies and actions that relate to a goal that is either programmatic or supports administrative activities. There is another set of activities that relates to "how" our work will get done. They reflect an overarching philosophy of integration and collaboration, of ethical behavior, and of a focus on the user of the information.

- We are taking a portfolio approach to optimize the investment in USDA science. We take advantage of our intramural capacity in science and statistics and seek alignment with our investment in projects funded through our extramural programs. We thus capitalize on our ability to do long-term, broad-scale science that is foundational and

must be performed by the public sector (stability) and to be nimble by funding universities and other research institutions as new questions emerge that require specialized concentrations, or as we identify gaps in capacity. One way the public/university partnership is strengthened is through funding of competitive, peer-reviewed research. Competitively-awarded research funding has proven paramount to addressing a number of challenges (e.g. weather risk, depleted water resources, animal disease and emerging plant pest risks). We continue to support the growth of the Agriculture and Food Research Initiative (AFRI), our primary competitive grants program, which has been one of the few accounts to receive substantial yearly increases in funding from Congress. We are leveraging our strong foundational research and statistical information capacity, including a sustained investment in research that supports sustainable intensification of production agriculture, to spur innovation and respond to emerging issues and opportunities. Ensuring the intellectual capital in traditional agricultural and natural resource disciplines must be sustained if we are to meet USDA's research needs into the future. Maintaining a core program in the traditional disciplines and approaches enables immediate responses to emerging issues and is the backbone for maintaining key disciplines and solving 21st century problems.

- We are promoting scientific integrity in the policies of USDA, both in the performance of scientific research itself as well as in its use. In this, we are aligned with the December 17, 2010 letter from Dr. John Holdren, Director of the Office of Science and Technology Policy, charging all Departments and agencies at the Federal level to develop sound policies that "ensure a culture of scientific integrity" and "strengthen the actual and perceived credibility of Government research." To this end, and in response to an Executive Order, we have developed a Scientific Integrity Policy for application across USDA agencies.
- We are moving science into practice through our technology transfer and Cooperative Extension efforts; promoting innovation in agriculture, forestry, and conservation. As evidenced in our annual Technology Transfer report, we maintain a high-level of commitment to work with the private sector in moving our innovation into commercialization.
- We will continue to address the continuum of learning, from K–12 education, to undergraduate and graduate education, to continuing education of professionals. Keeping the pipeline of students ready to move into the agricultural science and research jobs of the future must be a key focus. In this way, REE agencies put science and information into the hands of policymakers, practitioners, educators, and the interested public, thereby enhancing USDA's mission.
- We collaborate formally and informally with other USDA and Federal agencies, as well as public and private partners, on a national and international level to ensure our research, education, and extension activities are representative of current priorities and take advantage of existing knowledge.

- Our agricultural, environmental, and economics information bases provide data for analyses to inform policy, identifying emerging issues that require reliable data.

"It is simply service that measures success" -George Washington Carver

- ***REE's Guiding Principles***
  - *We listen openly to the people's needs, engaging our stakeholders and the users of the information we produce, to shape our priorities.*
  - *We use our disciplinary building blocks and ongoing core programs as the foundation of our ability to anticipate and respond to emerging issues and opportunities.*
  - *We create an environment of inquiry and innovation.*
  - *We use our capacity in research, in education, in extension, and in statistical measures to achieve our goals.*
  - *Our education and extension efforts advance all REE goals.*
  - *We leverage our work and resources through our partners in the State-based universities, other Federal science agencies, and with the private sector, globally and locally.*
  - *Our programs, from more than a century of transformative science to leading-edge economic research, inform USDA policy and other decision-makers.*
  - *We cultivate a world-class, broadly inclusive, research and statistical workforce.*
  - *We support excellence in research, in information gathering, and in education and extension through a capable and responsive organization.*
  - *Our infrastructure–the National Arboretum, the National Agricultural Library, our labs, our collections, and our experimental farms and watersheds–is a valuable asset and a legacy for science and the American people. We are committed to leveraging our assets to achieve sustainability and increase capacity to solve future problems.*
  - *We improve sustainable agricultural systems, integrating productivity, profitability, and stewardship of natural and human resources, upon which agriculture and land stewardship depend.*

III. Goals: Challenges, Strategies, and Actions

This section of the Action Plan describes the seven Goals that reflect the full scope and variety of REE activities; several Goals have sub-Goals to provide programmatic emphasis. For each Goal, a context is provided in the Challenge element with specifics about REE's role in meeting the challenge. Specific activities are further identified by the Strategies and Actionable items. It is these elements that REE tracks through a "scorecard" process to assess performance.

Structural Outline:

Goal 1. Sustainable Intensification of Agricultural Production
- Subgoal 1A. Crop and Animal Production
- Subgoal 1B. Crop and Animal Health
- Subgoal 1C. Crop and Animal Genetics, Genomics, Genetic Resources, and Biotechnology
- Subgoal 1D. Consumer and Industry Outreach, Policy, Markets, and Trade

Goal 2. Responding to Climate and Energy Needs
- Subgoal 2A. Responding to Climate Variability
- Subgoal 2B. Bioenergy/Biofuels and Biobased Products

Goal 3. Sustainable Use of Natural Resources
- Subgoal 3A. Water Availability: Quality and Quantity
- Subgoal 3B. Landscape-Scale Conservation, Management and Resiliency

Goal 4. Nutrition and Childhood Obesity

Goal 5. Food Safety

Goal 6. Education and Science Literacy

Goal 7. Rural Prosperity/Rural-Urban Interdependence

GOAL 1. Sustainable Intensification of Agricultural Production

CHALLENGE: The future of U.S. agriculture depends on continued improvements in production capacity, production efficiencies and environmental sustainability, with a focus on domestic economic growth. Continuing capability to address increasing needs for domestic and international food security is predicated on a strong and vital U.S. agriculture sector that is

increasingly able to compete economically as a leader in global food production and sustainability. Specific program and research priority areas include: expanding feed and food export markets; improving production and production efficiencies; generating beneficial knowledge, information, and technologies for adaptation to and mitigation of climate change; helping protect the U.S. crops, livestock, and ecosystems from exotic pests and diseases; and improving the nutritional quality and safety of domestic and imported food products. An additional priority exists for increasing economic growth in developing countries with largely agrarian populations. Vibrant and sustainable agricultural production is the very basis for broad economic development and stability in many of these countries, and until a nation has the capacity to feed, clothe, and shelter its rural and native populations, labor and capital cannot be freed for the pursuit of growth in other economic sectors. U.S. Agriculture must remain a leader in advancing these agendas for developing countries around the world.

Finally, all agricultural development depends on comprehensive scientific databases to facilitate development of affordable and appropriate technologies that will 1) improve food production capacity and efficiency; and processing, storage and distribution; 2) improve natural resource management, conservation and ecosystem services; and 3) advance the health and safety of all citizens.

REE ROLE: Develop and transfer knowledge and technologies that promote sustainable[3] agricultural systems locally, nationally, and globally for all types of agricultural production systems, thereby enhancing global food security and strengthening American agriculture. REE provides the knowledge and technologies that enable the U.S. agriculture, food, and fiber systems to produce the food, fiber, and energy to meet growing and changing world demands for these products in an economically and environmentally sustainable manner. It is a priority of REE to develop sustainable food production systems that increase the productivity of agriculture while minimizing environmental impacts by optimizing the use of inputs such as water, energy, pesticides, and fertilizer.

Sustainable Intensification of Agricultural Production
SUBGOAL 1A. Crop and Animal Production

STRATEGIES AND ACTIONS:

Invest in research, development, and extension of agricultural systems that include improved agronomic practices and incorporate enhanced crop and animal germplasm, to safely, sustainably, and humanely increase the production capacity, production efficiency, and nutritional value of food animals and crops. Improve feed and forage use efficiency in

[3] "Sustainable" as used here refers to the National Research Council's definition of sustainability as put forth in the "Toward Sustainable Agricultural Systems in the 21st Century" Report from June, 2010.

animals and identify alternative feed and forage options for animal systems that complement, but do not compete directly with human food and energy needs. Formulate and develop a framework for understanding the sustainability (productivity, economic, social and environmental) outcomes of agriculture/food/forestry practices and systems.

Actionable items

- Identify and implement best management practices for animal and crop systems that are environmentally, economically, and socially sound, based on the best scientific definition. . (ARS, NIFA)
- Develop optimal tillage management strategies for key crops (ARS, NIFA)
- Develop optimal strategies for pollinator/natural enemy management and conservation. (ARS, NIFA)
- Develop optimal strategies for concurrent cultivation of conventional, organic, identity protected, and genetically engineered (GE) crops. (ARS, NIFA)
- Develop optimal crop rotational strategies. (ARS, NIFA)
- Develop precision management practices for spatial application of water and nutrients to maximize use efficiency and increase profitability. (ARS, NIFA)
- Develop recommendations for optimal cover crops and management practices to enhance carbon sequestration and soil health in crop rotations. (ARS, NIFA)
- Develop new management options to enable crop and animal production systems to better adapt to and/or mitigate both direct biotic and abiotic stresses and indirect stress (such as heat stress or aflatoxin contamination of feed), related to climate change. (ARS, NIFA)
- Integrate best management practices and superior crop cultivars or animal breeds into profitable, productive, and environmentally sound crop and animal production systems. (ARS, NIFA)
- Develop enhanced cultivars and superior production systems to lengthen the fresh market harvest season for specialty crops and to increase the nutritional value, availability, and affordability of these crops for local/regional markets. (ARS, NIFA)
- Develop and implement labor and cost-saving technologies, such as robotics, remote sensing for biotic and abiotic stresses, improved spray application and fruit thinning technologies, and dynamic pre-harvest yield estimation to enhance production efficiencies for farms of all sizes. (ARS, NIFA)
- Develop heat resistant/drought tolerant crop and breed varieties that are resilient to the effects of climate change. (ARS, NIFA)
- Develop more sustainable production systems for conventional, organic and low input crops including better methodologies to estimate nitrogen (N) availability. Develop transformative system approaches to improving the sustainability of animal agriculture, including conventional, organic and biotechnological methods. (ARS, NIFA)

- Maximize the beneficial effects of soil health enhancement practices such as cover crops and crop rotations on soil erosion control, greenhouse gas mitigation and carbon sequestration. (ARS, NIFA)
- Provide producers with information to develop more sustainable production systems for conventional, organic and low input crops including better methodologies to estimate nitrogen (N) availability in organic systems to reduce soil nutrient losses, and to maximize the effects of soil health enhancement practices such as cover crops and crop rotations on soil erosion control, greenhouse gas mitigation and carbon sequestration. (ARS, NIFA)
- Develop integrated animal/crop/forage production systems that promote enhanced economic value, ecosystem services and soil health, while optimizing production capacity and production efficiencies for integrated systems. (ARS, NIFA)
- Develop and extend the use of improved feed ingredients and Technology- and science-based solutions for improved nutrient use efficiency of food animals, including comprehensive models for nutrient requirements and animal performance. Develop a comprehensive global feedstuff database. (ARS, NIFA)
- Develop reproduction technologies, and animal health products for improved efficiency, productivity and well-being of food animals. (ARS, NIFA)
- Develop a system for capturing and delivering data and information on environmental, economic, and social consequences of food, agriculture, and forestry systems and processes over the life cycle of product supply chains. (ARS, NIFA)
- Develop life-cycle inventory data on environmental, economic, behavioral, and social impacts of key agriculture-related processes to fill gaps in the current framework through NAL. (ARS, NIFA)
- Develop, assess, and share knowledge about transformative systems approaches to improving the sustainability of agriculture. (ARS, NIFA)
- Develop knowledge needed to define and support science-based animal welfare standards and guidelines that can be effectively implemented through production practices that address societal concerns and support industry viability, including management of fear and pain in food-producing animals. (ARS, NIFA)
- Develop data products that inform policy concerning progress of sustainable agriculture initiatives. (NASS)
- Consider the needs and enhance the role of the U.S. agricultural system in meeting and implementing the guidance set forth in the Dietary Guidelines for Americans. (ARS)

Sustainable Intensification of Agricultural Production

SUBGOAL 1B. Crop and Animal Health

STRATEGIES AND ACTIONS:

Generate mission-driven research and outreach activities that result in increased use of new varieties and technologies to mitigate losses from animal/plant diseases that impact the livelihood and health of people worldwide and increase productivity, sustainability, and product quality. Develop sustainable food production systems that enhance crop and animal health while minimizing environmental impacts.

Actionable items

- Establish a coordinated national research program in predictive biology, integrating ARS core competencies in infectious diseases, diseases complexes, microbial and host genomics, pathology, disease detection, and epidemiology to identify new pathogens and predictors of emerging diseases of livestock.
- Develop non-traditional drugs as alternatives to antibiotics that could be used in animal heath for antimicrobial agent substitutions.
- Develop and extend effective, affordable, and environmentally-sound integrated management strategies to reduce losses caused by crop and animal disease pathogens, insect pests, and weeds, including early detection, identification, monitoring, and implementation of biologically-based and area wide strategies to manage key native and invasive species and postharvest pests. (ARS, NIFA)
- Optimize integrated pest management practices for crops by developing knowledge and tools for cultural methods, biological control, and host plant resistance management tactics. (ARS, NIFA)
- Improve ability to provide surveillance, early detection, rapid response, and appropriate recovery for emerging or reemerging plant and animal diseases of high consequence through the development of tools and enhancement of national plant and animal disease diagnostic networks. (ARS, NIFA)
- Determine how to make bio-based pest management strategies more profitable and economically sustainable. (ARS, NIFA)
- Further refine resistance management strategies for pests in GMO crops (refugia size/location; refugia in a bag, stacked genes, etc.). (ARS, NIFA)
- Develop resistance management strategies for pesticides. (ARS, NIFA)
- Evaluate non-target impacts of pesticides including neonicotinoids and insect growth regulators on natural enemies and pollinators. (ARS, NIFA).
- Identify strategies to mitigate pesticide drift, including neonicotinoids in crop seeding operations that affect pollinators and natural enemies. (ARS, NIFA)

- Improve ability to provide surveillance, early detection, rapid response, and appropriate recovery for emerging or reemerging plant and animal diseases of high consequence through the development of tools and through the enhancement of national plant and animal disease diagnostic networks. (ARS, NIFA)
- Enhance development of effective zoonotic and production related disease counter measures such as diagnostics, surveillance, intervention, and vaccine development, for domestic and international animal populations through the enhancement of relationships and collaborations such as One Health and other international animal health programs. (ARS, NIFA)
- Partner with other Federal departments, such as the Department of State, Department of Defense, Department of Homeland Security, and Department of Health and Human Services, to develop strategies to transfer technologies and strengthen the national capacity to diagnose and control vector-borne and zoonotic diseases that impact livestock and human health. (ARS, NIFA)
- Explore partnerships with the National Institutes of Health (NIH) and Food and Drug Administration (FDA) to develop and extend alternatives to antibiotics, including pre- and probiotics, biotherapeutics, and immune modulators to enhance animal health and production under field conditions. (ARS, NIFA)
- Expand research capacity for current and emerging vector-borne and foreign animal diseases that will both help control disease in the countries of origin as well as provide valuable information on control strategies in the event of the entry into the United States. (ARS, NIFA)
- Develop new crop varieties and improved breeds with increased genetic resistance to diseases and pests. (ARS, NIFA)
- Continue to be an active partner in the National Antimicrobial Resistance Monitoring System (NARMS), including participation in the surveillance function for antibiotic resistant bacteria in animal populations. (ARS)
- Partner with the Food and Drug Administration (FDA) to address issues concerning drug use in livestock and antibiotic resistance. Many veterinary drugs used today were approved decades ago, and development of new animal drugs is limited.
- Investigate and develop new vaccine approaches and new vaccine deployment methods.

Sustainable Intensification of Agricultural Production

SUBGOAL 1C. Crop and Animal Genetics, Genomics, Genetic Resources, and Biotechnology

STRATEGIES AND ACTIONS:

Enhance the sustainability of agriculture while increasing productivity by generating new fundamental knowledge through research in genomic sciences and applications to crop and

animal production. Preserve, characterize, and deploy genetic diversity to ensure economic and environmental sustainability and to maintain American agriculture leadership in a global, biobased economy. Conduct biotechnology risk and benefits assessment research that accurately and scientifically informs regulators, supports product development, and consumer acceptance, and provides information to (Health and Human Services), FDA, State Department, and FAS relevant to trade issues.

Actionable items

- Enhance the capacity of genetic resources and genomics databases for target crops, animals, and priority pathogens, and expand the capacity of plant, animal and microbial germplasm collections to manage increased numbers of new experimental genomic/genetic stocks. (ARS, NIFA)
- Develop and extend the use of agricultural genetic products, production technologies, and practices with specific environmental and socio-economic value to improve production capacity, production efficiencies, product quality, plant and animal health, and animal well-being. (ARS, NIFA)
- Develop plant breeding strategies to produce varieties with improved resilience to weather stress and increased protection from disease and pests. (ARS, NIFA)
- Enhance research on the development of gene silencing strategies for pest management and crop improvement, including all relevant aspects of RNA activity and related protein and regulatory function that connects genotypes to phenotypes. (ARS, APHIS, NIFA)
- Conduct research on gene silencing strategies for pest management and for crop improvement, including RNAi technologies that inform regulatory decisions. (ARS, APHIS, NIFA)
- Develop livestock and aquaculture products and technologies with specific social and economic value that will improve production capacity, production efficiencies, product quality, animal health and animal well-being, and minimize environmental impacts. (ARS, NIFA)
- Develop and apply genetic and genomic technology and sequence information to accelerate and enhance improvements in animal and plant production, reproduction, and quality. (ARS, NIFA)
- Develop new understanding of the relationship of genotype to phenotype, and the molecular processes that translate DNA sequence information into biological traits across diverse environments. This will allow directed breeding to achieve specific outcomes based on predicted breeding values. (ARS, NIFA)
- Develop new varieties of crops and breeds/lines of livestock and aquaculture species with optimal nutritional content to enhance human health as a trait of primary importance, including more bioavailable vitamin and mineral content in new plant varieties and improved fatty acid profiles in animals. (ARS, NIFA)

- Develop improved tools for the analysis of complex genomes to support the genetic improvement of animal, food crop and other crop plants, including development and support of interconnected databases that enable researchers to generate and access new knowledge about the structure and function of plant and animal genomes enhancing translation to the field. (ARS, NIFA)
- Identify gene products and molecular processes that increase yield and improve composition and quality of crops and food animals. (ARS, NIFA)
- Develop and deploy effective methods to conserve plant, animal, and microbial natural genetic diversity for use in agriculture, and identify and utilize this genetic diversity to develop novel traits and properties that will enable development of useful plant varieties and animal breeds. One area of interest is the development of adaptive mechanisms to cope with disease and extreme environments. (ARS, NIFA)
- Develop and implement new molecular and genomic technological strategies to enhance the speed, efficiency and capacity of breeding pipelines. (ARS, NIFA)
- Assess new biotechnology products to promote more sustainable agricultural systems and determine risks and benefits on the environment and economy, including technologies that promote the coexistence of alternative and integrated agricultural production systems. (ARS, NIFA)
- Assess policies and management strategies that support the coexistence of diverse agricultural production systems. (ARS, NIFA)
- Develop new methods and extend technologies and practices to enhance the safety and quality of food and other agricultural products through improved pre- and post-harvest management, storage, and distribution. (ARS, NIFA)
- Increase access to high throughput genotyping and phenotyping technologies including field-based phenotyping, robotics, and tools for data capture analysis to accelerate breeding. (ARS, NIFA)
- Support large-scale coordinated community-wide phenotype data capture, access to remote sensing data, data integration, analysis and modeling. (ARS, NIFA)
- Develop new phenotyped and sequence-indexed genetic resources for trait analysis. (ARS, NIFA)
- Enhance tools and cyberinfrastructure for data management, integration, visualization, analysis, and modeling. (ARS, NIFA)
- Empower a workforce to use a new generation of genetic and genomic technologies and tools, and genetic and genomic resources. (ARS, NIFA)
- Expand our understanding of plant-microbe interactions to better inform system-level approaches to plant breeding. (ARS, NIFA)
- Continue support of the Interagency National Plan Genome Initiative and explore joint opportunities with the National Science Foundation and the Department of Energy to develop sustainable systems for food, bioenergy, and industrial feedstock production considering the minimization of inputs such as water, energy, pesticides,

and fertilizer, the effects of climate change, increased agricultural productivity, minimization of environmental impacts through plant genomics. (ARS, NIFA)

Sustainable Intensification of Agricultural Production

SUBGOAL 1D. Crop and Animal Consumer and Industry Outreach, Policy, Markets, and Trade

STRATEGIES AND ACTIONS:

Characterize and evaluate market performance and the provision of market information in domestic and international markets that affect producer production and marketing decisions in agriculture's food, fiber, and energy sectors. Invest in data development, analysis, and dissemination to improve the understanding of agriculture markets, domestic and foreign trade policies, and other factors that impact food systems. Make agriculture research outcomes readily accessible to the public/consumers and to producers and processors through improved education and extension methods.

Actionable items

- Analyze the performance of domestic and international agricultural markets and disseminate information on the short- and long-term outlook for supply, demand, trade, and prices of major agricultural commodities. (ERS)
- Conduct research on U.S. agricultural policy and the performance of the U.S. food and agriculture sector in increasingly globalized markets. (ERS)
- Conduct research on the implications of multilateral, regional, and bilateral trade agreements for U.S. producers and consumers of food and fiber (ERS).
- Analyze the impact of modern food animal and cropping systems on the potential to provide adequate food supplies while protecting and conserving the environment. Evaluate the impacts, including economic impacts, of new technologies, including integrated crop and animal systems and precision farming techniques, and their potential to increase the efficiency of these systems. (ARS, ERS, NIFA)
- Evaluate trends and changes in production agriculture and adjust 1) States included in U.S. market year average price calculations and 2) States included in the county estimates statistics program accordingly. (NASS)
- Develop and implement new research programs and expand access to new knowledge through education and Cooperative Extension, to lay and scientific audiences, including new/beginning and socially disadvantaged farmers, ranchers, and veterans, of the role that new technologies will play in addressing challenges that face global agriculture. (NIFA)

- Expand access to new knowledge and technologies for stakeholders, including new and beginning and socially disadvantaged farmers, ranchers and veterans, through education and extension. (NIFA)
- Characterize and evaluate trends in agricultural research funding and direction, both public and private; the use of various funding instruments; and key factors affecting research and development, and resultant productivity growth. (ERS)
- Develop innovative approaches to measuring scientific effort, outputs, and impacts using STAR METRICS or other information sources for effective quantitative research evaluation of REE research programs (ARS, ERS, NIFA).
- Examine the impacts of changes in market structure and other critical factors on price levels, volatility, and price discovery in major agricultural commodity markets. (ERS)
- Develop estimates of international agricultural productivity growth to improve understanding of patterns of growth and analyze how different factors—including government policies—influence productivity trends. (ERS)
- Provide technical assistance to improve agricultural statistics systems in developing and transitioning countries. (ERS, NASS)
- Produce annual international Food Security Assessments covering 76 food insecure countries that analyze the current food security situation, project food security developments over the next decade, and analyze the effect of alternative economic and policy alternatives on global food security. Reports and related research and data products address the range of food availability, access, utilization, stability factors that influence nutritional adequacy and food security at the national and household level. (ERS)
- Provide technical assistance to FAO to improve international monitoring of food security. (ERS, NASS)
- Produce annual domestic household food security assessments estimating the number of U.S. households unable to afford adequate food. Reports and related research and data products provide information and support research on causes and consequences of food insecurity and the effects of programs to support food security. (ERS, NASS)
- Understand the sources of food waste and loss within the supply chain, i.e., processing, transportation, marketing and consumption and the design of incentive mechanism to minimize losses. (NIFA)
- Examine the social, behavioral and economic sources and barriers to productivity growth, including incentives for collaboration between the public and private sectors for advancing food, agricultural and environmental sciences. (ERS, NIFA)
- Examine the economic impacts of local markets on food supply, demand and quality. (NIFA)
- Develop strategies and models to encourage the coexistence of multiple crop technologies, such as conventional, GMO, and organic production technologies throughout the supply chain. (NIFA)

- Provide the data infrastructure to allow for program and policy design, analysis, and evaluation. (NASS)

GOAL 2. Responding to Climate and Energy Needs

CHALLENGE: Production systems, whether for food, feed, fiber, or fuels are climate-dependent to varying extents. The ability to respond to changes in climate is critical. With an ever-increasing demand for food and non-food products and services, producers must take into account climate variability to sustain production of various plant varieties and animal breeds. Fundamental research is necessary to adapt agricultural production systems appropriate to a changing climate to meet increased food and energy demands, and to determine the role of agriculture in appropriate greenhouse gas reduction opportunities. Education and extension programs must also be developed and implemented to ensure that the knowledge gained reaches our many partners and the public.

Responding to Climate and Energy Needs
SUBGOAL 2A. Responding to Climate Variability

CHALLENGE: Agriculture, forest, and range production systems are affected by climate variability. Agricultural and forestry producers, land managers, and other decision makers need information, technologies, and decision-support tools to help them with adaptation strategies and greenhouse gas mitigation. Crop, animal, forest, and range management strategies must take climate variability into account to ensure sustainability. The potential for forests and agricultural lands to serve as carbon sinks and to reduce greenhouse gas emissions must be quantified to support sound policies and environmental markets. Outreach and extension networks must be implemented to advance the incorporation of climate-change mitigation and adaptation strategies into management practices and utilize scientific findings for restoration projects and planning.

REE ROLE: Develop and deliver science-based knowledge through research, education, and extension that empowers farmers, foresters, ranchers, land owners, resource managers, policymakers, and other Federal agencies to address the production, management and economic risks, challenges, and opportunities of climate variability and change, and position agricultural communities to significantly reduce emissions of atmospheric greenhouse gases and enhance carbon sequestration.

STRATEGIES AND ACTIONS:

Explain the processes driving the direct and indirect effects of climate variability on natural and managed ecosystems, including feedbacks to the climate system.
Actionable items

- Identify and quantify the effects of changing climate, climate variability, and atmospheric composition on agriculture, rangeland, and forest ecosystem's productivity and sustainability, through a trans-disciplinary system science approach involving agricultural sciences, natural and social sciences, mathematics and engineering. (ARS, NASS, NIFA, NRCS, Forest Service)
- Develop the forecasts for future impacts of climate changes on natural and managed ecosystems that can be used in air, soil, and water quality and agro-ecosystem policy analyses and management planning. (ARS, NIFA)
- Create a balance of fundamental and applied research to better understand animal and plant responses and the resulting management, genetic and nutrition changes that take place under long and short term climate variability and change. (ARS, NIFA)
- Explain the processes and mechanisms that determine how climate change affects invasive species, weeds, pathogens, and insects and determine the effects of changing climate stresses on vector behavior, distribution, and host susceptibility for different crops, livestock, and forest species. (ARS, NIFA)
- Determine how climate variability and extreme weather events impact the physical, chemical, and biological properties of soil, including cycling of carbon, water, and essential plant nutrients; erosion and sedimentation; and the resilience of soils to support agricultural production and other ecosystem goods and services. (ARS, NIFA)
- Perform risk assessments and pathway analyses of invasive species, and develop climate-driven epidemiological models of plant, livestock, and wildlife diseases. (APHIS, ARS, NRCS, Forest Service)

Develop knowledge and tools to enable adaptation of agriculture, forestry, and grasslands to climate variability and to improve the resilience of natural and managed ecosystems and vulnerable populations.

Actionable items

- Create adaptation strategies in response to the President's 2013 Climate Action Plan to sustain and increase the resiliency of crop, livestock, and forest tree production systems, biodiversity, and ecosystem services, including practices and technologies that increase the resilience of subsistence food systems to climate variability, weather extremes, and changes in the composition of the atmosphere (i.e., increasing carbon dioxide and ozone concentrations). (ARS, NIFA)
- Expand evaluation of gene expression (phenology) to include traits associated with susceptibility and adaptation to climate change to assemble a centralized marker, and trait database for key plant and animal commodities for marker-assisted breeding programs. Develop analysis tools for breeders trained by a nationally-coordinated education network. (ARS, NIFA)

- Use population genetics, climate matching, and ecological niche assessment to project potential ranges of invasive pests to enable future detection and mitigation. (ARS, NIFA)
- Strengthen existing monitoring programs, such as USDA's Forest Inventory and Analysis (FIA), National Resources Inventory (NRI), Regional Climate Hubs and Long Term Agroecosystem Research (LTAR), and integrate them with other monitoring and data collection systems and research networks and programs, such as Long Term Ecological Research, the National Ecological Observatory Network, and the Regional Integrated Science Assessment sites, to track and manage changes in land use and related effects on ecosystem processes. (ARS, NASS, NIFA, Forest Service, NRCS)
- Quantify consequences of producer choices for adapting to climate change on agricultural markets; agronomic practices; adoption of technology; ecological systems; and agricultural greenhouse gas emissions.(ERS)
- Develop new types of cropping systems that utilize biodiversity and generate a broader set of ecosystem services than at present, i.e., environmental quality, stable livelihoods, and rural communities that support adaptive management. (ARS, NIFA)

Develop knowledge and tools to enhance the contribution of agriculture, forestry, grasslands, and other land management practices to mitigate atmospheric greenhouse gas (GHG) emissions.

Actionable items

- Evaluate and improve biofuel cropping systems for feedstock production, greenhouse gas mitigation, and other ecosystem services. (ARS, NIFA)
- Develop information and technologies, including life cycle inventory, to build stakeholder capacity for estimating, measuring, tracking, and minimizing net GHG emissions per unit of commodity produced for multiple agricultural and forestry production scales. (ARS,, NIFA)
- Evaluate economic, GHG, and other environmental implications of alternative approaches to the design and implementation of GHG mitigation policies in the agriculture and forest sectors; apply new methodologies from behavioral economics to identify farmer and rancher behavioral factors likely to affect their participation in, and the performance of, offset markets and incentive programs. (ERS)
- Develop and transfer knowledge to producers, land managers, and other decision makers on the GHG mitigation potential of "transformative" agricultural systems to mitigate GHG emissions while providing other environmental, economic, and social benefits. (ARS, NIFA)
- Strengthen international capacity for agricultural GHG mitigation by providing leadership to the Global Research Alliance on Agricultural Greenhouse Gases. (ARS, ERS, NIFA)

Provide information and tools to USDA agencies, stakeholders, and collaborators to improve decision making.

Actionable items

- Organize, manage and make effective the USDA Regional Climate Hubs for the development and delivery of science products at the regional level to agricultural and forestry communities of practice. (ARS, NIFA. NRCS, Forest Service, CCPO, FSA, RD, RMA)
- Using Cooperative Extension, and other means expand user access to models and tools developed for assessments of adaptation and mitigation strategies with user-friendly interfaces to facilitate decision support by non-scientist end users, including new/beginning and socially disadvantaged farmers. (ARS, NIFA)
- Deliver comprehensive scientific and technical information on climate change, tailored to the agricultural, forestry, and natural resource management communities. (ARS, ERS, NIFA)
- Expand outreach and university extension and education activities in global change and climate, including Internet-based information systems for stakeholder access to information they can use. (ARS, NIFA)
- Establish partnerships with other Federal agencies such as NOAA, NASA, NSF, and EPA, and international research agencies, such as the Consultative Group on International Agricultural Research (CGIAR) System for supporting cutting edge discovery, learning, and outreach programs. (ARS, ERS, NIFA)
- Enhance remote sensing methods to assess impact of climate change on crop production. (ARS, NASS, NIFA)
- Provide vulnerable communities with information and tools that allow them to improve sustainability of agricultural practices and adapt to climate changes. (ARS, NIFA)

Responding to Climate and Energy Needs
SUBGOAL 2B. Bioenergy/Biofuels and Biobased Products

CHALLENGE: The Environmental Protection Agency (EPA) has finalized a rule implementing the long-term renewable fuels mandate of 36 billion gallons by 2022, established by Congress. The Renewable Fuels Standard requires biofuels production to grow from 11.1 billion gallons in 2009 to 36 billion gallons in 2022, with 21 billion gallons to come from advanced biofuels. About 24 million acres of dedicated feedstock crops will be required to produce these advanced biofuels. Increasing renewable fuels will reduce dependence on oil by more than 328 million barrels a year and reduce greenhouse gas emissions by more than 138 million metric tons a year when fully phased in by 2022. By 2015, 5.5 billion gallons of advanced biofuels is required. Strategic research, demonstration, commercialization, extension,

and education programs are needed to meet these national goals. The REE mission area takes into consideration the advice and recommendations received from outside sources, including the Biomass Research and Development Initiative (BRDI) Technical Advisory Committee and the National Agricultural Research, Extension, Education, and Economics Advisory Board (NAREEEAB) and its Renewable Energy Committee.

Feedstock production systems for the production of bioenergy and other bio-based products create new and diverse economic opportunities for rural communities. Developing, sustaining, and expanding these systems will rely on multi-disciplined scientific and technical expertise, sound business practices, and a well-trained workforce.

Climate, water, natural resource management, and energy development face interrelated challenges. Long-term sustainability of resources hinges on the knowledge base established by appropriate research, education, and extension programs.

REE ROLE: Lead global agricultural innovation to achieve energy efficiency and independence by integrating economically, environmentally, and socially sustainable regional-based biomass production systems into existing agricultural systems. Develop complete bioenergy supply chains that rely on agricultural production to provide clean biobased energy and rural economic development. Challenge our scientists to invent and develop new technologies to meet our Nation's energy needs.

STRATEGIES AND ACTIONS:

Increase biomass production efficiency to reduce production and biorefinery costs: conduct biomass plant improvement research and development to provide feedstocks for advanced biofuels and biobased products. Develop and apply understanding of the molecular basis for key plant traits and improving germplasm and varieties for energy crops; develop regionally-based sustainable new feedstock production systems for bioenergy feedstocks; and develop feedstock logistics and conversion technologies suitable to near-farm scales.

Actionable items

- Implement and leverage the five established USDA Regional Biomass Research Centers and NIFA-funded regional bioenergy delivery systems and bioenergy/bioproduct development projects, in cooperation with Forest Service Research and Development and other external resources, to effectively integrate knowledge about more sustainable crop and forest production bioenergy systems. (ARS, NIFA, Forest Service)
- Identify new genes that control biomass and develop improved germplasm for bioenergy feedstocks. (ARS, NIFA)

- Protect traditional germplasm in native plants through partnership with ARS, APHIS, and other Federal agencies. (ARS)
- Conduct research on conversion technologies, especially ones that are feedstock-flexible or that are commercially-viable at near-farm scale, for producing advanced biofuels and other marketable biobased products. (ARS, NIFA)
- Conduct and integrate research to reduce risks and improve the profitability and sustainability of existing biorefineries, including development of co-products such as biobased chemicals and other high-value products. Integrate bioenergy research with research on other renewable energy production, climate change, environmental improvement, food, and other biobased production, to diversify use of the rural landscape. (ARS, NIFA)
- Identify and develop woody biomass production systems that supply bioenergy production while improving forest health and sustainability. (NIFA, Forest Service)

Incorporate biomass and dedicated feedstock crops into existing agriculture, forestry, and agroforestry-based systems to increase diversity of the rural economy and sustainable land management.

Actionable items

- Engage and use the Cooperative Extension system to transfer knowledge in all aspects of bioenergy production, use, and conservation, to producers and end-users, including underserved and minority communities. (ARS, NIFA)
- Develop cost-effective waste-to-energy systems (using animal manures, crop and forest residues, food processing byproducts, and other residuals as feedstocks) for distributed production of fuels, biobased products, heat and power. (ARS, NIFA)
- Expand effective communication and information-sharing mechanisms, including the implementation of educational curricula, to prepare the needed workforce. (NIFA)
- Develop on-farm utilization of biorefinery co-products. (ARS, NIFA)
- Target multi-functional landscapes. (ARS, NIFA)

Address the uncertainties of expanded biomass and biofuel production to achieve benefits and avoid negative impacts on rural communities, economies, ecosystem services, and production of food, feed, and fiber. Develop biophysical models to evaluate the impacts of commercial-scale bioenergy feedstock production systems and policies on long-term productivity and other ecosystem services provided by underlying natural resources. Develop the statistical information base and analytic capacity to understand and model economic, social, and environmental benefits and impacts of biofuel production and bioenergy-related policies.

Actionable items

- Develop short- and long-term projections for crop and livestock production, prices, and trade and evaluate implications of bioenergy production for farm income,

commodity program budget expenditures, food prices, and other indicators of farm performance. (ERS)

- Develop models of bioenergy production, which incorporate social, economic, and environmental factors in order to identify sustainable outcomes. (ERS)
- Continue expanding current economic and biophysical research projects (e.g., the Greenhouse Gas Reduction through Agricultural Carbon Enhancement tool and the Conservation Effects Assessment Project [CEAP] Water Assessment Study) to include dedicated bioenergy feedstocks and linkages to outcomes on resource use, environmental quality (e.g., long-term productivity and ecosystem services provided and greenhouse gas emissions). (ARS, NRCS)
- Conduct studies to examine Federal policy and identify action steps to develop more sustainable production systems, which create reliable rural development and avoid unintended environmental consequences. (ERS)

GOAL 3. Sustainable Use of Natural Resources

CHALLENGE: Technologies and management prescriptions need to be developed that produce needed agricultural and forest products while sustaining the natural resources and ecosystem services that support their development. Research, education, and extension programs that improve soil, air, and water resources while supporting agricultural and forest production on working lands have been the hallmark of USDA for more than a century. Climate, water, and natural resource management face interrelated challenges. Long-term sustainability of resources hinges on the knowledge base established by appropriate research, education, and extension programs. Improving agriculture's conservation effectiveness through better management of agricultural landscapes improves agricultural productivity, its economic performance, as well as enhancing natural resources and ecosystem services. .

REE ROLE: REE develops and delivers the scientific knowledge base (agronomic, climatic, ecological, economic, social and institutional) to address sustainable use of natural resources and the environment, including soil, air, and water resources.

Sustainable Use of Natural Resources
SUBGOAL 3A. Water Availability: Quality and Quantity

CHALLENGE: As the population continues to increase across the U.S. and around the world, there is a growing demand for safe, reliable sources of water to meet the needs of Earth's diverse and expanding population. In many parts of the world, issues of water availability and safety are central to ensuring domestic and international food security and political stability. In the U.S., rising demands for water to support energy sector growth, sustain environmental flows (i.e., ecosystem services), and satisfy the water-rights claims of Native Americans and others, present

new challenges for agricultural water conservation. Especially in light of alterations to the supply and demand for water predicted with climate change, farmers, ranchers, and rural communities will be increasingly susceptible to these new competing demands, as well as to a mounting pressure to provide more water for urban and urbanizing areas at the expense of (surface and ground) water that currently supports agriculture and rural communities. While historically, drought and the reliability and safety of rural and agricultural water supplies were of concern primarily in the Western states, issues of agricultural water security have become a national challenge. In many areas, expanding urban populations and rising demands for water from non-agricultural sectors now encroach on water supplies traditionally reserved for irrigated agriculture. In other areas, ground and irrigation water supplies are being depleted or contaminated by agricultural use. In addition, the predicted impacts of climate change could alter other historic relationships, such as those between traditional flood protection and water supply. Shifts in the allocation and safety of these water resources could have dramatic impacts on the long-term supply of food, feed, and fiber in the U.S.

REE ROLE: Develop and provide the best available science and technology to inform decisionmaking and improve management practices to enhance water conservation, use, and quality.

STRATEGIES AND ACTIONS:

Foster a watershed/landscape-scale approach that encourages place-based agricultural water management and sustains U.S. natural resources, agriculture, and rural communities in the face of competing water demands.

Actionable items

- Continue utilizing decades old longitudinal studies and data to improve the observational capability and data accessibility of ARS Benchmark Watersheds and Experimental Ranges (BW&ER), including updating and maintaining the Sustaining the Earth's Watersheds Agricultural Research Data System (STEWARDS) database. (ARS)
- Continue to develop the Long-Term Agro-Ecosystem Research (LTAR) network as a platform for agricultural research to sustain local and global food supply and security (ARS); continue to encourage government-university research and outreach partnerships in the LTAR network with competitive funding opportunities for LTAR. (NIFA)
- Connect ARS LTAR and BW&ER networks with the Forest Service Experimental Forests and Ranges (EF&R) network to investigate climate change influences on water resource management and agricultural sustainability across gradients of natural, managed, agricultural, and urban ecosystems. (ARS, Forest Service)

- Develop a reference baseline for measuring changes in production capacity in response to changing environmental conditions and management decisions. (ARS)
- Identify universal hydro-climatic descriptors of watersheds and determine the significance of historical trends in temperature, precipitation, and runoff across North America. (ARS, Forest Service)
- Continue development and validation of ARS watershed and management simulation models to treat a broader spectrum of conditions, management and conservation scenarios, ecosystem services, economics, and crop production (including grass filter strips, terraces, and other practices). (ARS)
- Evolve USDA REE water programs to address regional, place-based water initiatives (Chesapeake Bay, Great Lakes, etc.). (NIFA, NRCS, Forest Service)
- Expand the National Agricultural Library's (NAL) Water Quality Information Center to provide USDA watershed research results and information on other USDA efforts involving water resources (ARS, Forest Service)
- Evaluate changes in watershed health and function in response to management, natural disturbances, and atmospheric deposition. (ARS, NIFA, Forest Service)
- Standardize methods and protocols for intensively monitored watersheds. (ARS, NIFA, Forest Service)
- Compare model output with field measurements to evaluate the validity of assessments of Farm Bill conservation practices and programs to provide real environmental benefits. (ERS. ARS)
- As a service to agricultural and environmental data users, the 2012 Census of Agriculture data for 38 individual land characteristics will be published at the 6-digit Hydrologic Unit Code (HUC) level after the U.S. and State level publications from the 2012 Census of Agriculture are released. Selected statistics at the HUC 6 level will be available for 2007 and 2012. (NASS)

Provide research and decision support tools to: increase the effectiveness of USDA conservation policies, programs, and practices; raise the ratio of conservation benefit/conservation investment; enhance the effectiveness of water-management institutions; preserve ecological flows; and facilitate the transfer of research advances to practical implementation.

Actionable items

- Develop new and/or improved conservation practices, and strategies for practice placement, to maximize conservation benefits at the watershed scale while minimizing conservation investments. (ARS, NIFA, NRCS, Forest Service)
- Develop user-friendly decision support tools for practitioners (conservationists, land managers, farmers, ranchers, and the tribal and reservation communities) that use state-of-the-art USDA research to rapidly and effectively solve practical problems at the field, landscape, or watershed scale. (ARS, NIFA)

- Improve our understanding of the aggregate effects of conservation practices at the watershed scale. (ARS, NIFA, NRCS, Forest Service)
- Develop a better understanding of the economic impacts and social drivers of conservation practice adoption in rural, agricultural, and urbanizing watersheds. (ARS, ERS, NIFA, Forest Service)
- Analyze the economic impact of different water use and management institutions on cropland values using geo-referenced datasets that incorporate information on cropland values, irrigation status, and physical characteristics at the plot level. (ERS, NASS)
- Utilize the Special Tabulations service offered by the National Agricultural Statistics Service to further uncover data relationships in the Census of Agriculture data. (NASS)

Improve the efficiency of water use (particularly for irrigation) and develop and extend science and technology to achieve the maximum "crop per drop" for agricultural goods and services.

Actionable items

- Conduct the Farm and Ranch Irrigation Survey for the year 2013 to provide needed information concerning crop water use, irrigation system and water management practices, water quantity by sources, and other information necessary to evaluate agriculture's impact on USDA goal for water resource management and sustaining rural economies. The Census of Aquaculture will also be conducted for 2013 which will provide data on another component of water used for agriculture. (NASS)
- Invest in research, development, and extension of new irrigation techniques and management of limited water resources, including strategies for water reuse or desalination of brackish water. (ARS, NIFA)
- Continue with research addressing the economics and factors influencing adoption of conserving "irrigation production systems," i.e., the integration of on-farm water-management practices with high-efficiency irrigation application systems. (ERS, NIFA)
- Support research examining the contributions of Native Americans to U.S. irrigated agriculture, including their crop/livestock values, water use by source, use of water-management and efficient irrigation practices, and potential for improving upon watershed water conservation goals. (ERS)
- Update the *Water Management and Conservation* chapter of ERS's Agricultural Resources and Environmental Indicators using data from the 2013 Farm & Ranch Irrigation Survey. (ERS)
- Support research and extension on innovative crop management systems and integrated crop-livestock systems that may achieve dramatic improvements in water

conservation and quality and other ecosystem services ("transformative" systems in the sense of NRC 2010). (NIFA)

- Continue work with water conservation efforts with a focus on socio-economic research and extension to increase adoption of appropriate practices and technologies (including alternative crops) to achieve increased water conservation at the watershed scale. (NIFA)
- Conduct life cycle analysis of crop/livestock systems to determine optimum water and energy inputs and geographic considerations for sustaining food, feed, fiber, and fuel productivity in the USA. (ARS, NIFA)
- Assess water vulnerability for agriculture and forestry as demand for water increases to meet needs related to: urban population growth, fracking and energy cooling, tribal water rights claims, sustaining environmental flows and endangered species, and the effects of climate change. (ARS, FS, NIFA)

Expand and/or elevate existing, and encourage new, Federal partnerships to promote water conservation at watershed, landscape, and regional scales in agricultural, rural, and urbanizing communities, and reduce the impacts of climatic disturbances.

Actionable items

- Propose new partnerships with the Department of the Interior Bureau of Reclamation (BOR), United States Geological Survey (USGS), and EPA to address areas of common interest, conduct cooperative research, and promote adoption of research outcomes to deliver/conserve water. (ARS, NRCS, Forest Service,)
- Continue cooperation with NOAA and other Federal agencies via the National Integrated Drought Information System (NIDIS) to promote place-based research and extension aimed at improving community drought preparedness. (ARS, ERS, NIFA, NRCS, Forest Service)
- Continue to explore and expand potential partnerships with EPA, the Army Corps of Engineers (USACE), USGS, the Bureau of Land Management (BLM), the Forest Service, and other Federal, state, local or tribal agencies or entities to improve water resource management on working lands at the watershed scale. (ARS, NIFA, NRCS, FSA, Forest Service)

Provide research and decision-support tools to maintain water availability and safety in a changing global environment.

Actionable items

- Identify components of the hydrologic system that are most sensitive to projected climate variability and determine their potential impacts on agricultural productivity, natural resources, and land conservation. (ARS, NIFA, NRCS, Forest Service)
- Estimate the impacts of projected climate variability on regional water availability and quality (including sediment yield) across diverse physiographic regions of the U.S. and their associated implications for conservation needs and agricultural productivity. (ARS, NIFA, NRCS, Forest Service)
- Develop climate-informed decision support systems to sustain U.S. agricultural production capacity and natural resources in light of climate-driven changes in water availability. (ARS)
- Develop regional use estimates of the "water footprint" (surface and groundwater) of agricultural production systems. (NIFA)
- Determine social, economic, and/or cultural circumstances or practices that promote or serve as barriers to reducing the water footprint of agricultural production, and develop outreach/extension programs that lower these barriers and promote the adoption of water conserving practices and technologies in rural and agricultural communities. (NIFA)
- Publish in the LCA Digital Commons life cycle assessment irrigation and manure management unit processes for the major commodity crops. (ARS,)

Develop and refine research and decision-support tools to understand the water implications of USDA's evolving bioenergy strategy to contribute to the development of sustainable bioenergy production systems.

Actionable items

- Evaluate the water implications of bioenergy feedstock production at watershed, landscape, and regional scales to reduce conflicts between food and fuel production and the provision of ecosystems services, particularly the availability of adequate supplies of clean, fresh water. (ARS, ERS, NIFA, Forest Service)

Provide statistical data to support management of productive working cropland.

Actionable items

- Provide additional data on crop conditions, soil moisture, and/or drought monitoring by publishing cropland data layer technology for all 48 contiguous states. (ERS, NASS)
- Summarize the 2012 Census of Agriculture by six-digit Hydrologic Unit Code and publish results in a Census Watershed Publication to enable better management of water resources at the local level. (ERS, NASS)

- Conduct research and explore new scientific and technological advances to enhance the quality, accuracy, and consistency of statistics, specifically in the areas of geographic information systems and remote sensing. (ERS, NASS)
- Evaluate trends and changes in production agriculture and adjust the Farm and Ranch Irrigation Survey and Agricultural Resource Management Survey programs accordingly. (ERS, NASS)
- Update the data product *Western Irrigated Agriculture*, which summarizes characteristics of irrigated farms by farm-size class. (ERS)

Sustainable Use of Natural Resources
SUBGOAL 3B. Landscape-Scale Conservation, Management and Resiliency

CHALLENGE: Well-managed agricultural, forest, and range land supplies important non-market goods and services for our environment. Farms, forests, and ranch lands provide food and cover for wildlife, help control flooding, reduce erosion, protect wetlands and watersheds, improve water quality and quantity, store carbon, and maintain air quality. They can absorb and filter wastewater and provide groundwater recharge. Well-managed agricultural lands also provide cultural and aesthetic benefits. With a rapidly increasing world population and expanding global markets, saving American farmlands, ranches, and forests is a prudent investment in the world's food, fiber and energy supply and the Nation's economic future.

Landscapes are a foundation of rural economic opportunities and focal points for addressing issues through a concentration of available resources that integrate leading-edge science, including assessments, adaptation tactics, monitoring, predictive models, and management actions. Science and technology development within landscapes is collaborative in nature and utilizes past and current work. Working across landscape levels enables focused investments in land management science and technology to better meet the needs of landowners and managers. Effective and efficient solutions will be evaluated for other landscapes.

Improved fertilizer nitrogen recommendations, optimized for production and environmental goals, as well as management technologies and improved models to evaluate nitrogen's life cycle for agricultural systems are needed to enhance crop nitrogen use and to mitigate nitrogen losses. Linking these tools to policy options and evaluation of policy strategies and markets are needed to encourage better and more efficient management of nitrogen, potassium, and phosphorus best management practices.

REE ROLE: In collaboration with other USDA agencies, including ARS, ERS, and Forest Service Research and Development and the Office of Environmental Markets, develop and provide the best available science and technologies to inform U.S. government policies and programs and to support application of land management practices that improve the

economic, social, and environmental sustainability of our Nation's working farms, ranches, and forests.

STRATEGIES AND ACTIONS:

Understand determinants of producer adoptions of conservation practices, including the role of markets for ecosystem services.

Actionable items

- Provide a statistical information base on agricultural land usage and conservation practices as a basis for understanding the determinants of government policy on land use. (NASS)
- Determine and evaluate the economic, demographic, resource, and climate issues that affect the adoption of conservation practices and influence the decision to participate in conservation programs. (ERS)
- Determine and evaluate the sociological and human behavioral issues that affect the adoption of conservation practices and influence the decision to participate in conservation programs. (NIFA)
- Evaluate the effectiveness of a range of agri-environmental program designs for promoting the provisions of ecosystem services from agriculture, including financial incentives, compliance, and market-based approaches. The research would include an assessment of the implications of multiple program objectives, such as water quality, biodiversity, pollinator services, wildlife habitat, and farm income, on policy design. (ERS, NIFA)
- Develop a coordinated agenda for research to identify and measure ecosystem services that different conservation and management practices and systems can produce. (ARS and NIFA)
- Promote implementation of the lessons learned from two synthesis projects of thirteen Conservation Effects Assessment Project (CEAP) watersheds that evaluated conservation practices and socioeconomic implications across the U.S. (NASS, NIFA, NRCS)
- Compile a complete database of the current research on ecosystem services and closely related topics and synthesize research activities from both the NRCS special emphasis watersheds and associated ARS benchmark watersheds to develop decision support for appropriate conservation practice application in critical watersheds. (ARS)
- Identify and analyze the barriers to sustainable ecosystem service management and formulate solutions to overcome these barriers, including those encountered by new/beginning and socially disadvantaged farmers, ranchers, and forest owners. (NIFA)

- Synthesize the suite of ecosystem services models and evaluate their applicability and effectiveness for use in environmental credit trading markets. (ARS)
- Focus science and technology development efforts at the landscape level, targeting place-based conservation and management options. (ARS, NIFA, Forest Service)

Develop an integrated (air, water, soil, biomass, wildlife) / multidisciplinary program that takes a full-accounting approach to conservation, improved efficiency, control technologies, environmental credit trading, and process-based models for reactive nitrogen.

Actionable items

- Fund competitive programming that improves nitrogen uptake, assimilation, accumulation, and/or utilization in plant and animal production systems or via plant and animal-microbe interactions. (NIFA)
- Fund a functional genomics and plant breeding program to understand nitrogen fixation in soybeans and transfer this functionality to perennial commodity crops, corn, wheat, and cotton, leading to reductions in nitrogen fertilizer application. (NIFA)
- Develop a program to improve efficiency of feed conversion of crude protein in the animal gut and evaluate new feedstocks as sources of amino acids for animal production, such as waste streams from biofuel production, to reduce the nitrogen and phosphorus in animal waste. (ARS, NIFA)
- Create a program to develop bioproduct processes that are cost-effective and that do not adversely impact the environment. For example, utilize byproducts in waste streams from biofuel production as a concentrated source of nitrogen for feed or fertilizer. (ARS, NIFA)
- Develop and evaluate policy strategies and markets to encourage better and more efficient management of nitrogen (e.g., trade, conserve, and remediate reactive nitrogen). (ERS, NIFA)
- Develop programming on a holistic systems approach, focused both toward understanding nutrient dynamics in *transformative* (e.g., organic, integrated crop-livestock, and alternative livestock) sustainable systems, and apply this knowledge in extension and education programs, including consideration of culturally appropriate foods. (ARS, NIFA)
- Provide statistical information on conservation and production practices though the alternating year's commodity rotation of the NASS survey program. (NASS)

Explain the determinants of socio-economically viable and environmentally sound livestock, forage, and forest production systems

Actionable items

- Develop a program to evaluate the impacts of cellulosic energy production on forage-based livestock systems. (ARS, NIFA)

- Develop knowledge to understand the adaptation requirements of forage-based livestock systems to extreme climatic variability (e.g., responsive systems to drought, responsive systems to temperature increases, and how to manage risk). (ARS, NIFA)
- Develop inventory and monitoring tools to optimally control the spread of invasive weeds in terms of reducing productivity losses to wildfire, altering wildlife habitats, and loss of biodiversity. (ARS, NIFA)
- Develop a program to evaluate more complex mixtures (e.g., functional groups) of pasture grasses and legumes as a risk reduction strategy and to optimally produce biomass for bioenergy production. (ARS)
- Develop a program to investigate the impacts on the phenology and spread of poisonous plants due to changing climate. (ARS)
- Through integrated research, education, and extension work at the USDA Regional Climate Hubs, develop agriculture and forest production programs that utilize the climate mitigation services of agricultural, range, and forest production systems . (ARS, Forest Service, NIFA, NRCS)

Advance the use of agroforestry as a viable agricultural option for meeting the multiple demands of food, fiber, feed, fuel, and natural resource conservation from these lands.
Actionable items

- Develop knowledge and technologies to improve the application of agroforestry practices and principles in protecting water and soil resources; building landscape-level resiliency to climate change impacts; reconnecting ecological services across rural-urban lands and communities; providing innovative and sustainable bioenergy production systems; creating multi-purpose landscapes that can produce food, fiber, and energy, and protect natural resources. (ARS, NIFA, Forest Service)

Manage agricultural watersheds and landscapes to improve the delivery of ecosystem services while sustaining or enhancing agricultural production.
Actionable items

- Develop robust indicators, statistics, and biome-specific metrics of the: 1) spatial connectivity of landscape elements; 2) quantity and quality of ecosystem services provided by agricultural landscapes; and 3) commodity values of ecosystem services delivered from working lands in tandem with Council on Environmental Quality efforts. (ERS, NASS, Forest Service, NRCS, Office of Environmental Markets (OEM))
- Partner with other Federal agencies, such as NOAA, NASA, and EPA, to develop an integrated management plan for agricultural watersheds and landscapes. (ARS, Forest Service, NRCS, OEM)

GOAL 4. Nutrition and Childhood Obesity

CHALLENGE: Childhood obesity has more than tripled, and adult obesity has doubled since 1980. The prevalence of obesity among children aged 6 to 11 years increased from 6.5 percent in 1980 to 18.0 percent in 2010. The prevalence of obesity among adolescents aged 12 to 19 years increased from 5.0 percent to 18.4 percent (CDC). At the same time, many sub-populations, including low-income, elderly, and tribal populations, suffer from food insecurity, do not have adequate micronutrients, or face limited access to healthy food choices. Obesity in itself is a complex issue with no simple solution or answer. Preventive nutrition and physical activity strategies proven to be efficacious are required to reduce the incidence and prevalence of obesity and related chronic diseases and thereby lower health care costs. Elimination of malnutrition will also be a significant challenge. Establishing a balance of food availability and adequate nutrition will only be accomplished by changing not only the food supply and the food environment, but also behaviors. This challenge will require multidisciplinary research to identify key determinants and potential solutions, as well as, monitoring, program evaluation, and translational activities to be conducted on a substantial scale in order to produce reliable results that can inform policies, nutrition assistance programming, and education/extension programs. The necessary scale is achieved through close coordination among REE agencies and strategic Federal and public-private partnerships.

REE ROLE: Build the evidence base for food-based and physical activity strategies and develop and evaluate effective education/extension translational activities to promote health and reduce malnutrition and obesity in children and all individuals with emphasis on high-risk populations.

STRATEGIES AND ACTIONS:

Link food systems to beneficial human health outcomes in the U.S. and internationally.
Actionable items

- Enhance the health-promoting quality of the food supply by connecting food production with human health outcomes as well as meeting the Dietary Guidelines for Americans. (ARS, NIFA)
- Determine the availability and affordability of food for American consumers, including the impact of USDA food assistance. (ERS)
- Identify the economic determinants of food choices, including the impact of policies to improve diets, using carefully designed data collection to capture the impact of food policy experiments. (ERS)

Conduct nutrition monitoring of the American population and evaluate policies influencing nutritional health.

Actionable items

- Determine food purchase, food/nutrient consumption, and dietary patterns of Americans, as they relate to health, nutritional status, and food security. (ARS, ERS)
- Conduct the What We Eat in America dietary survey portion of the National Health and Nutrition Examination Survey (NHANES) in partnership with CDC. (ARS)
- Determine food purchase, food/nutrient consumption, and dietary patterns of "at-risk" populations in the U.S. (ARS, ERS)
- Compile and provide U.S. food composition data for essential nutrients and biologically active food components. (ARS)
- Conduct analyses of the benefits and costs of policies to change behavior in order to improve diet and health, including nutrition education, labeling, advertising, taxes and subsidies, and regulation. (ERS)

Build the scientific basis for dietary guidance for health promotion and disease prevention across the life cycle.

Actionable items

- Identify the roles of foods, nutrients, dietary patterns, and physical activity in promoting health and preventing disease across the life cycle *that are realistic, achievable, and have a measured improved health outcome for all Americans."* (ARS, NIFA)
- Build the scientific evidence base for updating national dietary standards and guidelines. (ARS)
- Determine mechanisms, including interaction with genetic or modification to epigenetic factors, by which nutrition promotes healthy development and function from conception to old age. (ARS)
- Identify role of gut microbiome as a factor in metabolic health and how it is modified by diet. (ARS)
- Determine family, social, and environmental influences on food choices, dietary patterns, physical activity and health, especially healthy weight. (NIFA, ARS, ERS)

Develop and extend approaches to prevent obesity and related diseases, including translational activities to promote behavior change related to healthy eating and physical activity.

Actionable items

- Determine the causes and consequences of obesity and related disorders. (ARS, NIFA)
- Develop, evaluate, and support the implementation of *realistic and achievable* strategies to encourage healthy choices that enhance health and prevent

obesity/related diseases at the individual and community levels *that have a measurable improved health outcome*. Economic evaluations include controlled experiments testing alternative policies in real world contexts and translational activities that utilize the nationwide capacity of the Cooperative Extension Service and the Expanded Food and Nutrition Education Program focusing on high-risk groups. (ARS, ERS, NIFA)

- Evaluate the effectiveness of the *Dietary Guidelines for Americans* (DGA) and nutrition education programs built upon the DGA in preventing obesity and promoting health. (ARS, NIFA)
- Improve and evaluate the effectiveness of existing educational programs to elevate the health of low-income families and youth through nutrition, physical activity, and food resource management. (NIFA)
- Strengthen established strategic partnerships, such as the National Collaborative for Childhood Obesity Research partnership with the NIH, CDC, and the Robert Wood Johnson Foundation, to maximize impact. (ARS, ERS, NIFA)

GOAL 5. Food Safety

CHALLENGE: The production, processing, and distribution system for food in the U.S. is vulnerable to the introduction of biological, chemical and physical contaminants through natural processes and by intentional means. The Centers for Disease Control and Prevention estimates that there are 48 million foodborne illnesses annually in the United States, resulting in approximately 128,000 hospitalizations and 3,000 deaths. While the majority of microbial foodborne illnesses involve gastroenteritis, other serious health problems, including cancers, birth defects, meningitis, kidney failure and arthritis have also been attributed to exposure to foodborne pathogens and other contaminants. Deaths from exposure to foodborne allergens remain a concern. Research to support the regulation and control of veterinary drugs, chemical residues, heavy metals, persistent organic pollutants, and biological toxins is an integral component of USDA's food safety program. The emergence of antimicrobial resistant foodborne pathogens and the potential link to the use of antimicrobials in agricultural production is also a concern which needs further investigation. The economic costs associated with foodborne diseases are significant. ERS estimates that the economic costs for illness with an identified foodborne pathogen are over $14 billion annually, including costs associated with loss of life, medical costs, and lost productivity. This does not include the cost to industry of recalls. Preventing foodborne illnesses is essential, and will result in improved public health and substantial cost savings. USDA is investing resources to develop new research, education, extension and economic strategies to improve our ability to prevent and mitigate contamination of the food supply. Food safety is a multi-faceted challenge that can best be successfully addressed through engagement of trans-disciplinary teams of research, education, and

extension/outreach personnel, including social and behavioral scientists and health-related practitioners. USDA will continue educating and training the next generation of the workforce to ensure continuity in food science-related disciplines. Additional details on USDA intramural research can be found in the ARS 2011-2015 Action Plan for Food Safety.

REE ROLE: Generate science-based knowledge that informs decisions and policies that contribute to a safe food supply and the reduction of foodborne hazards. Foodborne hazards listed in this document may include pathogenic bacteria, including antimicrobial resistant strains of bacteria; toxic metabolites of bacteria (e.g., *Staphylococcus aureus* enterotoxin); viruses; molds and their toxic metabolites (e.g., aflatoxin); parasites, allergens, chemical contaminants (e.g., pesticides, heavy metals), and physical hazards (e.g., glass).

STRATEGIES AND ACTIONS:

Generate science-based knowledge that helps to illuminate the microbial ecology of foods and surrounding environments (for example, food contact surfaces, packaging, soil, water, air) and identify foodborne hazards on/in foods and surrounding environment.

Actionable items

- Develop approaches/designs for both microbial and population-based studies, monitoring of emerging foodborne hazards, and supplying data for identified data gaps. (ARS, NIFA)
- Develop approaches/designs for the analysis and interpretation of complex data on the presence and concentrations of foodborne hazards. (ARS, NIFA)
- Develop approaches to evaluate the effect of conservation practices and natural areas (e.g. riparian habitats) on foodborne hazards and the production of safe food and feed. (ARS, ERS, NIFA)
- Develop, implement, and evaluate strategies for addressing the role of soil, air, water, and food contact surfaces on the ecology of foodborne hazards along the food chain. (ARS, ERS, NIFA)
- Enhance partnerships with the FDA to advance science surrounding antibiotic use in livestock.

Generate science-based knowledge to understand the biology and behavior of foodborne pathogens.

Actionable items

- Develop specialized technologies to differentiate pathogenic from non-pathogenic organisms and to elucidate the differences between pathogens and non-pathogens. (ARS, NIFA)

- Design and develop methodologies, techniques and tools to elucidate the interaction among foodborne hazards in the environment. (ARS, NIFA)
- Develop a comprehensive microbial database containing molecular, physiological, and genetic data on each foodborne pathogen and its niche. (ARS)
- Understand the outcomes from foodborne illness, including severity and impact on medical costs, lost work productivity, quality of life and premature loss of life (economic burden). (ERS)
- Assess the interaction between antimicrobial use by humans and on farms and the development of antimicrobial resistance in food producing animals. (ARS)
- Provide relevant data and analyses to regulatory agencies for Hazard Analysis and Critical Control Points programs, risk analysis (assessments, management, and communication), labeling, persistence, and issues relative to international trade. (ERS, NIFA)
- Develop modeling systems and databases that can be used in risk analysis. (ARS)
- Develop advanced mathematical models and computer simulation tools to precisely and accurately predict the kinetics of growth and death of pathogens in food matrices. (ARS, NIFA)
- Determine the role/effect of transportation, lairage, slaughter, harvesting, processing methods, storage, distribution and equipment on pathogen survival, growth and transfer. (ARS, NIFA)

Develop technologies for the detection and characterization of foodborne hazards.

Actionable items

- Develop technologies for the detection and characterization of foodborne hazards that are cost effective and provide the required informational detail to determine and implement subsequent actions. (ARS, NIFA)
- Develop technologies for the rapid and sensitive detection of foodborne hazards and quality attributes that can be implemented for improved food safety and food defense. (ARS, NIFA)
- Develop multi-task, real-time, on/in-line inspection technologies that detect foodborne hazards and quality attributes simultaneously at required line speeds. (ARS, NIFA)

Address the food safety research, education, and outreach food safety priorities, as identified by the President's Food Safety Working Group.

Actionable items

- NIFA Requests for Applications (RFA) for funded projects integrate education and Cooperative Extension efforts that address food safety priorities. (NIFA)
- NIFA Requests for Applications for funded projects and ARS portfolios reflect research agenda priorities and complement respective strengths. (ARS, NIFA)

- Expand the Food Safety Research Information Office and Food Safety Information Center to provide information for food safety research projects from within all Federal food safety agencies, and to support the development of education and training materials. (ARS)
- Develop extension and educational strategies that transfer food safety information to our various REE stakeholders, utilizing Cooperative Extension Service's capacity to translate research findings and extend them to decision makers, industry, and consumers in ways that lead to behavioral change. (NIFA)
- With the FDA, address food safety, and associated regulatory, marketing, trade, and research activities substantially affecting public health. These partnership activities will assist in addressing priorities within the new Food Safety Modernization Act (FSMA). (ARS, NIFA)
- Educate and train the next generation of the workforce to ensure continuity in food science and related disciplines.

Develop intervention technologies and control strategies for foodborne hazards along the food production continuum.

Actionable items

- Provide the scientific basis for determining the critical control points in production and processing that can be mitigated through the development and implementation of intervention and control strategies. (ARS, NIFA)
- Develop technologies and approaches to evaluate the impact of intervention and control strategies on foodborne hazards along the food chain. This includes organic and conventional production systems (small, medium, and large operation) as well as alternative harvest, processing and marketing methods. (ARS, ERS, NIFA)
- Develop the economic models and statistical data to understand how interventions might be adopted and used by various agricultural production, food processing and marketing systems. (ERS, NASS)
- Develop economically viable control and mitigation strategies, taking advantage of environmental, vector, and reservoir characteristics. (ARS, ERS, NIFA)
- Provide outreach and extension training to producers and processors on intervention technologies and control strategies, tailored to the associated risks and the specific audience. (NIFA)
- Develop advanced food processing technologies to improve food safety, quality and nutritional value with broad sustainability goal including improved efficiency of energy and water usage. (ARS, NIFA)
- Develop technologies for assessing the efficacy of various processing methods to reduce or eliminate hazards in food and feed for human and animal consumption. (ARS, NIFA)

Generate science-based strategies, models, and data that identify and characterize effective management strategies and incentives for food safety improvement and the costs and benefits of improved safety for public health and industry viability.

Actionable items

- Update and extend economic burden estimates. (ERS)
- Identify incentives for food safety investment in meat and poultry plants. (ERS)
- Identify and advance on-farm food safety practices and incentives, through education and Cooperative Extension outreach. (ARS, ERS, NIFA)
- Develop the economic models and statistical data to understand consumer demand for food safety. (ERS)
- Develop the economic models and statistical data to understand the effectiveness of alternative government policies and other approaches to creating incentives for providing safety products, such as tort law or insurance, on industry practices (ERS).
- Collect producer data through the National Animal Health Monitoring System survey (reimbursable agreement with APHIS) related to the use of antibiotics. (NASS)

GOAL 6. Education and Science Literacy

CHALLENGE:

To maintain U.S. leadership in agriculture research, education and extension and address the new challenges of the 21st Century, USDA will need to support the development of a diverse workforce that contributes to future technological innovations within the national food and agricultural system by educating students and scientists in STEM fields, especially in food, agriculture, natural resources, and human sciences. Data on current enrollment and degrees granted clearly indicate a continuing lag in the production of a sufficient number and quality of graduates to fulfill agricultural-related workforce needs. USDA estimates 54,400 annual openings in these areas for individuals with baccalaureate or higher degrees However, only 29,300 individuals are expected to graduate each year from colleges of agriculture, life sciences, forestry, natural resources and veterinary medicine to fill these openings. In addition, there has been an increase in attrition of the workforce in the agricultural industry. In the 2012 Census of Agriculture t average age of principal farm operators was 58.3, up from 57.1 in 2007. The economic conditions in rural areas make it difficult to attract and retain workers, particularly young people who leave rural areas for better social and career options.

For more than 150 years, partnerships with Land Grant Universities and other federal agencies has helped USDA to create opportunities in agriculture, including for hundreds of thousands of minority and first-generation college students. However, wide disparities continue to persist in educational attainment. About 60 percent of white students earn bachelor's degrees within six years of beginning college, compared to only 49 percent of Hispanic students and 40 percent of black students.

If America is going to hold its leadership position in the global economy, it is vital that we leverage the talents and skills of students across the broad spectrum of economic, ethnic, and social segments of our Nation. The innovative solution to feeding the world and providing for its energy needs will be found only by strengthening existing and developing new educational pathways, including through non-Land Grant Universities, community colleges and high schools. This initiative is aligned with the recommendations made in the December 2012 President's Council of Advisors on Science and Technology (PCAST) *Report to the President on Agricultural Preparedness and the Agriculture Research Enterprise*.

Some factors that contribute to the difficulty in recruiting people to study and work in the agricultural sector include: (1) poor image and promotion of agriculture, (2) lack of innovative education and training initiatives, (3) elimination of agriculture subjects at the secondary levels that hampers early recruitment, (4) dearth of qualified science teachers from elementary to secondary levels or qualified trainers in higher education, (5) unclear career pathways in agriculture, and (6) disconnect between 2-year vocational institutions and baccalaureate granting institutions.

REE ROLE: **Cultivate, recruit and graduate the next generation of a highly-skilled diverse workforce that will contribute to innovations in food, agriculture, natural resources, and human sciences.**

STRATEGIES AND ACTIONS:

In cooperation with our partners (including Land Grant Universities, non-Land Grant Universities, community colleges, high schools and other Federal agencies), develop a well-integrated and coordinated approach to recruit a diverse pre-collegiate, undergraduate and graduate student population, minority and non-minority students, and research, education, and Cooperative Extension professionals .

Actionable items

- Increase Science (including food, agriculture, natural resources and human science), Technology, Engineering, and Math (STEM) focus at the elementary, middle school and high school levels that is highly relevant to agriculture sciences that contribute to student STEM educational outcomes; combine formal and informal learning strategies, and explore collaboration within and outside of USDA. (ARS, ERS, NASS, NIFA)
- Develop pre-collegiate programs, formal and non-formal internships and apprenticeships that engage youth with STEM professionals from USDA, Land Grant Universities and other partners that provide practical learning experiences to increase awareness to all youth about educational pathways and career opportunities in agriculture. (NIFA)

- Support the development and growth of mission relevant vocational/technical educational programs in food, agriculture, natural resources, and human sciences at community colleges. (NIFA)
- Develop and promote a scholarship program for 2-year vocational and baccalaureate levels, combined with agricultural industry internships and/or academic research internships; explore collaboration within and outside of USDA. (ARS, ERS, NASS, NIFA)
- Utilize fellowship and traineeship for graduate and postgraduate studies in agriculture shortage areas; and increase the visibility of these programs through a variety of media, Web-based or online communications materials, including collaboration within USDA agencies and with other Federal agencies such as the National Science Foundation (NSF), the National Park Service (NPS), and the National Oceanic and Atmospheric Administration. (ARS, ERS, NIFA, Forest Service)

Leverage technology and innovation to distribute business tools, information, and resources and use non-formal education programs, outreach, 4-H, and other youth development programs to transfer knowledge and technology.

Actionable items

- REE agencies will increase collaboration with extension communities of practice that target youth audiences, including the For Youth For Life (FYFL). (NIFA)
- Explore potential partnerships with foundations or other organizations to provide opportunities for high school science students to work on short-term science and innovation projects in USDA research labs in support of STEM initiatives. (ARS, Forest Service)
- Collaborate on the annual 4-H National Youth Science Day to highlight USDA resources relevant to the science day topic and other relevant opportunities to showcase USDA resources. (NIFA)
- Encourage 4-H National Headquarters and Agriculture in the Classroom (AITC) to work strategically with USDA in developing state standards based curricula and learning opportunities that align with USDA priorities, which reach youth in non-formal and formal settings. (NIFA)
- Increase mission relevant STEM educational content, aligned with respective state standards, of the Agriculture in the Classroom (AITC) Program's National Resource Directory electronic database. (NIFA)

Strengthen the science capacity at minority-serving institutions—including 1890 Land Grant Universities, the 1994 Tribal Colleges and Universities, Alaska Native-serving, native Hawaiian-serving and Insular Areas Institutions, and Hispanic-Serving Institutions (HSIs) (explore collaboration with Federal agencies—NIFA, ARS, ERS, Forest

Service, NPS, NSF, NOAA, the Department of Education, the Department of Labor, the National Aeronautics and Space Administration, and the National Institutes of Health).
Actionable items

- Support research and research infrastructure and develop the culture for meaningful collaborations with other institutions and Federal research laboratories. (NIFA)
- Promote training and development of students for a competitive and skilled workforce or to further their education. (NIFA)
- Provide opportunity for faculty development to enhance teaching skills and/or build competitive grant writing capacity. (NIFA)

Provide educational and training opportunities to beginning farmers and ranchers.
Actionable items

- Provide education, training, internships, and mentorships to beginning farmers and ranchers. (collaboration with NIFA, Office of Advocacy and Outreach (OAO), Office of Tribal Relations (OTR), FSA, and other agencies)
- Develop and disseminate new technologies and information that will help beginning farmers and ranchers succeed. (NIFA in collaboration with other USDA agencies)
- Through Cooperative Extension, eXtension, community-based, and non-governmental agencies, provide beginning farmer and rancher educational series focused on hands-on learning related to plant and livestock production. Develop a series of educational modules for new landowners/beginning farmers and ranchers. (NIFA)

Enhance existing partnerships with land-grant universities and other educational organizations to identify and assist socially disadvantaged and limited resource producers, beginning farmers, women producers, and veterans, and to remove program barriers to participation.
Actionable items

- Enhance access to government programs and grants to educational organizations that identify and assist minority producers, beginning farmers, women producers, and veterans. (NIFA, OAO, RD)
- Increase leveraging resources to address the unique needs of minority producers, beginning farmers, women producers, and veterans. (NIFA, OAO, RD)

GOAL 7. Rural-Urban Interdependence and Prosperity

CHALLENGE: Rural America has witnessed enormous change over the course of the last century. As agriculture's contribution to employment and income declined, many rural areas shifted to other activities, including manufacturing and service, recreation, and retirement oriented industries. The response to these changes reflects rural America's great geographic,

economic, and social diversity: while many communities are well-positioned to take advantage of new opportunities and they have increased in vitality, many others have lost their economic reason to exist and have experienced various degrees of distress, including persistent outmigration, poverty, and/or stagnant labor markets. In some cases, communities have ceased to exist altogether.

Rural economies are increasingly interconnected with the economies of urban centers as globalization of markets continues. Likewise, social and environmental challenges related to economic change often span the urban-rural divide. How rural areas position themselves both to compete and cooperate in this global environment, where skills, knowledge, and innovation are key drivers of economic growth and prosperity, is a central element in the debate about the future of rural America.

REE ROLE: Provide effective research, education, and extension that inform public and private decision-making in support of rural and community development.

STRATEGIES AND ACTIONS:

Establish the determinants of rural prosperity and develop indicators to measure regional assets and performance.

Actionable items

- Produce new information on the drivers of rural business innovation and growth, with emphasis on the role of community institutions and assets, through a national survey of rural business establishments. (ERS, RD)
- Evaluate the interactions among community assets, leadership, and industry location and expansion, focusing on health care as a key growth sector in rural America. (ERS)
- Strengthen USDA's ability to increase rural economic opportunity and address poverty by producing new knowledge about the drivers of rising child poverty in rural America, particularly factors related to changing rural labor markets and household wealth. (ERS)
- Increase awareness and capacity building of rural communities' response to natural and/or man-made disasters by increasing individual, family, small business, and community disaster preparedness through extension education, as well as collaboration with other agencies and volunteer organizations. (NIFA, FEMA)
- Produce new knowledge about the economic and social forces that encourage return migration to geographically disadvantaged (remote, low-amenity) rural areas, with emphasis on the role of local institutions and community leadership, as well as on social, cultural, and educational opportunities. (ERS, NIFA)

- Increase knowledge about the importance of regional innovation, collaboration, and asset development for sustainable rural economic growth. (ERS, NIFA)

Conduct research, education, and extension to help farmers, ranchers, and rural communities take advantage of new and growing market opportunities (such as local and regional food systems and organic agriculture) and technologies (such as broadband, green technologies, and renewable energies) and spur much-needed innovation.

Actionable items

- Investigate mechanisms for overcoming the impediments to broadband technology access and adoption in rural areas. (ERS, NIFA)
- Identify and transfer knowledge about the characteristics and factors that contribute to the success of local and regional food systems and their contribution to economic development and human health and well-being. (ERS, NIFA)
- Develop and share knowledge to help stakeholders implement successful organic production and marketing systems in response to growing consumer demand. (ARS, ERS, NASS, NIFA)
- Develop and share knowledge about emerging green technologies and green economy initiatives, including efforts related to rural bioenergy/bioproduct development and delivery, and their potential contributions to economic development in rural areas. (ARS, NIFA)
- Identify and encourage development of cost-effective, sustainable uses of woody biomass for bioenergy production through integrated research, education, and extension efforts. (NIFA)
- Effectively integrate knowledge about more sustainable crop and forest production bioenergy systems by leveraging the five established USDA Regional Biomass Research Centers (RBRC) and NIFA-funded regional bioenergy delivery systems and bioenergy/bioproduct development projects, in cooperation with Forest Service Research and Development and other external resources. (ARS, NIFA)
- Develop and share knowledge on tourism and agritourism programs. (NIFA)

Support information and technology transfer and translational research, "transformational extension," to inform citizens and enable and support vibrant and resilient communities.

Actionable items

- Develop partnerships with community/economic development organizations to promote adoption of USDA research outcomes for commercialization by rural entities, taking advantage of ARS's Agricultural Technology Innovation Partnership (ATIP) network. (ARS, NIFA)

- Help small businesses develop partnerships with colleges, universities, and/or Federal laboratories for research, development, and commercialization of new technologies, products, and services to enhance the vitality of rural communities. (ARS, NIFA)
- Improve rural data dissemination through the creation of new electronic geographic information systems. (ARS, ERS, NIFA)
- Provide information services to rural communities, officials, organizations and citizens through the NAL's Rural Information Center. (ARS)
- Utilize Cooperative Extension system behavioral science expertise in assisting individuals to adopt new transformational behaviors. (NIFA)
- Support integrated grant projects that translate bioenergy/bioproduct research findings into extension and education programs. (NIFA)
- Improve the rural communities' access to personal financial data (Financial Health Index Project, PowerPay-debt reduction program) available through NIFA's Family and Consumer Economics Web site. (NIFA)
- Provide information and support for building leadership capacity in rural communities. (NIFA)
- Support the development of social, cultural, and educational amenities that improve well-being and stimulate economic development in rural communities. (NIFA)
- Working with Cooperative Extension, provide personal financial management resources that will enhance the public's financial knowledge, skills, and responsibility through partnership with the Financial Literacy Education Commission (FLEC), and Federal, local, state and tribal organizations (NIFA, U.S. Treasury); improve public and private decision-making by implementing the Family and Consumer Economics Financial Capability Framework. (NIFA)

Build new partnerships with and address the needs of underserved and non-traditional populations.

Actionable items

- Strengthen partnerships with national level community based organizations (CBO) to solicit promotion assistance and data dissemination assistance for the 2012 Census of Agriculture to underserved populations. (NASS)
- Continually identify potential new partnerships and pursue those to enhance enumeration of underserved and non-traditional populations for data collection programs, including the Census of Agriculture. (NASS)
- Reflect on and improve data collection strategies to improve the quality of data for underserved populations through the use of the CBO/NASS Partnership Manual. (NASS)
- Assess 2012 Census of Agriculture outreach efforts to promote partnerships among colleges, universities, local and regional CBOs, faith-based organizations, and

extension to identify and address the needs of underserved populations. (NASS, NIFA)

- Develop opportunities for producing and marketing ethnically diverse foods. (NIFA)
- Incorporate underserved and non-traditional populations into food systems discussions leading to new marketing opportunities. (NIFA)
- Develop and share knowledge of programs relating to Urban Gardening, and the use of Master Gardeners Programs. (NIFA)
- Adapt outreach strategies that can efficiently and effectively address the needs of underserved populations in both rural and urban areas, e.g. using eXtension tools and social media platforms as a way to leverage limited staff resources. (NIFA)

Provide statistical data and analysis to promote efficient domestic agricultural production and marketing systems.

Actionable items

- Conduct 2017 Census of Agriculture content test to finalize new questionnaire content. (NASS)
- Provide statistically sound information for expanding economic opportunities by disseminating results of the 2012 Census of Agriculture. (NASS)
- Continually evaluate and strengthen agricultural program data series, including renewable energy, as funding allows. (NASS)
- Provide commodity and food market information that increases the efficiency and effectiveness of private domestic agricultural production and marketing systems. (NASS)
- Ensure that the Census of Agriculture enumerates U.S. farms with a high level of coverage. (NASS)
- Expand availability of data quality measures through a database that can be queried (for example, standard error, coefficient of variation, and generalized coefficient of variation). (NASS)
- Develop a Web-based interactive mapping application to communicate results from the 2012 Census of Agriculture. (NASS, ERS)
- Continue to work with statistical and public organizations to develop lesson plans and classroom activities that help increase student awareness of statistics and agriculture and increase statistical literacy in youth. (NASS)

IV. Implementation – Measuring Success

What is our measure of success? What identifies the success of this Action Plan? And what identifies success of science in the USDA? Success will depend upon the answers to four questions:

- ✓ Is the Action Plan implemented?
- ✓ What is the realistic timeline for each step? These will vary with the state of the science.

- ✓ Do the implementation steps accomplish their expected or desired results?
- ✓ Do those results, in turn, accomplish the overall goal of the Action Plan, which is to improve the quality, effectiveness, and visibility of USDA science?

Having defined grand challenges and goals for USDA science, responsible governance requires that some form of accountability be established to determine if those challenges are being met, how well they're being met, and if the resources being used to achieve these goals are being used in the most efficient manner possible. That also begs the difficult question of how to attribute improvements in some grand goal to the science that was designed to support it. For example, an overarching goal of public policy is to enhance economic welfare of rural Americans. How do we link USDA research on, for example, plant breeding to improved economic welfare? Linking science endeavors to desired outcomes is a strategic process, and attempting to make those connections raises some useful considerations about the nature of the science undertaken.

Addressing the challenges defined in the REE Action Plan is critical to developing and understanding the science that will be necessary to promote agricultural sustainability. Accountability is necessary to determine if we're moving science in the right direction—are we making the world better with our science? The challenges on the road ahead are grand and complex and will therefore be hard to observe whether they are being met.

The first step toward success has already occurred—goal teams that cut across the four agencies of the REE mission area, where appropriate in consultation with other mission areas, developed the strategies and actions contained herein. As implementation of the Action Plan progresses, it will be important to assess whether or not the expected changes have resulted in desired outcomes. For example, does the increased collaboration lead to better integration of functions and disciplines; does the research meet needs of key "customers" who need REE research such as the regulatory agencies, or agricultural stakeholders faced with immediate challenges? Does the communication plan lead to more informed stakeholders; do the professional staff development activities result in a workforce that is better informed and more able to communicate USDA's unique role; and do the recruiting and mentoring activities lead to a larger and more diverse pool of qualified applicants? Outcome measures might include some of the same factors that are provided earlier in this document as evidence of the need for these action steps, for example, allocation of investments or characteristics of the workforce.
A project with larger benefits for USDA science will also help further REE accountability efforts. USDA has successfully implemented the first Federal instance of VIVO, an interdisciplinary national network that enables collaboration and discovery among scientists across all disciplines within USDA and without. Building on this success, and as a next ground-breaking step to that large data collection and standardization effort, USDA has joined the STAR METRICs project, a multi-agency venture led by NIH, NSF and the Office of Science and

Technology Policy (OSTP). The STAR METRICS project is a partnership between science agencies and research institutions to document the outcomes of science investments to the public.

V. Closing Comments

The goals, strategies, and actions presented in this plan emphasize the cultivation of science-based evidence for decision makers and end users alike. Impact-driven agricultural science is critical to the future of agricultural and related industries in the U.S. The success of the action plan and the transformation of USDA into a high-profile research organization is dependent upon efficient use of research and educational resources and on continued support and resources from Congress. It is also dependent on meeting at least some of the immediate needs of stakeholders or "customers."

Regular, frequent progress checks will be made within the mission area, and on an agency level, for specific actions. Where necessary adjustments in funding will be made if possible. It is through ongoing stakeholder dialogue that we will maintain a culture of relevance. It is through our outcomes that the R&D return on investment can be measured.

REE will continue to engage with stakeholders as it works to implement this action plan. This includes regular discussion with and dissemination of materials and information to Congress, other appropriate federal agencies, academia, national associations, etc. The role these groups play in aiding REE to achieve its goals is critical and REE recognizes the need to maintain and build upon its existing relationships.

In part, accountability for progress made toward achieving these goals will occur via insertion of key items into senior-level REE mission area and agency performance plans. Establishing written, agreed upon, and reasonable goals in performance plans roots the goals and strategies within each agency and reaffirms their importance. Further, individual agency budget performance measures will be derived in part from the REE Action Plan.

It is expected that individual agencies within the mission area will refer to this document when drafting and refining their specific agency action plans. They will use it as a touchstone to guide them as they do their part to help America win in the global marketplace and strengthen our economy. By aligning with various components of the REE plan, specific agencies can and will demonstrate that their programs support the stated REE goals, which in turn support the broader Departmental goals set forth by the Secretary of Agriculture. Accomplishing the goals set forth in this document requires acceptance, support, and implementation from the REE mission area, the agencies, and their employees.

Glossary of Acronyms

AFRI	Agriculture and Food Research Initiative
AITC	Agriculture in the Classroom
APHIS	Animal and Plant Health Inspection Service
ARS	Agricultural Research Service
BLM	United States Department of the Interior Bureau of Land Management
BOR	United States Department of the Interior Bureau of Reclamation
BW&ER	Benchmark Watersheds and Experimental Ranges
CDC	Centers for Disease Control
CEAP	Conservation Effects Assessment Project
CGIAR	Consultative Group on International Agricultural Research
DGA	Dietary Guidelines for Americans
DHS	United States Department of Homeland Security
DOD	United States Department of Defense
DOI	United States Department of the Interior
DOS	United States Department of State
EPA	United States Environmental Protection Agency
ERS	Economic Research Service
FDA	United States Food and Drug Administration
FIA	Forest Inventory and Analysis
FEMA	Federal Emergency Management Agency
FSA	Farm Service Agency
GHG	Greenhouse gas
HHS	United States Department of Health and Human Services
HSI	Hispanic-Serving Institution
LTAR	Long-Term Agro-Ecosystem Research
NAREEE	National Agricultural Research, Extension, Education, and Economics
NAL	National Agricultural Library
NASA	United States National Aeronautics and Space Administration
NASS	National Agricultural Statistics Service
NIDIS	National Integrated Drought Information System
NIFA	National Institute of Food and Agriculture
NIH	National Institutes of Health
NOAA	United States National Oceanic and Atmospheric Administration
NPS	United States National Park Service
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NRE	Natural Resources and Environment Mission Area
NRI	National Resources Inventory
NSF	National Science Foundation

OAO	United States Department of Agriculture Office of Advocacy and Outreach
OCS	Office of the Chief Scientist
OEM	United States Department of Agriculture Office of Environmental Markets
OSTP	White House Office of Science and Technology Policy
OTR	United States Department of Agriculture Office of Tribal Relations
RBRC	United States Department of Agriculture Regional Biomass Research Centers
RD	Rural Development Mission Area
REE	Research, Education, and Economics Mission Area
STEM	Science, Technology, Engineering, and Math
STEWARDS	Sustaining the Earth's Watersheds Agricultural Research Data System
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey