

RESEARCH, EDUCATION, AND ECONOMICS

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*Action Plan*

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February 2012





United States  
Department of  
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Research  
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Economics

Office  
of the Under  
Secretary

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## **Research, Education, and Economics Action Plan February 2012**

### **Preamble**

As the 21<sup>st</sup> 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 in order to out-innovate, out-educate, and out-build the rest of the world. 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. The education begins with supporting science, technology, engineering, and math (STEM) programs so that science and mathematics are woven seamlessly into students' skills and interests.

The framework for my role as Under Secretary for Research, Education, and Economics (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, I have held a series of informal and formal consultations with multiple stakeholders in U.S. Department of Agriculture (USDA) science, 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 have also 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, can significantly inform our planning, going forward.

Through this systematic review process, I discovered several areas to focus on, regarding 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, could be made much more visible. We 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 introduce a plan for USDA science and research: the REE Action Plan. It links REE research, education, statistics, and economics programs to the Department's strategic plan and 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 research. The year 2012 marks the 150<sup>th</sup> 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. In preparation for this anniversary, and in light of the many pressing challenges we face, it is time to renew our Nation's commitment to maintaining and growing a progressive and innovative system of agricultural science. 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—its 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 feeding the world and inventing new technologies and energy sources needed in the decades to come.

Drafting the REE Action Plan has been an ongoing process of consultation, revising, 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 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.

Our new compact must reflect that, collectively, we have—at USDA and with our many partners—a robust infrastructure to perform world-class science. But, 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. Our new compact must reflect that we have at USDA, and in our partner institutions, many of the world's best scientists. This rich and deep talent base 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 and research—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.

We have proven in the past, time and again, what American agricultural science is capable of, and it is once again time for us to renew our commitment to its strengths and possibilities. 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 building 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 21<sup>st</sup> Century*”<sup>1</sup> 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 ***purposely*** organize research around problem-solving. These can readily be viewed as principles of USDA science.

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<sup>1</sup> *A New Biology for the 21<sup>st</sup> Century*. National Research Council. National Academies Press. 2009. Available at <http://www.nap.edu/catalog/12764.html>.

***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.

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 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.

## **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 university partnership is strengthened is through competitive, peer-reviewed research.
- We are leveraging our strong foundational research and statistical information capacity, including a sustained investment in research that supports 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 21<sup>st</sup> 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.”
- We are moving science into practice through our technology transfer and Cooperative Extension efforts; promoting innovation in agriculture, forestry, and conservation; and through informing program and policy decisions at the community, State, and national levels. More than that, we have programs that 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 has to be a key focus today if America is going to win the global marketplace of tomorrow. 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**

#### **Structural Outline:**

#### Goal 1. Local and Global Food Supply and Security

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 and Management

#### 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. Local and Global Food Supply and Security**

**CHALLENGE:** The future of U.S. agriculture depends on economic growth in the developing countries for expanding feed and food export markets; improving production and production efficiencies; generating beneficial knowledge, information, and technologies for adaptation and mitigation to climate change; helping protect the U.S. crops, livestock, and ecosystems from the threat of exotic pests and diseases; and improving the nutritional quality and safety of domestic and imported food products. In developing countries with largely agrarian populations, vibrant and sustainable agricultural production is the very basis for broad economic development and stability. 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. Agricultural development depends on an information base to facilitate economic decisions on access to affordable and appropriate technologies that can 1) improve food production; 2) improve natural resource management, harvesting, storage, and distribution; and 3) advance the health and safety of all citizens while minimizing environmental impacts.

**REE ROLE: Develop and transfer knowledge and skills that promote sustainable<sup>2</sup> agricultural systems locally, regionally, and globally for all types of agriculture production systems, thereby enhancing domestic and international food security and strengthening American agriculture. REE provides the information, technologies, analysis, and capacity to 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.**

**Local and Global Food Supply and Security  
SUBGOAL 1A. Crop and Animal Production**

**STRATEGIES AND ACTIONS:**

**Invest in research, development, and extension of new varieties and germplasm, practices, and systems of interest, both domestically and in developing countries, to safely and sustainably increase animal and crop production and its nutritional value. Improve feed and forage use efficiency in animals and identify alternative feed and forage options for animal systems that do not compete for human food and energy needs. Develop and populate a framework for understanding the sustainability (productivity, economic, and environmental) outcomes of agriculture/food/forestry practices and systems.**

*Actionable items*

- Identify and implement best management practices for animal and plant systems that are environmentally, economically, and socially sound, including optimized tillage management strategies for key crops, optimized strategies for pollinator management and conservation, precision management practices for spatial application of water to maximize irrigation water use efficiency and increase profitability and recommendations for optimal cover crops and management practices to enhance carbon sequestration and soil health in no-till corn-soybean based rotations. (ARS, NIFA)
- Develop new management options to allow enhanced animal production systems to adapt to and/or mitigate biotic and abiotic stresses, such as aflatoxins, related to climate change. (ARS, NIFA)
- Integrate superior germplasm and best management practices into profitable, productive, and environmentally sound integrated systems for crop and animal production. Develop enhanced germplasm and superior production systems to lengthen the fresh market specialty crop harvest season to increase the nutritional value, availability, and affordability for local/regional markets. (ARS, NIFA)
- Develop and implement labor and cost-saving technologies, such as remote sensing for biotic and abiotic stresses, spray application and fruit thinning technologies, and dynamic pre-harvest yield estimation to enhance production efficiencies for producers of all sizes. (ARS, NIFA)
- Develop more sustainable crop production systems for organic crops including producer guidance on nitrogen (N) availability in organic systems and

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<sup>2</sup> “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 21<sup>st</sup> Century” Report from June, 2010.

- recommendations on impact of crop rotation length and complexity on soil erosion control. (ARS, NIFA)
- Continue development and application of genetic, genomic, and other production technologies and alternative feed ingredients to improve nutrient utilization in livestock and aquaculture species and reduce environmental impacts. (ARS, NIFA)
  - Develop and extend improved feed ingredients, nutritional technologies, reproduction technologies, and animal health products for improved efficiency, productivity and well-being for agricultural 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 framework. (ARS, NIFA)
  - Develop, assess, and share knowledge about transformative systems approaches to improving the sustainability of agriculture. (ARS, NIFA)

## **Local and Global Food Supply and Security**

### **SUBGOAL 1A. Crop and Animal Health**

#### **STRATEGIES AND ACTIONS:**

**Invest in research, development, and outreach of new varieties and technologies to mitigate animal/plant diseases and increase productivity, sustainability, and product quality.**  
**Establish more sustainable systems that enhance crop and animal health.**

#### *Actionable items*

- Develop and extend effective, affordable, and environmentally-sound integrated control strategies to reduce losses caused by diseases, pests, and weeds, including early detection, identification, monitoring, and implementing biologically-based and areawide strategies to manage key native and invasive species and postharvest pests. (ARS, NIFA)
- Optimize integrated pest management practices for production 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 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, monitoring, 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 capacity to diagnose and

- control vector-borne and zoonotic diseases that impact livestock and human health. (ARS, NIFA)
- Explore partnering 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 U.S. (ARS, NIFA)

## **Local and Global Food Supply and Security**

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

#### **STRATEGIES AND ACTIONS:**

**Generate new fundamental knowledge through research in genomic sciences and applications of systems approaches required to enhance the sustainability of agriculture while increasing productivity. 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 inform regulators, product development, and consumer acceptance, and provide information to FAS relevant to trade issues.**

#### *Actionable items*

- Enhance the capacity of genetic resources and genome databases for target crops, animals, and priority pathogens, and expand the capacity of plant, animal, and microbial collections to manage increased numbers of new experimental genomic/genetic stocks. (ARS, NIFA)
- Develop and extend crop and agricultural genetic products, production technologies, and practices with specific environmental and socio-economic value to improve production efficiencies, product quality, plant and animal health, and animal well-being. (ARS, NIFA)
- Develop livestock and aquaculture products and technologies with specific social and economic value to improve production efficiencies, product quality, animal health and animal well-being, and environmental performance. Continue development and application of genetic and genomic technology and sequence information to improve animal and plant production, reproduction, and quality. (ARS, NIFA)
- Develop new varieties of crops and breeds/lines of livestock and marine animals that consider 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 healthy fat profiles in animals. (ARS, NIFA)
- Develop improved tools for genetic and genomic analysis of complex genomes to support genetic improvement of food 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 genomes. (ARS, NIFA)
- Identify and use genes and molecular processes that increase yield and improve composition and quality of crops. (ARS, NIFA)
- Develop effective methods to conserve plant, animal, and microbial genetic diversity for use in agriculture, and identify and utilize genetic diversity to develop novel traits and properties that will enable development of useful plant varieties and animal breeds. (ARS, NIFA)
- Develop and implement new methods using transgenes that enhance the speed and efficiency of conventional plant breeding. (ARS)
- Assess new biotechnology varieties to promote more sustainable agricultural systems and determine risks and benefits on the environment and economy, including technologies that promote the coexistence of different agricultural production systems. (ARS, NIFA)
- Assess policies and management strategies for their ability to contribute to the coexistence of different agricultural production systems. (ARS, NIFA)
- Develop 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)

## **Local and Global Food Supply and Security**

### **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, international, and regional markets and their impacts on global food security. (ERS)
- Conduct research on the U.S. food and agriculture sector's performance in increasingly globalized markets. (ERS, NASS)
- Evaluate trends and changes in production agriculture and adjust States included in U.S. market year average price calculations and States included in the county estimates statistics program accordingly. (ERS, NASS)
- Develop and implement new programs to inform lay and scientific audiences, including new/beginning and socially disadvantaged farmers and ranchers, 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 and ranchers 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)
- Examine the critical factors affecting price levels, volatility, and price discovery in cash and futures market research. (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 Food Security Assessments covering 70 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. (ERS)

## **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 a seemingly ever-increasing demand for energy, producers must take into account changes in climate and adaptations in various plant varieties. Foundational research is necessary to identify plant species appropriate for changing climate, to meet increased 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 decisionmakers need information, technologies, and decision-support tools to help them with greenhouse gas mitigation, and adaptation strategies. 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 that empowers farmers, foresters, ranchers, land owners, resource managers, policymakers, and Federal agencies to manage the risks, challenges, and opportunities of climate variability, and position decision makers to 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 ecosystems productivity and sustainability. (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 quality and agro-ecosystem policy analyses and management planning. (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)
- Project economic and legal status consequences for landowners of climate-induced changes of natural and managed ecosystems emphasizing the well-being of producers (including beginning and socially disadvantaged farmers) and effects on agricultural markets, and ecosystem services. (ERS)
- 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 (including “transformative” systems as described by the 2010 National Research Council [NRC] publication “Toward Sustainable Agricultural Systems in the 21st Century,” e.g., crop-livestock, organic, agro-forestry, etc.) 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 the Forest Inventory and Analysis (FIA) and National Resources Inventory (NRI), and integrate them with other monitoring and data collection systems and research networks, such as Long Term Ecological Research sites, the National Ecological Observatory Network, and USDA Long Term Agroecosystem Research sites to track and manage changes in land use and related effects on ecosystem processes. (ARS, NASS, NIFA, Forest Service)
- Quantify consequences of producer choices for adapting to climate change on agricultural markets; farm structure, including land ownership; agronomic practices; adoption of technology; and ecological systems, and determine impacts on subsistence food sources. (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, ERS, 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 (e.g., NRC 2010) to mitigate GHG emissions while providing other environmental, economic, and social benefits. (ARS, ERS, 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 decisionmaking.**

### *Actionable items*

- 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, ERS, 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, ERS, NIFA)
- Establish partnerships with other Federal agencies such as NOAA, NASA, NSF, and the Environmental Protection Agency 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)
- 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 Technical Advisory Committee and the National Agricultural Research, Extension, Education, and Economics Advisory Board and 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 near-farm scale conversion technologies for advanced biofuel production that can accommodate feedstock flexibility. (ARS, NIFA)
- Conduct and integrate research to reduce risks and improve the profitability and sustainability of first- and second-generation biorefining, including development of co-products as biobased chemicals and other high-value products (e.g., glycerol-based polymers). 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 extension system in advancing 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, and other residuals as feedstocks) to produce distributed 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 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.

**REE ROLE: REE develops and delivers the scientific knowledge base 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 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, 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. 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 practices on 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*

- 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)
- 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);

- 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. (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. (ARS)

**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; 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,)
- Utilize the Partnership Management Team (PMT) to integrate ARS and NIFA research with NRCS and Forest Service program delivery. Work with Forest Service

to develop collaboration between researchers and managers using the experimental watershed network. (ARS, NIFA, NRCS, Forest Service)

**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 goals for water resource management and sustaining rural economies. (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)
- Promote research addressing the economics of conserving “irrigation production systems,” i.e., the integration of conserving on-farm water-management practices with high-efficiency irrigation application systems, encouraging both reduced applied water and crop-water consumption while maximizing farm income. (ERS, NIFA)
- 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. (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/conservate 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, or local agencies or entities to improve water

resource management on working lands at the watershed scale. (ARS, NIFA, NRCS, FSA, Forest Service)

### **Transform youth water education to support USDA’s vision for the future of water management.**

#### *Actionable items*

- Integrate non-traditional approaches to water education (social, cultural, artistic, etc.) with traditional biophysical approaches in all new water curriculum development funded through NIFA grant programs. Highlight concepts such as water “footprints” and “life cycle analysis” in new curricula to create a new appreciation for water among young people. (NIFA)
- Support the development of educational materials on the water cycle and water conservation through the Natural Inquirer and Forest Service Conservation Education. (Forest Service)
- Support partnerships that integrate new approaches to water education. (REE, 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)

### **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)

## **Sustainable Use of Natural Resources**

### **SUBGOAL 3B. Landscape-Scale Conservation and Management**

**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 USDA sister agencies such as the Forest Service's 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)
- 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)
- 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, 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 and ranchers. (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 to update USDA fertilizer nitrogen recommendations optimized for production and environmental goals, improved bioavailability of soil

- and applied nitrogen, control technologies to mitigate nitrogen losses, predictive and hindcasting tools to assess source candidates for mitigation, and improved process-based models to analyze nitrogen life cycle in agricultural systems. (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, 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)

### **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, develop agriculture and forest production systems that are adapted to climate variability. (NIFA)

**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, NRE, 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. (NRE, OEM, REE, and Forest Service)

**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 19.6 percent in 2008. The prevalence of obesity among adolescents aged 12 to 19 years increased from 5.0 percent to 18.1 percent (CDC). At the same time, many sub-populations, including low-income and elderly 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 research, 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 effective education/extension translational activities to promote health and reduce malnutrition and obesity in children and 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. (ARS)
- 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 natural 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. (ARS, ERS)
- 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. (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)

### **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 effective strategies to encourage healthy choices that enhance health and prevent obesity/related diseases at the individual and community levels. 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)
  - Provide the Cooperative Extension System health and wealth initiative “Small Steps to Health and Wealth”™ program that motivates youth and adult consumers to implement behavior change strategies that simultaneously improve their health and personal finances. (NIFA)

## **GOAL 5. Food Safety**

**CHALLENGE:** The production, processing, and distribution system for food in the U.S. is a diverse, extensive, and easily accessible system. This open system is vulnerable to the introduction of contaminants through natural processes and global commerce, and by intentional means. Thus, the food supply must be protected from pathogens, toxins, and chemical contamination that cause disease in humans. Outbreaks of *Escherichia coli* O157:H7 and *Salmonella* have attracted major media attention and drawn criticism of current food safety practices and policies. 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 estimates of the economic burden vary widely, it is clear that the burden is significant, and potentially as large as \$6 billion annually, including lost productivity and loss of life. Food safety strategies require research, education, and extension efforts in a holistic approach to the food chain because hazards can enter the chain at any point. An integrated approach should consider food safety as a continuous process from production, through harvesting and processing, to retail and the consumer. REE research provides the means to ensure that the food supply is safe and secure for consumers, and that food and feed meet foreign and domestic regulatory requirements. Since many foods are imported into the U.S., food safety is considered a global issue. The REE research program involves both national and international collaborations through formal and informal partnerships. Accomplishments and outcomes can be utilized in national and international strategies delivering research results to regulatory agencies, commodity organizations, industry, and consumers. Using REE’s strengths in education and extension will facilitate the delivery of research results to our stakeholders and consumers. Specifically, education and extension efforts targeted toward safe food harvesting and production practices are a critical need.

**REE ROLE: Provide science that informs decisions and policies that contribute to a safe food supply and the reduction of foodborne hazards.**

## **STRATEGIES AND ACTIONS:**

### **Provide research that helps to understand and define the microbial populations (pathogens and normal flora) in foods and surrounding environments.**

#### *Actionable items*

- Develop approaches/designs for the analysis and interpretation of complex data on microbial populations. (ARS, ERS, NIFA)
- Develop approaches/designs for both microbial and population-based studies, monitoring of emerging pathogens, and supplying data for identified data gaps. (ARS, ERS, NIFA)
- Develop approaches that will evaluate the impact of intervention or management strategies on microbial contamination in the food continuum. This includes organic, conventional, and other production systems at all levels (small, medium, and large operations) as well as alternative harvest, processing, and marketing methods. (ARS, ERS, NIFA)
- Develop approaches that will evaluate the effect of conservation practices and natural areas (e.g. riparian habitats) on foodborne hazards and the production of safe food. Provide approaches for the evaluation of the role of soil and water in conservation and in food production (e.g. produce). This research will provide needed information for management decisions based on risk assessment strategies, economic factors, and education or extension efforts. (ARS, ERS, NIFA)

### **Provide research to understand the biology and behavior of foodborne pathogens.**

#### *Actionable items*

- Develop specialized technologies, for example, to differentiate pathogenic from non-pathogenic strains, and to elucidate the differences between pathogens and non-pathogens. (ARS, NIFA)
- Develop a comprehensive microbial database containing molecular, physiological, and genetic data on each foodborne pathogen and their niche. (ARS)
- Understand the outcomes from foodborne illness, including severity and impact on medical costs, lost work productivity, and loss of life (economic burden). (ERS)
- Provide relevant data to regulatory agencies for use in Hazard Analysis and Critical Control Points programs, risk analysis (assessments, management, communication), labeling, persistence, and issues relative to international trade. (ERS, NIFA)
- Develop model systems that have a utility for use in risk analysis. (ARS)

### **Develop technologies for the detection and characterization of food supply contamination from microbial pathogens, toxins, chemicals, and biologics.**

#### *Actionable items*

- Develop detection technologies for emerging or multiple microbial pathogens that are cost effective and provide the required informational detail for the determination and implementation of subsequent actions. (ARS, NIFA)
- Develop technologies for the rapid and sensitive detection of toxins, chemicals, and biologics 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 contaminants and quality attributes simultaneously at required line speeds. (ARS, NIFA)
- Develop technologies for assessing the efficacy of various processing methods to reduce or eliminate the toxicity in contaminated foods for human/animal consumption. (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 for funded projects integrate education and extension efforts that parallel 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 Information Center to provide information for food safety research projects and education and training materials. (ARS)
- Develop extension and educational strategies that transfer food safety information to our various REE stakeholders, utilizing Cooperative Extension’s capacity to translate research findings and extend them to decisionmakers, 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 that works toward developing an integrated food safety system. (ARS, ERS, NIFA)

**Develop intervention and control strategies for foodborne contaminants along the food production continuum.**

*Actionable items*

- Determine the critical control points in production and processing that can be mitigated through the development and implementation of intervention and control strategies. (ARS, NIFA)
- Determine the role/effect of transportation, lairage, slaughter, harvesting, processing methods, storage, and equipment on pathogen survival, growth, and transfer. (ARS, NIFA)
- Develop mechanisms and approaches to evaluate and validate the effect of intervention and control strategies on food safety. (ARS)
- Develop the economic models and statistical data to understand how interventions might be adopted and used by various agricultural production systems. (ERS, NASS)
- Develop economically viable control and mitigation strategies, taking advantage of environmental, vector, and reservoir characteristics. (ARS, ERS, NIFA)
- Provide outreach to producers and processors on intervention and control strategies, tailored to the associated risks and the specific audience. (NIFA)

**Provide research 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)

**GOAL 6. Education and Science Literacy**

**CHALLENGE:** Over the next decade it is expected that there will be an increase in attrition of the workforce in the agricultural industry and the academic sectors. These concerns are well founded considering that the number of students enrolling in the food and agriculture sciences is decreasing, and many universities have either dropped or consolidated programs at the baccalaureate levels. The number of students going into graduate programs has also declined tremendously, and if this trend continues, we will be looking at acute workforce shortages in these areas. The estimated average age of U.S. farmers in 2007 was 57.1, up from 55.3 in 2002 and is about 16 years older than an American worker in general. Only about 55 percent of the 54,000 predicted annual agriculture-related jobs between 2010 and 2015 will be filled by graduates of agriculture sciences, according to a report by Purdue University and NIFA. 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.

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 in attracting students to the agricultural and natural resource sciences and supporting their achievement.

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: Recruit, cultivate, and develop the next generation of scientists, leaders, and a highly-skilled workforce for food, agriculture, natural resources, forestry, and environmental systems, and life sciences to out-educate our global competitors.**

**STRATEGIES AND ACTIONS:**

**In cooperation with Land Grant Universities and other Federal agencies, develop a well-integrated and coordinated approach to recruit minority and non-minority students; research, education, and Cooperative Extension professionals; pre-collegiate, undergraduate, and graduate students.**

*Actionable items*

- Increase Science, Technology, Engineering, and Math (STEM) focus at the elementary, middle school and high school levels that is highly relevant to agriculture sciences; combine formal and informal learning strategies, and explore collaboration within and outside of USDA. (ARS, ERS, NASS, NIFA)
- Utilize pre-collegiate programs, formal and non-formal internships and apprenticeships to increase awareness to all youth about career opportunities in agriculture. (NIFA)
- Develop 2-year degree courses at vocational/technical community colleges. (NIFA, in collaboration with the National Science Foundation [NSF] Advanced Technology Education [ATE] program)
- 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 Youth Science, Engineering, and Technology for Life community. (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. (NIFA)
- 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)

- 4-H National Headquarters and Agriculture in the Classroom (AITC) will work strategically with USDA in developing curricula and learning opportunities that align with USDA priorities, which reach youth in non-formal and formal settings. (NIFA)
- Increase STEM educational content, aligned with respective state standards, of the Agriculture in the Classroom (AITC) Program’s National Resource Directory electronic database. (NIFA)
- Complete a revised Food and Fiber Systems Curriculum Framework for use as a tool by teachers, curricular specialists, and industry professionals to promote agricultural science literacy among K-12 students. (NIFA)

**Strengthen the science capacity at minority-serving institutions—including 1890 Land Grant Universities, the 1994 Tribal Colleges and Universities, 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 further 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 minority producers, beginning farmers, and women producers and 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, and women producers. (NIFA, OAO, RD)
- Increase leveraging resources to address the unique needs of minority producers, beginning farmers, and women producers. (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-based industries. The response to these changes reflects rural America's great geographic, economic, and social diversity: while many communities well-positioned to take advantage of new opportunities 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. How rural areas position themselves to better compete in a 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 decisionmaking in support of rural and community development.**

### **STRATEGIES AND ACTIONS:**

**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)
- 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 investment and development and human 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, and their potential contributions for economic development in rural areas. (ERS, NIFA)
- Implement and leverage 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, to effectively integrate knowledge about more sustainable crop and forest production bioenergy systems. (ARS, NIFA)
- Conduct integrative scientific work that combines research, education, and extension efforts to identify and develop cost effective, sustainable uses of woody biomass for bioenergy production. (NIFA)
- Support development of educational programs/curricula to build rural America's capacity to work with bioenergy/bioproduct development and delivery. (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. (ARS, ERS, 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, 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/bioprocess 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)

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

*Actionable items*

- Provide personal financial management resources that will teach financial planning, management, and recovery through partnership with the Financial Literacy Education Commission (FLEC), Federal, local, and state organizations (NIFA, U.S. Treasury), and build public and private decisionmaking by implementing the Family and Consumer Economics Financial Capability Framework: 1) financial knowledge and understanding; 2) financial skills and competence; and 3) financial responsibility. (NIFA)
- Produce new information on the role of community institutions and assets in supporting rural business innovation and growth development through national surveys of rural community leaders and business establishments. (ERS, RD)
- Establish the interactions between community assets and business vitality and growth, with emphasis on the drivers of growth in distressed and low-asset rural areas. (ERS, NASS)
- Provide IRS Volunteer Income Tax Assistance Program (VITA) through NIFA’s state and local partners, Cooperative Extension, and the land grant university system. (NIFA)
- 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 the social, cultural, and educational opportunities. (ERS)
- Increase knowledge about the importance of regional innovation and collaboration for sustainable rural economic growth. (ERS, NASS)

**Build new partnerships with underserved and non-traditional populations.**

*Actionable items*

- Partner with national level community based organizations (CBO) to solicit promotion assistance and data collection assistance to 2012 Census of Agriculture mail list for underserved populations. (NASS)
- Identify potential new partnerships and pursue those to enhance enumeration of underserved and non-traditional populations in the 2012 Census of Agriculture. (NASS)
- Develop new data collection strategies to improve quality of data for underserved populations by the use of the CBO/NASS Partnership Manual. (NASS)
- Assess 2007 Census of Agriculture outreach efforts to promote partnerships among colleges, universities, local and regional CBOs, field based organizations, and extension to identify and address the needs of underserved populations. (NASS, NIFA)

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

*Actionable items*

- Conduct Census of Agriculture content test to finalize new questionnaire content. (NASS)
- Provide statistically sound information for expanding economic opportunities by conducting the 2012 Census of Agriculture. (NASS)
- Develop and implement a rotational agricultural renewable energy survey and data series. (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)

**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:

- (1) Is the Action Plan implemented?
- (2) What is the realistic timeline for each step? These will vary with the state of the science.
- (3) Do the implementation steps accomplish their expected or desired results?
- (4) 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 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 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. Rather than propose specific measures here, however, each goal team or agency component that is charged with implementing an action step will develop a clear expected outcome and associated measures of success.

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 groundbreaking 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 decisionmakers 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.

This document is a work in progress that will evolve over time without straying far from the general themes. It will be evaluated periodically and adapted as necessary to reflect progress, shifts in priority, and adjustments in funding. Regular, frequent progress checks will be made within the mission area, and on an agency level, for specific actions. 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.

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 and support from the REE mission area, the agencies, and their employees. 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.



## 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
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
OAD	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