



United States Department of Agriculture

# RESEARCH, EDUCATION, AND ECONOMICS ACTION PLAN PROGRESS REPORT

2015

Progress and  
Achievements



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## Preface

The Research, Education, and Economics (REE) Mission Area proved once again in 2015 that it is up to tackling big challenges in agriculture – not the least of which involves making sure we can feed the 9–10 billion people who will live together on the Earth by mid-century. Feeding so many citizens will require at least a 60-percent increase in agricultural productivity. We must do all of this in the face of global change that is threatening the productivity and profitability of our farms, ranches, and forests. Through the REE Action Plan, we identified goals that support top priorities for USDA science. The goals align with strategic plans developed by the Department and the REE agencies and respond to emerging issues facing agriculture.

When the White House identified pollinator health as one of the most critical food security concerns in 2015, REE helped to position USDA as a leader in support of White House strategies that promote the health of honey bees and other pollinators. Surveys and research conducted by our statistical agencies, National Agricultural Statistics Service (NASS) and Economic Research Service (ERS), informed the agricultural community and policymakers on the extent of pollinator losses and related impacts to the Nation’s economy, citizen health, and future food security. Furthering insight into factors affecting pollinator health, Agricultural Research Service (ARS) scientists developed biomarkers to detect bee malnutrition in colonies and National Institute of Food and Agriculture (NIFA)-funded researchers discovered new information about how queen bees communicate which may lead to more sustainable colonies.

Drought in the western United States during 2015 continued to threaten farmers and livelihoods, disrupt communities, and strain food systems. Nationwide, 18 percent of our fresh water supply originates on national forest land and grasslands and even more – 51 percent in the western States. So the USDA Forest Service is conducting important research and mapping forest lands to help plan for the future availability of quality drinking water. In other progress, NASS and ERS provided data critical for economic forecasts, water supply planning, and evaluating drought impacts. ARS scientists, in collaboration with National Aeronautics and Space Administration (NASA), developed techniques that forecast with more accuracy the amount of water available in mountain snowpack, information that will help manage limited water resources. NIFA-supported research is determining drought triggers that assist planners in developing drought response policies.

Through an astounding number of research publications in 2015 – over 20,000 – REE and its academic partners informed and engaged the scientific community in discussion of new advances and discoveries. The investments in NIFA-funded grants helped leverage over \$2.2 billion in additional funds to support our research priorities this year.

We are committed to our leadership role in developing the next generation of scientists, farmers, and ranchers who have the technical skills to tackle the major challenges. Partnering with the White House, USDA, through REE, co-sponsored a major gathering of Federal organizations, industry, non-profit organizations, and youth groups, to share ideas on raising the profile of agricultural research and education. Encouraging Science, Technology,

Engineering, and Math (STEM) students to enter into agricultural careers is a priority area, with agriculture facing an expected gap of 22,500 qualified candidates annually. Programs such as the Dairy Grazing Apprenticeship sponsored by NIFA are helping to develop the workforce necessary to produce food for a growing population. NIFA-supported education and training programs also engaged over 50 million young people and adults in understanding and applying agricultural science. Through distance education and on-site laboratory training programs, REE scientists are helping inform and develop future agricultural scientists and leaders.

REE works across organizations to ensure research efforts are complementary and work to fill gaps. Investments in agricultural science are leading to unprecedented advancements in the science of nutrition and nutrition education, agricultural systems, bioenergy, climate change, and plant and animal breeding and disease prevention. The selected achievements of 2015 reported here are the result of extensive collaboration among the agencies that comprise the REE Mission Area and our Federal, State, tribal, university, private and non-governmental partners and demonstrate our ability to make a difference in the lives of peoples and communities.

A handwritten signature in black ink that reads "Catherine E. Woteki". The signature is written in a cursive, flowing style.

Catherine E. Woteki, Ph.D.  
Chief Scientist  
Under Secretary for Research, Education, and Economics  
U.S. Department of Agriculture

## INTRODUCTION

The Research, Education, and Economics (REE) Mission Area works to address the challenges that exist today and those that will confront the country in the future. Through the combined efforts of all REE scientists, researchers, and partners, USDA has created a robust infrastructure to perform world-class science and to deliver classroom and community education and transfer technologies from the labs to the private sector for commercialization.

Building on REE's 2010 "A Roadmap for USDA Science," the REE Action Plan, first developed in 2012 and revised in 2014, establishes goals and priorities for USDA science and education. It includes strategies and actions to help coordinate efforts to achieve these goals.

This 2015 REE Action Plan Progress Report demonstrates progress in support of the REE Action Plan. The agencies reporting highlights of significant accomplishments in 2015 in support of the REE Action Plan include the following:

The ***Agricultural Research Service (ARS)*** is 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 90 locations across the country and at 5 overseas laboratories. The ARS research agenda is broad, with about 750 research projects organized under 4 major program areas: Nutrition, Food Safety, and Quality; Animal Production and Protection; Natural Resources and Sustainable Agricultural Systems; and Crop Production and Protection.

The ***Economic Research Service (ERS)*** is 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)*** is USDA's statistical agency. NASS conducts hundreds of surveys every year and prepares reports covering virtually every aspect of U.S. agriculture. The statistical data provided by NASS is essential to the public and private sectors for making effective policy, production, and marketing decisions on a wide range of agricultural commodities. 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 ***National Institute of Food and Agriculture (NIFA)*** is the primary extramural research, education, and extension funding agency of USDA. Its mission is to invest in and advance agricultural research, education, and extension to solve societal challenges. Some of funding opportunities are specific to the Land-Grant University System, and others open to participation by other academic institutions, government agencies, non-governmental organizations, and even private sector entities.

**Other USDA Organizations:** While other USDA organizations, Forest Service (FS) Research and Development (R&D), for example, do not directly fall within REE mission area jurisdiction, their contribution is vital to USDA's science agenda. Forest Service R&D provides the basic and applied science that underpins the agency's efforts to promote resilient forests and sustainable communities that can adapt to forest threats such as climate change, fire, and insect and disease infestations. The knowledge and information gained from this research benefits the American public by improving the health and productivity of the Nation's forests, and the quality of life of communities by providing protection from fire, improving water and air quality, and supporting other ecosystem services in both urban and rural communities.

### **REE Action Plan Framework**

The REE Action Plan is designed to guide and help coordinate research activity across the Department and inform other agricultural research entities. It provides further delineation of USDA's research priorities and remains the roadmap for promoting innovations related to agricultural science and education.

The Action Plan describes the seven goals that reflect the full scope and variety of REE activities including:

- Goal 1: Local and Global Food Supply and Security
- Goal 2: Responding to Climate and Energy Needs
- Goal 3. Sustainable Use of Natural Resources
- Goal 4. Nutrition and Childhood Obesity
- Goal 5. Food Safety
- Goal 6. Education and Science Literacy
- Goal 7. Rural-Urban Interdependence and Prosperity

Several goals have sub-goals to provide programmatic emphasis. For each goal or sub-goal, strategies are identified that provide a vision for how the goals can be supported. Through alignment with the various components in the REE plan, USDA agencies demonstrate that their programs support the stated goals, which in turn support the broader Departmental goals, set forth by the Secretary of Agriculture.

On the following pages for each of the seven goals, you will find brief descriptions of some recent successes achieved from the USDA investment in food, natural resources, and agricultural research, education, and technology transfer along with specific metrics.

## Goal 1: Sustainable Intensification of Agricultural Production

### Sub-Goal 1A: Crop and Animal Production

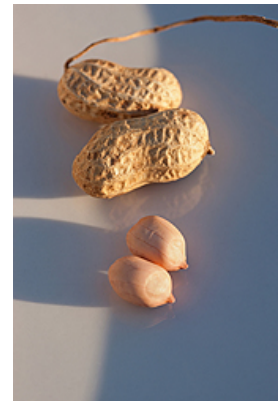
REE Objective: Invest in research, development, and extension to safely, sustainably, and humanely increase the production capacity, production efficiency, and nutritional value of food animals and crops

#### USDA Peanut Research:

#### Healthier for People and Cropping Systems; Increasing Economic Opportunity

Peanuts are important in the United States and around the world. As legumes, peanuts supply their own nitrogen -- with help from beneficial soil microbes—making them valuable for farmers looking for practical, beneficial crops to grow in rotation with other important crops like corn, cotton, and bioenergy crops. High in both protein and oil, peanuts are nutritious and versatile, making them a foundation of many businesses, from home-based to small business to multi-national companies, that can boost economies by providing numerous jobs.

When we eat peanuts as salted nuts or in candy, they are often *Spanish-type* peanuts—a high-oil peanut that also makes good peanut butter. Spanish peanuts became even better when land-grant university partners Texas A&M and Ohio State began a breeding program to increase the polyunsaturated oleic acid content of their oil. The higher oleic acid gives peanut oil two notable new qualities: “heart-healthy” in human diets; stays naturally fresh far longer in the products we often stock on our shelves. Exciting as they were, however, the first high-oleic peanuts had problems. Their desirable oil quality came at the cost of lower yield, often so low that the value of their excellent nutritional quality and longer shelf-life just didn’t compensate. They were also more susceptible to fungal diseases, so farmers had to choose between the expense of fungicide and getting even lower yields.



In 2015, REE researchers, working with collaborators at Oklahoma State University, co-released a new Spanish peanut variety—OLé—that is improved for *all three* traits: higher yield potential, greater disease resistance, and desirable high oleic acid content in its seed oil. This combination is expected to give farmers an additional crop value of \$83 to \$175 per acre. Planting seed is being increased now, and it is anticipated that in 2016 OLé will occupy most of the peanut acreage in Oklahoma and Texas, the primary Spanish peanut region. (<http://www.ars.usda.gov/is/pr/2015/150224.htm>)

In the meantime, the team continues to work on high-oleic peanuts that will be even more productive than OLé, bringing more value for U.S. farms and agricultural businesses, and ensuring a supply of high-oleic peanut products for nutrition and health. This research for healthy farms and healthy people is important for other peanut-growing areas of the globe, too, including places where peanuts are central to human nutrition and rural cash income.

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*The USDA achievements of 2015 reported here are the result of extensive collaboration among the agencies that comprise the Research, Education, and Economics (REE) Mission Area: Agricultural Research Service (ARS), Economic Research Service (ERS), National Institute of Food and Agriculture (NIFA), and National Agricultural Statistics Service (NASS).*

**Genetic Discoveries Supporting Animal Health** Demand for rainbow trout is rising as people understand the health benefits from eating seafood. However, there are limits to harvesting wild-caught seafood, and aquaculture yield is constrained by bacterial diseases that are naturally occurring in aquatic environments. REE scientists at the National Center for Cool and Cold Water Aquaculture used selective breeding to develop the first publicly available rainbow trout with specific disease resistance, resulting in healthier animals during the production cycle. The genetic basis of their disease resistance is being evaluated in collaboration with the Virginia Institute of Marine Science, the College of William and Mary, U.S. Fish and Wildlife Service, and the University of Pennsylvania. Private companies are producing and distributing the new trout line for aquaculture. It is also used by the Utah Division of Wildlife Resources in its State fish hatcheries program for stocking streams and rivers. ([http://www.ars.usda.gov/research/projects/projects.htm?accn\\_no=422513](http://www.ars.usda.gov/research/projects/projects.htm?accn_no=422513))



**New Innovations Supporting Barley Production** High Plains Farmers had an environmental need and an economic opportunity for growing barley--a crop that grows well in the region, protects soil from erosion, and serves as a feed crop with a good market. However, severe losses to a newly arrived pest, the Russian wheat aphid, brought barley production to a standstill. A USDA partnership through REE scientists at Stillwater, OK, and Aberdeen, ID, and collaborators at land-grant universities Idaho, Colorado State, Nebraska, and New Mexico State successfully used resources from the National Plant Germplasm System to breed and release 'Mesa' (winter barley) and 'RWA 1758' (spring barley). These aphid-resistant varieties have rejuvenated High Plains production of feed barley in environmentally sound agriculture. Recently licensed to private companies, the varieties had 2015 seed sales topping 20,000 bushels.

**Informing Crop and Livestock Producers** Sustainable intensification of agriculture requires accurate information about what factors drive productivity, and associated economic trade-offs. Recent REE research reports include Agricultural Productivity Growth in the United States: Measurement, Trends and Drivers, Econ. Res. Rept. 189, 2015; The Profit Potential of Certified Organic Field Crop Production, Econ. Res. Rept. 188, 2015; The Economics of Glyphosate Resistance Management in Corn and Soybean Production, Econ. Res. Rept. 184, 2015; and, Slaughter and Processing Options and Issues for Locally Sourced Meat, Outlook Rept. LDPM-216-01, 2012. Such REE research helps farmers and others understand opportunities and challenges of diverse crop and livestock production systems.

**Pollinator Health Initiatives** Demonstrating the economic importance of pollinators, REE surveys have estimated that beekeeper revenue from honey and pollination services is over \$900 million collectively. The White House Pollinator Health Task Force Efforts to lower winter mortality of bees will use a REE survey on quarterly and annual honey bee colony loss as a baseline. REE-supported scientists at Penn State, North Carolina State, and Tel Aviv universities revealed that a queen bee's effectiveness at communicating "availability" to potential mates could be a key factor in the future well-being of the colony. In addition to extensive work on understanding and preventing bee pests and diseases, REE scientists have developed biomarkers to detect bee malnutrition in colonies.

(<https://www.whitehouse.gov/sites/default/files/microsites/ostp/Pollinator%20Health%20Strategy%202015.pdf>)



# Sustainable Intensification of Agricultural Production Metrics by Supporting Agencies

## Subgoal 1A. Crop and Animal Production

Metric	Contributing Agencies			
	ARS	ERS	NIFA	NASS
Peer-reviewed journal publications	500	8		6
Non-peer-reviewed publications	108			21
Research monographs		4		
Material Transfer Agreements <sup>1</sup>	46			
Inventions	10			
New incoming agreements <sup>2</sup>	67			
New or updated data products				1
New or updated Websites	18			2
Briefings <sup>3</sup>	40	2		21
Federal Register Notices or other Government use <sup>4</sup>		1		12
Responses to requests for research findings, information, or analysis by decisionmakers <sup>5</sup>	140	20		
Extension publications from Formula grants			1,458	
Research publications from Formula grants			2,855	
Direct youth contacts by Extension			595,218	
Direct adult contacts by Extension			5,767,497	
Additional funds leveraged from Formula grant projects			\$493,000,000	
Patent applications reported by Formula grant recipients			66	
Extension professional FTEs from Formula grants			1,550	
Scientist years for Formula grant projects			1,107	
Number of active extramural grant projects <sup>6</sup>		1	3,690	

ARS = Agricultural Research Service

ERS = Economic Research Service

NIFA = National Institute of Food and Agriculture

NASS = National Agricultural Statistics Service

FTEs = Full-Time Equivalent staff

<sup>1</sup> Contracts governing the transfer of tangible research materials between two organizations, when the recipient intends to use it for his or her own research purposes.

<sup>2</sup> New incoming agreements are agreements where ARS is receiving funds from an outside source to do research based on the statement of work in a proposal or agreement.

<sup>3</sup> Briefings are for senior USDA staff, Congressional staff, or other Federal agencies.

<sup>4</sup> Federal Register Notices and/or other Government use are Federal Register Notices of Rules or other Federal Agency Decision Reports that use ERS research findings.

<sup>5</sup> Requests for information, research findings, data, and analysis by decisionmakers in USDA, Congress, and other Federal agencies.

<sup>6</sup> Active extramural grant projects may be associated with one or more Research, Education, and Economics (REE) Action Plan Goals/Subgoals.

## Goal 1: Sustainable Intensification of Agricultural Production

### Sub-Goal 1B: Crop and Animal Health

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

#### *Saving U.S. Wheat and Barley From Disease*

Wheat and barley, grown in the United States in 42 States, are vital to human nutrition, the economy, and to global food security. Since 2010, the combined annual market value of wheat and barley has been estimated to be between \$11 billion and \$18.5 billion. But wheat and barley production in the United States is threatened by devastating plant diseases, especially stem and stripe rusts. New strains of stem rust called Ug99 have recently emerged in East Africa and are spreading rapidly. If the stem rust strains arrive in the United States, they could overcome resistance in 80 percent of wheat and barley plants, resulting in significant crop failures.



(<http://www.ars.usda.gov/Main/docs.htm?docid=14649>) Stripe rust caused 25 percent of the wheat and barley crop in California to fail in 2003 alone. (<http://www.triticeacap.org/home/exciting-developments/356-2/>)

Strong partnerships forged within USDA to combat these serious threats. Using modern genomic technologies, plant scientists can identify and introduce novel resistance genes into regionally adapted wheat and barley varieties. REE awarded 45 university and 16 REE scientists and breeders a \$25 million grant entitled the *Triticeae Cooperative and Coordinated Agricultural Project (T-CAP)* in 2011. T-CAP enabled REE scientists working in Kenya and Ethiopia to develop a uniform system to field test its extensive small grains collection and to test for stripe rust. T-CAP also enabled university scientists to produce new germplasm with resistance to stripe rust. In additional cooperation, REE provided production and crop value statistics, facilitating an analysis and modeling of the potential economic effect of the plant diseases and various interventions

T-CAP, through REE, achieved several important impacts: (1) New varieties of disease-resistant wheat comprise an estimated 20 percent of the annual harvested acreage--worth \$3.5 billion--and 4 percent of the annual harvested barley acreage in the United States; (2) The new lines of wheat are more effective in resisting disease and have a higher nutritional value, a better yield, improved drought tolerance and greater environmental adaptability; (3) Over 100,000 acres of varieties that stack multiple genes conferring resistance to all known races of stripe rust were planted in the U.S. using new technologies; (4) Forty new genes resistant to Ug99 were identified from extensive trials in Kenya and Ethiopia over the last decade and are now being bred into U.S. grain; and (5) Project directors mentored 244 undergraduate and graduate students, plus 25 postdoctoral researchers since 2011 – empowering a new generation of plant scientists and breeders. (<http://www.triticeacap.org/>)

**Preventing Disaster: Halting the Highly Pathogenic Avian Influenza (HPAI) Outbreak** The 2014–2015 HPAI outbreak was the worst ever experienced in the United States. After an initial confirmed case in a backyard flock of chickens in Oregon, HPAI swept across 15 States, forcing officials to kill nearly 50 million birds. Consumers felt the economic impact as egg prices increased by 50.6 percent per dozen and egg shortages were seen all the way to the Midwest. Controlling HPAI was problematic as the constantly changing virus made production of effective vaccines difficult. But coordinated, proactive planning by REE agencies and the USDA Animal and Plant Health Inspection Service (APHIS) enabled rapid deployment of resources to help mitigate the economic impact of the outbreak. Within weeks, REE scientists evaluated the HPAI viruses isolated from infected birds and determined that migratory waterfowl played a significant role in the outbreak. REE scientists developed a rapid molecular test to detect the virus and quickly engineered a vaccine, rg-H5, using a new reverse genetics technology.

REE-funded scientists developed innovative vaccines against HPAI that are currently being tested for their effectiveness in protecting poultry. One vaccine uses nanoparticle technology that could help to revolutionize the way all vaccines are developed. The other vaccine uses virus-like particles that contain HPAI genes and plays a central role in a partnership between university researchers and REE researchers who are evaluating an intranasal administration of the vaccine.



REE collaborated closely with APHIS to provide diagnostic support and conduct clinical assessment of available vaccines. The assessment allowed APHIS to determine the vaccines to stockpile for potential use if HPAI were to return. Preventing the spread of HPAI is the focus of a program that has trained more than 53 agricultural workers from more than 40 countries on 6 continents. The program was developed through REE-funded research and extension efforts and is now sustained with APHIS support. REE framed potential impacts from HPAI that allowed USDA to convey information to stakeholders very rapidly in order to prepare for action like potential trade barriers imposed by importing countries.

<http://www.ars.usda.gov/News/docs.htm?docid=11244>

# Sustainable Intensification of Agricultural Production Metrics by Supporting Agencies

## Subgoal 1B. Crop and Animal Health

Metric	Contributing Agencies			
	ARS	ERS	NIFA	NASS
Peer-reviewed journal publications	1,094			
Non-peer-reviewed publications	156			
Material Transfer Agreements <sup>1</sup>	133			
Inventions	40			
New incoming agreements <sup>2</sup>	194			
New or updated Websites	62			
Briefings <sup>3</sup>	64			
Federal Register Notices or other Government use <sup>4</sup>				2
Responses to requests for research findings, information, or analysis by decisionmakers <sup>5</sup>	86	12		
Extension publications from Formula grants			827	
Research publications from Formula grants			1,620	
Direct youth contacts by Extension			584,386	
Direct adult contacts by Extension			3,712,713	
Additional funds leveraged from Formula grant projects			\$505,000,000	
Patent applications reported by Formula grant recipients			38	
Extension professional FTEs from Formula grants			847	
Scientist Years for Formula grant projects			1,152	
Number of active extramural grant projects <sup>6</sup>			3,285	

ARS = Agricultural Research Service

ERS = Economic Research Service

NIFA = National Institute of Food and Agriculture

NASS = National Agricultural Statistics Service

FTEs = Full-Time Equivalent staff

<sup>1</sup> Contracts governing the transfer of tangible research materials between two organizations, when the recipient intends to use it for his or her own research purposes.

<sup>2</sup> New incoming agreements are agreements where ARS is receiving funds from an outside source to do research based on the statement of work in a proposal or agreement.

<sup>3</sup> Briefings are for senior USDA staff, Congressional staff, or other Federal agencies.

<sup>4</sup> Federal Register Notices and/or other Government use are Federal Register Notices of Rules or other Federal Agency Decision Reports that use ERS research findings.

<sup>5</sup> Requests for information, research findings, data, and analysis by decisionmakers in USDA, Congress, and other Federal agencies.

<sup>6</sup> Active extramural grant projects may be associated with one or more Research, Education, and Economics (REE) Action Plan Goals/Subgoals.

## Goal 1: Sustainable Intensification of Agricultural Production

### Sub-Goal 1C: Crop and Animal Genetics

REE Objective: Generate new fundamental knowledge through research and application in genomic sciences to enhance the sustainability of agriculture while increasing productivity

#### *Big Data: Advances in Cyberinfrastructure for Agricultural Research*

The rapid increase in the ability to sequence genomes, profile gene activity, and analyze responses to weather, disease, and pests brought new challenges in managing, analyzing, and sharing trillions of data points with the global research community. The Interagency Working Group for Plant Genomics of the National Science and Technology Council has developed an unsurpassed system of open data and open access tools for strategic crops to support U.S. researchers. The database system includes MaizeGDB (corn), SoyBase (soybean), Legume Information System (legumes), The Triticeae Toolbox (T3) (<https://triticeaetoolbox.org/oat/>) and GrainGenes (wheat, barley, oat), Gramene (rice, grape, model plant systems), and the Genome Database for Rosaceae (GDR) (<https://www.rosaceae.org>). In wheat, barley, and oat breeding, T3 integrates rapidly expanding DNA sequence data with phenotype data from the fields for better analyses and predictions.



The GDR, funded by REE, supports research for apple, peach, plum, apricot, pear, cherry, almond, strawberry, and rose. In 2015, GDR published a standardized system for designating genes, added more functions to its Breeder's Toolbox, plus six new genome sequences for strawberries, and improved access to its marker data. MaizeGDB (<http://www.maizegdb.org/>), developed by REE, is an open access, community-oriented, central repository for maize data and information. A recent redesign enables the research community to find the latest information on genome sequence diversity, gene expression, and metabolic pathways, increasing use by over 60 percent.

The U.S. soybean crop, valued in excess of \$35 billion, depends on continued breeding improvements in order to achieve yield gains and avoid losses due to pathogens and environmental stresses. The REE database SoyBase provides access to the latest reference genome sequence, as well as to predicted genes, markers, and valuable trait mapping information. SoyBase serves 2,400 users per month, including researchers at large food companies, universities, Federal agencies, and government labs.

New USDA Big Data Initiative funds were critical to meeting the increased demand for open access to public soybean data and information. The Legume Information System (LIS) provides data visualization and analysis tools and serves as portal to data maintained at other sites. Using tools developed for LIS (<http://legumeinfo.org/>) and SoyBase (<http://soybase.org/sbt/>), REE released PeanutBase (<http://peanutbase.org/>). Together, the three databases provide access to curated genomes and gene sequences of eight species, including two that are models for legume research. Genomic information for wheat, barley, rye, oats and wild relatives are organized in GrainGenes 3.0. USDA REE also supports Gramene (<http://www.gramene.org/>), which is an open-source data resource for research in crops and model plant species.

**Limiting the Health Challenge Caused by Wheat Allergies** Reducing wheat allergens through plant breeding has been difficult because of complex genetic traits. Collaboration between REE and French National Institute for Agricultural Research (INRA) scientists targeted some genes in wheat for “silencing.” The result was genetically engineered wheat that could reduce the number of people who suffer reactions to this serious food allergy.

**FasTrack Breeding for American Orchards** The American tree fruit industry is facing many challenges -- from global competition to climate change. But development of improved varieties of fruit trees is a slow process that has changed little over the centuries caused by long generation cycles, large land areas that are costly to operate, and flowering only once per year. However, REE is speeding up the process of tree fruit breeding with the FasTrack breeding system that uses genetic engineering with the *FT* gene (*Flowering Time*). FasTrack plum trees, for example, flower and produce fruit with viable seeds within 1 year versus the typical 3-10 years for a conventional plum. FasTrack breeding varieties can be restored genetically to the non-genetically engineered state, too. REE scientists are working together to determine whether FasTrack plums have the "right stuff" to provide fresh nutritious fruit on future manned Mars missions. Plums are an excellent source of nutrients important to astronauts during long-duration space travel.

**Breeding Disease-Resistant Animals** With the genome sequences of animals and animal disease organisms, breeders have access to new tools for identifying disease-resistant animals. REE scientists identified a gene associated with pneumonia in sheep and developed a test to identify animals with the high-risk gene, so sheep producers can breed flocks that are less susceptible, enhancing the health of flocks and increasing profits.

Bovine respiratory disease (BRD) costs nearly \$1 billion a year in dairy and beef cattle losses. Through a combined phenotype to genotype approach, starting with new standards for precise description of BRD symptoms in cattle, researchers were able to find genomic regions that can enhance resistance.

(<http://www.brdcomplex.org/researchers.html>)

**Innovation Supporting Catfish Production** The U.S. imports more than 85 percent of its seafood at a high cost. High feed prices and low-cost imports reduced U.S. catfish production by more than 50 percent within the last decade. Research is needed to develop practical solutions that will facilitate growth of the U.S. aquaculture industry, leading REE to develop a catfish genome sequence and gene annotation project. The search led to DNA-based markers to identify fish resistant to infection by two major diseases. These markers will be useful in practical catfish breeding for aquaculture.

(<http://reeis.usda.gov/web/crisprojectpages/1005404.php>)



## Sustainable Intensification of Agricultural Production Metrics by Supporting Agencies

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

Metric	Contributing Agencies		
	ARS	ERS	NIFA
Peer-reviewed journal publications	660		
Non-peer-reviewed publications	145		
Research monographs	1	1	
Material Transfer Agreements <sup>1</sup>	189		
Inventions	13		
New incoming agreements <sup>2</sup>	134		
New or updated data products		1	
New or updated Websites	54		
Briefings <sup>3</sup>	40		
Responses to requests for research findings, information, or analysis by decisionmakers <sup>5</sup>	80	3	
Extension publications from Formula grants			386
Research publications from Formula grants			755
Direct youth contacts by Extension			57,234
Direct adult contacts by Extension			423,817
Additional funds leveraged from Formula grant projects			\$244,000,000
Patent applications reported by Formula grant recipients			18
Extension professional FTEs from Formula grants			145
Scientist years for Formula grant projects			481
Number of active extramural grant projects <sup>6</sup>			1,482
New plant varieties and germplasm lines	70		

ARS = Agricultural Research Service

ERS = Economic Research Service

NIFA = National Institute of Food and Agriculture

FTEs = Full-Time Equivalent staff

<sup>1</sup> Contracts governing the transfer of tangible research materials between two organizations, when the recipient intends to use it for his or her own research purposes.

<sup>2</sup> New incoming agreements are agreements where ARS is receiving funds from an outside source to do research based on the statement of work in a proposal or agreement.

<sup>3</sup> Briefings are for senior USDA staff, Congressional staff, or other Federal agencies.

<sup>5</sup> Requests for information, research findings, data, and analysis by decisionmakers in USDA, Congress, and other Federal agencies.

<sup>6</sup> Active extramural grant projects may be associated with one or more Research, Education, and Economics (REE) Action Plan Goals/Subgoals.

## **Goal 1: Sustainable Intensification of Agricultural Production**

### **Sub-Goal 1D: Consumer and Industry Outreach, Policy, Markets, and Trade**

REE Objective: 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.

#### ***Data Making the World Work Better and Smarter***

As farmers, consumers, businesses, or policymakers, we often take for granted the important agricultural data on which we rely. Most of the time, these data keep food and agricultural systems working smoothly with information on crop production, farm income, food and agricultural prices, trade, nutrition, and food security. REE agencies work together to collect, report, and interpret data from nearly every stage of the food production system, and their efforts help farmers to decide what to produce and how to market their products. Businesses use the data to manage inventories and make investment decisions. Policymakers need data to understand the needs and the effectiveness of programs that can support farmers, protect the environment, and improve consumer access to nutritious food. Often, insights into new and emerging developments across the agriculture sector, such as the growth in markets for local foods, the demand for organic foods, and the environmental outcomes of changing agricultural practices, are gained. Other times, data point to critical shortcomings in the way we operate, stimulating policies and action, as well as calls for more data.

NASS is the primary source of data about the Nation's agriculture sector, but many other Federal agencies provide information that USDA relies on for understanding markets for food and agricultural commodities. To understand developments in the processing and industrial sectors of agriculture—such as grain milling and oilseed processing—the Census Bureau had been the source of important survey-based data from 1904 until 2011, when the program was terminated due to budget constraints. The data had been important to USDA and its stakeholders in understanding the demand for some of the most widely produced and traded agricultural commodities, supporting estimates of market conditions and reliable price forecasts. (<http://www.nass.usda.gov/>)

NASS, ERS and the USDA, Office of the Chief Economist worked together to reinstate data collection efforts across agricultural sectors. Renamed the Current Agricultural Industrial Report (CAIR) Series, the new surveys improve upon the Census Bureau efforts by collecting the information most important to USDA analysts and researchers. Data from these surveys became available in 2015 and were used immediately by ERS researchers to improve the commodity market outlook forecasts that are extremely influential and have tangible effects on commodity prices. The market intelligence provided by the CAIR reports helps markets work better, helps farmers make better production decisions, and helps firms to reduce their costs and risks, leading to an abundant food supply for domestic and export markets. ([http://www.nass.usda.gov/Surveys/Guide to NASS Surveys/Current Agricultural Industrial Reports/index.php](http://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Current_Agricultural_Industrial_Reports/index.php))

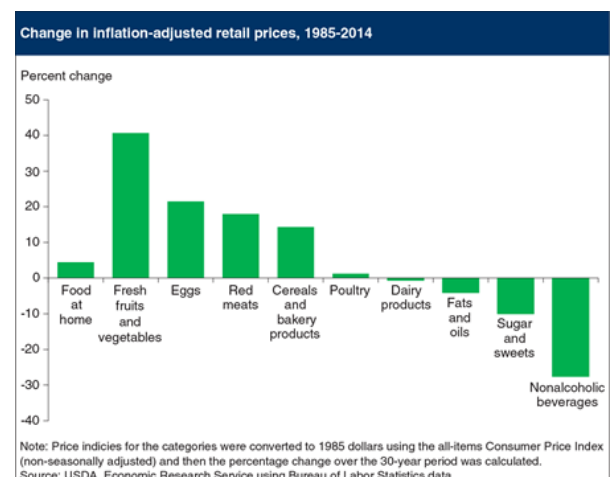


**Stemming the Tide of Food Loss Using Data** The United States has one of the most productive and efficient agriculture sectors in the world, but a tremendous amount of food is lost or wasted between the farm where it is produced and the consumer who ultimately purchases it. ERS estimates that 31 percent—or 133 billion pounds—of the 430 billion pounds of the available food supply at the retail and consumer levels in the United States in 2010 went uneaten. The estimated value of this food loss was \$161.6 billion using retail prices. USDA recognizes food loss as a challenge, and in 2015, the Secretary announced a new initiative to reduce food waste in the United States. ERS is actively working to improve public understanding of food loss and why losses occur. A key data product is the Loss-Adjusted Food Availability Data (LAFA) Series, which provides popular proxies for actual consumption of over 200 commodities and estimates of food loss at the retail and consumer levels. The agency joined the public discussion of food waste through publications and press, promoting sound policy initiatives to address the challenge. ([http://www.ers.usda.gov/data-products/food-availability-\(per-capita\)-data-system.aspx](http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system.aspx))

**The Agricultural Resource Management Survey (ARMS)** ARMS is a series of interviews with farm operators about their cropping practices, farm businesses, and households. ARMS samples and collects information from farms of all sizes, family and nonfamily farms, and corporate and unincorporated farms. Information collected by the ARMS is used by ERS to construct many official government estimates including farm income, costs of production, and agricultural productivity. ARMS is also used widely by economists at ERS and across the Land-Grant University System to study a variety of important topics including farm management, structure, and farm household well-being. (<http://www.ers.usda.gov/data-products/arms-farm-financial-and-crop-production-practices.aspx>)

**Reaching Our Stakeholders** The data and information produced by the REE agencies would be of little value if it never reached the people who can act upon it. Or, sometimes the sheer volume of information and its complexity can undermine its usefulness if it dissuades users from taking the time to read a lengthy report or sort through extensive data. The REE *Charts of Note* is an innovative product intended to provide REE stakeholders the ability to stay on top of ERS research findings and noteworthy developments across the food and agriculture sector. Delivered by email and posted on the ERS website daily, *Charts of Note* provides users a sense of the breadth of topics studied at ERS and the ability to quickly drill down to more detailed data and analysis if needed.

(<http://www.ers.usda.gov/data-products/charts-of-note.aspx>)



## Sustainable Intensification of Agricultural Production Metrics by Supporting Agencies

### Subgoal 1D. Consumer and Industry Outreach, Policy, Markets, and Trade

Metric	Contributing Agencies		
	ERS	NIFA	NASS
Peer-reviewed journal publications	40		
Outreach newsletters	91		5
Research monographs	33		
New or updated data products	190		6
Briefings <sup>3</sup>	35		
Federal Register Notices or other Government use <sup>4</sup>	15		5
Responses to requests for research findings, information, or analysis by decisionmakers <sup>5</sup>	265		
Extension publications from Formula grants		1,361	
Research publications from Formula grants		2,667	
Direct youth contacts by Extension		765,096	
Direct adult contacts by Extension		3,800,439	
Additional funds leveraged from Formula grant projects		\$117,000,000	
Number of extramural grants awarded	14		
Patent applications reported by Formula grant recipients		62	
Extension professional FTEs from Formula grants		1,193	
Scientist years for Formula grant projects		401	
Number of active extramural grant projects <sup>6</sup>	49	1,601	

ERS = Economic Research Service

NIFA = National Institute of Food and Agriculture

NASS = National Agricultural Statistics Service

FTEs = Full-Time Equivalent staff

<sup>3</sup> Briefings are for senior USDA staff, Congressional staff, or other Federal agencies.

<sup>4</sup> Federal Register Notices and/or other Government use are Federal Register Notices of Rules or other Federal Agency Decision Reports that use ERS research findings.

<sup>5</sup> Requests for information, research findings, data, and analysis by decisionmakers in USDA, Congress, and other Federal agencies.

<sup>6</sup> Active extramural grant projects may be associated with one or more Research, Education, and Economics (REE) Action Plan Goals/Subgoals.

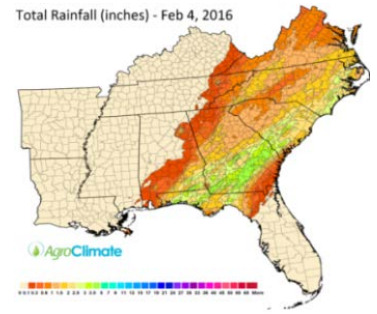
## Goal 2: Responding to Climate and Energy Needs

### Sub-Goal 2A: Responding to Climate Variability

REE Objective: Develop science-based knowledge to address climate variability; position agricultural communities to reduce emissions of greenhouse gases and enhance carbon sequestration.

#### Data Tools for Informed Decisions

Many valuable accomplishments for the year are the result of cross-divisional teams that developed useful tools to support decisionmakers with research-based data. Knowing weather and climate patterns--driving forces behind the success or failure of cropping systems--is vital information to land managers. One such tool, AgroClimate, supported by REE and the National Oceanic and Atmospheric Administration (NOAA), helps users manage climate risk with tools that provide information on crops best suited to grow in their region, based on water availability and the amount of water a crop will use. (<http://agroclimate.org/>)



Useful to Usable (U2U) is an integrated research and extension project funded by the REE working to improve farm resilience and profitability in the North Central United States by transforming existing climate data into usable products for the agricultural community. The goal is to help producers make better long-term plans on what, when, and where to plant, and how to manage crops for maximum yields and minimum environmental damage. (<https://mygeohub.org/groups/u2u>)

Understanding the impact of climate change on agricultural production and food security is crucial to help feed, clothe, and fuel a growing world population. REE joined with multiple institutions to model the economic responses of global agriculture to scenarios of climate change through 2050, including changes in harvested area, international trade, production, consumption, and price. All scenarios modeled show the potential for significant increases in prices for food and agricultural commodities, raising important concerns about food security, particularly for poor households. (<http://iopscience.iop.org/article/10.1088/1748-9326/10/8/085010/pdf>)

Ensuring nutritional security and supplying the calories for an ever-growing population presents a major challenge because of a combination of factors. REE has formed transdisciplinary teams to enable agriculture to adapt to a changing climate through the Genetics by Environment by Management (GxExM) approach, seeking to increase actual farmer yields rather than increasing potential yields offered by crop genetic potential. (<https://dl.sciencesocieties.org/publications/aj/pdfs/107/4/1215>)

Under the heading of *GRACenet* - Greenhouse gas Reduction through Agricultural Carbon Enhancement Network, REE scientists are generating information that is needed by producers, program managers, and policymakers concerning carbon storage in agricultural systems. The goal is to develop practices that enhance carbon sequestration in soils and to provide a sound scientific basis for carbon credits and trading programs. ([http://www.ars.usda.gov/research/programs/programs.htm?np\\_code=212&docid=21223](http://www.ars.usda.gov/research/programs/programs.htm?np_code=212&docid=21223))

**Nitrogen Management Tool** With REE support, Cornell University scientists are providing corn growers with low-cost soil assessment and greenhouse accounting tools and that also provides an evaluation of the costs and benefits of various policy incentives. The Adapt-N tool was voted by growers as the new product of the year by *Agro Professional* magazine. The tool makes it possible to improve nitrogen use efficiency, thus improving farm profits, while reducing environmental losses. (<http://www.adapt-n.com/>)



**Assessing California Drought Impact on Agriculture** In cooperation with the U.S. Geological Survey, NASA, and the California Department of Water Resources, the USDA released geospatial products related to the ongoing California drought. The datasets map the extent of idle agricultural acreage in California since 2011. The datasets highlight steady increases in idle farmland as the drought has extended now into its fourth year. The results of this remote sensing project have provided better quantification of the ongoing drought, visualizing the impacts in near real-time during the growing season over a large geographic area. (<https://www.nasa.gov/feature/ames/federal-agencies-release-data-showing-california-central-valley-idle-farmland-doubling>)

**USDA Regional Climate Hubs** REE and FS scientists are using research from across mission areas to assist agricultural and natural resource managers in making decisions related to climate variability and in implementing those strategies. The hubs created an online Climate Hub Tool Shed to share Web resources from across the country for adapting to climate variability and change. In addition, the new Climate Change Fellows Program is bringing young scientists on board to work with projects that will ultimately help the land manager deal with the risks associated with climate change. The Fellows will gain a better understanding of public sector needs as they help develop solutions for vulnerabilities faced by land managers in their region. ([http://tools.taccimo.info/tbl\\_tools\\_list.php](http://tools.taccimo.info/tbl_tools_list.php))

In addition, a new data hub at USDA's National Agricultural Library (NAL) provides access to regionally collected agricultural research data which support action for climate change adaptation and mitigation. The Agricultural Model Improvement and Intercomparison Project (AgMIP) and NAL established a data hub at NAL that could serve to provide national access to regionally collected agricultural research data, which support climate and general environmental modeling. (<https://agmip.nal.usda.gov/>)

**Assessing Drought Impact on Forests** Water shortages can result in substantial social and economic consequences. The FS led a scientific assessment titled "Drought Impacts on U.S. Forests and Rangelands: A Comprehensive Science Synthesis." Written by 77 expert authors from Federal service, universities, and national labs, the report draws on more than 1,000 scientific citations. The report identifies appropriate ways to quantify and monitor drought, assesses consequences for forests and rangelands and their values, and identifies potential adaptation strategies. (<http://www.fs.fed.us/science-technology/climate-change/drought-forests-and-rangelands>)

# Responding to Climate and Energy Needs Metrics by Supporting Agencies

## Subgoal 2A. Responding to Climate Variability

Metric	Contributing Agencies			
	ARS	ERS	NIFA	FS
Peer-reviewed journal publications	163	1		289
Non-peer-reviewed publications	40			43
Outreach newsletters	4			
Research monographs		2		
Material Transfer Agreements <sup>1</sup>	3			
New incoming agreements <sup>2</sup>	15			
New or updated data products				7
New or updated Websites	6			
Briefings <sup>3</sup>	40	5		
Federal Register Notices or other Government use <sup>4</sup>		2		
Responses to requests for research findings, information, or analysis by decisionmakers <sup>5</sup>	140	14		
Extension publications from Formula grants			765	
Research publications from Formula grants			1,498	
Direct youth contacts by Extension			714,673	
Direct adult contacts by Extension			1,924,463	
Additional funds leveraged from Formula grant projects			\$151,000,000	
Conferences supported	1			
Patent applications reported by Formula grant recipients			35	
Extension professional FTEs from Formula grants			418	
Scientist years for Formula grant projects			424	
Number of active extramural grant projects <sup>6</sup>		1	1,409	

ARS = Agricultural Research Service

ERS = Economic Research Service

NIFA = National Institute of Food and Agriculture

FS = Forest Service

FTEs = Full-Time Equivalent staff

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<sup>2</sup> New incoming agreements are agreements where ARS is receiving funds from an outside source to do research based on the statement of work in a proposal or agreement.

<sup>3</sup> Briefings are for senior USDA staff, Congressional staff, or other Federal agencies.

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<sup>5</sup> Requests for information, research findings, data, and analysis by decisionmakers in USDA, Congress, and other Federal agencies.

<sup>6</sup> Active extramural grant projects may be associated with one or more Research, Education, and Economics (REE) Action Plan Goals/Subgoals.

## *Goal 2: Responding to Climate and Energy Needs*

### *Sub-Goal 2B: Bioenergy/Biofuels and Biobased Products*

REE Objective: To lead global agricultural innovation to achieve energy efficiency and independence by integrating economically, environmentally, and socially sustainable region-based biomass production systems into existing agricultural systems.

#### *Biomass for New Economic Growth*

The use of biomass can have a profound impact upon the American economy that is now heavily dependent on petroleum. U.S. petroleum consumption currently accounts for \$350 billion in the transportation sector each year and \$255 billion in the chemicals and products sector. Clearly, the economic potential of sustainable alternatives to petroleum-based products is impressive. An estimated 1 billion tons of biomass feedstocks is projected to be sustainably available annually by 2030, and USDA is working to optimize biomass production and use and help develop a robust bioeconomy that will benefit rural economies, create and preserve jobs, create and enhance ecosystem services like cleaner water, reduced greenhouse gas emissions, and increased biodiversity.

In 2015, REE's efforts to develop natural rubber from guayule, a desert shrub, to replace imported rubber was critical in the production of tires that Cooper Tire & Rubber Company is test-driving at its research facility in Texas today. If the current demand for tires is maintained, it is estimated that the U.S. tire industry will need an additional 83.7 million barrels of naphtha and 6.5 billion barrels of crude oil to support tire production, all of which could be eliminated from U.S. demand through the use of non-petroleum-based rubber from guayule.

Meanwhile, REE is using its Small Business Innovation Research (SBIR) program to develop biomass products. SBIR funding for PolyNew Inc., has produced a novel polymeric impact modifier that is 100 percent based on renewable resources and can be economically processed to enable biodegradable plastics from renewable resources. In 2015, sufficient quantities of material were produced for evaluation purposes. These nanocomposites have superior thermal and mechanical properties and have been used for the pilot-scale production of biodegradable plastic cutlery on standard injection molding equipment without problems.

To enable biomass-related collaborations among Government agencies, industry and academia, REE has made data from Government-funded research publicly available through two highly used data resources. The Feed Grains Data Base contains historical market data on feed grains, including production, price, and industrial use information; it aggregates market data on the traditional feed grains used to produce alcohol for fuel use (<http://www.ers.usda.gov/data-products/feed-grains-database/>). The other resource is the U.S. Bioenergy Statistics, in which REE publishes information on ethanol and biodiesel supply and use, feedstock supply and use, co-product information, infrastructure statistics, and price data for biofuels and their feedstocks. (<http://www.ers.usda.gov/data-products/us-bioenergy-statistics.aspx>)

**Engine Oil from a Weed** Industry is looking for plant-based oils that have the physical properties that improve engine performance, reduce gasoline consumption, and will reduce the use of petroleum. REE scientists are refining a process to develop estolides, a biobased lubricant, from the pennycress plant, a weed that inhabits soybean fields. They discovered that the pennycress oil content is about double that of soybeans, which is also used in the production of estolides. Pennycress is especially attractive because it is a non-food crop that can be grown in the winter as a ground cover and harvested in time to prep the soil for growing soybeans or another crop over the summer. Using a winter ground cover helps to prevent soil erosion while fixing nutrients in the soil, especially nitrogen, from leaching into nearby water ways. Scientists have recently refined and improved the estolide chemical properties and solved large-scale batch production issues. The improved technology was transferred to the USDA's industrial partner for the commercialization of estolide products.



**Biofuels and Uncertainty in Greenhouse Gas Accounting** A 2015 REE biofuel research study with environmental and trade components examined uncertainty in greenhouse gas (GHG) emission accounting for three types of biofuels: U.S. corn ethanol, Brazilian sugar cane ethanol, and U.S. soybean biodiesel. The work concludes that crop yields and land-use change conversion are important determinates of GHG accounting in biofuels. In addition, an REE report examines the main factors affecting the demand and supply of biofuels; shifts in biofuel production, consumption, and policy; and trends in biofuels trade, focusing on the United States, Brazil, and the European Union. (<http://www.ers.usda.gov/media/1895316/eib144.pdf>)

**Liberty™ Switchgrass** REE crop breeders and agronomists have released the first publically available commercial variety of a perennial grass, Liberty™ switchgrass, a high-yielding source for cellulosic biomass for the central and upper Midwest. Liberty™ combines the high growth rate of lowland switchgrass with the cold and disease tolerance of upland switchgrass, creating valuable stable hybrid that may be used in cellulosic biorefineries. Says recently retired REE geneticist Ken Vogel, “Right now, Liberty™ can yield 8 tons of biomass per acre, and with further breeding, we have the potential to get to 10 tons per acre—maybe as soon as 5 years from now.” (<http://blades-newsletter.blogspot.com/p/october-2015.html>)



**Sustainable Feedstock Production and Management Systems** The FS has partnered with multiple universities to publish studies on economic indicators of woody crop production as well as assess the provision of biomass and carbon ecosystem services of purpose-grown woody crops in the Midwest. This helps land owners, growers, and communities determine the capability and potential returns of short rotation woody crops. (<http://www.treesearch.fs.fed.us/pubs/47771>; <http://www.treesearch.fs.fed.us/pubs/49609>)

# Responding to Climate and Energy Needs Metrics by Supporting Agencies

## Subgoal 2B. Bioenergy/Biofuels and Biobased Products

Metric	Contributing Agencies			
	ARS	ERS	NIFA	FS
Peer-reviewed journal publications	68	5		67
Non-peer-reviewed publications	11			11
Research monographs	0	1		
Material Transfer Agreements <sup>1</sup>	13			
Inventions	8			
New incoming agreements <sup>2</sup>	2			
New or updated data products		12		1
Briefings <sup>3</sup>	20	2		
Federal Register Notices or other Government use <sup>4</sup>		1		
Responses to requests for research findings, information, or analysis by decisionmakers <sup>5</sup>	40	17		
Extension publications from Formula grants			168	
Research publications from Formula grants			329	
Direct youth contacts by Extension			22,430	
Direct adult contacts by Extension			42,697	
Additional funds leveraged from Formula grant projects			\$55,000,000	
Patent applications reported by Formula grant recipients			8	
Extension professional FTEs from Formula grants			47	
Scientist years for Formula grant projects			115	
Number of active extramural grant projects <sup>6</sup>			292	

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ERS = Economic Research Service

NIFA = National Institute of Food and Agriculture

FS = Forest Service

FTEs = Full-Time Equivalent staff

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<sup>5</sup> Requests for information, research findings, data, and analysis by decisionmakers in USDA, Congress, and other Federal agencies.

<sup>6</sup> Active extramural grant projects may be associated with one or more Research, Education, and Economics (REE) Action Plan Goals/Subgoals.



## Goal 3: Sustainable Use of Natural Resources

### Sub-Goal 3A: Water Availability: Quality and Quantity

REE Objective: 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.

#### *Dealing with Drought: New Tools for Managing Water Resources*



Impacts from climate change threaten water supply, ecosystems, and food production. Drought is one of the costliest natural hazards in the United States each year with significant socioeconomic impacts. Persistent drought in California has caused farmers to fallow over 1 million acres of land in the Central Valley – 15 percent of its irrigated farmland and more than double the idle acreage of 2011, the most recent non-drought year. Studying the consequences and potential responses to drought management and drought-like conditions in multiple regions of the United States, USDA and its partners are finding ways to protect and improve landscapes that generate and store critical water supplies. Empowered with the scientific data, USDA works with producers, communities, affected States, and other Federal agencies to develop tools for decisionmakers and planners to manage land in drought-stricken areas and to improve long-term drought resilience.

One such tool making an impact on communities is the snow research model iSnobal developed by REE. A validated tool used in California, iSnobal replaces statistical models that are unreliable in extreme weather variations. As mountain regions warm, accurate models to predict and calculate snow water equivalents – or the amount of water derived from snowpack – are critical for water resource planning.



REE scientists working with NASA are extending iSnobal modeling to use in managing water supply and to forecast streamflow. Running in almost real-time using remote sensing and modeling, iSnobal provides snow and water input data in the Tuolumne River basin of California, a remote area where field-based measurements are difficult to obtain, and significantly improves the accuracy of water forecasts for the basin. Widespread forecasting will improve as well when iSnobal is expanded to the entire Sierra Nevada Mountains where the snowpack provides 30 percent of California's water supply in a normal year. The increased accuracy of the forecasts for water produced from melting snow pack is critical in drought conditions, providing the anticipated water supply information to Federal, State, and local agencies to best manage limited water resources for agriculture, municipal, industrial, and environmental uses.

<http://dx.doi.org/10.1016/j.jhydrol.2014.06.051>

**The Importance of Economic Forecasting** REE integrated data from multiple Federal agencies to provide an update on the California drought situation and its potential implications for farmers, crop and livestock production, and consumers. The updated Website has provided data for over 13,500 people seeking information on the Farm and Food Impacts page, and accounts for over one-third of the visits to the California Drought Webpage. (<http://www.ers.usda.gov/topics/in-the-news/california-drought-farm-and-food-impacts/california-drought-farms.aspx>)

The most complete and detailed profiles of irrigation in the United States are available because REE was able to update the 2013 Farm and Ranch Irrigation Survey, supplementing basic irrigation data collected from farm and ranch operators in the 2012 Census of Agriculture. Information includes water sources, amount of water used; acres irrigated by system type; irrigation and yield by crop; and system investments and energy costs. The data is critical for economic forecasts, water supply planning, and evaluating drought impacts.

([http://www.agcensus.usda.gov/Publications/2012/Online\\_Resources/Farm\\_and\\_Ranch\\_Irrigation\\_Survey/fris13.pdf](http://www.agcensus.usda.gov/Publications/2012/Online_Resources/Farm_and_Ranch_Irrigation_Survey/fris13.pdf))

**Mapping: National Forest Land and the Water It Supplies** Fresh water originates in the region's national forests for over 19 million people in the southeast. Federal, State, and private forests cover over 30 percent of the region's total land area and provide 36 percent of total water supply. Over 2,100 individual communities rely directly on national forest land for drinking water, including Houston, Atlanta, Knoxville, and Birmingham. The detailed maps from a report by FS scientists visualize the estimated volume of drinking water originating on national forest lands in the southeastern States and serve as a research aid to partners ensuring the future availability of quality drinking water from forested lands, especially in areas experiencing stress in the water supply.

(<http://www.srs.fs.usda.gov/pubs/47706>)

**Tree Rings Helping Inform Conservation Efforts** FS scientists examined tree rings and long-term climate records in the southern Appalachian forests for response to drought and varied precipitation cycles. The study concluded for all species that tree growth was more sensitive to precipitation distribution than to total annual precipitation. Fewer small storms and more time between rain events resulted in approximately 25 percent decreased forest productivity, even in regions with relatively high total annual rainfall. Using patterns from the past can help prepare for the future.

**Stewardship of Aquatic Species and Critical Habitat** The FS established the National Genomics Center for Wildlife and Fish Conservation anchored by state-of-the-science environmental DNA (eDNA). Scientists designed a sensitive process to analyze DNA in water samples to detect aquatic invasive species, to monitor endangered species and evaluate a population's viability, and to assess genetic connections. The new method detects organisms in low abundance and is faster, less invasive, and extremely cost effective compared to traditional methods. Twenty-two States, 7 Federal agencies, and 10 tribes are currently using the Center for analysis. This new method significantly improves success rates for stewardship of aquatic species and critical habitat and will expand as the eDNA database grows. (<http://www.fs.fed.us/research/genomics-center/>)

# Sustainable Use of Natural Resources Metrics by Supporting Agencies

## Subgoal 3A. Water Availability: Quality and Quantity

Metric	Contributing Agencies			
	ARS	ERS	NIFA	FS
Peer-reviewed journal publications	279	1		109
Non-peer-reviewed publications	74			12
Material Transfer Agreements <sup>1</sup>	10			
Inventions	1			
New incoming agreements <sup>2</sup>	54			
New or updated data products				1
New or updated Websites	23			
Briefings <sup>3</sup>	4	2		
Responses to requests for research findings, information, or analysis by decisionmakers <sup>5</sup>	65	29		
Extension publications from Formula grants			694	
Research publications from Formula grants			1,360	
Direct youth contacts by Extension			250,147	
Direct adult contacts by Extension			1,697,886	
Additional funds leveraged from Formula grant projects			\$70,000,000	
Number of extramural grants awarded		1		
Patent applications reported by Formula grant recipients			32	
Extension professional FTEs from Formula grants			377	
Scientist years for Formula grant projects			194	
Number of active extramural grant projects <sup>6</sup>		3	770	

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ERS = Economic Research Service

NIFA = National Institute of Food and Agriculture

FS = Forest Service

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<sup>5</sup> Requests for information, research findings, data, and analysis by decisionmakers in USDA, Congress, and other Federal agencies.

<sup>6</sup> Active extramural grant projects may be associated with one or more Research, Education, and Economics (REE) Action Plan Goals/Subgoal.

## *Goal 3: Sustainable Use of Natural Resources*

### *Sub-Goal 3B: Landscape-Scale Conservation, Management, and Resiliency*

REE Objective: Develop the best available science and technologies to inform U.S. Government policies and programs and support application of land management practices

#### *The Story of Resilient and Climate Smart Landscapes*

Drought, flooding, pests...all impact the many services we ask from our working lands. Land managers face new challenges as populations and extreme weather events increase across the landscape. To help producers navigate challenges to the landscape, efforts across REE focus on managing for conservation and resiliency to ensure sustained production of food, feed, fiber, fuel, clean and abundant drinking water, and biodiversity.

Resilient agricultural landscapes require healthy soils, and one of the many promising ways to improve soil health is the use of cover crops. The Cover Crop Chart, version 2.0, produced by REE scientists, is a tool that helps land managers quickly identify and evaluate options for cover crop species. The tool has been downloaded over 6,000 times by users in 37 countries.

(<http://www.ars.usda.gov/Services/docs.htm?docid=20323>)

Droughts and warmer temperatures have major impacts on forest and range ecosystems that are different from impacts on agriculture, so many of the approaches to quantify drought and assess impacts do not apply to forests and ranges. A recent FS report, Effects of Drought on Forests and Rangelands in the United States, evaluates appropriate ways to quantify and monitor drought, assesses consequences, and identifies potential adaptation strategies.

(<http://www.treesearch.fs.fed.us/pubs/50261>)

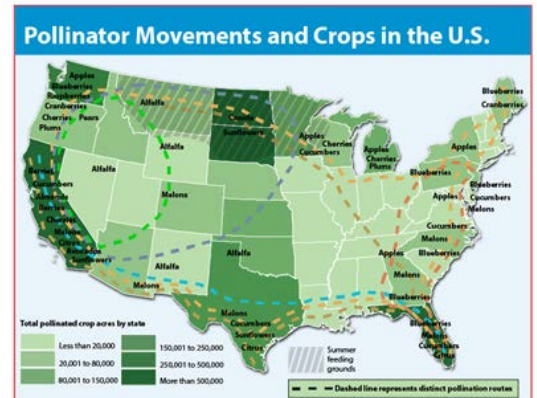
A guide for integrating climate change information into landowners' plans for management of their forests, Adaptation Workbook, was developed and released this year by USDA scientists and their colleagues at the Northern Institute of Applied Climate Science. Already used by land managers to create 150 real-world adaptation demonstrations in the upper Midwest and Northeast, the guide is now being used in other regions. ([www.adaptationworkbook.org](http://www.adaptationworkbook.org))

In addition, empowering land managers to improve soil health and resilience on their lands keeps soil and nutrients in place and improves water quality downstream, ensuring a healthy and more resilient landscape. Donn Branton, a producer in New York, has seen the benefits of improvements he made for the health of his soils and the resilience of his production by increasing the number of earthworms on his land through the use of no-till and cover crops. "Every decision we make on the farm is an investment. The reason we've stuck with low-till, cover crops and other practices is because they improve the soil, our yields, the environment, and our bottom line," said Branton.

(<http://www.usda.gov/documents/donn-branton-farmer-profile.pdf>)

**Human Behavior:** To better understand attitudes toward making changes in production practices, REE funded landscape-scale projects to improve the resiliency of farm and forest operations in uncertain conditions and included the human behavior and communication sciences. For example, The Sustainable Corn Coordinated Agricultural Projects (CAP) published an atlas that maps farmer confidence in their ability to employ mitigation and adaptation strategies. The Regional Approaches to Climate Change (REACCH) CAP found that the highest trusted source for climate change information is Certified Crop Advisors (CCAs). (<https://www.reacchpna.org/home>)

**Resilient Pollinators Help Make a Resilient Landscape:** In partnership with Michigan University’s Center for Native American Studies, staff of the Hiawatha and Ottawa National Forests (Forest Service Eastern Region) have worked with five Federally Recognized Tribes to plan and implement a series of efforts to recover native plants, encourage pollinator protection, and restore threatened ecosystems.



**Nutrient Management:** Nutrient runoff from agricultural operations can affect downstream water users and the quality of aquatic environments. Farmers and ranchers now have access to the Agricultural Conservation Planning Network, a free spatial toolset developed by REE scientists that will help them better manage this runoff while supporting agricultural production. (<http://northcentralwater.org/acpf/>)



**Forest Adaptation and Mitigation:** REE funded a consortium of 59 scientists across 18 universities and a FS research station to improve the adaptability of loblolly pine to changing climate conditions. The map-based project Pine Integrated Network: Education, Mitigation, and Adaptation Project (PINEMAP) Decision Support Tool includes helpful tools that predict extreme temperature risk, growing season length, and a tool to better match seed sources with future climates to optimize productivity. Through training events, over 170 professional foresters who manage 16.4 million acres of loblolly forests have learned about new climate-adapted management practices.

(<http://www.pinemap.org/>)

**Targeting Policy Options:** The cost of reducing agricultural impacts on the environment depends heavily on what information is available to help program administrators target resources more efficiently. Focusing on the Chesapeake Bay, REE research showed how performance-based policies can be more cost effective than those that target inputs or specific practices. REE research also demonstrated that effective outreach on the benefits of manure as a nutrient source increased the local demand for manure by crop producers, reducing hauling costs by up to 15 percent. The Conservation Effects Assessment Project (CEAP) has contributed to the development and refinement of more accurate planning tools which allow conservationists and landowners to select the appropriate suite of conservation practices. (<http://www.ers.usda.gov/publications/err-economic-research-report/err166.aspx>)

## Sustainable Use of Natural Resources Metrics by Supporting Agencies

### Subgoal 3B. Landscape-Scale Conservation, Management, and Resiliency

Metric	Contributing Agencies			
	ARS	ERS	NIFA	FS
Peer-reviewed journal publications	236	8		12
Non-peer-reviewed publications	91			12
Research monographs		3		
Material Transfer Agreements <sup>1</sup>	15			
Inventions	11			
New incoming agreements <sup>2</sup>	36			
New or updated data products		1		
New or updated Websites	22			
Briefings <sup>3</sup>	50	5		
Federal Register Notices or other Government use <sup>4</sup>		1		
Responses to requests for research findings, information, or analysis by decisionmakers <sup>5</sup>	170	25		
Extension publications from Formula grants			904	
Research publications from Formula grants			1,771	
Direct youth contacts by Extension			290,063	
Direct adult contacts by Extension			1,946,746	
Additional funds leveraged from Formula grant projects			\$259,000,000	
Number of extramural grants awarded		7		
Patent applications reported by Formula grant recipients			41	
Extension professional FTEs from Formula grants			550	
Scientist years for Formula grant projects			677	
Number of active extramural grant projects <sup>6</sup>		12	2,134	

ARS = Agricultural Research Service

ERS = Economic Research Service

NIFA = National Institute of Food and Agriculture

FS = Forest Service

FTEs = Full-Time Equivalent staff

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<sup>3</sup> Briefings are for senior USDA staff, Congressional staff, or other Federal agencies.

<sup>4</sup> Federal Register Notices and/or other Government use are Federal Register Notices of Rules or other Federal Agency Decision Reports that use ERS research findings.

<sup>5</sup> Requests for information, research findings, data, and analysis by decisionmakers in USDA, Congress, and other Federal agencies.

<sup>6</sup> Active extramural grant projects may be associated with one or more Research, Education, and Economics (REE) Action Plan Goals/Subgoals.

## Goal 4: Nutrition and Childhood Obesity

REE Objective: To build the evidence for strategies and effective activities that promote health and reduce malnutrition and obesity in children and high-risk populations.

### *Making Progress in Preventing Child Obesity*

The childhood obesity rate has more than doubled among children and quadrupled among adolescents over the past 30 years. Over one-third of children and adolescents are overweight or living with obesity. Obesity early in life leads to lasting problems related to health as well as psychosocial problems, ultimately resulting in much greater risk of chronic disease as an adult, decreased productivity, and increased costs of health care. REE research on childhood obesity prevention has provided important insights to guide development of educational and behavioral interventions.

REE agencies have uniquely addressed childhood obesity and coordinated their programs in collaboration with USDA's Food and Nutrition Service (FNS), university researchers, and extension professionals, demonstrating that USDA is an important partner in solving the challenges of childhood obesity. USDA's school meal programs serve healthy meals to more than 30.3 million American children each school day. REE agencies have conducted and supported research that helps to enhance the effectiveness of USDA programs in promoting healthful food choices. For example, USDA school meals have been featuring more fruit, whole grains, and a healthier mix of vegetables since 2012. REE research has shown that these meals are more nutritious than the typical brown bag lunch packed from home that contained desserts, snack chips, or sweetened drinks that are not permitted in reimbursable school meals. (<http://www.ncbi.nlm.nih.gov/pubmed/25419622>)



But healthier school meals are only effective if students accept the healthier choice. REE, with support from FNS, has sponsored innovative research in behavioral economics to develop simple, low-cost strategies that increase student acceptance of these healthful foods. "Smarter Lunchrooms" research, conducted in actual school cafeteria settings, found that simple changes such as better placement of healthy foods to make them more visible and convenient and creative naming could measurably improve students' selection and consumption of healthy foods, increase participation in the school meal programs, and reduce wasted food. Schools that placed low-fat milk in front of other beverages increased consumption by an average of 9 percent and assigning creative names like "X-ray Vision Carrots" decreased food waste by an average of 14 percent. FNS has used the findings from this research to create its "Smarter Lunchrooms Scorecard," which is being used by schools nationwide to improve the consumption of healthier foods by students. (<http://www.ers.usda.gov/amber-waves/2013-september/eating-better-at-school-can-new-policies-improve-children%E2%80%99s-food-choices.aspx>)

**Impacting the Lives of Children** USDA school meals can provide up to half a child’s food intake on a school day, making them an important focus of change. The need for strategies outside of school to help children maintain healthy growth remains an important aspect of childhood obesity prevention. Researchers at the REE Children’s Nutrition Research Center (CNRC) in Houston, Texas, tracked the weight of 7,500 elementary school children of ethnically diverse backgrounds and found that children who were overweight and obese, or Hispanic, gained more weight each summer than during the school year. (<http://www.ncbi.nlm.nih.gov/pubmed/25557689>)

Chronic disease and poor health disproportionately affect low-income and minority Americans. The Expanded Food and Nutrition Education Program (EFNEP) directly reaches over half a million low-income adults and families annually – plus another 400,000 family members reached indirectly – through a community-based, relationship-driven, hands-on educational approach. Annual data consistently confirms that EFNEP works: improvements in diets and improved nutrition practices; participants demonstrate the ability to stretch their food dollars farther, handle food more safely, and increase their physical activity levels. The mother of a young former participant said, “He enjoyed his nutrition class so much that he changed the ways he eats. He will not eat his pancakes with syrup, only with fruit on top, he loves to make fruit smoothies, and he has been a good example to his siblings.”



**WIC Policy Changes: Healthier Foods More Widely Available** The USDA’s Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) helps safeguard the health of low-income pregnant, breastfeeding, and postpartum women, infants, and children younger than 5 years of age, by providing a package of supplemental foods, nutrition education, and referrals to health care. Participants obtain their foods at WIC-authorized retail food stores in their communities. In 2009, the WIC food package changed to include added fruits, vegetables and whole grains, breakfast cereals with limited added sugar, and low-fat milk for preschoolers. Research found that because WIC-participating retailers were required to stock these healthy foods, some convenience stores and other smaller stores expanded the types and quantities of healthy food items they stocked. Because WIC-authorized stores serve both WIC and non-WIC customers, the improved availability of healthy foods in these stores increased access to healthy foods for the entire community.

([http://www.ers.usda.gov/amber-waves/2015-april/painting-a-more-complete-picture-of-wic-how-wic-impacts-nonparticipants.aspx#.Vp\\_OE\\_krJpg](http://www.ers.usda.gov/amber-waves/2015-april/painting-a-more-complete-picture-of-wic-how-wic-impacts-nonparticipants.aspx#.Vp_OE_krJpg))

**The Dietary Quality of Preschoolers** Childcare centers can be ideal settings to work with parents to learn healthy eating habits. REE-funded researchers tested a preschool adapted liking survey (PALS) that generates a valid and reliable index to identify preschoolers at risk for low-quality nutrition. The observational study identified 416 economically disadvantaged preschoolers ages 3-5-year-old (41 percent overweight/obese) enrolled in Head Start and School Readiness programs. Researchers found that using PALS improves the understanding of a child’s dietary behavior and the accuracy of predicting his/her nutritional status.



## Nutrition and Childhood Obesity Metrics by Supporting Agencies

Metric	Contributing Agencies		
	ARS	ERS	NIFA
Peer-reviewed journal publications	255	18	
Non-peer-reviewed publications	70		
Research monographs		22	
Material Transfer Agreements <sup>1</sup>	10		
New incoming agreements <sup>2</sup>	27		
New or updated data products		20	
New or updated Websites	4		
New or updated mobile apps	1		
Briefings <sup>3</sup>	4	17	
Federal Register Notices or other Government use <sup>4</sup>		6	
Responses to requests for research findings, information, or analysis by decisionmakers <sup>5</sup>	10	58	
Extension publications from Formula grants			1,927
Research publications from Formula grants			3,774
Direct youth contacts by Extension			5,131,966
Direct adult contacts by Extension			5,664,434
Additional funds leveraged from Formula grant projects			\$186,000,000
Conferences supported	2		
Number of extramural grants awarded		30	
Patent applications reported by Formula grant recipients			88
Extension professional FTEs from Formula grants			1,665
Scientist years for Formula grant projects			536
Number of active extramural grant projects <sup>6</sup>		42	1,635

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NIFA = National Institute of Food and Agriculture

FTEs = Full-Time Equivalent staff

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<sup>5</sup> Requests for information, research findings, data, and analysis by decisionmakers in USDA, Congress, and other Federal agencies.

<sup>6</sup> Active extramural grant projects may be associated with one or more Research, Education, and Economics (REE) Action Plan Goals/Subgoals.

## Goal 5: Food Safety

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

### *A Safe Food Supply and Reducing Foodborne Hazards*

America's health-conscious, fast paced society demands more ready-to-eat, fresh and minimally processed fruits and vegetables to meet the Dietary Guidelines for Americans encouraging 5 to 13 servings of fruits and vegetables each day. The number of farms producing fresh market vegetables has increased 49 percent since 2002, making more produce available to consumers.

Unfortunately, this trend towards a healthy diet coincides with an increase in the number of food borne illness outbreaks from contaminated produce. The CDC now reports that fresh produce accounts for almost 50 percent of all foodborne illnesses connected with outbreaks in the United States. Fresh produce may become contaminated at any point in the supply chain from farm to table, but preventing microbial contamination in the growing, harvesting and processing steps is better than trying to remove or kill the microbial pathogens once produce is contaminated.

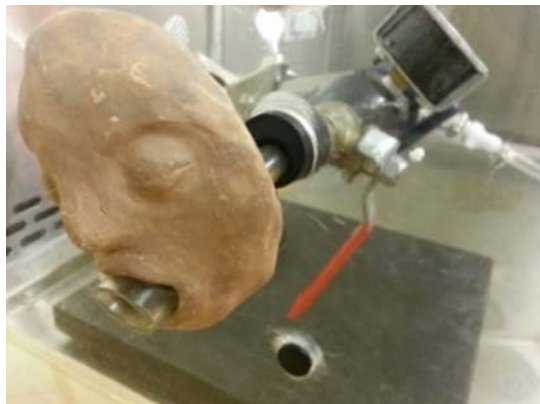


One of the most effective strategies to limit contamination of fresh produce focuses on understanding the specific pathogen and plant attributes that allow contaminants to survive on fresh produce. REE-funded research uncovered plant varieties that are more resistant to contamination than other varieties and discovered tomato genes that restrict growth of *Salmonella*. Research has also led to the discovery that the downy mildew pathogen of lettuce creates areas for *E. coli* to invade and further research found a variety of lettuce that is more resistant to downy mildew, and therefore may be less likely to be contaminated by *E. coli*. The findings may lead to breeding plants that resist contamination, helping farmers improve the safety of their crop and control plant diseases which can cost millions of dollars in lost product. (<http://agresearchmag.ars.usda.gov/2015/jul/lettuce/>)

Fundamental research often leads to solutions that are translated for use by producers, processors and consumers, with the goal of reducing illness caused by contaminated food. A national training center funded by REE and four regional centers will play leading roles in food safety education, and outreach for the 186,000 small farms that grow and market fruits and vegetables for the American public. Understanding current safety practices on farms is critical to improving and evaluating progress, so REE developed the first national surveys of safety practices of produce growers since 1999. The surveys provide a picture of food safety practices and costs and how these vary by commodity, region, and firm size. (<http://www.agcensus.usda.gov/Publications/2012/>)

**Training Tribal Cooks in Food Safety** REE supports training workshops to ensure that meals are prepared safely for families and community members across the country. The United Tribes Technical College Extension in Bismarck, North Dakota, provides classes and workshops to students from reservations across four States. Since 2013, 150 cooks have been trained, with 68 percent passing the ServSafe National Standardized exam. The Tribal Cooks Workshop provides training opportunities to cooks who prepare meals for the elderly, elementary school children, and detention center inmates. This workshop educates participants on food safety, nutrition, recipe development, “from-scratch” cooking, and hands-on kitchen skills. Safe food preparation is fundamental to the program which shows participants how to apply food safety measures to their everyday meals. ([http://www.uttc.edu/news/story/033111\\_02.asp](http://www.uttc.edu/news/story/033111_02.asp))

**Killing Bacteria with Natural Ingredients** REE-funded researchers determined that natural compounds often found in popular kitchen ingredients like oregano, cinnamon, and vinegar can be used to sanitize leafy greens. Plant extracts, essential oils, and organic sanitizers have proven to be effective in killing bacteria on leafy greens and extending their shelf life. When mixed with water and used to wash these leaves, the natural compounds compare to (and sometimes even work better than) chlorine bleach. In addition, they continue to kill bacteria during storage. Researchers incorporated plant essential oils into edible, plant-based films that are added into salad bags and the vapors from the oils kill the bacteria in the bags during storage. YouTube, Facebook, and Twitter spread the word to the benefit of growers and consumers. (<http://nifa.usda.gov/blog/improving-safety-leafy-greens>)



**Machine Simulation Helps Fight Stomach Flu** Norovirus is the No. 1 cause of foodborne illnesses and is easily transmitted from one person to another. To improve the understanding of transmission, REE-funded researchers developed a machine that simulates human vomiting and discovered that thousands of virus particles – more than enough to cause infection – are expelled in the process. Fascinated by grossology, Americans tuned in to the story that was covered by 200 media outlets and garnered 380,000 views for the YouTube video demonstrating the vomiting machine. (<https://www.youtube.com/watch?v=jGvqb87DXSI>)

## Food Safety Metrics by Supporting Agencies

Metric	Contributing Agencies			
	ARS	ERS	NIFA	NASS
Peer-reviewed journal publications	350	1		
Non-peer-reviewed publications	43			
Research monographs		3		
Material Transfer Agreements <sup>1</sup>	55			
Inventions	13			
New incoming agreements <sup>2</sup>	26			1
New or updated data products		2		
New or updated Websites	10			
Briefings <sup>3</sup>	11	3		
Federal Register Notices or other Government use <sup>4</sup>		7		
Responses to requests for research findings, information, or analysis by decisionmakers <sup>5</sup>		18		
Extension publications from Formula grants			573	
Research publications from Formula grants			1,123	
Direct youth contacts by Extension			285,527	
Direct adult contacts by Extension			833,279	
Additional funds leveraged from Formula grant projects			\$49,000,000	
Number of extramural grants awarded		2		
Patent applications reported by Formula grant recipients			26	
Extension professional FTEs from Formula grants			203	
Scientist years for Formula grant projects			148	
Number of active extramural grant projects <sup>6</sup>		4	430	

ARS = Agricultural Research Service

ERS = Economic Research Service

NIFA = National Institute of Food and Agriculture

NASS = National Agricultural Statistics Service

FTEs = Full-Time Equivalent staff

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<sup>5</sup> Requests for information, research findings, data, and analysis by decisionmakers in USDA, Congress, and other Federal agencies.

<sup>6</sup> Active extramural grant projects may be associated with one or more Research, Education, and Economics (REE) Action Plan Goals/Subgoals.

## Goal 6: Education and Science Literacy

REE Objective: 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 human sciences to promote global prosperity and sustainability.

### *Educating the Next Generation of Farmers and Ranchers: Dairy Grazing Apprenticeship*

The agricultural census of 2012 showed a 20-percent reduction in the number of new farmers in the 5 years since the previous census, a serious challenge to the workforce necessary to produce food for a growing population. To address the need, the REE funds a variety of training programs for novice farmers across the country through the Beginning Farmer and Rancher Development Program (BFRDP). Immensely popular, the program has awarded 217 grants since 2009, covering all 50 States. (<http://nifa.usda.gov/program/beginning-farmer-and-rancher-development-program-bfrdp>)

The Dairy Grazing Apprenticeship (DGA) (<https://www.dga-national.org/>), administered by the non-profit Grassworks, Inc., and funded by REE since 2010, is an example of a training program that educates new farmers and ranchers by leveraging resources and expertise from multiple Federal agencies, academic institutions, private industry, and nongovernmental organizations. Accredited by the U.S. Department of Labor, the DGA consists of 4,000 paid hours of training over 2 years. Nearly all of the education occurs on-farm under the guidance of a Master Dairy Grazier, while 288 hours of courses are offered through academic institutions, pasture walks, farming conferences, and peer-to-peer discussion groups. As of 2015, the DGA has 63 approved farm sites in Wisconsin and Minnesota, 22 apprentices, 7 Master Dairy Graziers, and more than 80 Apprentice Candidates awaiting placement.



As a DGA graduate, Nate Weisenfeld built his own herd and qualified for a low-interest Beginning Farmer and Rancher loan from the USDA Farm Service Agency. He continues to use the network he built at DGA to manage his operation.

**Diversifying the Agricultural Workforce** More than 200 students at minority-serving institutions and community colleges have benefitted from the Distance Learning Program (DLP) offered through REE. More than 40 REE economists taught DLP courses, instructing students remotely over the Web in more than 55 seminars and 7 panel discussions. As of the fall 2015 semester, the DLP has expanded from 3 to 21 institutions and is currently instructing over 50 students. A former DLP student, Sean Frazier,



received training and went on to complete an internship in REE while he was an undergraduate at Florida A&M University. He is now an Operations Associate with Tysons Foods in Little Rock, Arkansas, looking forward to building his professional network that he started at the USDA. *“I wanted to first thank you for all of your guidance and believing in me and helping me while I was in DC,” he said to his mentor. “Thank you for being a mentor for me while I was in undergrad, and you hopefully will continue to be a mentor for me going forward.”*

(<http://www.ers.usda.gov/about-ers/distance-learning.aspx>)

### **Developing the Next Generation of Agricultural Scientists**

Daniel Perry, an agricultural economics major, is an up-and-coming student trainee in REE from Marianna, Arkansas. He wouldn't have been able to attend college without the 1890s National Scholars Program, supported by USDA agencies. The program covers the cost of tuition and books and provides him with full-time employment at USDA during breaks from the University of Arkansas at Pine Bluff. It also prepares him for employment after graduation. Little did Daniel know he'd be supervised by a former 1890s scholar, Jill Bishop, who joined the staff of REE after graduating from Southern University in Louisiana. Daniel says, *“It gives me both the sense of security and responsibility. One reason some people don't finish school is money. This lets me control my destiny and make my own decisions.”*



**Experiential Learning Programs for Training** REE research facilities host hundreds of students in its laboratories to conduct experiments, feed and care for animals, and provide research support. REE-funded Hispanic-Serving Institutions supported 130 internships at USDA agencies. The internships by REE agencies help students learn the discipline of agricultural research and research methods through hands-on activities, as needed by employers in the agricultural industry. As a participant in the Scholarships and Fellowships to Recruit and Support Students program, David Simmons, an REE-supported Post-Doctoral fellow at the University of Maine, is collaborating with USDA researchers on organic methods of controlling insect pests in high-value horticulture, agriculture, and home and garden niche markets. (<http://nifa.usda.gov/program/hispanic-serving-institutions-education-grants-program>)

## Education and Science Literacy Metrics by Supporting Agencies

Metric	Contributing Agencies	
	ERS	NIFA
Extension publications from Formula grants		152
Research publications from Formula grants		297
Direct youth contacts by Extension		106,792
Direct adult contacts by Extension		303,850
Additional funds leveraged from Formula grant projects		\$8,000,000
Patent applications reported by Formula grant recipients		7
Extension professional FTEs from Formula grants		54
Scientist years for Formula grant projects		21
Number of active extramural grant projects <sup>6</sup>	1	223

ERS = Economic Research Service

NIFA = National Institute of Food and Agriculture

FTEs = Full-Time Equivalent staff

<sup>6</sup> Active extramural grant projects may be associated with one or more Research, Education, and Economics (REE) Action Plan Goals/Subgoals.

## Goal 7: Rural Prosperity/Rural-Urban Interdependence

REE Objective: To provide effective research, education, and extension that informs public and private decisionmaking in support of rural and community development.

### *Understanding the Issues and Building Opportunity in Rural America*

Rural America is recovering slowly from the job and income losses of the Great Recession of 2007-2009. While the majority of rural counties are now gaining jobs, many remain in decline; population growth and loss is similarly uneven. For hundreds of counties, population loss and a stagnant economy has persisted for decades. Many of these counties are remote from urban centers and have few natural amenities, like large bodies of water or a moderate climate, and agriculture is an important component of the local economy. Many lack alternatives on which to build a stable economic base. Other rural counties with persistent population loss have high poverty rates with families living in communities that struggle to mobilize resources and are far removed from the opportunities and services they need. Despite the disadvantages, these counties have valuable natural and human assets that may be leveraged to increase economic prosperity. Understanding and building on the human potential while investing in the strong links with the agricultural economy—fostering the next generation of farmers—was a primary focus in 2015.



Rural population loss is generally characterized by policymakers and others as young people leaving. However, stemming rural population loss and spurring economic development may depend less on retaining young adults after high school than on attracting them back as they settle down to start careers and raise children. A USDA study showed the primary motivators for returning to rural communities are to be near parents and to raise children “back home.” Good schools, municipal parks, and other recreational investments help attract return migrants.

<http://www.ers.usda.gov/media/1844084/err185.pdf>

REE funding in every State helped to sustain educational programs for 10,000 at-risk youth and their parents each year. In North Dakota, the “4-H SET for the Future Sustainable Community Project” offers science, technology, and engineering enrichment for isolated rural youth in three community sites. Professionals and volunteers work in mobile technology labs to bring higher level knowledge and skills to young people and to encourage them to enter careers in these fields.

<http://nifa.usda.gov/program/children-youth-and-families-risk-cyfar-grant-program>

And USDA is providing access to technical information through the National Agricultural Library (NAL) with an answer desk and online tools like the *Small Farm Funding Resources* online guide and screencast, the *Organic Roots* digital collection and the *Start2Farm.Gov* website. This year, support for veterans and military families was added to highlight opportunities in farming as a post-service career.

<http://www.start2farm.gov>



**Direct Sales Farms Growth and Challenges.** In a report informing Congress on the challenges facing direct sales farms, REE research showed that Direct-To-Consumer (DTC) food sales by farmers grew by about 32 percent from 2002 to 2007, but declined by about 1 percent from 2007 to 2012. The number of farms engaged in DTC sales increased in both periods. Like farmers overall, beginning farmers who market directly to consumers were more likely to see their farm operations survive *over time* than those marketing through traditional channels. (<http://www.ers.usda.gov/media/1763057/ap068.pdf>)

**Libraries Networking Success in Rural Areas** The Rural Information Center (RIC) networks with rural libraries to make USDA programs and services more accessible. After one RIC webinar, 97 percent of participants completing a survey reported an increase in skills and knowledge and 56 percent indicated they would apply that knowledge to address current issues in their community. (<http://www.webjunction.org/events/webjunction/rural-resources-funding-RIC.html>)

**Initiatives to Increase Fresh Produce Consumption and Reduce Child Obesity** Through REE support, Cornell University scientists are finding out how Community Supported Agriculture (CSA) that offers subsidies for low-income families affect nutrition and diet choices. Subsidies are combined with nutrition education in a randomized trial to evaluate effectiveness. The project's education includes development and dissemination of short courses for undergraduate and graduate students, focusing on links between local food systems and health. (<http://nifa.usda.gov/office/division-nutrition>)

**Promoting Farmers Markets** The REE is partnering with the Agricultural Marketing Service (AMS) to help applicants understand, develop, and submit Federal grant applications for the Farmers Market and Local Food Promotion Program. The workshop-based initiative works in every State and focuses on socially disadvantaged and limited-resource farmers. For example, the Mobile Markets of Northern Kentucky received \$100,000 to increase distribution and access to locally produced food through five mobile markets that will have the capability of processing Supplemental Nutrition Assistance Program (SNAP) benefits. Additional workshops promoting locally produced food were also held on Native American reservations and in 2 territories where information was delivered in Spanish. (<http://nifa.usda.gov/program/beginning-farmer-and-rancher-development-program-bfrdp>)



**Ag Production in Urban Areas** The REE led Urban Agriculture Pilot Project in Baltimore, Maryland, could lead to further study in other cities and a better understanding of migration and returns to agriculture. The pilot study looked at agricultural activities and the people involved with urban agriculture during 2015, including the number and location of agriculture plots, types and amounts of food produced, total value of agriculture products sold, square footage devoted to agriculture, and production and marketing practices. ([http://www.nass.usda.gov/Surveys/Guide\\_to\\_NASS\\_Surveys/Urban\\_Ag/](http://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Urban_Ag/))

**Organic Production Survey** The REE developed a survey to better understand the extent of organic production in the United States, including that which is certified, exempt from certification, and conventional production transitioning to organic. The survey findings will help producers understand and develop marketing opportunities. Federal and State agencies, as well as the private sector, can use this information for research, program design and improvement, and legislative initiatives.

## Rural Prosperity/Rural-Urban Interdependence Metrics by Supporting Agencies

Metric	Contributing Agencies	
	ERS	NIFA
Peer-reviewed journal publications	12	
Research monographs	6	
New or updated data products	4	
Briefings <sup>3</sup>	4	
Federal Register Notices or other Government use <sup>4</sup>	14	
Responses to requests for research findings, information, or analysis by decisionmakers <sup>5</sup>	38	
Extension publications from Formula grants		1,793
Research publications from Formula grants		3,512
Direct youth contacts by Extension		8,341,942
Direct adult contacts by Extension		7,989,495
Additional funds leveraged from Formula grant projects		\$68,000,000
Number of extramural grants awarded	2	
Patent applications reported by Formula grant recipients		82
Extension professional FTEs from Formula grants		3,255
Scientist years for Formula grant projects		206
Number of active extramural grant projects <sup>6</sup>	5	1,007

ERS = Economic Research Service

NIFA = National Institute of Food and Agriculture

FTEs = Full-Time Equivalent staff

<sup>3</sup> Briefings are for senior USDA staff, Congressional staff, or other Federal agencies.

<sup>4</sup> Federal Register Notices and/or other Government use are Federal Register Notices of Rules or other Federal Agency Decision Reports that use ERS research findings.

<sup>5</sup> Requests for information, research findings, data, and analysis by decisionmakers in USDA, Congress, and other Federal agencies.

<sup>6</sup> Active extramural grant projects may be associated with one or more Research, Education, and Economics (REE) Action Plan Goals/Subgoals.

## Impact of Investments in Research, Education, and Economics

One of the ways the REE agencies and our partners at the USDA Forest Service assess the impact of our investments in science is to track key performance indicators used in the science community. Our science agencies track different measures of the impact of their work due to the unique nature of the work they conduct, be it information gathering, informing policy, intramural research, or extramural research. The metrics in the table below demonstrate the depth and breadth of the impact the USDA is having on science and peoples' lives.

Metric	Contributing Agencies				
	ARS	ERS	NIFA	NASS	FS
Peer-reviewed journal publications	3,605	94		6	477
Non-peer-reviewed publications	738			21	78
Outreach newsletters		91		5	
Research monographs	1	74			
Material Transfer Agreements <sup>1</sup>	474				
Inventions	96				
New incoming agreements <sup>2</sup>	67			1	
New or updated data products		230		7	9
New or updated Websites	199			2	
New or updated mobile apps	1				
Briefings <sup>3</sup>	273	75		21	
Federal Register Notices or other Government use <sup>4</sup>		47		19	
Responses to requests for research findings, information, or analysis by decisionmakers <sup>5</sup>	731	499			
Extension publications from Formula grants			11,008		
Research publications from Formula grants			21,561		
Direct youth contacts by Extension			17,145,474		
Direct adult contacts by Extension			34,107,316		
Additional funds leveraged from Formula grant projects			\$2,205,000,000		
Conferences supported	2				
Number of extramural grants awarded		56			
Patent applications reported by Formula grant recipients			503		
Extension professional FTEs from Formula grants			10,304		
Scientist years for Formula grant projects			5,462		
Number of active extramural grant projects <sup>6</sup>		76	17,958		
New plant varieties and germplasm lines	70				

ARS = Agricultural Research Service

ERS = Economic Research Service

NIFA = National Institute of Food and Agriculture

NASS = National Agricultural Statistics Service

FS = Forest Service

FTEs = Full-Time Equivalent staff

<sup>1</sup> Contracts governing the transfer of tangible research materials between two organizations, when the recipient intends to use it for his or her own research purposes.

<sup>2</sup> New incoming agreements are agreements where ARS is receiving funds from an outside source to do research based on the statement of work in a proposal or agreement.

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