USDA

United States Department of Agriculture

RESEARCH, EDUCATION, AND ECONOMICS
ACTION PLAN PROGRESS REPORT, 2017

U.S. DEPARTMENT OF AGRICULTURE

Table of Contents

Preface

The United States is equipped with robust agriculture, food, and related industries that contribute greatly to our economy. U.S. agriculture is also expanding into new markets around the world, spurring innovation, and creating jobs and opportunities on and off the farm. American agriculture matters—both at home and abroad—and is vital to the success of feeding an ever-growing population.

The challenge to produce the safest, most nutritious, abundant food supply that is also capable of sustaining the more than 9 billion people anticipated worldwide by mid-century is no easy task. It requires enhancing and accelerating agricultural production while reducing the environmental impact on our natural resources. The United States Department of Agriculture (USDA) and its Research, Education, and Economics (REE) Mission Area are committed to solving urgent agricultural system challenges. Those include the need to increase sustainable production to meet the demand for food, feed, fiber, and the production of bioproducts in the context of climate variability, diminishing land and water resources, and increasing demands from the burgeoning population.

Agricultural research is crucial to the success and safety of our food and agriculture industries, the health of our citizens, and the American economy. USDA research has supported America's farmers and ranchers for over 100 years, helping our agricultural sector respond rapidly and successfully to challenges as they arise. From 2009 to 2016, REE invested $24 billion in intramural and extramural research, which has resulted in 3,186 inventions including 79 plant variety protections and 808 patents issued. Some excellent examples of these results are in another report that was just released—USDA's FY 2016 Annual Technology Transfer Report[1]. Those innovations range from an anti-cancer drug developed from omega-3 fatty acid derivatives by researchers funded by the National Institute of Food and Agriculture (NIFA) to a handheld fluorescent imaging device (HFID) that detects contaminated food and equipment surfaces by Agricultural Research Service (ARS) scientists. The annual technology report serves

[1] https://www.usda.gov/sites/default/files/documents/usda-fy16-tech-transfer-report.pdf

as an important reminder that USDA research not only contributes knowledge to the farming and ranching communities but also innovations which can help spur economic growth across the private sector.

In 2017, USDA Secretary Sonny Perdue chaired an Interagency Task Force on Agriculture and Rural Prosperity that released a report[2] proposing recommendations in five areas that will help rural America prosper. These recommendations included a focus on innovation and technology. Agricultural research is the engine that drives such innovation. Our agricultural production takes place primarily in Rural America, which includes 72 percent of the Nation's land and 46 million people. Our researchers are helping farmers use technologies such as precision agriculture to save money and increase production. This type of innovation enables sustainable use of American resources, while creating new jobs and increasing rural incomes.

REE's social science agencies also focus on ensuring good stewardship of the land and natural resources, as evidenced by their work related to pollinators. The productivity of the Nation's working lands—agriculture, forest, pasture, and range—depends on the labor of pollinators, which have faced multiple stressors that include pests, pathogens, and reduced habitat. The USDA Economic Research Service (ERS) released a study in June 2017 outlining changes in the Nation's land use and land covers, and the potential implications for pollinator forage quality and availability of pollinator-friendly habitat. This information could help policymakers decide how they can best incentivize landowners to create more forage-rich, pollinator-friendly habitats. The USDA National Agricultural Statistics Service (NASS) published a report in December 2016 on *The Cost of Pollination*—its first annual report and the first to publish prices per acre and per colony for honeybee pollination. In March 2017, NASS published new data on the economics of beekeeping in its annual honey report that included prices for queens, expenditures, and estimates on pollination and other incomes.

REE will continue to place a premium on expanding our scientific cooperation where we can and on sharing our information and technology as freely as possible. For

example, we have been a key partner in shaping initiatives such as Global Open Data for Agriculture and Nutrition (GODAN) and were instrumental in the creation of the G-20 Meeting of Agriculture Chief Scientists (MACS).

No one entity has all the answers, or all the skills, or all the intellectual capacity that will be required to feed more than 9 billion people. But, by working with our partners, USDA can attain it. Through partnerships and collaborations involving public and private sectors, Federal institutions, academia, and global governments, as well as private citizen groups, we can prevail in this as well as other important challenges.

As we move forward, we will review priorities and seek to invest in research, education, and economics on those topics where we can truly make a difference for U.S. and Global Agriculture.

Scott H. Hutchins, Deputy Under Secretary, Research, Education, and Economics
United States Department of Agriculture

[2] https://www.usda.gov/sites/default/files/documents/rural-prosperity-report.pdf

Introduction

USDA has created a robust infrastructure to perform world-class science, deliver classroom and community education, and transfer technologies from the laboratory to the private sector for the benefit of the Nation. Tracking our progress is essential to advancing our contributions and meeting consumer demands. After surveying the research environment, prioritizing customer needs, and assessing USDA's own capabilities and capacity, REE first documented its goals and objectives in the 2012 REE Action Plan[3], then in a revision, the 2014 REE Action Plan[4]. Each year REE produces an REE Action Plan Progress Report so that the mission area and its stakeholders can clearly track annual performance in the form of accomplishments and performance metrics. This information can guide future decisions, priorities, and resource allocations.

Tracking performance is essential for maintaining a focus and charting a path for the future. This is especially important in a dynamic global environment with ever-changing opportunities and challenges, constrained resources, and new emerging threats, even while the fundamental need to feed people throughout the world remains a key research priority.

This 2017 REE Action Plan Progress Report demonstrates progress in support of the REE Action Plan. The agencies reporting significant accomplishments in 2017 in support of the REE Action plan include:

The **Agricultural Research Service (ARS),** the largest intramural research agency of USDA. ARS has a workforce of approximately 8,000 employees, including 2,000 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 4 overseas laboratories. The ARS research agenda is broad, with about 700 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.

[3] https://www.usda.gov/sites/default/files/documents/usda-ree-science-action-plan.pdf

[4] https://www.ree.usda.gov/sites/www.ree.usda.gov/files/2017-07/2014REEActionPlanReportFINAL.pdf

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

The **National Agricultural Statistics Service (NASS)**, USDA's statistical agency. NASS conducts hundreds of surveys every year and prepares reports covering virtually every aspect of U.S. agriculture. 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)**, 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 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, such as Forest Service (FS) Research and Development (R&D), 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 urban and rural communities.

USDA Strategic Plan Framework

As part of the vision to make USDA the most efficient, most effective, and most customer-focused department in the Federal Government, the Department launched seven new strategic goals for fiscal years 2018-2022.

GOAL 1: Ensure USDA Programs Are Delivered Efficiently, Effectively, With Integrity and a Focus on Customer Service.

GOAL 2: Maximize the Ability of American Agricultural Producers To Prosper by Feeding and Clothing the World.

GOAL 3. Promote American Agricultural Products and Exports.

GOAL 4. Facilitate Rural Prosperity and Economic Development.

GOAL 5. Strengthen the Stewardship of Private Lands Through Technology and Research.

GOAL 6. Ensure Productive and Sustainable Use of Our National Forest System Lands.

GOAL 7. Provide All Americans Access to a Safe, Nutritious and Secure Food Supply.

REE Action Plan Framework

In a complementary manner, the REE Action Plan guides and coordinates research activity across the Department and informs 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 and nest within the seven overarching USDA Goal themes:

REE Goal 1: Sustainable Intensification of Agricultural Production **(USDA GOALS 2 & 3)**

REE Goal 2: Responding to Climate and Energy Needs **(USDA GOALS 4, 5 & 6)**

REE Goal 3. Sustainable Use of Natural Resources **(USDA GOALS 5 & 6)**

REE Goal 4. Nutrition and Childhood Obesity **(USDA GOAL 7)**

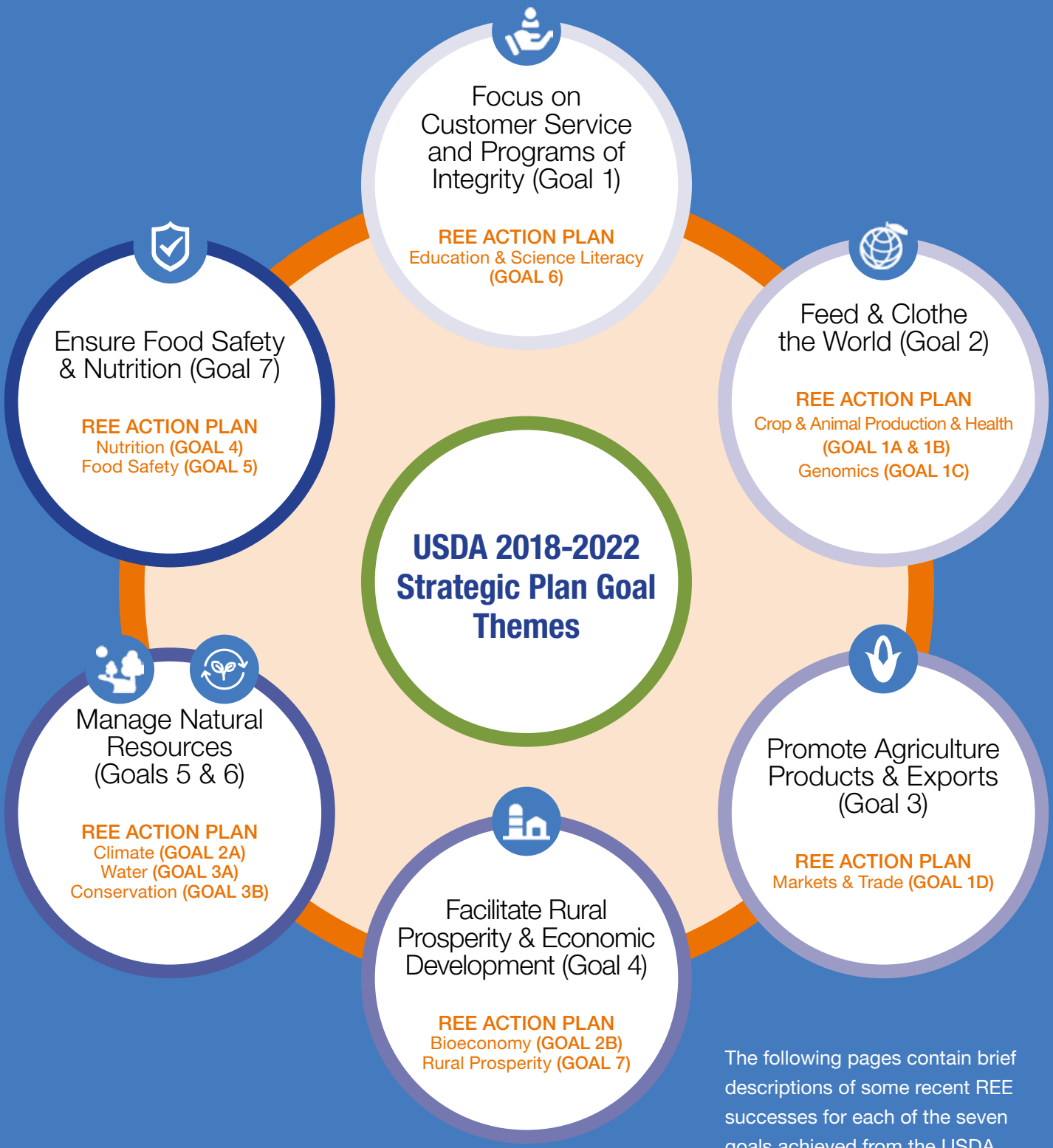
REE Goal 5. Food Safety **(USDA GOAL 7)**

REE Goal 6. Education and Science Literacy **(USDA GOAL 1)**

REE Goal 7. Rural Prosperity/Rural-Urban Interdependence **(USDA GOAL 4)**

Some REE Action Plan Goals contribute to more than one USDA Goal as research, education, and economics are tools that support every USDA strategic priority.

The Action Plan describes the seven goals that reflect the full scope and variety of REE activities and nest within the seven overarching USDA Goal themes.



The following pages contain brief descriptions of some recent REE successes for each of the seven goals achieved from the USDA investment in food, natural resources, and agricultural research; education; and technology transfer. The last section of this report also contains specific performance metrics charts.

Goal 1 | Ensure USDA Programs Are Delivered Efficiently, Effectively, With Integrity and a Focus on Customer Service

REE ACTION PLAN GOAL 6

REE ACTION PLAN
Education and Science Literacy (GOAL 6)

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.

Expeditionary Skills for Life: USDA-NIFA's 4-H Program and NASA Team Up to Help Youth to Develop Life Skills for Success

Astronaut and 4-H alumna Peggy Whitson was the inspiration for a new, collaborative project between the NIFA's land-grant university 4-H youth development partners and National Aeronautics and Space Administration (NASA). "Expeditionary Skills for Life"[5] transforms several training topics used to prepare astronauts to live and work together in space into activities that help youth to promote Science Technology Engineering and Math (STEM) education and develop important life skills that are useful in their everyday lives as well as for their future education and career readiness.

Youth conduct activities through a series of Expeditions[6]: (1) Self Care/Team Care: Preparing for the Voyage, (2) Cultural Competency: Embarking on Pilgrimages, (3) Leadership/Followership: The Challenge of the Quest, and (4) Teamwork Communication: Launching into Orbit. Each expedition begins with a video presented by a NASA astronaut or staff member that shows the importance of the expedition to the crews' mission. The youth then can complete age-appropriate learning activities to learn and practice the expedition skills.

A comment by Whitson characterized this new project well, "In order to find your limits, it is necessary to step beyond your 'comfort zone' and try new and challenging things…The 4-H program is one way young people can practice expanding their experiences, knowledge, and skills." For a partnership project like this, the 4-H National Headquarters[7] at NIFA and NASA design team brought together 24 experienced 4-H educators from 19 land-grant universities, 8 key personnel from NASA Headquarters and Johnson Space Center, and 6 NIFA staff from 3 divisions. Working only from existing resources, the team created the entire project in 8 months with the activities available for download from NASA and 4-H websites during the time of Peggy Whitson's third mission at the International Space Station. During the first 5 months of availability, more than 3,000 downloads of the activities were recorded.

> **"In order to find your limits, it is necessary to step beyond your 'comfort zone' and try new and challenging things…The 4-H program is one way young people can practice expanding their experiences, knowledge, and skills."**
> *— Astronaut and 4-H alumna Peggy Whitson*

As part of the project, NIFA Planning, Accountability, and Reporting (PARS) staff conducted a partnership evaluation to explore the strengths and weaknesses of the working relationships in the development of 4-H training curriculum. The evaluation also examined the effectiveness of the project and identified lessons learned for future partnerships in similar scope and size. Overall findings imply a perceived successful partnership and product from all parties involved. While there were areas identified for improvement, satisfaction scores for the partnership and for the project were rated high by all parties.

---

[5] NASA, 4-H Launch Expeditionary Skills for Life: https://www.nasa.gov/press-release/nasa-4-h-launch-expeditionary-skills-for-life

[6] Expeditionary Skills for Life Expeditions: https://www.nasa.gov/audience/foreducators/stem-on-station/expeditionary-skills-for-life.html

[7] 4-H National Headquarters at USDA-NIFA: https://nifa.usda.gov/program/4-h-positive-youth-development

USDA Works to Engage, Sustain, and Empower Women and Minorities in STEM

NIFA funded a program in which students and faculty in a university can create an outreach program with industry help to recruit and create interest in Science, Technology, Engineering, and Mathematics (STEM) fields for high school students in rural areas with limited access to both technological equipment and human-based technical expertise. Over 120 female and minority engineering students visited Texas State University, the Intel Austin Chip manufacturing lab, and San Marcos Convention Center for the Ingram School Engineering senior project event. These visits and the event engaged the students with engineers from NASA, Intel, NXP, FlexRadio, Tokyo Electron, Toyota, and Sensco. The program had a 100-percent retention rate during the life of the study, and the majority of these students improved their Grade Point Average (GPA). Students expressed an increase in their confidence and a stronger understanding of engineering.

2017 Agricultural Scholars Program Prepares Students for Careers in Agricultural Economics

ERS' *Agricultural Scholars Program* contributed to efforts to prepare and attract skilled career candidates in the field of agricultural economics. ERS hosted a diverse group of 10 students from 6 universities all interested in learning more about career opportunities in fields related to agricultural economics. The 2-week program introduced the students to many agencies within USDA and gave them an idea of what work is done within each agency, while simultaneously giving them the experience of what it is like for someone to live and work in Washington, DC. Informative meetings took place with representatives from the USDA's ERS, AMS, Office of the Chief Economist (OCE), NASS, Farm Service Agency (FSA), Foreign Agricultural Service (FAS), Chief Economists of the House and Senate Agricultural (AG) committees as well as the Chief Economist of the Farm Bureau. New networking opportunities were facilitated and ERS will maintain these established relationships as the students finish their studies and prepare to transition into their professional careers in agricultural economics.

Student Internship Opportunities With USDA-ARS

ARS sponsored 17 students as part of the 1890 National Scholars Program[8] as well as 25 students as part of the Wallace Carver Fellowship Program[9]. These students carried out research projects with ARS scientists across the country, including the National Agricultural Library. They worked in areas as varied as veterinary sciences, plant pathology, entomology, chemistry, and soil sciences. These programs are a small example of the ARS commitment to providing research opportunities to students and exposing them to the wide range of projects currently being researched by ARS scientists nationwide.

Research Assistantships With USDA Forest Service

FS R&D partnered with The Wildlife Society to improve engagement of Tribes and increase field research capacity by hosting and mentoring six Native American natural resource college students working towards careers as wildlife biology professionals. This real-time experience resulted in successfully matching five research projects with six students providing life-changing opportunities for future natural resource professionals, guidance on the path toward FS employment, integration of Traditional Ecological Knowledge into R&D work, delivery of useful information to Tribes, while expanding the capacity of our scientists to produce information through the students' data collection, management, analyses, and reports.

[8] 1890 National Scholars Program: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/careers/student/?cid=stelprdb1097347

[9] Wallace Carver Fellowship Program: https://www.usda.gov/media/blog/2016/08/19/usda-wallace-carver-fellowship-grows-next-generation-agricultural-leaders

Goal 2 | Maximize the Ability of American Agricultural Producers To Prosper by Feeding and Clothing the World

REE ACTION PLAN GOAL 1

REE ACTION PLAN
Sustainable Intensification of Agricultural Production **(GOAL 1)**
Subgoal 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.

Driving Innovation in Agricultural Production Through Advanced Technologies, Analytics, and Rapidly Evolving Cyber Infrastructure

Advanced technologies, analytics, and rapidly evolving global cyber infrastructure are driving innovation across all applications in production agriculture. USDA's research, education, and extension in production agricultural technologies focuses on areas including engineered devices (e.g., sensors, automation, robotics), technologies (biological, energy and environmental, food manufacturing, and others), and tools to improve agriculturally relevant plant, animal, forestry, and natural resource systems. Engineered products and processes improve production efficiency and capacity of biomass, biofuels, feedstock, bioenergy, and bio-based products and advance or expand utilization of waste and byproducts. Nanotechnology for agricultural and food systems addresses nanoscale science, engineering, and technology to promote opportunities for solution of problems in a wide range of critical challenges facing agriculture and food systems. Innovation in production agricultural technologies is accomplished in a number of ways.

New Trends in Robotics

USDA is speeding the development and use of robots that work alongside or cooperatively with people in agriculture through the National Robotics Initiative (NRI), a joint effort that includes USDA, the National Science Foundation (NSF), NASA, Department of Defense (DOD), and Department of Energy (DOE). Resulting technologies are helping meet farm labor needs and make farming safer, more efficient, and more profitable. For example, a USDA-funded project to the University of Minnesota developed algorithms that allow off-the-shelf robotics to work autonomously in complex environments such as apple orchards. Another project, led by the University of Pennsylvania, uses human-operated drones to produce high-resolution, multidimensional maps to improve the efficiency and yield of farm operations.

Since water is a critical issue in agricultural production, accounting for approximately 80 percent of the Nation's water use, a team of Cornell University researchers improved irrigation efficiency by measuring how much water stress crops can tolerate without detrimental effects on crop yield or quality. They accomplished this by developing a water sensor inserted into plants to continuously measure water within the plant. These low-cost chips efficiently provide real-time, sensitive water measurements that inform growers on irrigation management needs. Advances in technologies such as these are helping to address the most pressing farming needs in today's evolving agricultural environment.

Smart Farming

Small businesses are important in agricultural production innovation, especially "smart farming" efforts. California is the Nation's top agricultural producer, responsible for two-thirds of the country's fruits and nuts and more than one-third of its vegetables; however, drought is a significant stressor in the State's most productive regions like the Central Valley. With a USDA grant, Ceres Imaging[10] in Oakland, California, developed aerial imagery that helps farmers optimize how they apply water and fertilizer by capturing very high-resolution imagery at specific wavelengths. Image-processing techniques generate data on every plant in the field and modeling correlates this data to physical plant properties (e.g., plant water stress, leaf nitrogen content) allowing farmers and growers to view it on smartphones.

Similar technologies are applied to livestock. At USDA labs in Woodward, OK[11] and Miles City, MT[12], the Global Positioning System (GPS) is used to track cattle on the pasture and range landscape, determining how the pasture is used by cattle. This allows for management adjustments to decrease overgrazing and undergrazing in some portions. USDA scientists at Clay Center, NE[13] have developed software to predict heat stress events covering much of the Midwest. The software provides an early warning to farmers so that appropriate measures can be undertaken, improving animal welfare.

Nanotechnology-Based Improvements

USDA-supported research is finding that nanotechnology[14] can enhance renewable fuels, increase crop yields, manage agricultural pests, and more. The Connecticut Agricultural Experiment Station (CAES)[15] is using nanoscale elements as a comprehensive agricultural soil amendment strategy to suppress crop disease, improve nutritional content, and enhance overall yield. Advances are important because soil pathogens significantly limit agricultural production, reducing crop yield by 10-20 percent and resulting in billions of dollars in annual losses. Similarly, pathogen control efforts by fungicides exceed $600 million per year in the United States. Nanoparticle elements can be used to strategically suppress disease, improve nutritional status, and enhance crop growth and yield. Mississippi State University is researching ways nanochitosan can be used as a combined fire-retardant and antifungal wood treatment that is also environmentally safe. Additionally, experts in nanotechnology, molecular biology, vaccines, and poultry diseases at the University of Wisconsin are working to develop nanoparticle-based poultry vaccines to prevent poultry infections that severely impact poultry production.

---

[10] http://www.ceresimaging.net/

[11] https://www.ars.usda.gov/plains-area/sprrs/rangeland-and-pasture-research/

[12] https://www.ars.usda.gov/plains-area/miles-city-mt/range-and-livestock-research/

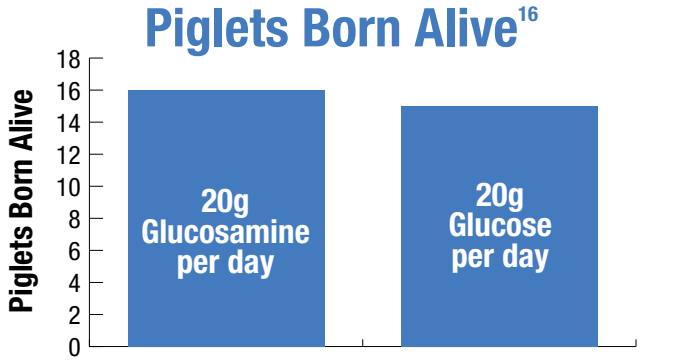
[13] https://www.ars.usda.gov/plains-area/clay-center-ne/marc/

[14] USDA Announces $5.2 Million for Nanotechnology Research: https://content.govdelivery.com/accounts/USDAOC/bulletins/14015c9

[15] http://www.ct.gov/caes/site/default.asp

Functional Animal Nutrition

Research on animal nutrition has vastly improved the way we feed animals raised for food contributing to production gains, healthy animals, and reductions in animal waste. Numerous biologically active substances, when included as a minor component of animal diets, can result in further improvements. USDA research has shown that various compounds can influence aspects of animal reproductive efficiency, growth, and health. Recent results indicated that glucosamine, a compound similar to sugar, alters placental development in pigs and results in increased litter size[16]. Biochanin A, an isoflavone found in red clover, alters the dynamics of the ruminal microbial environment, reducing the release of ammonia and improving digestion of cellulose in forage diets. The addition of carbohydrase to poultry diets has improved growth. The addition of phytase to catfish diets reduces phosphate pollution from aquaculture systems. Thus, inclusion of biologically active substances in the diets show great promise to deliver further gains in food animal production.



[16] FY 2016 Annual Report on Technology Transfer: https://www.usda.gov/sites/default/files/documents/usda-fy16-tech-transfer-report.pdf

Enhancing Food Security in the Northeast Through Regional Food Systems

Over 7 million people in northeastern U.S. communities are food insecure[17]. Low-income families disproportionately face many barriers that affect their access to healthy and affordable foods. The USDA-funded Enhancing Food Security in the Northeast (EFSNE)[18] through regional food systems project, led by Pennsylvania State University, coalesced 12 different disciplines to determine whether greater reliance on regionally produced food could improve food access to low-income communities, while also benefiting regional farmers, food supply chain firms, and other food system participants. The team found that half the land was devoted to production of livestock feed for animal-based foods such as dairy and eggs, but only about one-tenth produced food crops like grains, fruits, and vegetables. The project established an eXtension[19] community of practice for Community, Local, and Regional Food Systems that now engages more than 360 members and has provided resources to more than 250 eXtension educators. New courses on food systems were also developed at Tufts University and Penn State and an undergraduate student internship program was offered for three consecutive years. The diverse team has served as a model for how to engage the entire supply food chain from production to consumption. The team's successes include determining the actual amounts of food that can be produced and consumed within a region, the ways food is distributed, and how communities can design ways to better meet the needs of all people.

---

[17] Food insecurity—the condition assessed in the food security survey and represented in USDA food security reports—is a household-level economic and social condition of limited or uncertain access to adequate food. https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/definitions-of-food-security

[18] http://agsci.psu.edu/research/food-security

[19] http://agsci.psu.edu/research/food-security/extension-outreach

The Cost, Value, and Health of Pollinators

About 35 percent of the world's food crop production depends on pollinators, including managed honeybees. However, pollinators face a number of stressors, such as parasites, poor nutrition, pesticides, and diseases. USDA supports a wide array of research efforts to better understand and address the challenges facing pollinators and the implications for crop production and food systems. For instance, USDA-NASS published its first Cost of Pollination survey report[20] in December 2016, a new data series that provides detailed information about the market for pollination services, including the prices that farmers pay for this critical input to the production of crops. This data helps researchers and policy makers understand the role that the commercial pollination industry plays in the production of different types of crops. Additionally, USDA-ERS released a study in June 2017 on changes in the Nation's land use and land covers[21], and the potential implications for pollinator forage quality and availability of pollinator-friendly habitat. This work could lead to changes in the way policy makers incentivize landowners to create more forage-rich, pollinator-friendly habitats.

Tripling Fresh-Market Broccoli Production to Meet Eastern U.S. Consumer Demand

Consumer demand for locally produced broccoli is high, but the challenge of meeting that demand cannot be mitigated due to a limited number of available adapted varieties produced along the east coast. Additionally, there is a need to expand the distribution network from farms to market. To address the need, a Cornell University team initiated the Eastern Broccoli Project[22] with support from a USDA Specialty Crop Research Initiative (SCRI) grant with the goal of tripling eastern U.S. broccoli production to a farm gate value of $100 million per year. Its strategy requires increasing profits for all supply chain participants including seed companies, growers, and fresh produce distributors.

Expanded eastern production has great potential to reduce the overall cost and carbon footprint of broccoli consumed in the East and increase food security by diversifying production areas, providing new opportunities for rural economic development, reducing the use of transportation fuel and irrigation water, and diversifying rotations for vegetable farms.

[20] Cost of Pollination Survey Report: https://www.nass.usda.gov/Publications/Methodology_and_Data_Quality/Cost_of_Pollination/04_2017/polcos16.pdf

[21] Land Use, Land Cover, and Pollinator Health: A Review and Trend Analysis: https://www.ers.usda.gov/webdocs/publications/84035/err-232.pdf?v=42908

[22] The Eastern Broccoli Project: https://blogs.cornell.edu/easternbroccoliproject/

REE ACTION PLAN
Sustainable Intensification of Agricultural Production **(GOAL 1)**
Subgoal 1B | Crop and Animal Health

REE Objective: Mitigate losses from animal and plant diseases that impact people worldwide. Develop sustainable food production systems that enhance crop and animal health while minimizing environmental impacts.

Getting a Grip on Citrus Greening Disease

Citrus greening disease, also known as Huanglongbing, is causing an unprecedented crisis in the citrus industry in the United States and worldwide. Citrus greening results in malformed, green fruit with very bitter, off-flavor juice. Currently, diseased trees cannot be cured and typically die within a decade. A recent USDA-ERS Fruit & Tree Nut market outlook report[23] found that Florida continues to experience significant losses in orange-bearing acres (i.e., down 6 percent in 2016/17 from the previous season). This is reflective of ongoing issues with citrus greening disease, which was first discovered in Florida in 2005 and is blamed for most of the lost citrus cropland. As Florida's citrus production continued to shrink in 2016/17, the share of U.S. oranges used for juice dropped further to 53 percent of all U.S. oranges, down from a 64-percent share the previous season and down from 74 percent in 2000/01. At least 80 percent of all citrus trees in Florida are now infected. Furthermore, the disease has spread to other important citrus-growing States including Louisiana, Georgia, South Carolina, Texas, Hawaii, and most recently to California. Citrus greening is the result of a three-way interaction between citrus plants, a bacterial pathogen, and an insect carrier. The Asian citrus psyllid (ACP) insect serves as the primary disease carrier, transmitting the disease-causing bacterium, *Candidatus* Liberibacter asiaticus (CLas), from diseased plants to healthy citrus. Conventional control measures such as antibiotics or insecticides are often ineffective, pesticide-resistance is increasing, and removal of infected trees is costly and undesirable. Sustainable solutions to the complex challenges posed by citrus greening capitalize on interdisciplinary approaches aimed at each of the three interacting organisms. Leveraging resources from ARS, NIFA's Specialty

[23] USDA-ERS Fruit and Tree Nuts Outlook, September 29, 2017: https://www.ers.usda.gov/webdocs/publications/85287/fts-365.pdf?v=43007

Crop Research Initiative (SCRI)[24] and Small Business Innovation Research program, and private industries, REE researchers have increased understanding of citrus greening disease and developed effective approaches to help the citrus industry withstand its ravages.

A USDA-NIFA sponsored study, led by researchers from the University of Florida, is looking at the potential role of Wolbachia, a commensal bacterium on altering the ability of CLas to cause the disease in citrus. In complementary research, USDA-ARS collaborators in Florida are coordinating with other universities to test new approaches to culture CLas on artificial media. If successful, researchers can do much more to evaluate and manipulate interactions between Wolbachia and CLas. Wolbachia is a bacterium that naturally inhabits the psyllid's gut and produces a protein that suppresses expression of CLas genes responsible for pathogenicity. This prevents CLas from killing the psyllid hosts. Wolbachia is not found in citrus plants and may explain why plants are infected by CLas. Study results suggest that through gene silencing techniques or gene editing, the Wolbachia protein could be altered to repress the genes that confer the ability for CLas to infect citrus. If successful, this technology could significantly reduce the impact of the disease on citrus plants.

Additional research involves a partnership between Pathsensors[25], a leading biotech company; ARS; and plant pathologists at University of California-Riverside. This partnership resulted in the development of a highly sensitive, high-throughput, and user-friendly diagnostic assay that detects CLas before citrus trees display visible symptoms. The technology is called "Cellular Analysis and Notification of Antigen Risks and Yields" (CANARY)[26]. CANARY was first developed by MIT researchers to combat human pathogens and has been adapted to detect several agriculturally important plant diseases, including citrus greening. Researchers genetically modified an immune cell which makes CLas-specific antibodies that bind to the pathogen; if CLas is present in the sample, the biosensor lights up within minutes.

Once detected, infected trees are removed, curtailing the spread of the disease to other trees. This technology was launched at the American Phytopathology Society (APS)[27] annual meeting in August 2017 and should soon be commercially available to diagnosticians.

Important efforts to safeguard the U.S. citrus germplasm collection are in place to withstand the harm caused by citrus greening. The ARS National Clonal Germplasm Repository for Citrus and Dates, in Riverside, California[28], is the USDA's primary citrus germplasm repository or Genebank, and is located within the citrus greening "ground zero" zone in California. To insure the survival of this critical resource for future generations, ARS scientists established a frozen copy of the national citrus germplasm collection at the USDA ARS's National Laboratory for Genetic Resources Preservation in Fort Collins, Colorado[29]. Samples can be thawed and regrown in the laboratory for use in breeding and for research to develop long-term stable resistance to citrus greening.

[24] https://nifa.usda.gov/funding-opportunity/specialty-crop-research-initiative-scri

[25] https://pathsensors.com/

[26] https://www.ll.mit.edu/publications/technotes/TechNote_CANARY.pdf

[27] http://www.apsnet.org/Pages/default.aspx

[28] https://www.ars.usda.gov/pacific-west-area/riverside-ca/national-clonal-germplasm-repository-for-citrus/

[29] https://www.ars.usda.gov/plains-area/fort-collins-co/center-for-agricultural-resources-research/plant-and-animal-genetic-resources-preservation/

New Tools Help Farmers Grow Healthier Grapes, Almonds, and Pistachios

Every vineyard in California eventually becomes infected by one or more fungal pathogens that cause deadly trunk diseases known as cankers. Trunk canker diseases also attack almond and pistachio crops, which, combined with grape, are valued at almost $11 billion per year from California alone. Chronic canker infections damage the wood, killing the parts of the trees and vines from which new shoots grow. Yield losses due to canker diseases are considerable and infection reduces what should be a 25-year lifespan in half. With support from NIFA's Specialty Crop Research Initiative (SCRI), researchers from the USDA-ARS and university partners are working across scientific disciplines to help grape and nut tree growers reduce losses due to canker diseases. This 4-year effort focuses on extending the productive lifespan of orchards and vineyards through the development of early detection tools, expanding the availability of plant material with resistance to trunk diseases, and educating growers on how to implement effective strategies to prevent disease.

New online disease management plans, an economic tool, and a pathogen database (TrunkDiseaseID.org) are now available for pest-control advisors, diagnosticians, and extension farm advisors, all who influence growers' decisions about disease management. To increase adoption of practices that prevent trunk canker diseases, studies on grower usage and perceptions brought new perspectives to trunk-disease management leading to improved educational materials for growers.

REE ACTION PLAN
Sustainable Intensification of Agricultural Production **(GOAL 1)**
Subgoal 1C | Crop and Animal Genetics, Genomics, Genetic Resources, and Biotechnology

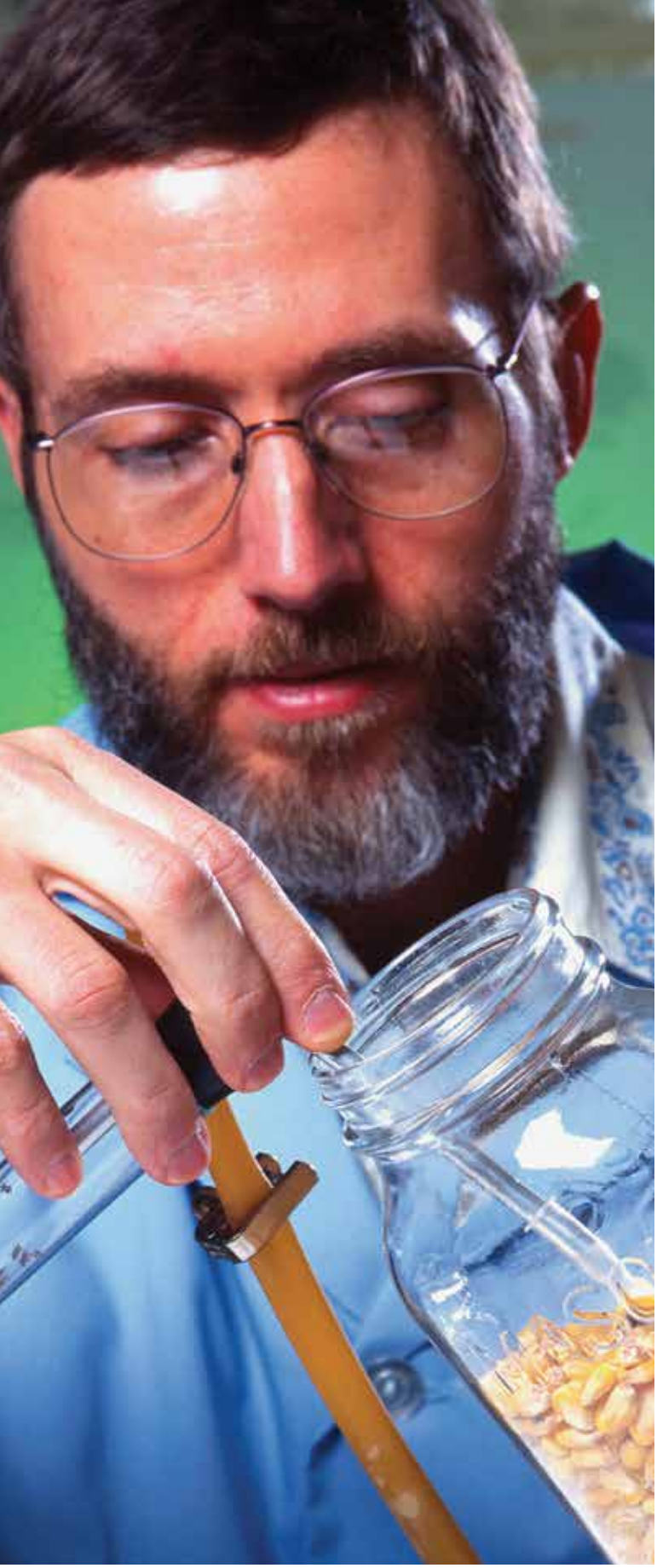
REE Objective: Generate new fundamental knowledge through research in genomic sciences and applications to crop and animal production.

Better Breeding Through Genome-Enabled Technologies

For centuries, humans have bred plant and animal species for improvement in yield, production efficiency, and quality. Recent advances in DNA sequencing technologies have helped develop approaches for genetic improvement of agricultural species that increase accuracy and reduce the resources required for breeding programs. An example is improved resistance to bacterial cold-water disease of rainbow trout, which is responsible for losses up to 39 percent in hatchery stocks. Although rainbow trout is one of the most important aquaculture species, progress in genetic research was hindered due to lack of genome information. In response to this gap in genome information, the ARS scientists at the USDA Cool and Cold Water Agriculture Research lab in Leetown, WV[30] partnered with collaborators to develop a draft genome reference sequence. The project resulted in a characterized variation at the DNA sequence level so that state-of-the-art technologies could be applied to genetic improvement for disease resistance. These breeding technologies improved disease resistance twofold. Additionally, these genomic tools provided insight into the biological processes underlying disease resistance in fish. Now, efforts are underway to apply a similar strategy to improve other commercially important traits, including resistance to other diseases and increased fillet yield, offering opportunities to increase farm productivity, animal welfare, and sustainability of rainbow trout production systems.

Genome-enabled techonologies are also impacting crops. Fresh and processed tomatoes account for more than $2 billion in U.S. annual farm cash receipts. Tomato quality and yield are greatly reduced due to insect pests and the viruses they transmit causing growers to typically spend $842 per acre to protect their crop. Sugars (acyl sugars) produced by a wild tomato provide strong resistance against many important insect pests. NIFA-funded researchers at Cornell University identified genetic variation in specific chromosomes that alters the chemical structure of these sugars and created a series of tomato lines that produce high levels of these compounds. Tests by cooperating entomologists at the University of Florida and University of California (UC), Davis demonstrated the importance of this chemistry on resistance, finding that some of these new lines have both significantly greater control of whitefly and western flower thrips which reduces the likelihood of virus transmission. Tomato growers will benefit from this research since the use of insect-resistant tomato hybrids would protect plant health, tomato quality, and yield while also substantially reducing the pesticides and labor currently spent on insect control.

[30] https://www.ars.usda.gov/northeast-area/leetown-wv/cool-and-cold-water-aquaculture-research/



The Genome History of Maize

Recently, genome information was used to identify a suite of useful genes which were unknowingly selected by farmers over millennia. It takes a thousand genes to tune a plant to its environment, and corn landraces are diverse and locally adapted to hundreds of environments. ARS scientists from Ithaca, NY, together with scientists from the International Maize and Wheat Improvement Center (CIMMYT)[31] and Purdue University joined forces to identify and catalog the genes selected by farmers over 10,000 years in the adaptation of corn across the Americas. A powerful new genomics paradigm (F-One Association Mapping (FOAM))[32] developed for the study can now be applied to diverse locally adapted germplasm.

Complex Conifer Genomes

Although the genomes of many plant and tree species have been sequenced, a conifer tree was not sequenced because of the very large size of its genome. However, once new sequencing technology became available around 2010, NIFA decided it was time to sequence a conifer genome and loblolly pine was chosen due to its great economic importance. NIFA provided funding to the Pine Reference Sequencing (PineRefSeq)[33] project conducted by a team of researchers at the University of California at Davis, Johns Hopkins University, Texas A&M University, Indiana University, Washington State University, Children Hospital in Oakland, CA, and the USDA Forest Service. This team used the latest sequencing technology and developed methods to assemble very large genomes including loblolly pine, sugar pine, and Douglas-fir. These sequences have been published, publicly released, and are now being used routinely in conifer breeding programs, conservation, and restoration programs. The project was completed in early 2018, and groups around the world have begun improving the quality of the three initial genome sequences and sequencing additional conifer genomes using the approach and protocols developed under PineRefSeq.

---

[31] International Maize and Wheat Improvement Center (CIMMYT): http://www.cimmyt.org/

[32] Maize study finds genes that help crops adapt to change: http://news.cornell.edu/stories/2017/02/maize-study-finds-genes-help-crops-adapt-change

[33] Pine Reference Sequences (PineRefSeq): http://pinegenome.org/pinerefseq/

Genomic Editing Improves Wheat Yields

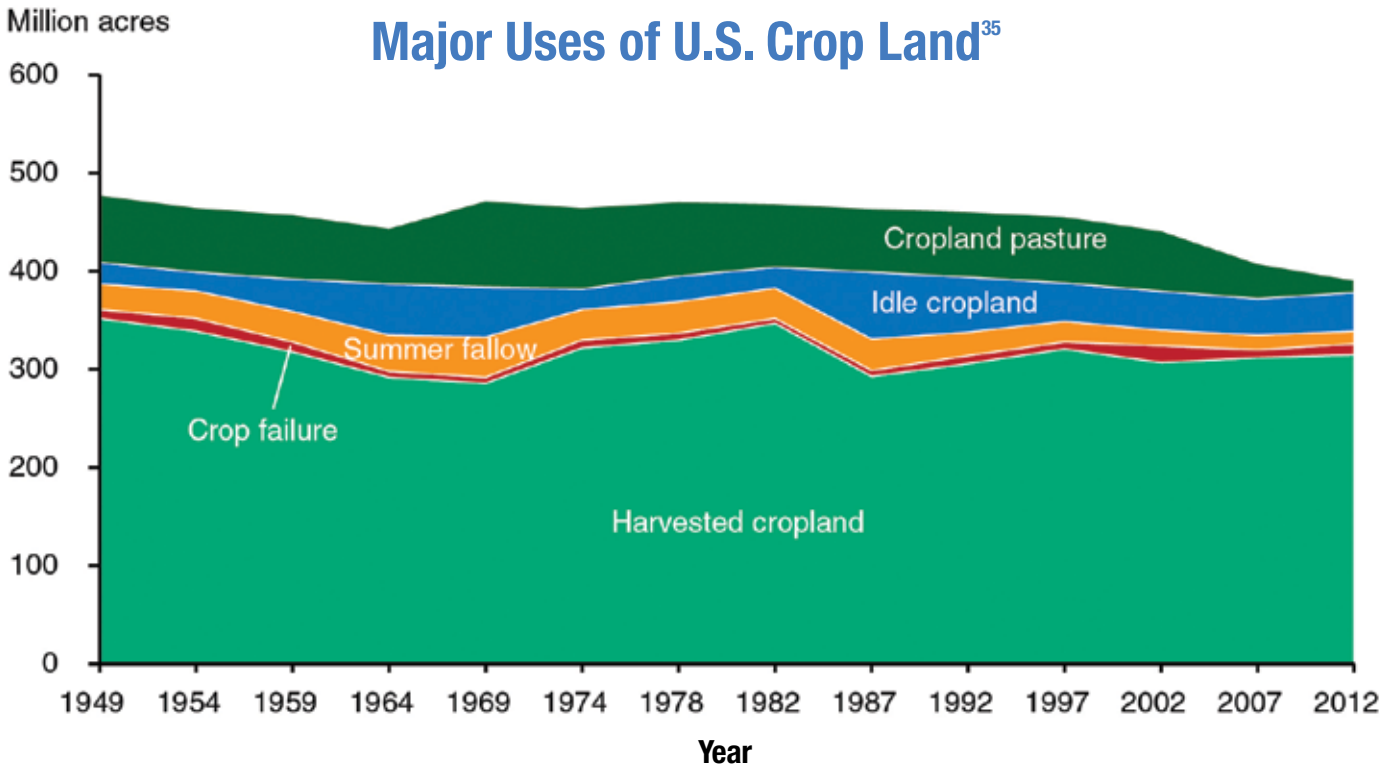
Genome editing has recently emerged as an innovative technology to generate variation for major agronomic traits. A team of researchers from Kansas State University, Oklahoma State University, and Cornell University explored the capabilities of this technology for unlocking the potential of the wheat genome to build a foundation for approaches for wheat improvement. To accomplish this, a consortium of University and ARS scientists utilized genome editing on wheat genes controlling yield and then assessed and validated their value for improving yield potential. Early results demonstrate that the Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)/CAS9-based gene editing is a powerful tool for modifying the wheat genome and for creating the gene variants that beneficially affect yield traits. Establishing a pipeline for deploying this technology in wheat breeding programs should accelerate the rate of genetic gain and help improve production. This NIFA-funded project is a part of the overarching International Wheat Yield Partnership[34] program aimed at increasing the genetic yield potential of wheat using innovative approaches.

[34] International Wheat Yield Partnership Program: http://iwyp.org/

Goal 3 | Promote American Agricultural Products and Exports

REE ACTION PLAN GOAL 1

Major Uses of U.S. Crop Land[35]



REE ACTION PLAN
Sustainable Intensification of Agricultural Production **(GOAL 1)**
Subgoal 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.

Providing Policymakers and the Public With Information on Agricultural Resource Use

The U.S. farm sector is comprised of about 2.1 million farms that operate on more than 900 million acres and support more than 6 million people living in the associated farm households. The productivity of the U.S. farm sector and its role in feeding a growing global population reflects the efficient use of a highly productive resource base. REE agencies play a critical role in collecting, documenting, and disseminating information about the U.S. agricultural sector. This information allows farmers, scientists, researchers, and policymakers to identify opportunities, avoid risks, and develop innovative ways to improve productivity.

For over 60 years, USDA-ERS has reported detailed information about the major uses of the 2.3 billion acres of land that comprise the United States. It is the only consistent accounting of all major uses of public and private lands. The latest installment was released in August 2017 in "Major Uses of Land in the United States"[35], which includes a detailed report of the latest information on U.S. land use patterns, as well as a comprehensive online data product that includes regional and State information dating back to 1945. A wide range of researchers, policy analysts, and organizations use the data to analyze landuse patterns and trends. Information in this report and data product comes from across USDA and several other departments, including NASS that conducted the Tenure, Ownership, and Transition of Land (TOTAL)[36] survey in 2014, as well as the Forest Service, Bureau of Land Management, and U.S. Geological Survey (USGS)[37].

[35] Major Uses of Land in the United States: https://www.ers.usda.gov/data-products/major-land-uses.aspx

[36] Tenure, Ownership, and Transition of Land (TOTAL): https://www.agcensus.usda.gov/Publications/TOTAL/

[37] U.S. Geological Survey (USGS): https://www.usgs.gov/

In recent years, the importance of pollinators as a resource on which the Nation's food supply depends has become more widely recognized due to reports that the honeybee population is under stress from many different sources, including disease, parasites, and poor nutrition. The ERS released a study in June 2017 that explores changes in the Nation's land use and land covers, and the potential implications for pollinator forage quality and availability of pollinator-friendly habitat. This work could lead to changes in the way policymakers incentivize landowners to create more forage-rich, pollinator-friendly habitats.

Risk Mitigation Strategies: How They Are Applied to Crop Insurance and Biofuel Endeavors

Farming is an inherently risky endeavor. There is uncertainty in pricing, yield, and revenue which vary from year to year. While production contracts and good farming practices can manage some of this risk, Federal Crop Insurance[38] has become a critical tool for many farmers as a way of guarding against losses from volatile weather conditions and fickle markets. The Noninsured Crop Disaster Assistance Program (NAP)[39] is an option for producers of commodities for which Federal Crop Insurance is not available. A recent ERS report[40] shows the value of this program in mitigating yield risk and protecting producer revenue.

Crop insurance subsidies help make risk management more affordable to farmers. Due to a recent policy change, crop insurance subsidies can now also provide an important incentive to protect soil and wetlands. ERS research[41] shows that tying the availability of premium subsidies to compliance with soil and wetland conservation practices provides strong incentives for farmers to protect highly erodible land and refrain from draining wetlands, and the incentives go up when crop prices are high.

---

[38] Federal Crop Insurance: https://www.rma.usda.gov/fcic/

[39] Noninsured Crop Disaster Assistance Program (NAP): https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/noninsured-crop-disaster-assistance/index

[40] Changes to the Noninsured Crop Disaster Assistance Program Under the Agricultural Act of 2014: Their Potential Risk Reduction Impacts: https://www.ers.usda.gov/publications/pub-details/?pubid=83650

[41] Conservation Compliance: How Farmer Incentives Are Changing in the Crop Insurance Era: https://www.ers.usda.gov/publications/pub-details/?pubid=84456

The emerging advanced biofuel industry and the production of energy crops (e.g., miscanthus and switchgrass) offer potential new opportunities for small and medium-sized farms to produce high-valued crops and enhance the economic viability of agriculture and rural communities. Energy crop production involves substantial upfront investments in establishment and a long-term commitment of land to the crop in the presence of liquidity and credit constraints, yield, price, and demand uncertainty. New decision tools for farm and market systems as well as new approaches to rural development will increase participation in this new economic opportunity. Long-term contracts will be critical to induce the production of perennial energy crops as a feedstock for the emerging cellulosic biofuel industry. ERS researchers developed a framework to analyze the determinants of landowner choice among a land leasing contract, a fixed price contract, and a revenue-sharing contract for energy crop production. They found that the refinery can potentially earn a higher profit by offering a menu of these three types of contracts rather than only a single type of contract. By allowing self-selection of contract type based on landowner risk and time preference, the contract terms needed to induce production of energy crops are reduced.

To meet a goal increasing biomass production, the researchers also analyzed the effects of two supplemental policy interventions, (an establishment cost subsidy and subsidized crop insurance for energy crops) on the incentives to allocate land to energy crop production and the biomass price needed to meet the goal. An establishment cost share subsidy as well as subsidized crop insurance for energy crops has the potential to mitigate the disincentives due to risk aversion and a preference for present over future returns, credit constraints, and subsidized crop insurance for conventional crops and to lower the private cost of cellulosic biofuel production, although at the expense of increased government expenditures. These findings suggest the need to consider both the direct effects of these policies and their unintended consequences in policy design and selection.

Organics: Providing Data to Industry and Policymakers

The organic industry needs quality data to monitor growth and plan for the future. The 2016 Certified Organic Survey[42], conducted by NASS in conjunction with USDA's Risk Management Agency (RMA)[43], provides this data in the report titled *Certified Organic Survey, 2016 Summary*[44] released September 2017. The survey is the fifth organic production survey and the third certified organic-only production survey conducted at the State and national levels by NASS. The 2016 Certified Organic Survey collected certified organic crop information for acreage harvested, quantity produced, quantity sold, and value of sales for field crops, vegetables, fruits, tree nuts, berries, and horticulture, as well as inventory, quantity sold, and value of sales for livestock, poultry, and livestock products. The data are used to guide industry planning, monitor growth, and shape decisions regarding farm policy, research, and funding allocations. Certified organic survey data are used by farm organizations to petition Congress or State legislatures for funding and support of industry-related programs. Government, extension, and university scientists use the data to determine research needs. Suppliers to the organic industry use the data to plan production and marketing of new products. Other USDA agencies, such as RMA, use the data to provide better insurance coverage for certified organic crops through the Federal Crop Insurance Corporation.

---

[42] The 2016 Certified Organic Survey: https://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Organic_Production/index.php

[43] USDA's Risk Management Agency (RMA): https://www.rma.usda.gov

[44] "Certified Organic Survey, 2016 Summary": https://www.nass.usda.gov/Publications/Todays_Reports/reports/census17.pdf

Farm Fresh Food Boxes: Expanding Rural Economies through New Markets for Farmers and Retailers

Farm Fresh Food Boxes (FFFB)[45] is an integrated research and extension project that takes an innovative approach to make healthy, affordable food available in food deserts by connecting farmers, retailers, and consumers. The FFFB project is a multi-State collaboration. The extension team engages farms and associated retail sites in three participating States—Vermont, Washington, and California—and promotes this innovative program to consumers in rural communities with limited access to fresh, local produce. The research team examined the economic impacts of FwFFB on farmers, retailers, and consumers. Participants were farmers, rural community members, and small food retailers.

With this approach, farms offer weekly boxes of fresh produce at retail sites that provide convenient access to consumers. Retail sites post flyers detailing the content and cost of FFFB from participating area farms. Customers pre-order advertised boxes at the retail site or online on a week-to-week basis for later pick-up. Box contents and flyers change throughout the season to move produce that is most abundant. Preliminary data reflect project outcomes that include market potential, measure of economic impact, measure of acceptability, comparative use of FFFB among consumer at Farmers Market and Community Supported Agriculture (CSA) shares, and benefits and barriers to farmers, retailers, and consumers. FFFB provides a low-risk strategy to address the complex supply, demand, and distribution challenges faced by producers and retailers of fresh local foods, while overcoming barriers that consumers face in accessing affordable, healthy food.

[45] Farm Fresh Food Boxes (FFFB): https://reeis.usda.gov/web/crisprojectpages/1008781-farm-fresh-food-boxes-expanding-rural-economies-through-new-markets-for-farmers-and-retailers.html

Goal 4 | Facilitate Rural Prosperity and Economic Development

REE ACTION PLAN GOALS 2 & 7

REE ACTION PLAN
Responding to Climate and Energy Needs **(GOAL 2)**
Subgoal 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.

Research Advancing the Bioeconomy

With $6.9 million in funding from USDA-**NIFA's Biomass Research and Development Initiative (BRDI)**[46], **Cooper Tire**[47] has successfully built and tested an automotive passenger tire comprised of 100 percent guayule as an alternative to natural rubber; the first tire of this build to be constructed. The work was completed in partnership with ARS, Cornell University, University of Arizona, State University of New York Stony Brook, Clemson University, and PanAridus (Casa Grande, AZ).

The guayule plant is native to the U.S. southwest and Mexico. ARS researchers domesticated and developed a guayule farming system (Maricopa, AZ)[48] and provided the biotechnology and chemistry (Albany, CA)[49] breakthroughs in guayule rubber processing, stabilization, and performance, which were the main drivers of this farm-to-commercial tire research project. ARS then transferred the guayule technology to Cooper Tire for testing.

Beginning in mid-2016, Cooper began testing the durability and performance of the prototype tire (covering over 1.7 million miles in the lab and test track) and determined it performed as well or even better than traditional Hevea-based rubber. This is significant, as it will reduce our Nation's dependency on imported rubber sources and petroleum-based replacements.

According to Chuck Yurkovich, Senior Vice President of global R&D at Cooper, the BRDI funding and support from ARS provided "an opportunity to reduce dependence worldwide on imports from a very narrow band round the equator" for natural rubber. The project also demonstrated that guayule can be a commercial crop, convert desert wastelands into profitable agro-ecosystems, and produce thousands of jobs, which will be needed to grow, harvest, and transport the biomass. "It's beneficial for the environment and the economies" according to Yurkovich.

BRDI, a program authorized in Section 9008 of the Farm Bill[50], has been a NIFA keystone program in assisting industries cross the economic "valley of death." Between FY 2012-FY 2014, BRDI has invested over $30 million in research into the bioeconomy. This has created over 320 jobs, over 20 new product processes or materials, and leveraged over $16 million in private funding support. BRDI expired in Fiscal Year 2017 under the current Farm Bill.

---

[46] Biomass Research and Development Initiative (BRDI): https://nifa.usda.gov/funding-opportunity/biomass-research-and-development-initiative-brdi

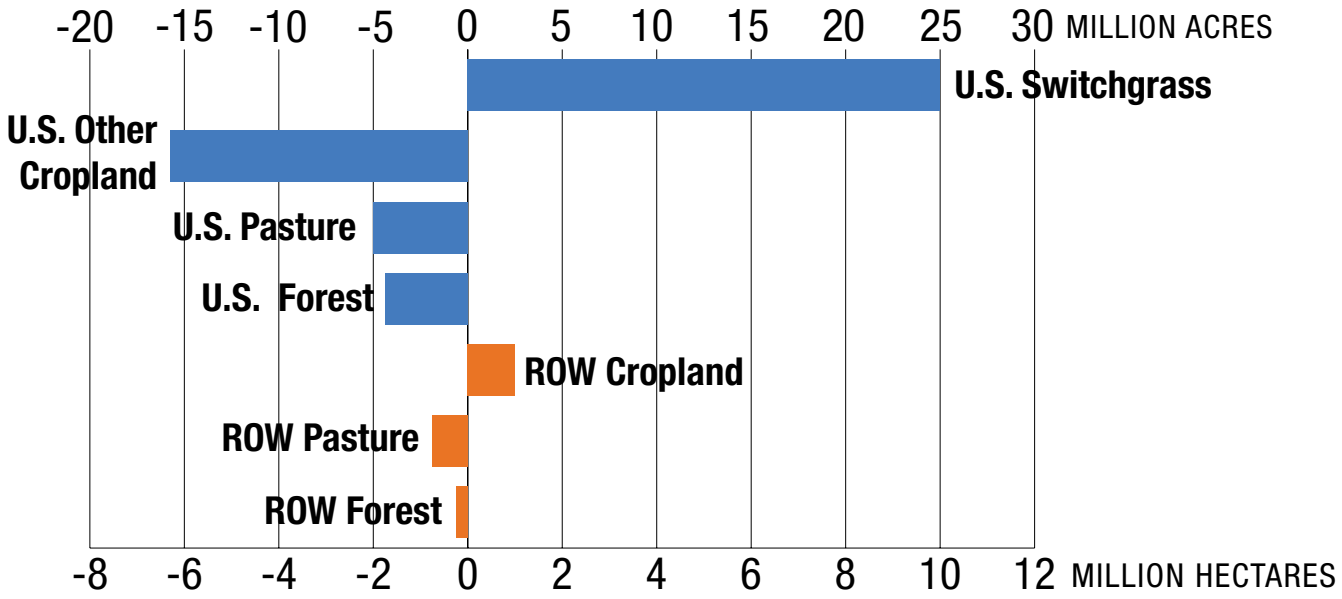
[47] Cooper Tire: http://us.coopertire.com/

[48] U.S. Arid Land Agricultural Research Center: Maricopa, AZ: https://www.ars.usda.gov/pacific-west-area/maricopa-arizona/us-arid-land-agricultural-research-center/

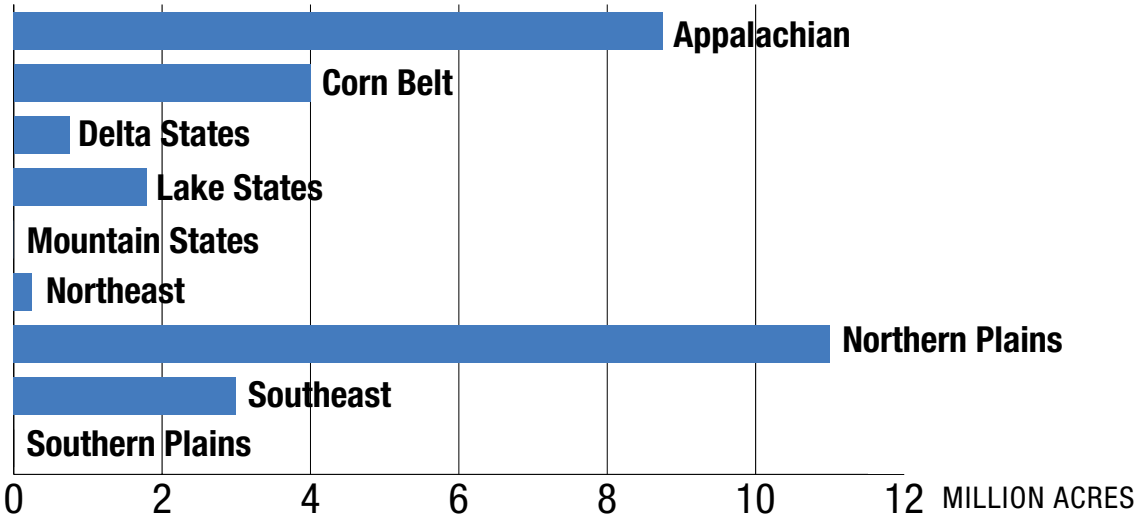
[49] Western Regional Research Center: Albany, CA: https://www.ars.usda.gov/pacific-west-area/albany-ca/wrrc/

[50] 2014 Farm Bill's Energy Title Provisions: http://farmenergy.org/news/summary-2014-farm-bills-energy-title-provisions

Land-use change in the United States and the rest of the world (ROW) in 2030 under SUBSIDY scenario relative to reference scenario[51]



Switchgrass area by USDA region at 250 TWh of bioelectricity generated using switchgrass[51]

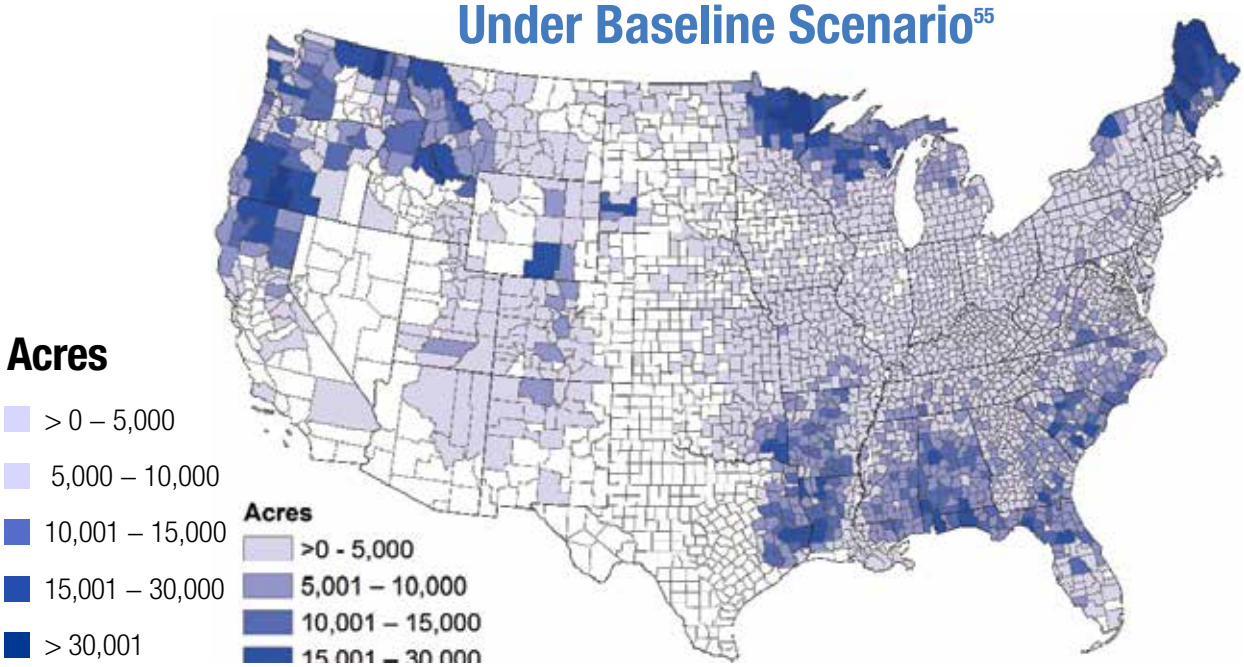


Dedicated Energy Crops and Competition for Agricultural Land (ERR-223)

Dedicated energy crops, such as switchgrass in the United States, are viewed as potential renewable feedstocks for liquid fuels or bioelectricity. However, markets do not presently exist for large-scale use of this resource. The ERS study, "Dedicated Energy Crops and Competition for Agricultural Land"[51] examined three policy scenarios that could create a market for bioelectricity using dedicated energy crops: a subsidy for bioelectricity generation, a national Renewable Portfolio Standard (RPS), and a national cap-and-trade policy to limit carbon dioxide (CO_2) emissions. Many States already have an RPS that requires a percentage of electricity production to be generated from renewable energy sources. A policy with a cap on CO_2 emissions would have the potential to create demand for

[51] Dedicated Energy Crops and Competition for Agricultural Land (ERR-223): https://www.ers.usda.gov/publications/pub-details/?pubid=81902

Distribution of Projected Available Feedstocks Under Baseline Scenario[55]



combustible biomass to generate electricity, including crops grown solely for their energy content. The study considered a number of policies, illustrating how the introduction of dedicated energy crops on a large scale could affect other agricultural land uses, prices of other crops, and trade in agricultural products.

Assessing Sustainability of an Expanded Forest Biomass Production Program on Biodiversity

Understanding the effects of an expanded forest biomass production program demands specifics: how much is available, where is it located, and how much biomass can be produced and used effectively. FS worked with partners at Weyerhaeuser[52] and the National Council for Air and Stream Improvement (NCASI)[53] to evaluate the implications of expanding wood biomass harvesting to forest biodiversity using projected available forest feedstocks that could be available for industrial uses generated (Volume 1 of the 2016 Billion-Ton Report[54]). Removing wood biomass may affect biodiversity through the loss of biomass associated with harvesting logging residues and altered forest age distribution associated with whole-tree biomass harvesting. Nearly half of projected harvests occurred in Southern United States followed by northcentral and northeast regions. Logging residues were the primary feedstock across the Nation in most instances. Depending on their distribution and habitat requirements, species that rely on wood biomass or early successional habitat would experience both negative and positive impacts. The generated spatial results can be integrated with local biodiversity assessments to help identify species vulnerable to an expanded forest biomass production program based on projected amounts of feedstocks available by forest habitat type for a region. For private land owners, biomass markets provide an additional opportunity to realize an economic return on their land and provide the needed raw material for the renewable energy market.[55]

---

[52] Weyerhaeuser: https://www.weyerhaeuser.com/

[53] National Council for Air and Stream Improvement (NCASI): http://www.ncasi.org/

[54] Volume 1 of the 2016 Billion-Ton Report: https://energy.gov/eere/bioenergy/2016-billion-ton-report

[55] Donner DM, TB Wigley, DA Miller. 2017. Forest biodiversity and woody biomass harvesting. Pages 399-449 In U.S. Department of Energy. 2017. 2016 Billion-Ton Report: Advancing domestic resources for a thriving bioeconomy, Volume 2: environmental sustainability effects of select scenarios from Volume 1. R.A. Efroymson, M.H. Langholtz, K.E. Johnson, and B.J. Stokes (Eds.), ORNL/TM-2016/727. Oak Ridge National Laboratory, Oak Ridge, TN 624 p. doi 10.2172/1338837: https://energy.gov/eere/bioenergy/downloads/2016-billion-ton-report-volume-2-environmental-sustainability-effects

Converting Switchgrass and Corn Stover Sugars Into Biodiesel and Bio-Jet Fuel Without Costly Enzymes

ARS researchers in Peoria, Illinois[56], worked with industrial partners to demonstrate direct conversion of extracted plant sugars into oils to be used as biodiesel or bio-jet fuel. This new process will produce a renewable intermediate for biodiesel or bio-jet fuel while being cost competitive with petroleum-based oils. The actual savings of this technology could reduce cellulosic ethanol production costs by 16 percent to 20 percent.

Providing Open Access to Research Data Funded Through USDA Grant Programs

In support of the Federal Open Data Initiative[57], the National Agricultural Library (NAL)[58] published novel data products developed through the NIFA's Agriculture and Food Research Initiative (AFRI)[59] and the Biomass Research and Development Initiative (BRDI) programs. The published data sets describe aviation fuel production from poplar biomass and kraft lignin extraction for cellulosic ethanol production. Both data sets are novel contributions to the field and inform industry development of cellulosic biomass-based fuels.

---

[56] National Center for Agricultural Utilization Research: Peoria, IL: https://www.ars.usda.gov/midwest-area/peoria-il/national-center-for-agricultural-utilization-research/

[57] Data.Gov: Open Government: https://www.data.gov/open-gov/

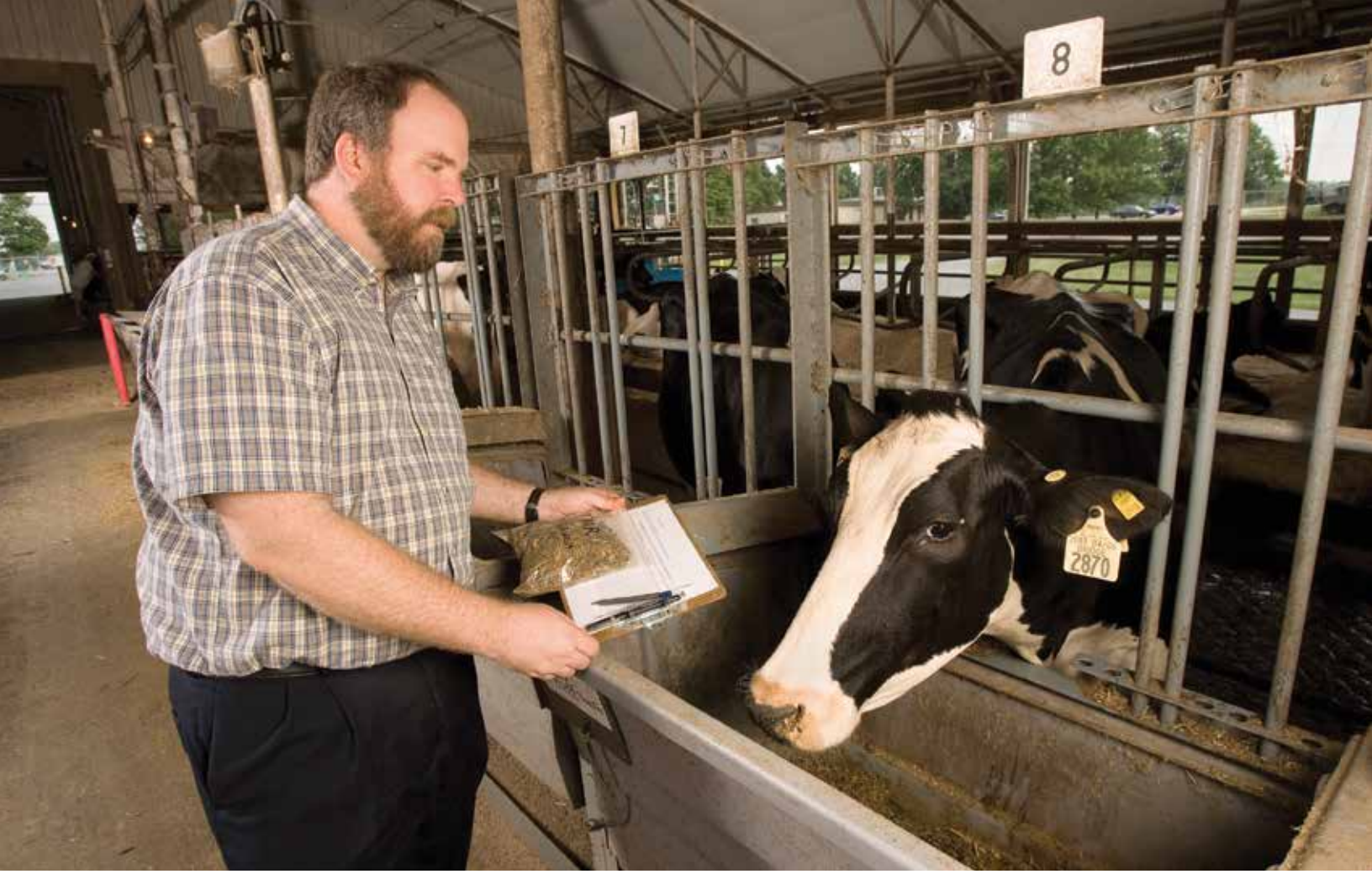
[58] National Agricultural Library (NAL): https://www.nal.usda.gov/

[59] Agriculture and Food Research Initiative (AFRI): https://nifa.usda.gov/program/agriculture-and-food-research-initiative-afri

Transferring Dead Trees From Source of Wildfire Fuel to Biofuel

Trees killed by bark beetles have been for years a source of fuel for forest fires. Now, those trees are being turned into a biofuel source for transportation and biobased products. The Sustainable Bioenergy Alliance Network of the Rockies (BANR)[60] is a NIFA-funded Coordinated Agricultural Project (CAP) led by Colorado State University. BANR brings together scientists, educators, and extension specialists from universities and government agencies to work with industry partners to address the major challenges across feedstock development, production, logistics, and economical and sustainable utilization of insect-killed trees for the production of biofuels and biochar. Beetle-killed biomass represents a vast bioenergy resource—approximately 46 million acres—and is typically located far from urban industrial centers in relatively inaccessible areas, which means transportation costs are a key barrier to widespread utilization of this vast resource. Various sensing approaches are used to identify suitable biomass and teams collaborate on tackling the logistical problems of harvesting, collecting, transporting, and storing the raw biomass without negatively impacting natural forest regeneration and water resources. BANR's education team is developing middle and high school science units that focus on bioenergy; professional development for K-12 teachers; research opportunities for K-12 teachers and undergraduate students; and online coursework for undergrads, graduate students, and K-12 teachers.

[60] The Sustainable Bioenergy Alliance Network of the Rockies (BANR): http://banr.nrel.colostate.edu/



REE ACTION PLAN
Rural Prosperity/Rural-Urban Interdependence **(GOAL 7)**

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

Innovation Driving Opportunities in Rural Communities

In 2017, Rural America's job growth accelerated as it continued its recovery from the 2007-2009 recession. To sustain this growth, rural areas find value from increasing access and use of broadband, investing in physical infrastructure, and improving the education and health of rural populations. These elements are among the factors that support innovation in economic activities, which is widely regarded as essential to dynamic and resilient local economies with long-term growth potential.

Rural areas are often assumed to have less innovative non-agricultural establishments than urban areas due to disadvantages in location and resources. Recent research at ERS[61], however, paints a fuller picture of the rural-urban innovation gap using a comprehensive measure that extends beyond the traditional focus on science- and engineering-based innovation. The measure identifies several areas where rural innovation is thriving. For example, while urban establishments are more likely to be substantive innovators than those in rural areas, innovation rates are similar in rural and urban manufacturing; relatively high substantive innovation rates are found in several traditional rural industries, including food manufacturing, textiles, and paper. While innovation-intensive industries did not add significantly more jobs than other industries after the recession, rural labor markets dominated by substantive innovators did grow faster from 2010 to 2014.

[61] Innovation in the Rural Nonfarm Economy: Its Effect on Job and Earnings Growth, 2010-2014: https://www.ers.usda.gov/publications/pub-details/?pubid=85170

REE programs are continuing to foster innovation and the adoption of new technologies as well as enhancing workforce capacity for the disabled farming labor force, while providing needed tools and resources to rural communities.

ARS has been expanding technology transfer and the commercial impact of ARS research through a new paradigm adoption where technology transfer is integrated as an early part of the research process[62], beginning when the research objectives are first conceived. This year, more than 245 technology transfer strategy sessions were held with scientists. ARS has also established an Innovation Fund for its scientists to enhance the commercial potential of an agricultural solution currently under development. In FY 2017, 29 proposals were awarded and over 50 strategy calls were conducted with non-selected Innovation Fund projects. Additionally, engagement is done in outreach activities that match technical expertise of ARS researchers with small and early-stage firms. Building business innovation helps to create workforce development opportunities.

NIFA[63] has identified agricultural workforce capacity as a critical need of people and places to help promote community vitality. With the mission of cultivating accessible agriculture, AgrAbility[64] is a federally funded NIFA grant program consisting of a national project and individually funded State or regional projects. AgrAbility includes assistance to farmers, ranchers, farmworkers, and veterans who are living with disabilities and engaged in production agriculture. In 2017, the North Carolina AgrAbility Partnership[65] provided outreach opportunities to these individuals. Through AgrAbility, USDA enhances the quality of life for agricultural workers with disabilities, so that they, their families, and their communities continue to succeed in rural America.

NASS is creating data that assist the farming workforce through surveys and reporting. The Farm Computer Usage and Ownership Survey Report[66] includes data on farm computer usage, access, ownership or leasing, farm business use, and internet access. The report indicated that 73 percent of farms nationally have computer access and most farmers access the Internet via a Digital Subscriber Line (DSL) (29 percent). Computer usage for farm business is 47 percent nationally, up 4 percent from 2015. Providing needed data tools helps to transfer information.

In 2017, the Rural Information Center (RIC)[67], a service of the National Agricultural Library (NAL), celebrated its 30th Anniversary of service to rural America. During this time period, RIC responded to more than 53,000 requests for information, developed a Web presence, worked collaboratively with public and private entities, and created products that assist with delivering knowledge to rural communities.

4-H Health Study Mapping Project

Tennessee 4-H members representing the National 4-H Global Positioning System/Geospatial Information System (GPS/GIS) Leadership Team presented the group's health study mapping project at the Environmental Systems Research Institute (ESRI) International Users Conference in San Diego on July 10, 2017. Geographic Information Systems (GIS) is the use of location-based data to study relationships, make informed decisions, and create maps. Using GIS software, maps and charts were created showing obesity hotspots and how strongly four possible contributing health factors correlate to obesity in every county of the lower 48 States.

---

[62] A New Strategic Approach to Technology Transfer: https://www.ars.usda.gov/research/publications/publication/?seqNo115=328972

[63] USDA AgriAbility: https://nifa.usda.gov/program/agrability

[64] National AgriAbility Project: http://www.agrability.org/

[65] North Carolina AgrAbility Partnership: http://www.ncagrability.org/

[66] Farm Computer Usage and Ownership Survey Report: http://usda.mannlib.cornell.edu/usda/current/FarmComp/FarmComp-08-18-2017_correction.pdf

[67] Rural Information Center (RIC): https://www.nal.usda.gov/ric

Agricultural Exports Help Grow Rural Jobs

Agriculture exports supported about 1.1 million civilian jobs in the United States in 2015. ERS researchers[68] modeled the effect of an increase in demand for U.S. agriculture exports on total employment. They found that a hypothetical 10-percent increase in demand increased exports by 6.7 percent and added 41,500 jobs. The resulting employment growth was about four times as large in rural areas as in urban areas.

Local Food Marketing Practices Survey

NASS released results from the first Local Food Marketing Practices Survey[69] conducted in cooperation with USDA's Know Your Farmer, Know Your Food (KYF2) Initiative. The survey covers local food marketing practices for fresh and value-added foods, such as meats and cheese. The survey was administered in all 50 States and is intended to produce benchmark statistics on the number of farms that market food directly, the value of these direct sales, and the marketing practices used in conjunction with direct sales.

Trends in Rural Education Reported

Rural Americans are increasingly well educated and nearly one in five (ages 25 and older) have at least a 4-year college degree. ERS researchers[70] found that rural women now have higher college completion rates than rural men. The urban-rural pay gap varies by education level. Median earnings are about 40 percent higher for urban than for rural advanced degree holders but nearly the same for those without a high school diploma.

---

[68] The Potential Effects of Increased Demand for U.S. Agricultural Exports on Metro and Nonmetro Employment: https://www.ers.usda.gov/publications/pub-details/?pubid=83069

[69] Local Food Marketing Practices Survey: https://www.agcensus.usda.gov/Publications/Local_Food/

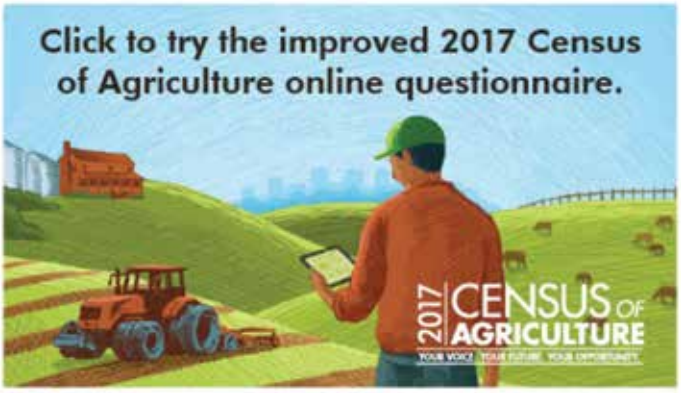
[70] Rural Education at a Glance, 2017 Edition: https://www.ers.usda.gov/publications/pub-details/?pubid=83077

2017 CENSUS OF AGRICULTURE

YOUR VOICE. YOUR FUTURE. YOUR OPPORTUNITY.

Census of Agriculture Accessible for New Farmers

In order to be more customer service oriented, agricultural producers who are new to farming or did not receive a Census of Agriculture Report form in 2012 were given the opportunity to sign up to receive the 2017 Census of Agriculture Report form by visiting www.agcensus.usda.gov and clicking on the "Make Sure You Are Counted" button on the USDA-NASS website. Farm and ranch operators were also offered the opportunity to have their names added to the Census mailing list by sending in their contact information using pre-addressed, mail-in postcards which are also available.



AGRICULTURE NASS COUNTS

Goals 5 & 6 | Strengthen the Stewardship of Private Lands Through Technology and Research & Ensure Productive and Sustainable Use of Our National Forest System Lands

REE ACTION PLAN GOALS 2 & 3

REE ACTION PLAN
Responding to Climate and Energy Needs **(GOAL 2)**
Subgoal 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.

Putting Science on the Ground to Respond to and Prepare for Climate Variability

As the earth's surface temperature rises, agriculture is facing a more variable climate—dry years are becoming drier and wet years are becoming wetter. USDA scientists are collaborating with other agencies and institutions to develop science-based tools that empower farmers, foresters, ranchers, landowners, resource managers, and Federal agencies to prepare for and respond to climate variability.

The AgroClimate Workbook[71] provides a wealth of weather and climate decision tools for farmers, ranchers, and land managers. This multi-year project provides a wide range of resources to land managers that enable them to deal with weather and climate issues in their day-to-day management decisions and long-term planning. The AgroClimate Workbook provides an introduction to the effects of climate on agriculture and is designed to be used in conjunction with a wide variety of USDA tools, fact sheets, and videos found on AgroClimate.org.

These decision-support tools have helped land managers manage their crops more efficiently under a more variable climate. In the Southeast, for example, the Strawberry Advisory System[72] is a plant disease decision support tool that has helped Florida strawberry growers assess the risk of epidemics from anthracnose and Botrytis on

their farms. Farmers can target fungicide application to periods when disease conditions are favorable, reducing production costs and avoiding unnecessary sprays.

Such tools are only useful if they are used. After concluding that the agricultural community and working lands stakeholders in the U.S. Caribbean were not taking full advantage of the many USDA resources available, the Caribbean Climate Hub[73] developed an online tool that communicates information via maps, graphics, videos, and

[71] AgroClimate Workbook: http://www.agroclimate.org

[72] Strawberry Advisory System: http://agroclimate.org/tools/sas/

[73] Caribbean Climate Hub: https://www.climatehubs.oce.usda.gov/hubs/caribbean

text about all the USDA agencies working in Puerto Rico and the U.S. Virgin Islands and how they can communicate in the U.S. Caribbean region. Such tools help overcome obstacles arising from lack of access or understanding about USDA roles, programs, and requirements.

USDA is exploring other innovative ways to deliver information and resources. The Southeast Hub's Lately Identified Geospatial Hazard Tracking System (SERCH LIGHTS)[74] is an email alert service that notifies Continental United States subscribers (extension professionals, technical assistance providers, and land managers) when climate-related conditions of potential concern arise in their area of interest and provides links to supporting resources and management information. Alerts are based on National Oceanic Atmospheric Administration (NOAA) data sets, products, and models developed by other USDA agencies using NOAA data. The SERCH LIGHTS alert system offers two subscription packages: The Monthly Drought Alert[75] and the Cattle Heat Stress Alert[76]. SERCH LIGHTS is exploring additional alerts including an Emerald Ash Borer Alert and a Fire Weather Alert.

Seedlot Selection Tool Facilitates Long-Term Forest Planning

With long-lived species such as trees, making appropriate planting decisions under changing climate conditions can be challenging. The Seedlot Selection Tool[77] is a web-based mapping program that helps forest managers and nurseries match seedlots (seed collections from a known origin) with planting sites based on current and future climate information. Updates to the tool are expanding its coverage across most of North America. In 2017, the Northwest Climate Hub[78] funded expansion of the tool's coverage across much of the Continental United States. Similarly, the Northern Forests Hub[79] is supporting work to fill remaining gaps in functionality for the Eastern United States, and international agencies supported the tool expansion to Canada and northern Mexico.

---

[74] Southeast Hub's Lately Identified Geospatial Hazard Tracking System (SERCH LIGHTS): https://globalchange.ncsu.edu/serch/tools-services/serch-lights/

[75] The Monthly Drought Alert: https://www.climatehubs.oce.usda.gov/hubs/southeast/tools/serch-lights-monthly-drought-outlook-email-alert

[76] Cattle Heat Stress Alert: https://www.climatehubs.oce.usda.gov/hubs/southeast/tools/serch-lights-cattle-heat-stress-alert

[77] Seedlot Selection Tool: https://seedlotselectiontool.org/sst/

[78] Northwest Climate Hub: https://www.climatehubs.oce.usda.gov/hubs/northwest

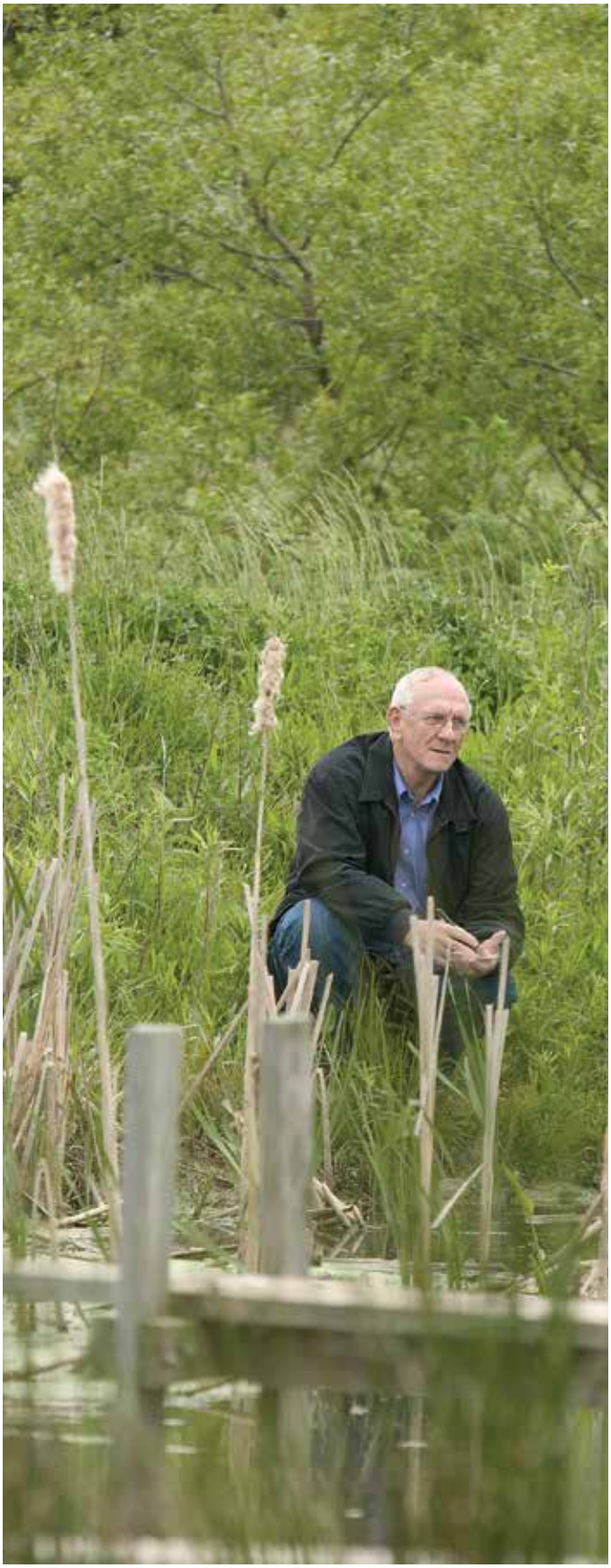
[79] Northern Forests Hub: https://www.climatehubs.oce.usda.gov/hubs/northern-forests

Species Potential Habitat Tool Evaluates Species for Reforestation Efforts

The Species Potential Habitat Tool is a web application land managers can use to identify tree species that are climatically suitable for specific sites given a variety of projected climate change scenarios. The tool compares current habitats with future habitats, indicating where suitable climates occur now, and where they will continue to occur in the future, where they might disappear, and where they might emerge. The Species Potential Habitat Tool currently includes five conifer species in western North America but will be expanded to include many more North American species as climatic-habitat maps become available.

Enabling Swine Farmers to Make More Informed Choices to Enhance Productivity, Profitability, and Environmental Quality

NIFA funded work at the University of Arkansas to create a decision support tool, the Live Swine Carbon Footprint Calculator. This tool calculates the greenhouse gas emissions involved in sow and grow-finish production, which can help producers identify areas for potential improved efficiency. This work also developed the Pork Production Environmental Footprint Calculator (PPEFC)[80] which is now being disseminated by the National Pork Board[81]. University of Arkansas researchers also used the PPEFC to develop regional and national life cycle inventory data sets, which have been published in the USDA Life Cycle Assessment (LCA) Commons[82].



[80] Pork Production Environmental Footprint Calculator (PPEFC): https://www.pork.org/environment/environmental-impact-pig-farming/

[81] National Pork Board: https://www.pork.org/

[82] USDA Life Cycle Assessment (LCA) Commons: https://www.lcacommons.gov/

Rangeland Hydrology and Erosion Model (RHEM) Risk Assessment Tool, Widely Verified and Applied

The USDA Rangeland Hydrology and Erosion Model (RHEM)[83] tool evaluates the risk of excessive runoff and soil erosion on rangeland and provides information critical to assessing and managing western rangelands in the United States. In particular, RHEM has been used in post-fire assessments of where the potential for erosion is greatest in watersheds, which has led to savings of many millions of dollars in planning post-fire erosion protection implementation. In addition, this tool greatly facilitates the development of Ecological Site Descriptions[84], which are formal documents currently being developed in a large and active program across the United States by the Natural Resources Conservation Service (NRCS)[85], Forest Service, and Bureau of Land Management (BLM)[86] to describe the hydrologic and vegetation functions of land resources, particularly for grazing lands. Validation and verification of the model is ongoing. In 2017, RHEM's capacity to simulate flow and soil erosion was tested on a small watershed in Arizona and on 124 sites in Arizona and New Mexico.

Innovation in Rice Irrigation Management and Cropping Practices Reduces Irrigation and Greenhouse Gas Emissions

Irrigation management is a key component to Greenhouse Gas (GHG) mitigation in rice. Flooded rice systems contribute significantly to global anthropogenic non-CO_2 GHG emissions. USDA scientists studying the relationships between water, fertilizer, and GHG emissions discovered that intermittent or Alternate Wetting and Drying (AWD) during rice production reduced irrigation use by 20 to 70 percent relative to conventional (i.e., continuous flooding), while rice yields remained largely unchanged and GHG emissions were reduced. While additional work is needed to fully test and adapt the practice in the field, these findings suggests that significant reductions in water use are possible, which will help sustain rice production under conditions of increased water scarcity and during periodic droughts.

---

[83] Rangeland Hydrology and Erosion Model (RHEM): https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045656.pdf

[84] Ecological Site Descriptions: https://esis.sc.egov.usda.gov/Welcome/pgReportLocation.aspx?type=ESD

[85] Natural Resources Conservation Service (NRCS): https://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/

[86] Bureau of Land Management (BLM): https://www.blm.gov/

REE ACTION PLAN
Sustainable Use of Natural Resources (GOAL 3)
Subgoal 3A | Water Availability, Quality, and Quantity

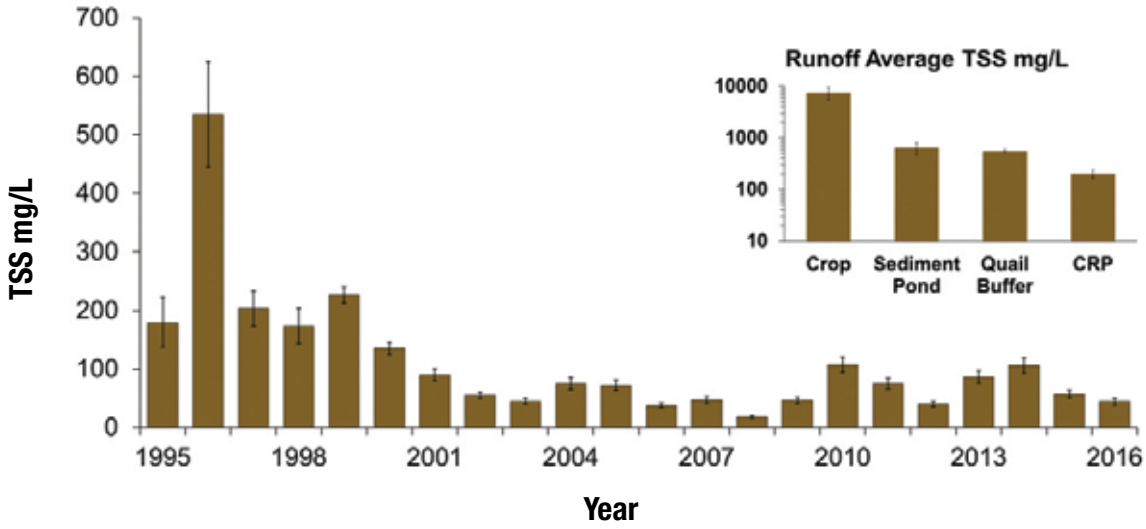
REE Objective: Provide research and decision support tools to: increase the effectiveness of USDA conservation policies, programs, and practices; raise the ratio of conservation benefit/conservation investment; and facilitate the transfer of research advances to practical implementation.

In the 21st century, the Nation faces depleted ground water reserves, degraded water quality, and adverse climate conditions that are reducing the amount of available freshwater. Our shared freshwater supply has been significantly reduced and is becoming more variable, unreliable, and inadequate to meet the needs and demands of an expanding population. Science can provide the tools needed by water planners and managers to accurately predict the outcomes of proposed water management decisions and new technologies can widen the range of options for future water management.

Addressing Harmful Algal Blooms and Hypoxia

Over the past several decades, harmful algal blooms and hypoxia (low-oxygen conditions) have negatively affected water quality, water supply, and revenue for lakefront economies that are dependent on aquatic or seafood harvests or tourism. Without the appropriate conservation practices, agricultural operations can be sources of nitrogen and phosphorus that promote cyanobacteria and algal growth, often resulting in dense overgrowths or “blooms” that can have high concentrations of harmful algal bloom toxins. Several agencies within USDA have coordinated research efforts to advance technology and conservation practices, modeling, and our understanding of nutrient runoff management that can help prevent harmful algal blooms and associated negative water quality effects. For example, the USDA Forest Service National Agroforestry Center has produced tools to maximize the effectiveness of conservation buffers.

Beasley Lake Average Annual Total Suspended Solids (TSS) (Milligrams per Liter of Solids per Liter of Water)



Conservation Management Practices Reduce Off-Site Nutrient Transport

Within the Western Lake Erie Basin Watershed, ARS[87] scientists used flue gas desulfurization gypsum as a surface amendment, implemented drainage water management, and the 4Rs of nutrient stewardship[88] to significantly reduce phosphorus loss from crop production agricultural systems. In the Southeastern Coastal Plain , ARS[89] scientists studied fields managed with strip tillage and conventional tillage over 18 years. Strip tillage reduced surface runoff and total pesticide loss by twofold, sediment runoff by sevenfold, and total nutrient loss by 50 percent. It also increased organic nitrogen and carbon. Winter cover crops proved to reduce sediment loss during spring periods of high runoff and increased soil carbon and nitrogen content. Promotion and adoption of these practices could potentially reduce agriculture's environmental footprint and help address harmful and nuisance algal blooms in freshwater systems. In the Mississippi Delta Region, ARS scientists determined the potential benefits of integrated agricultural management practices on lake water quality by studying 20 years of water quality data in the Conservation Effects Assessment Program (CEAP)[90] Beasley Lake. Conservation Reserve Program (CRP)[91] acreage, sediment retention basins, and vegetated buffers and ditches reduced concentrations of sediment, nutrients, and pesticides transported from production acreage into the oxbow lake. Lake conditions shifted to becoming more sustainable, benefitting fisheries and other ecosystem services provided by Beasley Lake. Lastly, in Ohio, three sites that have implemented controlled drainage and drainage water recycling systems as part of a Coordinated Agricultural Project (CAP) funded by NIFA saw significant improvements. The average corn yield increase over 37 site-years was 19 percent, with a 29-percent increase in dry years, while soybean increase was 12 percent overall and 25 percent in dry years. Controlled drainage and drainage water recycling are two kinds of water and nutrient-trapping practices that are very effective at limiting the amount of nitrogen and water leaving fields, making farms more resilient to drought and improving yields, and potentially improving freshwater quality.

---

87 Western Lake Erie Basin CEAP Biological Endpoints Partnership: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/wa/home/?cid=stelprdb1047933

88 The 4Rs of nutrient stewardship: http://www.nutrientstewardship.com/4rs

89 Coastal Plain Soil, Water and Plant Conservation Research: Florence, SC: https://www.ars.usda.gov/southeast-area/florence-sc/coastal-plain-soil-water-and-plant-conservation-research/

90 Conservation Effects Assessment Program (CEAP): https://www.ars.usda.gov/ceap/

91 Conservation Reserve Program (CRP): https://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-program/

Vegetation Management Practices Reduce Nutrient Transport Off-Site

USDA-supported Science-based Trials of Rowcrops Integrated with Prairie Strips (STRIPS) is helping farm communities transform strategic portions of the agricultural landscape to perennial prairie plant communities. Converting just 10 percent of a crop-field to diverse perennials reduces soil loss from fields by 90 percent and the amount of nitrogen in surface runoff by 85 percent. Prairie strips enhance habitat for biodiversity, including birds, pollinators, and other beneficial insects; and reduce the need for pesticides. Currently, 30+ actively managed farms in Iowa have implemented STRIPS, but wide implementation could decrease nutrient inputs to the Gulf of Mexico and reduce the hypoxia zone.

Loblolly pine is widely planted in the United States for its timber and its byproducts. Planting switchgrass in between the pines, or intercropping, provides bioenergy feedstock without competing for land currently in food production. Six years (2009-2014) of data from a FS study[92] conducted on Weyerhaeuser's managed pine forest, North Carolina, shows that fully grown switchgrass in between pine tree beds improved downstream water quality by reducing nitrate and phosphate concentrations while loads were reduced by 92 percent and 23 percent, on average, compared to the traditional pine forest. The phosphate load was reduced by about 45 percent at the intercropped site. Pine-switchgrass intercropping may thus be a viable method of producing a sustainable bioenergy crop on pine forest lands while protecting water quality.

Where Nutrient Input Reductions Occur Affects Water Quality and Commodity Prices

ERS evaluated the economic and environmental merits of least-cost measures designed to reduce nitrogen delivery and hypoxia to the Gulf of Mexico. Measures considered included on-farm adoption of nitrogen-reducing production practices and converting some croplands to riparian buffers and wetlands. Even though the Upper Mississippi and Ohio sub-basins contribute the most nutrients reaching the Gulf, the most cost-effective reductions are found in the lower Mississippi sub-basin. Addressing both Gulf and local water quality impacts spreads the conservation effort more evenly among sub-basins, effectively resulting in higher overall water quality benefits because total nutrient reductions throughout the entire basin are higher. However, implementing enough nutrient-reduction measures to meet water quality goals reduces yields, reduces crop acreage, and increases commodity prices. Additionally, proximity to the Gulf and conservation practices on tile drained land were found to be important factors associated with low-cost nutrient reduction reaching the Gulf.

To help track the science related to agricultural operations and Great Lakes harmful algal blooms and hypoxia, the USDA National Agricultural Library has created an online, automatically updated bibliography called, "Great Lakes Harmful Algal Blooms and Hypoxia: Agricultural Aspects."[93]

---

[92] An Overview of Hydrologic Studies at Center for Forested Wetlands Research, USDA Forest Service: https://www.fs.usda.gov/treesearch/pubs/7128

[93] Great Lakes Harmful Algal Blooms and Hypoxia: Agricultural Aspects: https://www.nal.usda.gov/waic/great-lakes-harmful-algal-blooms-and-hypoxia-agricultural-aspects

Improving Vineyard Irrigation Management Using Remote Sensing for Water Use Monitoring From Field to Regional Scales: Pixelated Irrigation Management

ARS scientists in Beltsville, Maryland[94] are working with partners to develop an evapotranspiration (ET) toolkit that can monitor daily vineyard water use from field to regional scales using operational satellites. The ET toolkit fuses data from multiple satellite platforms to provide water use data with both high spatial and temporal resolution. The toolkit has been evaluated in vineyards in the Central Valley since 2013, with new test sites in 2017 in northern and southern California to assess model performance under different climate conditions and vine varieties. With a more robust ET monitoring system, vineyard partners in California indicate a 10-percent reduction in water use would result in considerable economic savings of up to $200 million based on the value of irrigated water, which in 2014 and 2015 reached $1,000 or more per acre-foot in some parts of California. Pumping costs in 2017 were projected to be around $150 per acre, so a 10-percent savings would yield about $14 million across the entire vineyard acreage of the State.

Analysis of Strategies for Adaptation to Future Water Supply Vulnerabilities in the United States

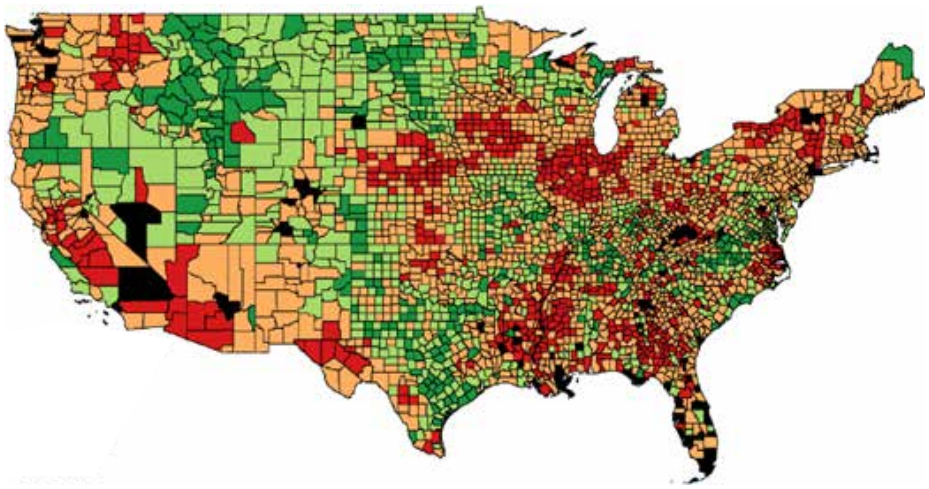
Water yield and snow water equivalent throughout the contiguous United States were projected to decrease over the twenty-first century using the Variable Infiltration Capacity (VIC)[95] model for 14 alternative climate futures. FS scientists found that water yield is likely to decrease over much of the United States despite generally increasing future precipitation. Snow accumulation is projected to decrease almost everywhere by the latter half of the century, with the time of peak snow pack in some basins projected to occur up to 2 months earlier than it currently does occur. These changes will have important implications for activities on national forests and other Federal lands.

---

[94] Beltsville Agricultural Research Center: Beltsville, MD: https://www.ars.usda.gov/northeast-area/beltsville-md/beltsville-agricultural-research-center/

[95] Variable Infiltration Capacity (VIC) Macroscale Hydrologic Model: https://vic.readthedocs.io/en/master/

Percent Change in County Average Compliance Incentives
2014 Farm Act versus the 2008 Farm Act[96]



REE ACTION PLAN
Sustainable Use of Natural Resources (GOAL 3)
Subgoal 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.

Using Data to Help Landowners and Program Managers Make Better Decisions

The increasing availability of geographically-detailed data on land uses, socio-economic information, and soil characteristics—along with "big-data" computing tools—enables fine-grained research on how USDA actions impact the rural landscape.

Recent ERS research Conservation Compliance[96] answers complex questions about the effect of compliance requirements on soil erosion. Highly Erodible Land Compliance (HELC) ties eligibility for USDA farm programs to soil conservation on highly erodible cropland. Producers must meet soil and wetland conservation requirements to remain eligible for farm program benefits including commodity payments, crop insurance premium subsidies, and conservation payments. Combining survey data on soil erosion with administrative data showed: (1) about 75 percent of highly erodible cropland is subject to HELC, (2) average erosion reduction has been larger on highly erodible cropland subject to compliance when compared to similar land that is not subject to compliance, and (3) substantial erosion reduction occurred on highly erodible soils in fields not subject to HELC. This not only confirmed that HELC resulted in soil erosion reduction, but also that some erosion reduction would have happened even without compliance.

Natural hydrological and ecological processes, coupled with land use management choices, can coincide to form hydro-ecological hotspots in rural landscapes. With NIFA support, scientists from the New Jersey Institute of Technology have demonstrated the need for whole-watershed analyses, rather than on a farm-by-farm or field-by-field approach, to develop strategies that prevent placing pollutants in parts of the landscape prone to storm runoff. This found as much as 70 percent of the rainfall runoff is generated on approximately 10 percent of the land in a watershed. The findings from the regional models suggested that critical source areas contribute disproportionately to poor water quality and impaired aquatic ecosystem integrity. Further investigation at larger scales and different sites is needed for policy intervention (such as targeting the Conservation Reserve Program (CRP) and Environmental Quality Incentives Program (EQIP)[97] in these areas).

[96] Conservation Compliance: How Farmer Incentives Are Changing in the Crop Insurance Era: https://www.ers.usda.gov/publications/pub-details/?pubid=84456

[97] Environmental Quality Incentives Program (EQIP): https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip

The ARS Agricultural Conservation Planning Framework (ACPF)[98] toolbox provides land managers and communities a way to take a landscape view of sustainable production and conservation management. Well-managed soils lose less water and nutrients to runoff and leaching, improving production and effectively treating natural losses due to "leakiness" of agricultural lands. Additional practices that control water flows and nutrient losses can be applied at field, field edges, and riparian zones. The ACPF identifies and prioritizes locations where specific landscape attributes are favorable for installation of each type of practice. The toolbox also helps watershed planners identify riparian management alternatives. The framework has been applied in a variety of landscapes, including tile-drained watersheds, dissected watersheds dominated by runoff, and permeable bedrock (Karst) terrain.

Geospatial decision support products derived by USDA helped provide rapid response for Hurricanes Harvey, Irma, and Maria. Remotely sensed satellite and meteorological information (such as wind swath and precipitation data from NASA and NOAA information) was combined with USDA information on crop areas. USDA was able to quickly produce estimates of the inundated areas of crop and pasture land, and the percentages of impacted crops, in Texas, Louisiana, and Florida. Using "see through the clouds" data from the European Space Agency Sentinel-1 synthetic aperture radar[99], real-time storm inundation over crop and pasture lands was captured, which provided flooding assessments and the sharing of critical data with both USDA and FEMA decision makers.

Understanding Producer Decision Making About Landscapes Within the Prairie Pothole Region

What influences producers' decisionmaking on landscapes under their control? A North Dakota State University survey of State producers who voluntarily participated in a working wetlands pilot program found that payment level, payment guarantee, contract length, and maintenance requirements were important attributes of the program. Among those surveyed, most producers agreed that participation in the wetland program development process is important. All survey respondents agreed that they would not have enrolled in the program if they were not allowed to continue farming their wetlands when possible and two-thirds agreed the terms of the program are a good fit for their land in the long run. Additionally, most farmers agreed that incentives are effective for wetlands conservation and the best option from among regulation, incentivized regulation, incentives, easements, technical assistance, voluntary, and educational programs.

[98] Agricultural Conservation Planning Framework (ACPF): https://data.nal.usda.gov/dataset/agricultural-conservation-planning-framework-acpf-toolbox

[99] European Space Agency Sentinel-1 synthetic aperture radar: https://earth.esa.int/web/guest/missions/esa-operational-eo-missions/sentinel-1

Helping Farmers Diversify Income, Enhance Local Food Capacity, and Improve Water Quality Through Agroforestry

By practicing agroforestry—the integration of trees with agriculture—farmers, ranchers, and forest owners are diversifying operations and enhancing water quality. Lands adjacent to rivers, streams and lakes, and low-performing lands can be planted with trees or shrubs to benefit water quality and to produce edible, medicinal, or ornamental products for home use or sale. Outcomes have included establishment of the Appalachian Beginning Forest Farmer Coalition[100] to provide education, training, and support to beginning forest farmers and technical assistance providers. Virginia Tech and the USDA National Agroforestry Center (NAC)[101] created a tool to determine the economic benefits of adding edible and floral forest products to riparian forest buffers. Additionally, they are developing recommendations and practical tools for merging Virginia's nutrient credit trading markets and agroforestry production in Virginia's region of the Chesapeake Bay Watershed[102].

Helping Ranchers Increase Enterprise Flexibility With Multistate Analysis of Seasonal Weather

Ranching is a challenging and sometimes risky business with cattle production (and associated enterprise income) largely being dependent on seasonal weather patterns and corresponding forage production. ARS is working with the USDA Regional Climate Hub[103] to develop GrassCAST[104], a new, regionally tailored forecast of estimated grassland production that gives grazing land managers the tools they need to plan their grazing strategies. This type of science-based knowledge, practical information, management, conservation strategies, and decision tools are critical to helping ranchers adapt to weather variability and changing climatic conditions to maintain livestock production and landscape scale conservation.

---

[100] Appalachian Beginning Forest Farmer Coalition: https://www.appalachianforestfarmers.org/

[101] USDA National Agroforestry Center (NAC): https://www.fs.usda.gov/nac/index.shtml

[102] Chesapeake Bay Watershed: https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/initiatives/?cid=stelprdb1047323

[103] USDA Climate Hubs: https://www.climatehubs.oce.usda.gov/#

[104] Developing Tools for Better Management of Rangeland, Pastures and Forages (GrassCAST Project): https://www.ars.usda.gov/research/project/?accnNo=433337

Goal 7 | Provide All Americans Access to a Safe, Nutritious, and Secure Food Supply

REE ACTION PLAN GOALS 4 & 5

REE ACTION PLAN
Nutrition and Childhood Obesity
(GOAL 4)

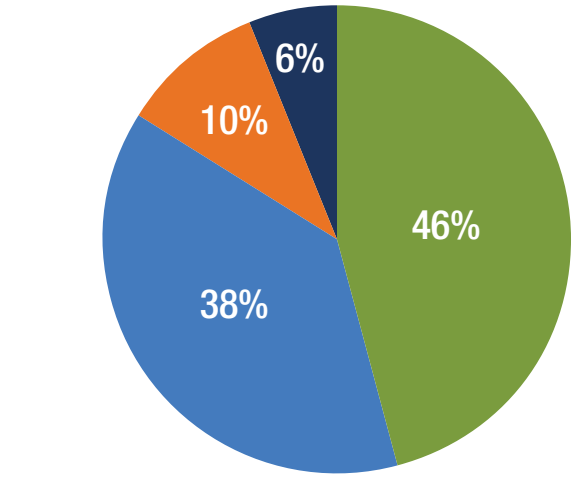
REE Objective: Promote health and reduce malnutrition and obesity in children and all individuals with emphasis on high-risk populations.

REE Research Examines How USDA School Meals and a Healthy School Environment Can Improve Children's Diets

Through the USDA National School Lunch Program (NSLP)[105], more than 30 million children receive lunch every school day, while more than 14.5 million children eat breakfast through the School Breakfast Program (SBP)[106]. In 2016, 73 percent of lunches and 85 percent of breakfasts were served at free or reduced-price, making them an important part of the nutrition safety net for low-income children. In 2015, 17 percent of households with children were classified as food insecure, with 8 percent of children reported to be food insecure. Food insecurity among children has been associated with negative health, social, and academic outcomes. An ERS review found that NSLP participation was associated with significantly lower rates of food insecurity among households with children after accounting for other factors.

The ERS review also found that school meals were important sources of the more nutritious foods consumed by low-income children and those from food-insecure households. Similarly, ARS researchers[107 108], using nationally representative data collected from 2007-2012, found that the NSLP and SBP meals made substantial contributions to the diets of children who ate both meals on a given school day. For these children—82 percent from low-income households—the meals contributed 47 percent of their total energy intake, 58 percent of fruit intake, and 77 percent of their milk intake.

Recipients of Free or Reduced-Price School Lunches[110]



SNAP = Supplemental Nutrition Assistance Program

Note: Food insecurity and program participation measured during the 30-day period in mid-December for households with annual incomes below 185 percent of the Federal poverty line and school-age children (ages 5-17)

In 2010, the Healthy, Hunger-Free Kids Act[109] mandated updated nutrition standards for USDA school meals. In response, current school meals contain more whole fruit, whole grains; schools serve only low or nonfat milk and serve a nutritious mix of vegetables including dark green and red/orange vegetables and legumes. The Act also mandated updated standards for non-USDA foods sold at school (often referred to as "competitive foods"). Given the central role of schools in children's lives, these changes have considerable potential to improve their dietary intakes and shape better long-term eating habits.

---

105 National School Lunch Program (NSLP): https://www.fns.usda.gov/nslp/national-school-lunch-program-nslp

106 School Breakfast Program (SBP): https://www.fns.usda.gov/sbp/school-breakfast-program-sbp

107 Cullen KW & Dave JM. The new Federal school nutrition standards and meal patterns: Early evidence examining the influence on student dietary behavior and the school food environment. J Acad Nutr Diet. 2017;117(2):185-191.

108 Cullen KW & Chen TA. The contribution of the USDA school breakfast and lunch program meals to student daily dietary intake. *Prev Med Rep.* 2016;5:82-85.

109 Healthy Hunger-Free Kids Act: https://www.fns.usda.gov/school-meals/healthy-hunger-free-kids-act

110 "Children's Food Security and USDA Child Nutrition Programs, Economic Information Bulletin Number 174, https://www.ers.usda.gov/webdocs/publications/84003/eib-174.pdf?v=0

Changes in school lunch standards began to be implemented in 2012, breakfast changes in 2013, and competitive food standards in 2014. National data on the impact of these changes are not yet available, but an ARS review of small, local studies indicates that these changes have improved the school food environment, making healthier foods more generally available, and reducing availability of candy and several higher fat items. Effects on selection and consumption were less conclusive; there was some evidence of improved vegetable consumption, but effects varied across studies and food waste was a concern. Further research using nationally representative data will be necessary to fully assess impacts of current USDA school meal policies and programs. However, results suggest that the updated standards have changed the school food environment but additional strategies to promote consumption may be valuable.

Offering more local fruits, vegetables, and other foods has been suggested as a means of improving the appeal of these foods. USDA's Farm-To-School Program[111] assists schools to serve locally produced foods. Many farm-to-school programs also provide hands-on learning experiences such as school gardening and cooking activities, farm visits, and other food and agriculture activities integrated into the educational curriculum. ERS research has found that 35 percent of all U.S. school districts served local foods in school meals during the 2011-12 school year. Districts in counties with a higher density of farmers' markets and in States with more legislated policies supporting farm-to-school programs were more likely to serve local foods daily, as were districts that were larger, urban, and with more affluent, educated populations.

NIFA-sponsored researchers have developed creative strategies to engage students in further improving their food environment. A study conducted in a rural Oregon county engaged 4-H youth participants as advocates for healthy snacking and healthy environmental changes within their schools and food stores near schools. After the intervention, teachers in intervention schools were less likely to use unhealthy food as rewards for students than teachers in control schools. The mean availability of healthy snacks and beverages in food stores near intervention schools increased by 21 percent, while mean availability of these products decreased in stores near control schools.

ARS Research Informing Dietary Guidance for Infants and Young Children

Information on consumption of foods and beverages by young children is limited and baseline data are needed to prepare for the 2020-2025 Dietary Guidelines for Americans, which will include recommendations for children under 2 years of age for the first time. ARS researchers used national data from over 2,700 children aged 0-24 months collected in the National Health and Nutrition Examination Survey (NHANES)[112] to document early beverage consumption patterns. Formula and breast milk were the most common beverages for infants under 1 year of age. In toddlers from 1-2 years, plain milk, water, 100 percent fruit juice, and sweetened beverages were—in that order—the most often provided by caregivers. Non-Hispanic, Black, and Mexican-American children were more likely to consume sweetened beverages, 100 percent fruit juice, and infant formula than non-Hispanic White children. The same pattern of consumption was seen in children from lower income households. This data documents disparity in beverage consumption by race/ethnicity and income level early in life that may relate to later excess weight gain.

[111] USDA's Farm-To-School Program: https://www.fns.usda.gov/farmtoschool/farm-school

[112] National Health and Nutrition Examination Survey: https://www.cdc.gov/nchs/nhanes/index.htm

USDA National Household Food Acquisition and Purchase Survey Informs on the Importance of USDA's Supplemental Nutrition Assistance Program to Low-Income Households With Children

USDA's Supplemental Nutrition Assistance Program (SNAP)[113] provides low-income households with food purchasing benefits intended to allow them to purchase a nutritionally adequate diet. In 2014, approximately one in four American children was part of a household receiving SNAP benefits. Previous research has shown that SNAP reduces food insecurity and alleviates poverty, especially among households with children. Recently, ERS and the Food and Nutrition Service (FNS) collaborated to conduct the National Household Food Acquisition and Purchase Survey (FoodAPS)[114], which collected detailed information on the foods purchased by a national sample of American households over the course of a week. The survey oversampled SNAP-participating households, providing a unique opportunity to conduct a detailed analysis of the food-spending patterns of SNAP households. Even with SNAP benefits, participating households spend less on food than higher income households. Higher income ineligible households spend roughly 25 percent more on food from grocery stores and other sources to be prepared at home as SNAP households and almost three times as much on restaurant and other food prepared away from home. For SNAP-participating households with children, SNAP contributes 68 percent of spending for food purchased from grocery stores and other retailers for at-home consumption, demonstrating its importance to children's food security.

[113] Supplemental Nutrition Assistance Program (SNAP): https://www.fns.usda.gov/snap/supplemental-nutrition-assistance-program-snap

[114] FoodAPS National Household Food Acquisition and Purchase Survey https://www.ers.usda.gov/data-products/foodaps-national-household-food-acquisition-and-purchase-survey/

NIFA Research Develops Obesity Prevention Intervention in Early Child-Care Setting

One in four U.S. children under age 5 years is either overweight or obese. Many low-income and ethnic-minority children receive out-of-home care in federally or State-subsidized childcare, where meals are provided according to nutrition standards established by the USDA Child and Adult Care Food Program (CACFP)[115]. A NIFA-funded study built on this foundation to develop, test, and evaluate a multifaceted obesity prevention intervention in the early child-care setting, targeting low-income, multi-ethnic children. The intervention included daily curricula for teachers, parents, children, snacks, beverages, physical activity, and screen time policies. It also provided technical assistance with menu modifications. Children and parents were followed for a period of 3 years, with both children and parents improving on several dietary behaviors that were maintained 12 to 18 months after the intervention had ended. Half (50 percent) of the obese and 54 percent of the overweight children in intervention schools decreased their Body Mass Index (BMI) percentile at the 18-month followup, indicating improvement in weight status, while the control group did not show similar improvement. These findings suggest that childcare centers can be feasible, effective settings to promote healthy eating behaviors and physical activity for young children who may be at risk for becoming overweight.

[115] Child and Adult Care Food Program (CACFP): https://www.fns.usda.gov/cacfp/child-and-adult-care-food-program

REE ACTION PLAN
Food Safety **(GOAL 5)**

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

USDA Food Safety Science Supports Our Industry Partners

REE activities in research, education, and extension help farmers and other producers, processors, and retailers of food. For example, ARS researchers[116] developed an innovative solution for farmers to control the production of dangerous toxins in grains and tree-nuts. This research has helped saved lives as aflatoxin is a potent carcinogen causing liver cancer, immune suppression, and stunting in children. This breakthrough technology, referred to as "biocontrol," is approved by the United States Environmental Protection Agency (US-EPA)[117] as a biopesticide and is now widely used in the United States to reduce aflatoxin production throughout the value chain. The technology involves the use of a mixture of atoxigenic (non-toxic) strains originating from the environment where the crops are grown. These strains outcompete and displace the aflatoxin producing fungi, thus reducing contamination and toxin production. Biocontrol through competitive exclusion is the only technology ready for wide-scale dissemination for aflatoxin control. The Texas Corn Producers Board[118] and the Arizona Cotton Research and Protection Council[119] are long-term supporters of this ARS research. These industry partners have worked with ARS to perform trials of this biopesticide and helped other industry groups by supplying product to other States, including California and New Mexico, for their use. This ARS research also has an international component through the International Institute of Tropical Agriculture (IITA)[120], the Foreign Agricultural Service (FAS)[121], and the Bill and Melinda Gates Foundation[122]. Additionally, implementation in Nigeria and Kenya has had a positive effect on human health, as well as economic benefits. Finally, this research has and continues to bring significant economic benefits to the United States.

---

116 Improvement of Biological Control of Aflatoxin Contamination with Atoxigenic Strains of Aspergillus flavus on Cotton, Corn, and Pistachios: https://www.ars.usda.gov/research/project/?accnNo=426179

117 United States Environmental Protection Agency (US-EPA): https://www.epa.gov/

118 Texas Corn Producers Board: http://texascorn.org/

119 Arizona Cotton Research and Protection Council: http://azcotton.org/

120 International Institute of Tropical Agriculture (IITA): http://www.iita.org/

121 USDA-Foreign Agricultural Service (FAS): https://www.fas.usda.gov/

122 The Bill and Melinda Gates Foundation: https://www.gatesfoundation.org/

ERS is also studying the effect of industry incentives to improve the safety of chicken. In 2006, the Food Safety and Inspection Service (FSIS)[123] started disclosing the identities of chicken slaughter establishments with poor or mediocre performance on tests for *Salmonella.* ERS researchers found that public disclosure of the identities of such establishments was strongly correlated with a substantial drop in *Salmonella* in chicken. The reduction in *Salmonella* levels demonstrated that the FSIS *Salmonella* standard on carcasses of young chickens could be lowered. FSIS then reduced its *Salmonella* standard on young chicken carcasses by more than 50 percent in 2011.

Another area of food safety concern is antimicrobials. Antimicrobials are commonly used in agriculture for both therapeutic and prophylactic purposes. Farmers are seeking alternatives to antimicrobials due to concerns by the public for the potential for antimicrobial resistance. NIFA has been funding research, education, and extension activities focused on reducing antimicrobial-resistant bacteria in animal and crop production. A team at Kansas State University and Texas A& M University is disseminating information to assess the relative risks and benefits of various alternatives to antibiotics used for swine and cattle production through a new website: KSUantibiotics.org[124]. Findings indicate that dairy manure can be a source of antimicrobial-resistant genes which can enter the human food chain when manure is used to fertilize croplands. NIFA's Antimicrobial Resistance (AMR) program[125] funded research that evaluated manure treatment systems and the critical control points at which dairy farm operations can prevent the spread of antimicrobial resistance from "farm to fork." Investigators identified important parameters for optimum removal of certain antimicrobials. In addition, plant-uptake experiments were conducted to determine if certain types of manure treatment systems, combined with appropriate manure application in crop fertilization, can prevent the spread of antimicrobial resistance from "farm to fork."

---

[123] Food Safety and Inspection Service (FSIS): https://www.fsis.usda.gov/wps/portal/fsis/home

[124] Public Disclosure of Tests for Salmonella: The Effects on Food Safety Performance in Chicken Slaughter Establishments: https://www.ers.usda.gov/webdocs/publications/83661/err-231.pdf?v=42880

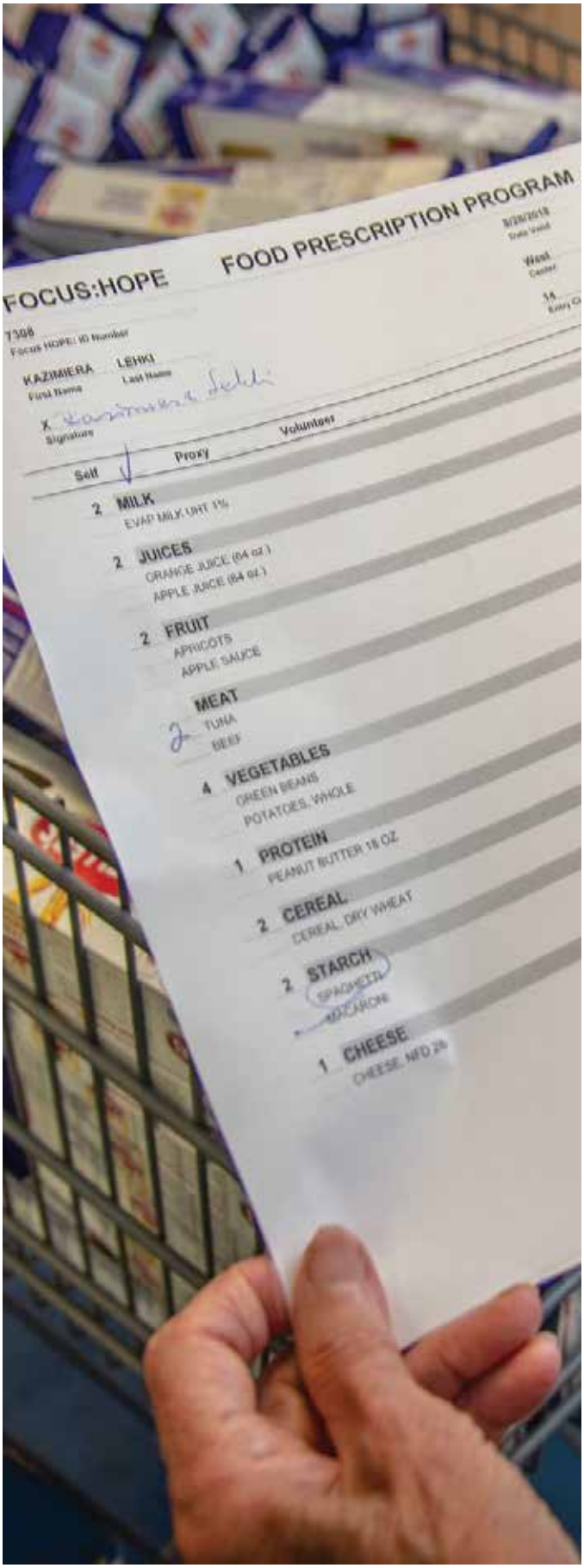
[125] KSU Antibiotics in Livestock Production: https://www.asi.k-State.edu/research-and-extension/antibiotics/index.html

Enhancing Food Security in the Northeast Through Regional Food Systems

More than 7 million people in the Northeastern United States communities are food insecure. Low-income families disproportionately face many barriers that affect their access to healthy and affordable foods. This problem was tackled head-on by the USDA-funded Enhancing Food Security in the Northeast (EFSNE) project. The project was designed to determine whether greater reliance on regionally produced food could improve food access to low-income communities, while also benefiting regional farmers, food supply chain firms, and other participants in the food system. The project focused on low-income community sites within 9 locations across the northeast, defined as 12 States from Maine to West Virginia and the District of Columbia.

The team found out that half of the land in the region was devoted to production of livestock feed, but only about one-tenth of it was used to produce food crops like grains, fruits, and vegetables. Therefore, the region is far more self-reliant for animal-based foods such as dairy and eggs, and less for food crops. The project also found that the region's ability to provide for its own consumption of potatoes could be increased from 33 percent to 41 percent above what it is now using different land-use configurations and irrigation management options. However, unless farmers prepare to use adaptive measures to manage increasing temperatures during the growing season, potato yields could be reduced up to 70 percent by mid-century.

Bringing together this diverse group of researchers, educators, entrepreneurs, and community leaders had other benefits as well. The project established an eXtension[126] community of practice for Community, Local, and Regional Food Systems that now engages more than 360 members and has provided resources to more than 250 Extension educators. New courses on food systems were also developed at Tufts University and Penn State, including an undergraduate student internship program that was offered for 3 consecutive years.



[126] USDA-NIFA's Antimicrobial Resistance (AMR) Program: https://nifa.usda.gov/antimicrobial-resistance

This 90-member EFSNE project has generated strong interest from many food system enthusiasts in the Northeast United States, as well as nationally. The team has served as a model for engaging the entire supply food chain from production to consumption, determining the actual amounts of food that can be produced and consumed within a region, identifying the ways food is distributed, and designing ways to better meet needs of all people.

Global Incidence and Burden of Foodborne Disease

Better information on the extent and distribution of foodborne disease globally provides a foundation for strengthening food safety around the world, including in countries that export to the United States. In FY 2017, an ERS researcher was the lead author on a paper publishing the first set of global estimates attributing the incidence of major foodborne enteric illnesses to specific food exposures[127], e.g., salmonellosis from chicken consumption. In collaboration with faculty at the Technical University of Denmark, ERS provided the first global estimates of the percentage of enteric illnesses that are foodborne. These attribution estimates are provided for 11 major foodborne pathogens for all 14 of

the World Health Organization's (WHO)[128] global burden of disease world subregions. FSIS supported the WHO research initiative as a means of strengthening USDA and U.S. Food and Drug Administration[129] capacity to assure the safety of U.S. food imports.

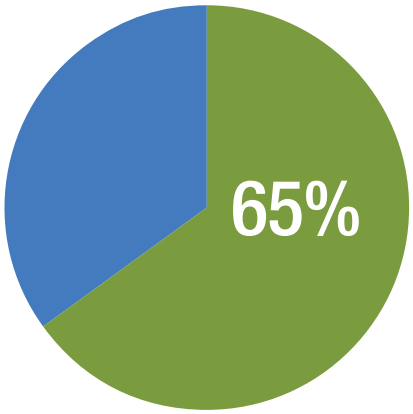
---

[127] Expanded Food and Nutrition Education Program (EFNEP): https://nifa.usda.gov/program/expanded-food-and-nutrition-education-program-efnep

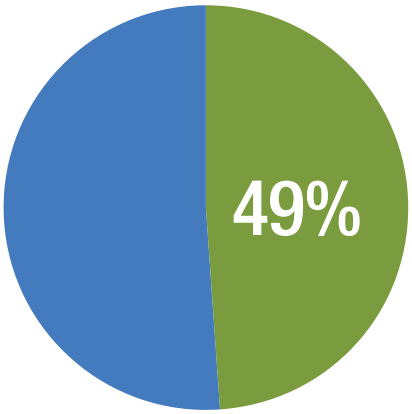
[128] WHO estimates of the global burden of foodborne diseases: http://www.who.int/foodsafety/publications/foodborne_disease/fergreport/en/

[129] World Health Organization's (WHO): http://www.who.int/en/

Impact of Expanded Food and Nutrition Education Program[132]



Percentage of adults improving food safety practices



Percentage of youth improving food safety and preparation knowledge or practices

All Things Bugs, LLC: Insects as a Food Ingredient

NIFA has funded research on how insects can be a potential source of food or food ingredients. Aaron T. Dossey from All Thing Bugs, LLC[130] successfully developed a patent-pending technology for generating high quality, safe powder products made from at least three species of insects: (1) cricket, (2) mealworm, and (3) waxworm. Griopro® **cricket powder**[131] ingredient product was developed under the Small Business Innovation Research Program (SBIR)[132] Phases I and II and has been commercialized successfully. The proprietary Griopro® cricket powder ingredient proved to be a safe, functional, and high-quality ingredient in several food and beverage products including: tortillas, pastas, taco meat, sausages, cereals, puffed extruded snacks, baked goods, protein bars, protein shakes, extruded rice pastas, and other products. Dossey was able to demonstrate that the process used destroyed any potential foodborne pathogens. Furthermore, the incorporation of this ingredient into these products at levels ranging from 15-30 percent did not negatively impact any of the products based on structural integrity, color, or aroma. Dossey also discovered that he could produce alternative meats (taco meat, sausage, etc.) made using 100 percent insect powders (plus water and seasoning) with no other ingredients.

The Expanded Food Nutrition Education Program (EFNEP)

In 2016, EFNEP employed 1,908 educators who are members of the communities they served. In turn, EFNEP educators worked directly with 118,976 adults and 365,369 youth. These educators tailored lessons on diet quality to include food safety[133]. In 2016, an average of 65 percent of adult graduates improved their food safety practices and 49 percent of youth improved their food safety knowledge or practices, such as storing, thawing, and preparing food safely. Furthermore, the EFNEP education in nutrition and food safety led one participant to find a satisfactory job using her newly acquired knowledge to secure a job in the food service industry. Upon being hired, the participant's employer shared that she had earned a higher starting pay rate because she held an EFNEP Certificate, demonstrating her food safety knowledge. The additional benefits of this training included the participant and her daughter being able to move from a homeless shelter into an apartment of their own. The EFNEP training and newly acquired job enabled this woman to create a new life for herself and her daughter.

---

130 U.S. Food and Drug Administration (FDA): https://www.fda.gov/

131 All Thing Bugs, LLC: http://allthingsbugs.com/

132 Small Business Innovation Research Program (SBIR): https://nifa.usda.gov/program/small-business-innovation-research-program-sbir

133 2016 Impacts: The Expanded Food and Nutrition Education Program (EFNEP), https://nifa.usda.gov/sites/default/files/resource/EFNEP%20Impact%20Data%20Report%202016%20FINAL.pdf

Performance Metrics by Agency

REE Goal Measure	ARS		ERS	
	FY 2016	FY 2017	FY 2016	FY 2017
Peer-reviewed journal articles, publications, and monographs	3,610	4,120	152	128
Non-peer reviewed publications	754	737	118	117
Material transfer agreements	468	664	N/A	N/A
Number of new inventions	127	115	N/A	N/A
Number of patents issued	58	58	N/A	N/A
New incoming agreements	596	621	N/A	N/A
New or updated digital data products, online tools and applications	477	463	100	100
Information, analysis and research findings provided in form of briefings or reports to decision makers and policy makers	135	167	511	419
Federal Register Notices or other Government use of research data	N/A	N/A	46	46
Direct contact by extension (# of contacts)	N/A	N/A	N/A	N/A
Number of extramural/outgoing grants/agreements awarded	554	732	N/A	N/A
Extension professional FTEs from Formula grants	N/A	N/A	N/A	N/A
Scientist years for Formula grant projects	N/A	N/A	N/A	N/A
New plant varieties and germplasm lines	100	133	N/A	N/A
Funding to external organizations - research	$102,226,000	$116,555,600	N/A	N/A
Funding to minority serving institutions	$12,477,000	$13,270,600	N/A	N/A
Survey of customer satisfaction done within the past 3 years	N/A	N/A	N/A	N/A
Additional funds leveraged from all grants to other organizations, including formula grant projects	$20,445,200	$23,311,100	N/A	N/A

ARS = Agricultural Research Service

ERS = Economic Research Service

NASS = National Agricultural Statistics Service

NIFA = National Institute of Food and Agriculture

FS R&D = Forest Service Research and Development

FTE = Full Time Equivalent

N/A = Not Applicable

NASS		NIFA		FS R&D		TOTALS	
FY 2016	FY 2017	FY 2016	FY 2017	FY 2016	FY 2017	FY 2016	FY 2017
5	13	22,443	23,839	540	652	26,750	28,752
8	29	10,045	8,167	72	69	10,997	9,169
N/A	N/A	N/A	N/A	N/A	N/A	468	664
N/A	N/A	152	216	-	11	279	342
N/A	N/A	32	21	N/A	9	90	88
150	130	N/A	N/A	N/A	N/A	746	751
8	6	696	702	26	49	1,307	1,320
20	20	N/A	N/A	N/A	N/A	666	606
36	20	N/A	N/A	N/A	N/A	82	66
N/A	N/A	67,961,434	63,655,419	N/A	261,936	67,961,434	63,917,355
N/A	N/A	2014	1,978	N/A	1,125	2,568	3,835
N/A	N/A	10,578	10,695	N/A	N/A	10,578	10,695
N/A	N/A	6,131	-	N/A	N/A	6,131	-
N/A	N/A	222	177	N/A	N/A	322	310
60	60	$973,421,000	$808,018,747	N/A	$55,051,105	$1,075,647,060	$979,625,512
14	14	$108,797,775	$110,693,963	N/A	$5,285,764	$121,274,789	$129,250,341
73	73	N/A	N/A	N/A	Yes	73	73
N/A	N/A	$2,393,620,000	-	N/A	$17,189,472	$2,414,065,200	$40,500,572

Performance Metrics by Goal Area

REE Goal Measure	Goal 1A FY 2017	Goal 1B FY 2017	Goal 1C FY 2017	Goal 1D* FY 2017
Peer-reviewed journal articles, publications, and monographs	4,782	5,795	2,748	1,827
Non-peer reviewed publications	1,580	1,262	483	1,025
Material transfer agreements	41	191	283	-
Number of new inventions	225	252	235	216
Number of patents issued	27	45	29	21
New incoming agreements	92	178	128	-
New or updated digital data products, online tools and applications	199	245	153	58
Information, analysis and research findings provided in form of briefings or reports to decision makers and policy makers	80	121	19	-
Federal Register Notices or other Government use of research data	4	3	-	-
Direct contact by extension (# of contacts)	8,142,803	3,694,655	567,765	6,422,899
Number of extramural/outgoing grants/agreements awarded	2,091	2,175	2,141	1,978
Extension professional FTEs from Formula grants	1,510	730	158	1,333
Scientist years for Formula grant projects	-	-	-	-
New plant varieties and germplasm lines	47	27	217	-

ARS = Agricultural Research Service

ERS = Economic Research Service

NASS = National Agricultural Statistics Service

NIFA = National Institute of Food and Agriculture

FS R&D = Forest Service Research and Development

FTE = Full Time Equivalent

* Goal 1D was not reported in the FY 2016 Progress Report

Goal 2A FY 2017	Goal 2B FY 2017	Goal 3A FY 2017	Goal 3B FY 2017	Goal 4 FY 2017	Goal 5 FY 2017	Goal 6 FY 2017	Goal 7 FY 2017
2,566	1,124	1,516	3,226	2,613	1,013	163	1,148
610	184	349	686	985	238	77	1,544
8	58	3	11	16	53	-	-
222	244	219	221	216	225	216	216
22	34	21	22	21	26	21	21
35	75	48	24	15	26	-	-
156	25	94	166	59	42	29	51
53	14	32	35	63	35	5	80
2	-	2	2	7	3	-	15
1,931,006	104,246	1,283,273	2,803,891	11,833,336	859,966	693,839	25,434,905
2,035	2,006	2,035	2,004	2,016	2,031	1,979	1,978
427	63	336	499	1,884	211	82	3,416
-	-	-	-	-	-	-	-
3	-	2	5	6	-	-	-

Report Acronyms

ACP	Asian Citrus Psyllid
ACPF	Agricultural Conservation Planning Framework
AFRI	Agriculture and Food Research Initiative
AG	Agricultural
AMR	Antimicrobial Resistance
APS	American Phytopathology Society
ARS	Agricultural Research Service
AWD	Alternate Wetting and Drying
BANR	Bioenergy Alliance Network of the Rockies
BRDI	Biomass Research and Development Initiative
BLM	Bureau of Land Management
CACFP	USDA Child and Adult Care Food Program
CAES	The Connecticut Agricultural Experiment Station
CANARY	Cellular Analysis and Notification of Antigen Risks and Yields
CAP	Coordinated Agricultural Project
CD	Controlled Drainage
CEAP	Conservation Effects Assessment Program
CIMMYT	International Maize and Wheat Improvement Center (Centro Internacional de Mejoramiento de Maíz y Trigo)
CLas	Candidatus Liberibacter asiaticus
CO2	Carbon Dioxide
CRISPR	Clustered Regularly Interspaced Short Palindromic Repeats
CRP	Conservation Reserve Program
CSA	Community Supported Agriculture
DOD	Department of Defense
DOE	Department of Energy
DSL	Digital Subscriber Line
DWR	Drainage Water Recycling
EFNEP	Expanded Food and Nutrition Education Program
EFSNE	Enhancing Food Security in the Northeast
EQIP	Environmental Quality Incentives Program
ERS	Economic Research Service
ESA	European Space Agency
ET	Evapotranspiration
EU	European Union
FAS	Foreign Agricultural Service
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FFFB	Farm Fresh Food Boxes
FoodAPS	National Household Food Acquisition and Purchase Survey
FOAM	F-One Association Mapping
FS	Forest Service
FSA	Farm Service Agency
FSIS	Food Safety and Inspection Service
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GPA	Grade Point Average
GPS	Global Positioning System
HABs	Harmful Algal Blooms
HELC	Highly Erodible Land Compliance

IITA	International Institute of Tropical Agriculture
KYF2	Know Your Farmer, Know Your Food Initiative
KSU	Kansas State University
LCA	Life Cycle Assessment
LGUs	Land-Grant Universities
NAC	National Agroforestry Center
NAL	National Agricultural Library
NANP	National Animal Nutrition Program
NAP	Noninsured Crop Disaster Assistance Program
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NASS	National Agricultural Statistics Service
NCASI	National Council for Air and Stream Improvement
NHANES	National Health and Nutrition Examination Survey
NIFA	National Institute of Food and Agriculture
NOAA	National Oceanic Atmospheric Administration
NRCS	Natural Resources Conservation Service
NRI	National Robotics Initiative
NSF	National Science Foundation
NSLP	National School Lunch Program
NPP	Predicted Net Primary Productivity
OCE	Office of the Chief Economist
OECD	Organization for Economic Co-operation and Development
PARS	Planning, Accountability, and Reporting
PEDV	Porcine Epidemic Diarrhea Virus
PineRefSeq	Pine Reference Sequences
PPEFC	Pork Production Environmental Footprint Calculator
R&D	Research and Development
REE	Research, Education, and Economics
RHEM	Rangeland Hydrology and Erosion Model
RIC	Rural Information Center
RMA	Risk Management Agency
RPS	Renewable Portfolio Standard
SBIR	Small Business Innovation Research Program
SBP	School Breakfast Program
SCRI	Specialty Crop Research Initiative
SERCH LIGHTS	Southeast Hub's Lately Identified Geospatial Hazard Tracking System
SNAP	Supplemental Nutrition Assistance Program
STEM	Science, Technology, Engineering, and Math
STRIPS	Science-based Trials of Rowcrops Integrated with Prairie Strips
TOTAL	Tenure, Ownership, and Transition of Land
UC	University of California
US-EPA	United States Environmental Protection Agency
USGS	U.S. Geological Survey
USDA	United States Department of Agriculture
VIC	Variable Infiltration Capacity
WHO	World Health Organization

Links to Supplemental Materials

Introduction

The REE 2014 Action Plan: https://www.ree.usda.gov/sites/www.ree.usda.gov/files/2017-07/2014REEActionPlanReportFINAL.pdf

Goal 1: Sustainable Intensification of Agricultural Production

SUBGOAL 1A Plant (Crop) and Animal Production

Ceres Imaging: http://www.ceresimaging.net

USDA Rangeland and Pasture Research Lab, Woodward, OK: https://www.ars.usda.gov/plains-area/sprrs/rangeland-and-pasture-research

USDA Range and Livestock Research Lab, Miles City, MT: https://www.ars.usda.gov/plains-area/miles-city-mt/range-and-livestock-research

USDA Meat Animal Research Center, Clay Center, NE: https://www.ars.usda.gov/plains-area/clay-center-ne/marc

The Connecticut Agricultural Experiment Station: http://www.ct.gov/caes/site/default.asp

USDA Announces $5.2 Million for Nanotechnology Research: https://content.govdelivery.com/accounts/USDAOC/bulletins/14015c9

FY 2016 Annual Report on Technology Transfer: https://www.usda.gov/sites/default/files/documents/usda-fy16-tech-transfer-report.pdf

Food insecurity: https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/definitions-of-food-security

Enhancing Food Security in the Northeast Project (EFSNE): http://agsci.psu.edu/research/food-security

Cost of Pollination Survey Report: https://www.nass.usda.gov/Publications/Methodology_and_Data_Quality/Cost_of_Pollination/04_2017/polcos16.pdf

Land Use, Land Cover, and Pollinator Health: A Review and Trend Analysis: https://www.ers.usda.gov/webdocs/publications/84035/err-232.pdf?v=42908

The Eastern Broccoli Project: https://blogs.cornell.edu/easternbroccoliproject

SUBGOAL 1B Crop and Animal Health

USDA-ERS Fruit and Tree Nuts Outlook, September 29, 2017: https://www.ers.usda.gov/webdocs/publications/85287/fts-365.pdf?v=43007

NIFA Specialty Crop Research Initiative (SCRI): https://nifa.usda.gov/funding-opportunity/specialty-crop-research-initiative-scri

Pathsensors: https://pathsensors.com

MIT Cellular Analysis and Notification of Antigen Risks and Yields (CANARY): https://www.ll.mit.edu/publications/technotes/TechNote_CANARY.pdf

American Phytopathology Society (APS): http://www.apsnet.org/Pages/default.aspx

ARS National Clonal Germplasm Repository for Citrus and Dates, Riverside, CA: https://www.ars.usda.gov/pacific-west-area/riverside-ca/national-clonal-germplasm-repository-for-citrus

ARS's National Laboratory for Genetic Resources Preservation, Fort Collins, CO: https://www.ars.usda.gov/plains-area/fort-collins-co/center-for-agricultural-resources-research/plant-and-animal-genetic-resources-preservation

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

ARS Cool and Cold Water Agriculture Research Lab, Leetown, WV: https://www.ars.usda.gov/northeast-area/leetown-wv/cool-and-cold-water-aquaculture-research

International Maize and Wheat Improvement Center (CIMMYT): http://www.cimmyt.org

Maize study finds genes that help crops adapt to change: http://news.cornell.edu/stories/2017/02/maize-study-finds-genes-help-crops-adapt-change

Pine Reference Sequences (PineRefSeq): http://pinegenome.org/pinerefseq

International Wheat Yield Partnership Program: http://iwyp.org

The 2016 Certified Organic Survey: https://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Organic_Production/index.php

USDA's Risk Management Agency (RMA): https://www.rma.usda.gov

"Certified Organic Survey, 2016 Summary": https://www.nass.usda.gov/Publications/Todays_Reports/reports/census17.pdf

SUBGOAL 1D Consumer and Industry Outreach, Policy, Markets, and Trade

Major Uses of Land in the United States, 2012: https://www.ers.usda.gov/publications/pub-details/?pubid=84879

Tenure, Ownership, and Transition of Land (TOTAL): https://www.agcensus.usda.gov/Publications/TOTAL

U.S. Geological Survey (USGS): https://www.usgs.gov

Major Uses of Land in the United States, 2012: https://www.ers.usda.gov/publications/pub-details/?pubid=84879

Federal Crop Insurance: https://www.rma.usda.gov/fcic

Noninsured Crop Disaster Assistance Program (NAP): https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/noninsured-crop-disaster-assistance/index

Changes to the Noninsured Crop Disaster Assistance Program Under the Agricultural Act of 2014: Their Potential Risk Reduction Impacts: https://www.ers.usda.gov/publications/pub-details/?pubid=83650

Conservation Compliance: How Farmer Incentives Are Changing in the Crop Insurance Era: https://www.ers.usda.gov/publications/pub-details/?pubid=84456

Farm Fresh Food Boxes (FFFB): https://reeis.usda.gov/web/crisprojectpages/1008781-farm-fresh-food-boxes-expanding-rural-economies-through-new-markets-for-farmers-and-retailers.html

Goal 2: Responding to Climate and Energy Needs

SUBGOAL 2A Responding to Climate Variability

Federal Emergency Management Agency (FEMA): www.fema.gov

European Space Agency (ESA): http://www.esa.int/ESA

National Oceanic Atmospheric Administration (NOAA): http://www.noaa.gov

AgroClimate Workbook: http://www.agroclimate.org

Strawberry Advisory System: http://agroclimate.org/tools/sas

Caribbean Climate Hub: https://www.climatehubs.oce.usda.gov/hubs/caribbean

Southeast Hub's Lately Identified Geospatial Hazard Tracking System (SERCH LIGHTS): https://globalchange.ncsu.edu/serch/tools-services/serch-lights

The Monthly Drought Alert: https://www.climatehubs.oce.usda.gov/hubs/southeast/tools/serch-lights-monthly-drought-outlook-email-alert

Links to Supplemental Materials

Cattle Heat Stress Alert: https://www.climatehubs.oce.usda.gov/hubs/southeast/tools/serch-lights-cattle-heat-stress-alert

Seedlot Selection Tool: https://seedlotselectiontool.org/sst

Northwest Climate Hub: https://www.climatehubs.oce.usda.gov/hubs/northwest

Northern Forests Hub: https://www.climatehubs.oce.usda.gov/hubs/northern-forests

Pork Production Environmental Footprint Calculator (PPEFC): https://www.pork.org/environment/environmental-impact-pig-farming

National Pork Board: https://www.pork.org

USDA Life Cycle Assessment (LCA) Commons: https://www.lcacommons.gov

Rangeland Hydrology and Erosion Model (RHEM): https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045656.pdf

Ecological Site Descriptions: https://esis.sc.egov.usda.gov/Welcome/pgReportLocation.aspx?type=ESD

Natural Resources Conservation Service (NRCS): https://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home

Bureau of Land Management (BLM): https://www.blm.gov

Subgoal 2B Bioenergy/Biofuels, and Biobased Products

Biomass Research and Development Initiative (BRDI): https://nifa.usda.gov/funding-opportunity/biomass-research-and-development-initiative-brdi

Cooper Tire: http://us.coopertire.com

U.S. Arid Land Agricultural Research Center: Maricopa, AZ: https://www.ars.usda.gov/pacific-west-area/maricopa-arizona/us-arid-land-agricultural-research-center

Western Regional Research Center: Albany, CA: https://www.ars.usda.gov/pacific-west-area/albany-ca/wrrc

2014 Farm Bill's Energy Title Provisions: http://farmenergy.org/news/summary-2014-farm-bills-energy-title-provisions

2014 Farm Bill's Energy Title Provisions: http://farmenergy.org/news/summary-2014-farm-bills-energy-title-provisions

Dedicated Energy Crops and Competition for Agricultural Land (ERR-223): https://www.ers.usda.gov/publications/pub-details/?pubid=81902

Weyerhaeuser: https://www.weyerhaeuser.com

National Council for Air and Stream Improvement (NCASI): http://www.ncasi.org

Volume 1 of the 2016 Billion-Ton Report: https://energy.gov/eere/bioenergy/2016-billion-ton-report

Donner DM, TB Wigley, DA Miller. 2017. Forest biodiversity and woody biomass harvesting. Pages 399-449 In U.S. Department of Energy. 2017. 2016 Billion-Ton Report: Advancing domestic resources for a thriving bioeconomy, Volume 2: environmental sustainability effects of select scenarios from Volume 1. R.A. Efroymson, M.H. Langholtz, K.E. Johnson, and B.J. Stokes (Eds.), ORNL/TM-2016/727. Oak Ridge National Laboratory, Oak Ridge, TN 624 p. doi 10.2172/1338837: https://energy.gov/eere/bioenergy/downloads/2016-billion-ton-report-volume-2-environmental-sustainability-effects

National Center for Agricultural Utilization Research: Peoria, IL: https://www.ars.usda.gov/midwest-area/peoria-il/national-center-for-agricultural-utilization-research

Data.Gov: Open Government: https://www.data.gov/open-gov

National Agricultural Library (NAL): https://www.nal.usda.gov

Agriculture and Food Research Initiative (AFRI): https://nifa.usda.gov/program/agriculture-and-food-research-initiative-afri

The Sustainable Bioenergy Alliance Network of the Rockies (BANR): http://banr.nrel.colostate.edu

Goal 3: Sustainable Use of Natural Resources

SUBGOAL 3A Water Availability: Quality and Quantity

Western Lake Erie Basin CEAP Biological Endpoints Partnership: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/wa/home/?cid=stelprdb1047933

The 4Rs of nutrient stewardship: http://www.nutrientstewardship.com/4rs

Coastal Plain Soil, Water and Plant Conservation Research: Florence, SC: https://www.ars.usda.gov/southeast-area/florence-sc/coastal-plain-soil-water-and-plant-conservation-research

Conservation Effects Assessment Program (CEAP): https://www.ars.usda.gov/ceap

Conservation Reserve Program (CRP): https://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-program

An Overview of Hydrologic Studies at Center for Forested Wetlands Research, USDA Forest Service: https://www.fs.usda.gov/treesearch/pubs/7128

Great Lakes Harmful Algal Blooms and Hypoxia: Agricultural Aspects: https://www.nal.usda.gov/waic/great-lakes-harmful-algal-blooms-and-hypoxia-agricultural-aspects

Beltsville Agricultural Research Center: Beltsville, MD: https://www.ars.usda.gov/northeast-area/beltsville-md/beltsville-agricultural-research-center

Variable Infiltration Capacity (VIC) Macroscale Hydrologic Model: https://vic.readthedocs.io/en/master

SUBGOAL 3B Landscape-Scale Conservation, Management, and Resiliency

Conservation Compliance: How Farmer Incentives Are Changing in the Crop Insurance Era: https://www.ers.usda.gov/publications/pub-details/?pubid=84456

Environmental Quality Incentives Program (EQIP): https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip

Agricultural Conservation Planning Framework (ACPF): https://data.nal.usda.gov/dataset/agricultural-conservation-planning-framework-acpf-toolbox

European Space Agency Sentinel-1 synthetic aperture radar: https://earth.esa.int/web/guest/missions/esa-operational-eo-missions/sentinel-1

Appalachian Beginning Forest Farmer Coalition: https://www.appalachianforestfarmers.org

USDA National Agroforestry Center (NAC): https://www.fs.usda.gov/nac/index.shtml

Chesapeake Bay Watershed: https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/initiatives/?cid=stelprdb1047323

USDA Climate Hubs: https://www.climatehubs.oce.usda.gov/#

Developing Tools for Better Management of Rangeland, Pastures and Forages (GrassCAST Project): https://www.ars.usda.gov/research/project/?accnNo=433337

Links to Supplemental Materials

Goal 4: Nutrition and Childhood Obesity

National School Lunch Program (NSLP): https://www.fns.usda.gov/nslp/national-school-lunch-program-nslp

School Breakfast Program (SBP): https://www.fns.usda.gov/sbp/school-breakfast-program-sbp

Findholt, Nancy, Izumi, B, Shannon, J., Smith, C. "Engaging Youth as Advocates to Create Healthy Snacking Zones Around Rural Schools-Year 5" *Journal of Nutrition Education and Behavior.* 2017; 49(7):S113-S114.: http://www.jneb.org/article/S1499-4046(17)30358-5/abstract

Cullen KW & Dave JM. The new Federal school nutrition standards and meal patterns: Early evidence examining the influence on student dietary behavior and the school food environment. *J Acad Nutr Diet*. 2017;117(2):185-191.: https://www.sciencedirect.com/science/article/pii/S2212267216313363

Cullen KW & Chen TA. The contribution of the USDA school breakfast and lunch program meals to student daily dietary intake. *Prev Med Rep*. 2016;5:82-85.: https://reader.elsevier.com/reader/sd/B76A2D0DCA092DC0C3E7190EC523CA151E8C03DC199289DC2611F5BF1DB91F392A6A4661DF414779757ABC9EC1D9FDE4

Ralston K, Treen K, Coleman-Jensen A, Guthrie J. Children's Food Security and USDA Child Nutrition Programs. Economic Information Bulletin No. (EIB-174) 33 pp, June 2017.: https://www.ers.usda.gov/webdocs/publications/84003/eib-174.pdf?v=42905

Healthy Hunger-Free Kids Act: https://www.fns.usda.gov/school-meals/healthy-hunger-free-kids-act

USDA's Farm-To-School Program: https://www.fns.usda.gov/farmtoschool/farm-school

National Health and Nutrition Examination Survey: https://www.cdc.gov/nchs/nhanes/index.htm

Supplemental Nutrition Assistance Program (SNAP): https://www.fns.usda.gov/snap/supplemental-nutrition-assistance-program-snap

FoodAPS National Household Food Acquisition and Purchase Survey https://www.ers.usda.gov/data-products/foodaps-national-household-food-acquisition-and-purchase-survey

Child and Adult Care Food Program (CACFP): https://www.fns.usda.gov/cacfp/child-and-adult-care-food-program

Grimes CA, Szymlek-Gay EA, Nicklas TA. Beverage Consumption among U.S. Children Aged 0–24 Months: National Health and Nutrition Examination Survey (NHANES). *Nutrients*. 2017;9(3):264; doi:10.3390/nu9030264.: http://www.mdpi.com/2072-6643/9/3/264/htm

Tiehen L, Newman C, Kirlin, JA. The Food Spending Patterns of Households Participating in the Supplemental Nutrition Assistance Program: Findings From USDA's FoodAPS. EIB-176, 2017.: https://www.ers.usda.gov/webdocs/publications/84780/eib-176.pdf?v=42962

Messiah SE, Lebron C, Moises R, Mathew MS, Sardinas K, Chang C, Palenzuela J, Walsh J, Shelnutt KP, Spector R, Altare F, and Natale R. Healthy caregivers-healthy children (HC2) phase 2: Integrating culturally sensitive childhood obesity prevention strategies into childcare center policies. Contemporary Clinical Trials. 53 (2017) 60-67.: https://www.sciencedirect.com/science/article/pii/S1551714416303287/pdfft?md5=539db118843ae6ac9c48500daa39d42a&pid=1-s2.0-S1551714416303287-main.pdf

Goal 5: Food Safety

Improvement of Biological Control of Aflatoxin Contamination with Atoxigenic Strains of Aspergillus flavus on Cotton, Corn, and Pistachios: https://www.ars.usda.gov/research/project/?accnNo=426179

United States Environmental Protection Agency (US-EPA): https://www.epa.gov

Texas Corn Producers Board: http://texascorn.org

Arizona Cotton Research and Protection Council: http://azcotton.org

International Institute of Tropical Agriculture (IITA): http://www.iita.org

USDA-Foreign Agricultural Service (FAS): https://www.fas.usda.gov

The Bill and Melinda Gates Foundation: https://www.gatesfoundation.org

Food Safety and Inspection Service (FSIS): https://www.fsis.usda.gov/wps/portal/fsis/home

Goal 6: Education and Science Literacy

NASA, 4-H Launch Expeditionary Skills for Life:| https://www.nasa.gov/press-release/nasa-4-h-launch-expeditionary-skills-for-life

Expeditionary Skills for Life Expeditions: https://www.nasa.gov/audience/foreducators/stem-on-station/expeditionary-skills-for-life.html

4-H National Headquarters at USDA-NIFA: https://nifa.usda.gov/program/4-h-positive-youth-development

1890 National Scholars Program: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/careers/student/?cid=stelprdb1097347

Wallace Carver Fellowship Program: https://www.usda.gov/media/blog/2016/08/19/usda-wallace-carver-fellowship-grows-next-generation-agricultural-leaders

Goal 7: Rural Prosperity/ Rural-Urban Interdependence

Innovation in the Rural Nonfarm Economy: Its Effect on Job and Earnings Growth, 2010-2014: https://www.ers.usda.gov/publications/pub-details/?pubid=85170

A New Strategic Approach to Technology Transfer: https://www.ars.usda.gov/research/publications/publication/?seqNo115=328972

The Potential Effects of Increased Demand for U.S. Agricultural Exports on Metro and Nonmetro Employment: https://www.ers.usda.gov/publications/pub-details/?pubid=83069

Local Food Marketing Practices Survey: https://www.agcensus.usda.gov/Publications/Local_Food

Rural Education at a Glance, 2017 Edition: https://www.ers.usda.gov/publications/pub-details/?pubid=83077

United States Department of Agriculture

Mention of a trade name or brand name does not constitute endorsement or recommendation by USDA over similar products not named.

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339/ Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at How to File a Program Discrimination Complaint and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

The USDA is an equal opportunity provider, employer, and lender.

www.ree.usda.gov | (202) 720-1542

NOVEMBER 2019