USDA

United States Department of Agriculture

Agricultural Research Service

2018 - 2020 STRATEGIC PLAN

TRANSFORMING AGRICULTURE

ABSTRACT

U.S. Department of Agriculture, Agricultural Research Service. 2018. Agricultural Research Service 2018-2020 Strategic Plan – Transforming Agriculture. Washington, D.C.

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INTRODUCTION

The Mission, Vision, and Core Values of ARS

MISSION

ARS delivers scientific solutions to national and global agricultural challenges.

VISION

Global leadership in agricultural discoveries through scientific excellence

CORE VALUES

Scientific excellence, creativity, innovation, integrity, leadership, collaboration, accountability, transparency, diversity, respect, inclusiveness, and public service

These values underpin ARS' commitment to delivering cutting-edge, scientific tools and innovative solutions for American farmers, producers, industry, and communities to support the nourishment and well-being of all people; sustain our nation's agroecosystems and natural resources; and ensure the economic competitiveness and excellence of our agriculture.

Why Agricultural Research?

The United States Department of Agriculture (USDA) was founded in 1862 upon the foundation of agricultural research. This vision, truly incredible for the time, was designed to assist farmers, many of whom were pioneers in then strange lands, to become more successful through improved plants, animals, and farming practices. This investment, along with mechanization and chemical inputs, contributed to the transformation of the United States from a relatively poor agrarian nation into an economic superpower. In 1900, 41 percent of the U.S. workforce was employed in agriculture; in 2002, that figure was 1.9 percent. Between 1929 and 2007, the share of disposable personal income spent on food by Americans fell from 23.4 to 9.7 percent. Agricultural production increased 269 percent between 1948 and 2013 with almost no variation in the amount of land being farmed. Agricultural productivity has increased an average 1.9 percent annually between 1948 and 1999; productivity growth in manufacturing over the same period averaged 1.3 percent annually. Agricultural exports grew dramatically during the last half of the 20th century. The dramatic reduction in the U.S. workforce required to feed the nation freed labor for other industries. The substantial reduction of the household budget required for food freed consumer spending. These factors combined as major factors in the creation of the modern U.S. economy.

The USDA Agricultural Research Service (ARS) contributed substantially to this agricultural transformation. From the earliest of days, improved crops produced more and higher quality food and were more resistant to pests and diseases. New breeds of animals produced greater quantities of healthier meat per animal. ARS-invented technologies such as frozen vegetables made healthier food more available to the U.S. consumer outside of growing seasons. ARS water management tools and technologies helped mitigate the great demand for water required by agriculture. New farming practices reduced fertilizer runoff and mitigated other environmental impacts. ARS has become the trusted source for quality nutritional data to guide industry and U.S. policy. ARS-developed technologies and practices have helped keep the U.S. food supply remarkably safe.

With such success, why the need to continue investing in agricultural research?

The answer is simple – tremendous challenges remain.

Food production is the most essential element of any economy – people must have food to survive. This is a national security issue as well as a humanitarian one. Failure to satisfy an expansion in demand for food can be detrimental to economic growth. Current projections indicate that global food production must nearly double to feed a rapidly growing population that will increase by one-third between now and 2050.

We must not only produce more food, we must keep the food we produce safe from pests and disease — and we must keep it safe to eat. This is a continual evolutionary battle of humans versus insects, mites, viruses, bacteria, fungi, nematodes, and contaminants. We must continually develop new strategies and technologies to counter new and evolving challenges to our food supply.

Nutrition remains a paradoxical challenge. We need to improve the nutritional quality of food reaching populations in many underfed parts of the nation and the world. We must also address the riddle of obesity, which increasingly impacts all aspects of human health in the United States with concomitant human and economic consequences.

We must do all of this while maintaining or increasing farm profitability and viability and reducing the substantial environmental footprint of U.S. agriculture.

There is much to do and the need for investment in agricultural research is great. This strategic plan informs the trajectory through which ARS research activities will achieve impact. It is the precursor for subsequent strategic plans which may be created under this current Administration.

What are ARS Research Priorities?

ARS outlines 15 research goals in Chapter Two of this strategic plan that span four major goal areas:

- Nutrition, Food Safety, and Quality
- Natural Resources and Sustainable Agricultural Systems
- Crop Production and Protection
- Animal Production and Protection

These strategic research goals are identified with stakeholder input in the development of ARS' national program action plans. Five-year action plans are developed on a continuous, rotating basis as part of the ARS national program cycle that ensures the relevance, quality, performance, and impact of our research, as documented in Appendix 1. This strategic plan will be updated to reflect national program action plans produced in the previous year (as indicated by the years listed for each strategic research goal).

In addition, ARS integrates research done in the strategic research goals to address high-level priorities that cut across multiple national programs:

- ARS Synergies
- Antimicrobial Resistance
- Climate Change
- Microbiome

These and the synergistic research collaborations that ARS has catalyzed to tackle "wicked" problems in agriculture are described in more detail in Chapter One of this Plan.

ARS' Annual Report on Science will document progress made on and resulting impacts of these research goals and cross cutting initiatives.

Why the Agricultural Research Service?

SUSTAINED FOCUS: LISTEN – IDENTIFY – COORDINATE – RESEARCH – TECHNOLOGY TRANSFER

ARS is a problem-solving Agency. We listen to our stakeholders, to the Administration, and to Congress to identify critical national and regional agricultural problems. We coordinate with other Federal research agencies so as to have complementary research portfolios. We target those problems that are best suited to our core competencies. Then we work to not just solve the problems, but to transfer the products of ARS research into use. Often that means starting with research to understand the fundamental nature of problems and biological systems, then sustaining our research focus into the development of applied solutions. Journal articles are seen as a means to success; impact is the end result. No research effort in ARS is complete without technology transfer – whether that means informing the farmer of best practices or partnering with private industry to produce and deliver the solution.

UNIQUE RESOURCES: LONG-TERM RESEARCH SITES – PILOT PLANTS – REPOSITORIES AND COLLECTIONS – DATA AND MODELS – SPECIALIZED EQUIPMENT

ARS' long-term focus on solving research problems is complemented by our investments in long-term tools used for addressing those problems. ARS has many types of long-term research sites located in a variety of climates and agricultural settings, including those specifically supporting Long Term Agro-Ecosystem Research (LTAR), Long Term

Ecological Research (LTER), Greenhouse gas Reduction through Agricultural Carbon Enhancement network (GRACEnet), and the National Ecological Observatory Network (NEON). ARS has pilot plants located at each of its four Regional Research Centers. ARS has hundreds of collections of biological materials (plants, animals, fungi, protozoa, bacteria, viruses) – critical global resources for all agricultural research. Even more critical to the world's food supply is the National Genetic Resources Program (NGRP). It is the NGRP's responsibility to acquire, characterize, preserve, document, and distribute to scientists, germplasm of all lifeforms important for food and agricultural production. The National Plant Germplasm System (NPGS), for example, is one of the largest distributers of germplasm in the world. NPGS conserves more than 580,000 accessions and annually distributes approximately 250,000 of these to external researchers. ARS develops and maintains numerous, agriculturally important long-term datasets and models that are available for use by any scientist around the world. The National Agricultural Library (NAL) is a global treasure that maintains published scientific publications, important datasets, and products supporting agriculture and agricultural research. The ARS long-term focus on problem solving allows it to buy, build, and maintain unique, specialized research equipment and facilities that enable us to do research not possible by others.

NATIONAL REACH

Agriculture is often regionally or even locally specific in application, yet solutions need to be capable of broad reach to be economical or effective. ARS is not in one location or one State or one region of the country. It is in more than 90 locations located across the nation and in four overseas laboratories. Our leadership and coordination of research through National Programs means we coordinate research teams housed in multiple locations as needed to develop comprehensive solutions to agricultural problems. We collaborate extensively with universities and research organizations across the country and around the world, and more than one-third of ARS locations are co-located on university campuses. This enables us to organize research teams rapidly to respond in a crisis or in a sustained way for long-term research – tapping into expertise and specialized resources across the Agency and around the world.

TOP-FLIGHT RESEARCHERS

ARS' nearly 2,000 full-time scientists and engineers (including postdoctoral scholars) are recognized for their research quality and impact. Thirty-five total and five current ARS scientists are members of the National Academies of Sciences and ARS researchers have earned numerous other prestigious honors and awards. ARS research units are led by Research Leaders – active scientists who are critical to the research mission and operation of the Agency.

RESEARCH SUPPORT IS MISSION CRITICAL

ARS researchers are supported by the people who make it possible – those who hire and manage employees, those who procure what ARS needs to do its job, those who manage finances, those who execute agreements, those who manage facilities and information technology – and those who lead the Agency to ensure its research is relevant, of quality, and that the Agency meets performance expectations. Chapters 3 and 4 outline program and administrative goals linked to supporting the ARS research mission.

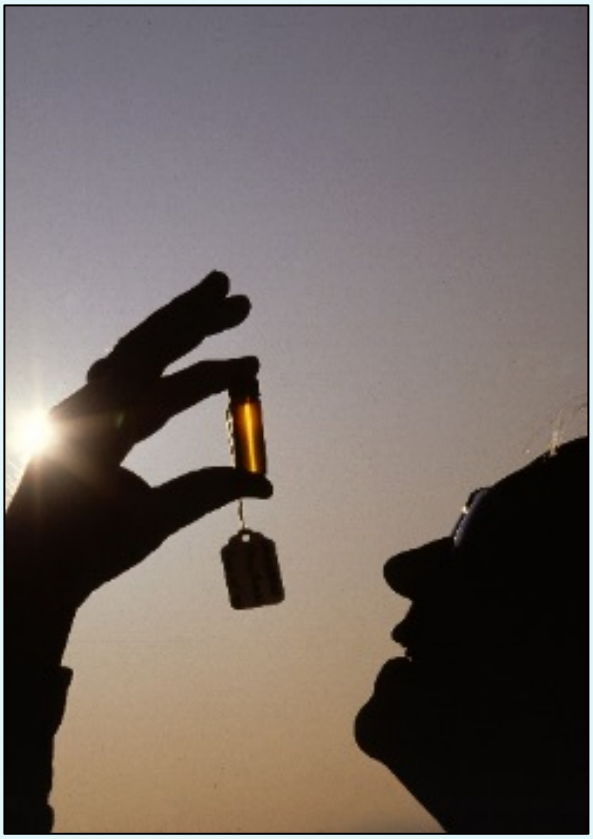
Civil Rights and Diversity is Key

As much as for any endeavor, the creative process that drives research demands a diversity of people and the ideas they generate. In Chapter 5, ARS outlines civil rights and diversity goals that emphasize these are not just fundamental human rights but the best way to accomplish the Agency's mission.

CHAPTER ONE: CROSS-CUTTING RESEARCH PRIORITIES

ARS integrates research done in its four major goal areas (Chapter Two) using cross-cutting initiatives to address high-level Agency, departmental, and national priorities. The intent of these initiatives is to tie together the work done by researchers across National Programs and locations—and in many cases with the work done by other Agencies and university scientists—in ways that synergistically address key agricultural research challenges. Some of these priorities are long-standing, have well-developed plans, and have produced significant results. Others are in the early planning stages. All reflect substantial, high-level commitments made by ARS to solving important problems with a holistic approach.

ARS Synergies

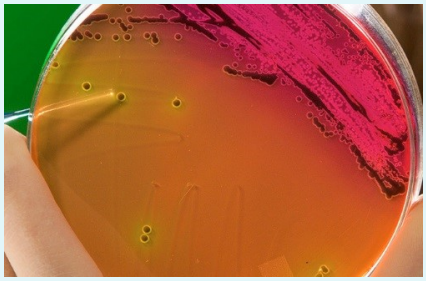


In 2015, ARS launched an initiative with a goal of transforming U.S. agriculture with a new level of innovation and creativity. The initiative recognized that in the minds of the farmer, the consumer, and the citizen, having sufficient food to meet a growing population, ensuring it is of wholesome quality, and addressing the substantial environmental footprint of agriculture are inseparable needs that demand an integrated response. As part of this initiative, the Office of National Programs identified the following goals:

- Decrease the impact of emerging pests, pathogens, and invasive species that threaten U.S. agriculture.
- Utilize the Long-Term Agro-Ecosystem Research (LTAR) Network to develop management strategies and evaluate genetic material that will increase provision of ecosystem goods (agricultural productivity and quality) and services (resilience to weather variability and changing climate), while decreasing environmental impacts.
- Increase resource-use efficiency through emerging technologies.
- Reduce postharvest losses by 20 percent.
- Increase yield potential.

To meet these goals in an integrated way, the Office of National Programs designed novel mechanisms to foster synergistic research collaborations and bold ideas that cut across national programs, scientific disciplines, and geographic locations. These approaches augment the impact of individual projects, focusing on system-level insight driven research outputs with the potential to break new ground for U.S. agriculture.

Antimicrobial Resistance



Antimicrobial resistance (AMR) has been an area of focus during the past two decades for USDA, which plays a dual role in protecting animal agriculture and public health. Growing concern regarding antimicrobial resistance led to development of the *USDA Antimicrobial Resistance (AMR) Action Plan* and Executive Order 13676, *Combating Antibiotic- Resistant Bacteria*. The *National Action Plan for Combating Antibiotic Resistant Bacteria* was published on March 27, 2015, and identified the following goals:

1. Accelerate basic and applied research and development.
2. Slow the emergence of resistant bacteria and prevent the spread of resistant infections.
3. Strengthen national "One Health" surveillance efforts.
4. Advance development and use of rapid and innovative diagnostic tests.
5. Improve international collaboration and capacities.

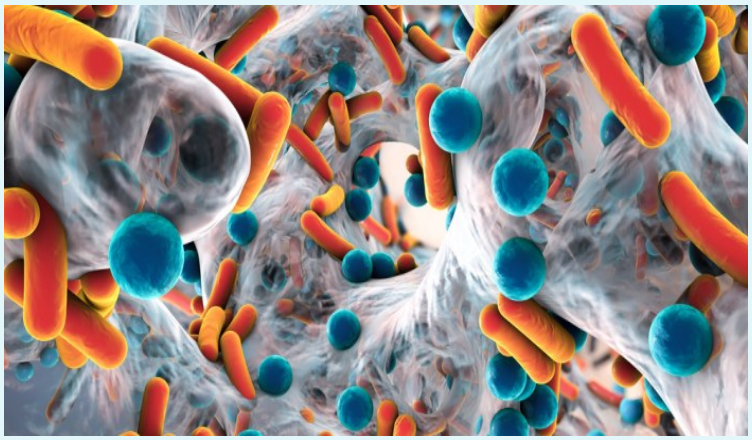
ARS research across multiple national programs is critical to addressing these goals and objectives. Using multidisciplinary approaches, working in laboratories, on farms, and at processing facilities, research across national programs provides insight into the ecology of antibiotic resistant bacteria in livestock, in the environment, on fresh produce, and on meat at processing. This research improves methods for detecting and evaluating mitigation strategies and develops alternatives to antibiotics that affect the entire food chain from farm to plate. ARS will deliver scientific information and novel medical interventions to support responsible antibiotic stewardship.

Climate Change

The USDA Climate Change Science Plan has the vision that farmers, foresters, ranchers, land owners, resource managers, policymakers, and Federal agencies are empowered with science-based knowledge to manage the risks, challenges, and opportunities of climate change and positioned to reduce emissions of atmospheric greenhouse gases and enhance carbon sequestration. USDA's Science Plan identifies the science the Department needs to pursue over the next 5-8 years to meet the needs of the nation. This Science Plan was developed as a cooperative effort between USDA research agencies and USDA program and service agencies.

ARS research in support of the Department's vision of empowering decisions and policies with science-based understanding of the impacts and implications of climate change are widespread and cross-cutting. Within the natural resources research area, there is scientific effort on how changing climate impacts air quality, soil health, soil conservation, water availability, and water quality, as well as how our management of these resources can influence the drivers of climate change. Beyond the natural resources area, additional research questions exist around impacts on human nutrition, food security, animal health and productivity, crop health and productivity, the adaptation of crops and livestock to changing weather patterns and extreme events. ARS research is aimed at addressing all of these concerns. Specifically, some cross-location, interdisciplinary efforts at ARS are focused on multiple aspects of the interface between production and climate, such as the Long-Term Agroecosystem Research network and the ARS role in implementing the USDA Regional Climate Hubs. Because of the nature of these efforts, there are obvious ties also between this work and the ARS Big Data initiative.

Microbiome



The National Microbiome Initiative (NMI) was launched by the White House Office of Science and Technology Policy (OSTP) in 2016 to advance the understanding of microbiomes—communities of microorganisms (bacteria, viruses, and fungi) that live on or in people, plants, animals, soil, oceans, and the atmosphere—for applications in health care, food production, and environmental management. Microbiomes promote the healthy functioning of diverse ecosystems, and affect human and animal health, crop and soil health, climate change, and other complex systems. By contrast, dysfunctional microbiomes are associated with human chronic diseases such as obesity, diabetes, and asthma; reductions in agricultural productivity; and local ecological disruptions such as the hypoxic zone in the Gulf of Mexico.

New technologies enable ARS scientists to make breakthrough discoveries about the importance of microbiomes and the knowledge to better manage microbiomes in a manner that prevents dysfunction or restores healthy function. To promote greater synergy in microbiome research across U.S. government, ARS, together with 20 U.S. government agencies, developed a 5-year Interagency Strategic Plan for Microbiome Research to identify and prioritize consensus research needs across Federal agencies, to efficiently promote the understanding of how microbiomes function, and to develop new technologies for manipulating those functions to address societal problems.

The new strategic plan for microbiome research has three areas of concentration and cooperation for transforming microbiome research, thus accelerating the translation of discoveries into solutions:

1. **Supporting interdisciplinary and collaborative research** to enable a predictive understanding of the function of microbiomes in diverse ecosystems, to enhance public health, food, and environmental security, and grow new bioeconomy product areas.

2. **Developing platform technologies** to generate critical insights and to improve access to and sharing of microbiome data across ecosystems.

3. **Expanding the microbiome workforce** through educational opportunities, citizen science, and public engagement.

The plan also guides the coordination of microbiome research activities across U.S. government agencies; describes interagency objectives, structure, and operating principles; and describes research focus areas to accelerate the development of new products and services that improve human health and nutrition, the health and safety of crop and animal production, ecosystem services, and industrial applications of microbiomes.

Because of the scientific advances being made in microbiome research across ARS, leaders in the ARS Office of National Programs are fostering interactions across our scientific community to (1) establish common research approaches for microbiome analysis and (2) to foster integration of research outcomes to enhance knowledge of how different agricultural microbiomes interact within their hosts or environments.

CHAPTER TWO: SCIENCE GOALS

This chapter lists the heart of the ARS strategic plan – our research goals. These goals are grouped into four major goal areas and are derived from the national program action plans, the heart of the ARS strategic planning for research. These action plans are developed and managed in support of the missions of USDA and the Research, Economics, and Education (REE) Mission Area, and with valuable input from stakeholders and scientists. They are also developed in coordination with the other three agencies of the REE Mission Area and other Federal research agencies.

Every ARS research project is part of a national program. National program action plans are produced as part of the 5-year ARS national program cycle that ensures relevance, quality, performance, and impact of our research (Appendix 1). For logistical reasons, the beginning of national program cycles are distributed across a 5-year period and thus most are not simultaneous with span of the ARS strategic plan. Recognizing this, each research goal will document the 5-year span of its national program action plan and this strategic plan will be updated annually to reflect changes made from action plans published the previous year.

The ARS Annual Report on Science will document the products of these research goals and their performance measures.

ARS is an essential part of One USDA. Our research supports the missions USDA's action and regulatory agencies, including the Agricultural Marketing Service; Animal Plant and Health Inspection Service; Center for Nutrition Policy and Promotion; Farm Service Agency; Food and Nutrition Service; Foreign Agricultural Service, including International Cooperation and Development; Food Safety and Inspection Service; Grain Inspection, Packers and Stockyards Administration; and Natural Resources Conservation Service. ARS researchers work in close collaboration with staff from these agencies to provide scientific expertise and problem-solving in support of their missions.

The table below cross-walks ARS research goals to the FY 2018-2022 USDA Strategic Goals and the 2014 REE Action Plan.

ARS Research Goal Area	ARS Research Goal (associated national program number)	REE Action Plan Goal	USDA Strategic Objective(s)
1: Nutrition, Food Safety and Quality	1.1 Define the Role of Food and its Components in Optimizing Health Throughout the Life Cycle for all Americans (National Program 107)	4	7.3
	1.2 Protect Food from Pathogens, Toxins, and Chemical Contamination during Production, Processing, and Preparation (National Program 108)	5	7.1
	1.3 Improve Postharvest Quality and Develop New Uses of Agricultural Products (National Program 306)	2B, 7	2.2
2: Natural Resources and Sustainable Agricultural Systems	2.1 Effectively and Safely Manage Water Resources to Sustain and Increase Agricultural Production and Water Use Efficiency while Protecting the Environment and Human and Animal Health (National Program 211)	3A	1.4, 5.1*, 5.2, 5.3

ARS Research Goal Area	ARS Research Goal (associated national program number)	REE Action Plan Goal	USDA Strategic Objective(s)
	2.2 Enhance and Protect Soil Resources; Manage Nutrients and Emissions from Agricultural Soils, Livestock Production Systems, and Byproducts; and Improve Production from Agroecosystems to be Resilient to Changing Climates (National Program 212)	2A, 3B	1.4, 5.1*, 5.2, 5.3
	2.3 Improve Management Decisions and Enhance the Function and Performance of Rangelands, Pastures, Forage, and Turf Agroecosystems while Enhancing Ecosystem Services (National Program 215)	1A, 1B, 1C, 2A, 2B, 3	1.4, 2.3, 5.1*, 5.2, 5.3
	2.4 Integrated Solutions for Agriculture Enabling Greater Productivity, Profitability, and Natural Resource Enhancement (National Program 216)	3B	5.1*, 5.2, 5.3
3: Crop Production and Protection	3.1 Harness the Genetic Potential of Plants to Transform U.S. Agriculture (National Program 301)	1A, 1C, 2A, 2B	2.2
	3.2 Develop and Transfer Information and Technologies for Productive and Profitable Food, Fiber, and Ornamental Production Systems (National Program 305)	1A, 1B	2.2*, 2.3, 5.3
	3.3 Improve and Expand our Knowledge of Existing and Emerging Plant Diseases and Develop Effective and Sustainable Disease Management Strategies that are Safe to Humans and the Environment (National Program 303)	1B, 1C, 2A	2.3
	3.4 Provide Technology to Manage Pest Populations Below Economic Damage Thresholds by the Integration of Environmentally Compatible Strategies that are Based on the Biology and Ecology of Insect, Mite, and Weed Pests (National Program 304)	1B, 2A	2.3
4: Animal Production and Protection	4.1 Improve Food Animal Production Efficiency, Industry Sustainability, Animal Welfare, Product Quality, and Nutritional Value while Safeguarding Animal Genetic Resources (National Program 101)	1A, 1C, 2A	2.2
	4.2 Support a Thriving Domestic Aquaculture Industry Based on Improved Genetic Stocks and Scientific Information on Biotechnologies and Management Practices to Ensure a High Quality, Safe Supply of Healthful Seafood and Aquatic Products (National Program 106)	1A, 1B, 1C	2.2*, 2.3
	4.3 Protect and Ensure the Safety of the Nation's Agriculture and Food Supply through Improved	1B, 1C, 2A	2.3

ARS Research Goal Area	ARS Research Goal (associated national program number)	REE Action Plan Goal	USDA Strategic Objective(s)
	Disease Detection, Prevention, and Control (National Program 103)		
	4.4 Eliminate arthropod vectors and the diseases that they transmit to livestock, humans, and other animals and nullify their economic impact (National Program 104)	1B, 2A	2.3

*Primary USDA Objective used for reporting.

Goal Area 1 - Nutrition, Food Safety, and Quality

Goal Area 1, Nutrition, Food Safety, and Quality, exists to lead and coordinate ARS research and information dissemination to define the role of food and its components in optimizing health for all Americans; develop tests and processes that keep the food supply safe; reduce and control pathogens and toxins in agricultural products; and improve the economic viability and competitiveness of American agriculture by enhancing the quality and utilization of agricultural products for the benefit of producers and consumers.

GOAL 1.1 – DEFINE THE ROLE OF FOOD AND ITS COMPONENTS IN OPTIMIZING HEALTH THROUGHOUT THE LIFE-CYCLE FOR ALL AMERICANS

NATIONAL PROGRAM 107 - HUMAN NUTRITION: 2019-2024

Nutrition research addresses optimization of health and prevention of chronic diseases since nutrient requirements to prevent deficiency diseases have been mostly defined. Scientists continue to discover new functions of nutrients and new metabolic pathways, including microRNAs and the role of intestinal bacteria in regulating metabolism and preventing disease. ARS is well-positioned to work on these issues, particularly since three of the six Human Nutrition Research Centers have congressionally mandated missions of studying nutrition and its health effects during different phases of the lifecycle.

ARS human nutrition research studies nutrient composition of foods; what people consume; methods to improve the precision and accuracy of those activities; nutrient requirements for all age groups, including pregnant and lactating women; how nutrition can maintain health throughout the lifespan from conception to old age; and how to prevent development of chronic diseases, including obesity. Unique aspects of ARS research supporting Goal 1.1 are: its work with crop and animal production researchers to discern how changes in farming conditions and practices affect the nutrient content of the American diet; compilation of food composition analysis and its dissemination in databases; and administration of a nationally representative diet survey of how much and what foods Americans eat. This information is needed by regulatory agencies, health agencies, and health professionals to understand the nutritional status of the American population and its multiple subgroups.

Research under Goal 1.1 supports ARS cross-cutting priorities by collaborative work with ARS scientists working on postharvest quality (Goal 1.3), soils (Goal 2.2), plant genetic improvement (Goal 3.1), and animal production (Goal 4.1). Two examples of such collaborative research include evaluation of genetics, feed, and management of dairy herds for changes in nutritional content of milk and the study of nutrient content of beans as a function of climate, crop genetics, and on-farm inputs.

The Human Nutrition National Program will support this Goal through research in five components: (1) linking agricultural practices and beneficial health outcomes, (2) monitoring food composition and nutrient intake of the nation, (3) scientific basis for dietary guidance, (4) prevention of obesity and obesity-related diseases, and (5) life stage nutrition and metabolism.

PERFORMANCE MEASURE FOR GOAL 1.1

Monitor nutrient composition of food supply and consumption by Americans while conducting research on life stage nutrition and metabolism. Strengthen the scientific basis for dietary guidance for health promotion and disease prevention and develop strategies for prevention of obesity and related diseases.

STRATEGIES AND MEANS FOR GOAL 1.1 (PROBLEM STATEMENTS)

- Determine agricultural practices that influence the nutritional status of Americans.
- Provide U.S. food composition data.
- Determine food consumption and dietary patterns of Americans.
- Improve the scientific basis for updating National Dietary Standards and Guidelines.
- Identify roles of food, food components and physical activity in promoting health and preventing disease.
- Understand the causes and effects of obesity and obesity-related disorders.
- Develop and evaluate strategies to prevent obesity and obesity-related diseases.
- Identify dietary and related lifestyle impacts for healthy development and function from conception to old age.
- Identify determinants and consequences of nutritional status, diet and body composition on metabolic programming.

GOAL 1.2 – PROTECT FOOD FROM PATHOGENS, TOXINS, AND CHEMICAL CONTAMINATION DURING PRODUCTION, PROCESSING, AND PREPARATION

NATIONAL PROGRAM 108 – FOOD SAFETY: 2016-2020

Food safety research seeks ways to assess, control, or eliminate potentially harmful food contaminants, including introduced and naturally occurring pathogenic bacteria, viruses and parasites, non-biological-based chemical contaminants and residues, mycotoxins, and plant and animal toxins. Food safety is a global issue of concern; thus, this research involves both national and international collaborations through formal and informal partnerships. Accomplishments and outcomes are utilized in national and international

strategies delivering research results and advances to regulatory agencies, commodity organizations, industry, academia, research and extension agencies, and consumers.

The safety of the food supply continues to be a visible public health issue and a national and international priority. Outbreaks of foodborne illness are still seen as a significant cause of morbidity, mortality, and chronic conditions. The cost and burden resulting from these events can result in economic devastation both nationally and internationally. The cause of many outbreaks often remains unresolved, but issues such as intensive food production, global climate change, international trade, consumption habits, travel and immigration of peoples, are regarded as areas of concern.

Persistent outbreaks of major commodity-specific foods that potentially directly affect public health, regulations, industry, and trade, require our attention. A predominant research focus of this goal is implementation of the Food and Drug Administration Food Safety Modernization Act. The challenges of implementation cannot be overestimated and consequently major changes within several food safety regulatory agencies, especially the USDA Food Safety Inspection Service; and the Food and Drug Administration, and the Center for Food Safety and Nutrition and Center for Veterinary Medicine have significantly impacted ARS research supporting Goal 1.2.

Recently, it has become more evident that scientists nationally and internationally have very different opinions on what aspects of food safety research are critically important; there is no consensus. Recent issues of food adulteration, examples which include adulteration of horsemeat, dioxins, olive oil, and honey, has placed a greater emphasis on traceability, food integrity, and the assurance of food supply networks. Adulteration is generally not considered a food safety issue *per se* but a quality issue. Additionally, adulteration as part of food integrity is often economically motivated and thus may be considered a criminal activity. Many international food agencies have stressed that a greater focus is needed on food fraud, and consequently are realigning their research and regulatory surveillance programs. This effort is being also considered in the United States. In addition, there is national and international concern regarding the increase in antimicrobial resistant bacteria, especially those carrying resistance to antibiotics of last resort for humans. There is also a greater emphasis on assisting emerging nations to develop secure food supplies. However, in most cases this is not a food safety issue, but rather an issue of postharvest losses due to inadequate storage capabilities such as no refrigeration, or inadequate processing interventions. Ensuring adequate supplies of food does encompass some challenges to food safety when global climate change, water availability, and plant or animal diseases are considered.

Research of Goal 1.2 supports and is integrated into all four major ARS goal areas. For example, scientists working on Goal 1.2 collaborate with those working on animal health (Goal 4.3) to decrease the impact of emerging pathogens; with those working on human nutrition (Goal 1.1) and postharvest quality (Goal 1.3) develop improved and cost effective interventions to assist in reducing postharvest losses and improved nutrition; and with plant genetic improvement (Goal 3.1) and plant diseases (Goal 3.3) to develop resistant crops that increase yield potential. Scientists supporting Goal 1.2 also works with those working antimicrobial resistance as part of research on animal health (Goal 4.3) to develop alternatives to antibiotics for use in agricultural production systems; with scientists working on aquaculture (Goal 4.2), water resources (Goal 2.1), and soil and air (Goal 2.2), to ensure the safety of the food supply as affected by climate change; and with scientists working on food animal production (Goal 4.1) and animal health (Goal 4.3) to understand the role of the animal microbiome on host physiology, health, and safety.

The Food Safety National Program will support this Goal through research in the following component: foodborne contaminants.

PERFORMANCE MEASURE FOR GOAL 1.2

Develop new technologies that assist ARS customers in detecting, identifying, and controlling foodborne diseases associated with the consumption of animal products that affect human health.

STRATEGIES AND MEANS FOR GOAL 1.2 (PROBLEM STATEMENTS)

- Identify and characterize the movement, structure, and dynamics of populations throughout food production, processing, and storage, with an emphasis on epidemiology, ecology, and host-pathogen relationships.
- Use an integrative approach to understand the basic genetic components of pathogens, their expression, and directly relate this information to the microorganism's biology.
- Develop and validate technologies for the sensitive and specific detection and characterization of microbial pathogens at the earliest possible stage in the food chain, thus avoiding or preventing the need for processing interventions, or possible recall.
- Develop and validate technologies for the sensitive and specific detection and characterization of undesired chemical contaminants including chemical residues, and bacterial, fungal, plant, and animal toxins at the earliest possible stage in the food chain, thus avoiding or preventing the need for processing interventions, or possible recall.
- Develop and validate intervention strategies to control or eliminate foodborne pathogens or other zoonotic organisms, chemical contaminants, and biological toxins from foods.
- Determine and predict the behavior of microorganisms in foods or their immediate environment. Data and predictions are transferred to regulatory agencies and industry as an integral part of microbial risk assessment used to support food safety measures.
- Develop multidisciplinary approaches to understand the ecology, development, persistence, and transmission of antimicrobial resistance in foodborne microorganisms. Improve detection techniques facilitating the speed, ability, and accuracy of detecting resistant bacteria in food producing animals and their products.

GOAL 1.3 - IMPROVE POSTHARVEST QUALITY AND DEVELOP NEW USES OF AGRICULTURAL PRODUCTS

NATIONAL PROGRAM 306 – PRODUCT QUALITY AND NEW USES: 2020-2024

Research supporting Goal 1.3 will increase our knowledge and develop technologies to better measure or enhance the quality of crop and animal products after harvest. Similarly, the marketability and value of commodities can be increased by ensuring that value-added food products (such as fresh-cut or minimally processed produce) retain sensory quality, nutritional value, and are free from food safety hazards, in cooperation with ARS scientists working on food safety (Goal 1.2). The research done for Goal 1.3 will also generate new information on health-promoting components of foods and assess their effects on important human diseases and obesity, in cooperation with ARS scientists working on human nutrition (Goal 1.1) and other partners. In addition to food quality and safety, consumers have expressed concern over rising food prices which can be attributed to multiple factors. A significant factor in the cost of food production can be attributed to food waste or rot. Estimates indicate that approximately 31 percent of all food, and 40 percent of fresh produce and seafood produced in the United States is lost as waste among retailers, food service businesses, and consumers. Additional losses occur during food harvesting, storage, and distribution. The magnitude of the loss is even greater when resources spent on growing food such as fuel, water, fertilizer, chemicals, land-use, and human resources are considered. Goal 1.3 research will develop technologies that improve quality, extend product shelf life, reduce waste, and decrease costs.

ARS conducts research on the development of nonfood, nonfuel biobased products from agricultural commodities and byproducts. Interest in biobased products has increased as consumers and governments have sought more environmentally friendly products that provide alternatives to petroleum and which do not contribute to greenhouse gases. There is some public concern that biobased products could contribute to the rising cost of food in the United States. ARS seeks opportunities to develop biobased products from agricultural feedstocks that do not compete with food. ARS also supports quality and processing research on crop fiber, such as cotton, and from animal hides, such as leather and wool. Stakeholders who produce fibers and hides constitute an important segment of our rural economy. These industries are severely impacted by energy and production costs and have lost market share to foreign competition. Technologies that improve fiber quality, reduce the energy consumption of processing equipment, and develop new products are needed to help the fiber industry compete in a global market.

ARS conducts biorefining research supporting Goal 2.3 that enables technologies which improve profitability, reduce risks, increase the value of coproducts and biobased products, and expand the options available to existing biorefiners for generating revenue. Collaborations with existing biorefiners are critical to ensure that ARS conducts research that benefits industry. Given its limited resources for biorefining research, ARS must focus its biorefining research on a relatively limited number of promising biorefining technologies. ARS has been a long-time leader in research on biochemical conversion of agricultural materials into biobased products. ARS also leads Federal government research to benefit bio/renewable diesel producers, which make up the bulk of lipid-based biorefiners. Furthermore, ARS has significant research experience and capabilities in pyrolysis, a technology that can produce biochar and advanced biofuels compatible with the Nation's existing fuel-distribution infrastructure and that could be deployed at or near the farm.

Goal 1.3 and 2.3 scientists collaborate with other scientists in ARS, especially researchers in: Human Nutrition, and Food Safety (Goal 1); water, soils, emission, bioenergy, and agricultural byproducts (Goal 2); crop food and fiber quality, and diseases (Goal 3); and animal product quality, diseases, and insect control (Goal 4). These collaborations integrate nutritional quality, end use quality assurance, and food safety of agricultural products.

The Product Quality and New Uses program will support this Goal through research in three components: (1) foods, (2) non-food (fibers including hides), and (3) biorefining.

PERFORMANCE MEASURES FOR GOAL 1.3

Develop methods and technologies to better define, measure, preserve, or enhance quality and create new uses of food crops, animals, and agricultural fibers, as well as non-food, non-fuel, biobased products and sustainable technologies and processes.

Develop technologies to enable sustainable commercial production of bioenergy feedstocks and other biofuels.

STRATEGIES AND MEANS (PROBLEM STATEMENTS)

- Define, measure, preserve, enhance, and reduce attributes that impact quality and marketability.
- New bioactive ingredients and health-promoting foods.
- New and improved food processing and packaging technologies.
- Maintain and enhance fiber and hide quality.
- Enable technologies to produce new and expand marketable non-food, nonfuel biobased products derived from agricultural feedstocks.
- Evaluate and report the quality parameters of commercially viable food cultivars, in collaboration with breeders, as part of a Congressionally designated direct mission of service.

- Technologies for producing advanced biofuels or other marketable biobased products.
- Technologies that reduce risks and increase profitability in existing industrial biorefineries.
- Accurately estimate the economic value of biochemical conversion technologies.
- Improve bio/renewable diesel's engine performance.

Goal Area 2 - Natural Resources and Sustainable Agricultural Systems

ARS conducts research that *explains* the nature and function of agricultural systems and their physical, chemical, and biological components. With that explanatory power, we develop abilities to *predict* how agricultural systems may respond to different environments or management scenarios. Once we can make predictions with confidence, we turn that knowledge into *decision support* tools and methods for:

- Improving the efficiency and effectiveness of management practices for agricultural systems and working lands to enhance ecosystem goods and services, including the sustainable production of agricultural commodities;
- Managing soil, water, air, and biological resources for society's benefits, including reductions in environmental impact, under different climatic and environmental conditions; and
- Optimizing agricultural products and coproducts as renewable, bio-based nutrients, inputs to manufacturing and energy sources.

Major priorities for ARS research on interactions among land, water, atmosphere, and diverse biological communities include:

- Remediation and use of degraded water for production of a wide range of crops;
- Protection and enhancement of ecosystem goods and services arising from our natural resources;
- Adaptation of agricultural production systems to climate change and mitigation of agricultural greenhouse gas emissions;
- Development of diverse energy crops and agronomic practices for efficient and sustainable production, optimized for different geographic regions and climatic conditions throughout the United States;
- Identification of safe uses of agricultural wastes and byproducts in generating energy and fuel and value-added biochemical products and fertilizers;
- Creation and evaluation of conservation practices and land management decision-support tools arising from ARS long-term agricultural research conducted in the Agency's unique, critical infrastructure of instrumented watersheds, rangelands, and croplands;
- Development of widely accessible databases to support analyses of agriculture, land management, and the environment; and
- Creation of a broad-based data and information access portal at the National Agricultural Library to enable life-cycle analyses and development and validation of sustainability indices for agricultural production and delivery systems.

GOAL 2.1 – EFFECTIVELY AND SAFELY MANAGE WATER RESOURCES TO SUSTAIN AND INCREASE AGRICULTURAL PRODUCTION AND WATER USE EFFICIENCY WHILE PROTECTING THE ENVIRONMENT AND HUMAN AND ANIMAL HEALTH

NATIONAL PROGRAM 211 – WATER AVAILABILITY AND WATERSHED MANAGEMENT: 2016-2021

Fresh water is essential to maintaining both agricultural and industrial production, ecosystem integrity, and human health. Throughout history, a key measure of civilization's success has been the degree to which human ingenuity has harnessed freshwater resources for the public good.

As the Nation was established and expanded, it flourished in part because of abundant and readily available water and other natural resources. With expansion to the arid west, investments in the use of limited water resources became critical to economic growth and prosperity. In the 19th century, water supplies for new cities were secured by building reservoirs and water distribution systems. The 20th century was characterized by pivotal accomplishments in U.S. water resource development and engineering. Investments in dams, water infrastructure, irrigation, and water treatment provided safe, abundant, and inexpensive sources of drinking water, aided flood management and soil conservation, created recreational opportunities for the public, and dramatically improved hygiene, health, and economic prosperity. The Nation's water resources and water technologies were the envy of the world. Certainly, water-related science and technology have served our Nation well. However, the 20th century was also characterized by significant increases in irrigated area, fertilizer use, and improved crop genetics that combined to produce explosive growth in agricultural production as the Nation became a major exporter of agricultural products. Concurrently, agriculture became the largest consumptive user of freshwater, but possibly the least understood in terms of opportunities for conserving water supplies and improving water quality for all users.

As the 20th century drew to a close, the water resource situation in both the U.S. and the world began to change. Runoff and drainage from heavily fertilized fields increasingly affected the aquatic health of our waterways and oceans. Key ground water reserves began to become depleted, water quality became increasingly degraded, and adverse climatic conditions (e.g., drought) began to significantly reduce available freshwater supplies. At the same time, freshwater allocations began to shift among different users and needs (e.g., from agricultural to urban uses; from storing water supplies in reservoirs to maintaining in-stream flows to ensure healthy aquatic ecosystems; from industrial and energy production to recreation). Our shared freshwater supply was significantly reduced as it also became more variable, unreliable, and with increasing frequency, less than adequate to meet the needs and demands of an expanding population. Meanwhile, large-scale and complex water quality issues began to affect the Gulf of Mexico, Chesapeake Bay, and the Great Lakes. Clearly, new technologies were needed to allow agriculture to better manage both water quantity and quality.

As the 21st century unfolds, these new challenges for agriculture are intensifying—increasing demands for water from our cities, farms, and aquatic ecosystems; increasing reliance in the eastern humid and sub-humid states on irrigated agriculture for stable crop and animal production and farm income; changing water supplies due to groundwater depletion in some areas; climate variability and change; and the need to tap alternative water resources. These challenges are not insurmountable, and in terms of their impact on both water supply and use and water quality, agricultural lands can play an important role in meeting them. Advances in agricultural water management can provide

important and unique contributions to the complex problem of water management at regional and national scales. Science and engineering can create new and emerging technologies that widen the range and effectiveness of options for future water management; and science can develop and provide the tools needed by managers and planners to accurately predict the outcomes of proposed water management decisions at farm to national scales. The factual basis for decision-making includes an understanding of these new technologies, their effectiveness as well as potential unintended consequences, and a strategy for getting water users and agencies to adopt the technologies determined to be most effective. Thus the Nation has the opportunity to apply and use science and technology to protect, sustain, enhance, and manage our water resources, improving human and ecological health while continuing to build a strong and growing economy.

Scientists working on Goal 2.1 collaborate with those working on Goals 2.2, 2.4, 3.1, and 3.2, who are using the Conservation Effects Assessment Project (CEAP) and the Long-Term Agroecosystem Research (LTAR) platforms to (1) identify new technologies and strategies; and (2) address local, regional, and national agricultural related issues. These scientists are also working with internal and external partners to leverage ARS existing infrastructure and program investments in watershed and rangeland research to organize a continental-scale research platform specifically for agriculture.

The Water Availability and Watershed Management National Program will support this Goal through research in four components: (1) effective water management in agriculture; (2) erosion, sedimentation, and water quality protection; (3) enhancing and documenting the benefits of conservation practices; and (4) watershed management to improve ecosystem services in agricultural landscapes.

PERFORMANCE MEASURE FOR GOAL 2.1

Develop technology and practices to promote improvement of integrated, effective, and safe water resource management.

STRATEGIES AND MEANS (PROBLEM STATEMENTS)

- Irrigation scheduling technologies for sustainability.
- Water productivity and water requirements at multiple scales.
- Irrigation application methods.
- Dryland and rain-fed water management.
- Drainage water management and control.
- Alternative water resources for irrigation.
- Field scale processes controlling soil erosion and the transport and fate of sediments and contaminants.
- In-stream physical and biological processes controlling contaminant fate, transport, and effects.
- Processes influencing the relationships between contaminants and aquatic ecosystems.
- Development and testing of cost-effective measures to control the transport and fate of contaminants in agriculture, urban, and turf systems.
- New and innovative modeling and assessment tools to quantify sediment and contaminant transport on the landscape.
- Selection, placement, and combination of conservation practices to achieve improvements in water quantity and quality in watersheds.
- Improve conservation technologies to better protect water resources: development and testing of new designs, equipment, and materials.

- Ensure that conservation and agricultural management practices can increase agricultural profitability and resilience under changing climate and land use.
- Link conservation practice performance to multiple ecosystem responses and services across agricultural landscapes and aquatic systems.
- Improve watershed management and ecosystem services through large area, long term field research, site characterization, and data dissemination in agricultural watersheds and landscapes.
- Develop tools and methods to improve water resource management.
- Measure and predict water-driven agroecosystem productivity and other ecosystem services.
- Impacts of climate and land-use change on water use and sustainability.

GOAL 2.2 – ENHANCE AND PROTECT SOIL RESOURCES; MANAGE NUTRIENTS AND EMISSIONS FROM AGRICULTURAL SOILS, LIVESTOCK PRODUCTION SYSTEMS, AND BYPRODUCTS; AND IMPROVE PRODUCTION FROM AGROECOSYSTEMS TO BE RESILIENT TO CHANGING CLIMATES

NATIONAL PROGRAM 212 – SOIL AND AIR: 2016-2020

Agricultural systems function within the soil-atmosphere continuum. Mass and energy exchange processes occur within this continuum and agriculture can significantly affect the processes. Emissions from agriculture to the atmosphere affect air quality and increase atmospheric greenhouse gas concentrations. While greenhouse gas fluxes are a part of the natural cycling of carbon and nitrogen, agricultural practices can also contribute to these fluxes that influence climate change.

A changing climate impacts agriculture, range and pasture systems, and soils through alterations of precipitation and temperature patterns. Increased atmospheric carbon dioxide concentration has an enhanced fertilization effect on plants, particularly weeds. Combining these impacts of changing climate can alter habitats, thus changing the distribution of pathogens, weeds, and invasive species, resulting in increased threats to agricultural production and increasing the cost of production. The impacts of climate change clearly create challenges to agriculture and soil, water and air resources, and yet may also offer new opportunities for agricultural production and enhancement of soil quality.

Soils are a crucial boundary resource between agriculture and the atmosphere. Soils in agricultural systems must be managed to meet rising global demands for food, feed, fiber, fuel, and ecosystem services while maintaining soil productivity and limiting undesirable interactions between soils and the atmosphere. Enhancement of soil productivity is a focus of ARS research and together with crop improvement research offers promise for meeting future global agricultural demands.

The variability of the atmosphere, soils, and plants, and the complexity of interactions among these systems require collaborations by ARS scientists conducting research on Goal 2.2. Formal and informal cross-location research projects including the Greenhouse gas Reduction through Agricultural Carbon Enhancement network (GRACEnet), the Resilient Economical Agricultural Practices project (REAP; formerly called the Renewable Energy Assessment Project), the Long-Term Agroecosystem Research (LTAR) Network, and field campaigns focused on air quality and soil health are successful

examples. Synthesis and integration of information, including sources outside Goal 2.2 research, increases the utility and impact of ARS research for producers, land managers, and policymakers. Efficient assimilation of data into existing and future collaborative databases enhances synthesis and integration analyses and expands research opportunities.

Research conducted on soil and air in this goal provides direct links to other ARS research goals. To monitor, manage, and sustain our soils, reduce erosion, and conduct research that leads to more efficient use of resources to reduce atmospheric emissions ties closely with other natural resources goals (Goal Area 2). Additionally, managing soils for sustainable agricultural productivity directly relates to crop production (Goal Area 3) and research on the soil microbiome (e.g., its influence on soil-borne plant pathogens and pests) also directly relates to crop protection (Goal Area 3). Through their influence on crop and forage productivity, outcomes of this research goal have indirect impacts for animal production (Goal Area 4). More directly, the impact of animal production effluents (e.g., animal wastes and manures) has a high relationship to the Soil and Air goal.

The Soil and Air National Program will support this Goal through research in three components: (1) management and stewardship of soil resources; (2) managing nutrients in agroecosystems; and (3) reducing environmental risk of agricultural operations.

PERFORMANCE MEASURE FOR GOAL 2.2

Improve quality of atmosphere and soil resources and understand the effects of climate change through development of knowledge and technologies.

STRATEGIES AND MEANS FOR GOAL 2.2 (PROBLEM STATEMENTS)

- Preventing and ameliorating soil degradation.
- Agricultural management for resilient soil.
- Enhancing soil biodiversity and functions.
- Improving nitrogen management.
- Improving phosphorus management.
- Improved understanding of macro- and micro-nutrient cycling in soils.
- Reducing pathogens and antibiotic resistance.
- Managing emissions from farm animal systems.
- Reducing environmental risk of potential contaminants from cropping and postharvest systems.
- Reducing risk and developing beneficial agricultural uses of agricultural, industrial, and municipal byproducts.

GOAL 2.3 - IMPROVE MANAGEMENT DECISIONS AND ENHANCE THE FUNCTION AND PERFORMANCE OF RANGELANDS, PASTURES, FORAGE, AND TURF AGROECOSYSTEMS WHILE ENHANCING ECOSYSTEM SERVICES

NATIONAL PROGRAM 215 - GRASS, FORAGE, AND RANGELAND AGROECOSYSTEMS: 2019-2023

Grass, forages, and rangelands—which include turfgrass, herbaceous biomass harvested for fuel, forages harvested for feed, and pastures and native ecosystems for grazing—cover vast areas of the earth. Although these areas support a variety of native and non-native plant and animal life, some grasslands and most rangelands are typically unsuitable for growing annual crops due to characteristics of the environment, such as topography, rainfall or other water sources, soil

type, and climate. However, these areas benefit humans and animals in a variety of ways, including contributing significantly to nutrient cycling (e.g., carbon, nitrogen), maintaining water quality, providing vital habitats that support plant and animal species diversity, generating biomass for feed and fuel, and contributing to human food security through grazing of ruminant and non-ruminant animals. Turfgrass-covered areas contribute many of the same ecological services, while at the same time providing either aesthetic value or utility for recreational or other purposes. Although grass, forage, and rangeland areas contribute a great deal to human existence and species biodiversity, proper management to balance productivity and ecological benefits is very complex. Often, information is lacking that enables optimal use and productivity in terms of animal, biofuel, or other uses with ecological services such as nutrient cycling, recreation, and wildlife habitat. Improper management also contributes to dangerous or detrimental conditions such as wildfire, dust storms, and excessive erosion.

The integration of grass, forage, and rangeland research into broader production systems is a priority of ARS research. Major national initiatives, including the Long-Term Agroecosystem Research (LTAR) Network, Dairy Agro-ecosystem Working Group, and the Conservation Effects Assessment Project, all include objectives to better integrate pasture, forage, and rangeland management strategies as part of a broader vision to enhance local nutrient cycling and improve the environmental sustainability of animal production systems. Climate change, bioenergy development, increasing recreational activities, preserving natural resources, social interests, and a growing population all make management of grass, forage, and rangelands challenging and complex. Meeting competing demands for increasing food production while maintaining ecosystem services on these areas requires a combination of fundamental knowledge, science-based tools, and management strategies to renew, maintain, and enhance productive sustainable systems.

The focus of this research program on grass, forage, and rangeland production systems provides critical linkages with other ARS research goals. Our management of the native landscape and grass and forage systems has direct impact on our air, soil, and water, and can result in either increasing or decreasing quality of these resources. Therefore, close association with research in other natural resources goals (Goal Area 2) is important. Additionally, managing for sustainable use of natural resources will have impacts and implications for animal production (Goal Area 4) and crop production (Goal Area 3), resulting in strategic linkages with research in those areas. Finally, this research is largely at the interface of natural and managed landscapes, often in marginal environmental settings where soils, nutrients, or water are limiting, making it an important part of ARS efforts to increase the production of quality nutrition while reducing negative environmental impact.

The Grass, Forage, and Rangeland Agroecosystems National Program will support this Goal through research in four components: (1) provide fundamental knowledge and understanding of interacting ecological components of grass, forage, and rangeland agroecosystems; (2) improve the physiology and genetics of plant materials to enhance health, vitality, and utility of pasture, biomass production for feed and fuel, rangeland, and turf systems; (3) develop integrated science-based tools to foster improved management of grass, forage, and rangeland agroecosystems; and (4) generate strategies to manage grass, forage, and rangeland agroecosystems that simultaneously contribute to environmental conservation and are beneficial to human and animal use.

PERFORMANCE MEASURE FOR GOAL 2.3

Develop and transfer economically viable and environmentally sustainable production and conservation practices, technologies, plant materials, and integrated management strategies based on fundamental knowledge of ecological processes that conserve and enhance the Nation's diverse natural resources found on its range, pasture, hay, and turf lands.

STRATEGIES AND MEANS FOR GOAL 2.3 (PROBLEM STATEMENTS)

- Fundamental characteristics and interactions of the atmosphere, plant, soil, animal, and nutrient interface (includes climate, environment, plant biology, wildlife and livestock dynamics, and water and nutrient management).
- Role of microbes in promoting healthy soils, plants, animals, and related ecosystems.
- Plant resilience and resistance to stressors.
- Environmental remediation and restoration.
- Genetic manipulation of the nutritional value of forages for livestock and other uses.
- Aesthetics and utility of turf.
- Measuring and monitoring system status and function at various scales.
- Tools that support management decisions and aid implementation.
- Fire assessment, management, and remediation.
- Livestock management and grazed or harvested forage utilization strategies.
- Improved growth, handling, and storage of harvested biomass for optimized quality and utilization as feed or feedstocks and positive environmental benefits.
- Land and animal management strategies that control or mitigate invasive species and reduce the negative impact of poisonous plants in the landscape.

GOAL 2.4 – INTEGRATED SOLUTIONS FOR AGRICULTURE ENABLING GREATER PRODUCTIVITY, PROFITABILITY, AND NATURAL RESOURCE ENHANCEMENT

NATIONAL PROGRAM 216 – SUSTAINABLE AGRICULTURAL SYSTEMS RESEARCH: 2018-2022

The National Research Council report titled *Toward Sustainable Agricultural Systems in the 21st Century* provides a foundation for Goal 2.4. The report identifies four goals that define sustainable agriculture:

- Satisfy human food, feed, and fiber needs, and contribute to biofuel needs;
- Sustain the economic viability of agriculture;
- Enhance environmental quality and the resource base; and
- Enhance the quality of life for farmers, farm workers, and society as a whole.

Simultaneously achieving these goals requires a systems approach. Research supporting Goal 2.4 will use a systems framework that defines production as a function of the interactions of genetics with environment and management (GxExM). The expansion of the traditional GxE interaction to include M highlights opportunities for management to enhance performance of genetic resources under varying environmental conditions. Feedback from producers and stakeholders about GxExM is universally favorable as this is how they "view the world." Additionally, products delivered to consumers are viewed as a function of (GxExM)xP where P is post-processing, socioeconomic factors that include price and consumer preferences, such as nutritional value and food safety.

The focus of this research program on sustainable production systems provides critical linkages with other ARS research goals. Our management of the production system affects our air, soil, and water, and can result in either increasing or decreasing quality of these resources. Therefore, close association with other natural resources goals (Goal Area 2) is important. Additionally, managing for sustainable use of natural resources will have impacts and implications for animal production (Goal Area 4) and crop production (Goal Area 3), resulting in strategic linkages with that research. Including the "P" in (GxExM)xP, relies on our research understanding of all aspects of the utilization of crops and other benefits of the production system (Goal Area 1).

The Sustainable Agricultural Systems National Program will support this Goal through research in three components: (1) building agroecosystems for intensive, resilient, production via GxExM; (2) increasing efficiencies for agroecosystem sustainability; and (3) achieving agroecosystem potential.

PERFORMANCE MEASURE FOR GOAL 2.4

Develop integrated solutions to solve challenges related to agricultural system productivity, profitability, energy efficiency, and natural resource stewardship.

STRATEGIES AND MEANS FOR GOAL 2.4 (PROBLEM STATEMENTS)

- Sustainable and resilient cropping systems.
- Sustainable and resilient grazing land systems.
- Integrated and diverse cropping and livestock systems.

- Long-term agroecosystem research (LTAR) network.
- Production economics.
- Technologies to enhance efficiency.
- Decision support.
- Sustaining intensified production.
- Enhancing ecosystem services.
- Enabling decision support for sustainability.

Goal Area 3 - Crop Production and Protection

Research conducted by ARS in support of Goal Area 3, Crop Production and Protection, will deliver science-based information and technologies to meet:

- Producers' needs for increased crop productivity, quality and value, protection from diseases and pests, and economically and environmentally sustainable methods of crop production;
- Consumers' demands for a ready supply of high quality, safe, affordable, and nutritious food;
- Workers' needs for a safe working environment;
- The public's desire to protect the environment; and
- The global community's needs for food security.

To meet these needs, ARS will conduct research that addresses the national priorities of genetic resource conservation and improvement, genomics, and information resources and tools; prevention and treatment of plant diseases; identification and management of arthropod and weed pests, including quarantine pests; improved crop management strategies; and the development of methyl bromide alternatives. Research priorities are well integrated with those that support other ARS goals.

GOAL 3.1 – HARNESS THE GENETIC POTENTIAL OF PLANTS TO TRANSFORM U.S. AGRICULTURE

NATIONAL PROGRAM 301 - PLANT GENETIC RESOURCES, GENOMICS, AND GENETIC IMPROVEMENT: 2018-2022

Crop plants underpin U.S. agriculture and food security. Increased crop yield, product quality, and production efficiency are required to safeguard the Nation's agricultural economy and food supply. Goal 3.1 addresses the critical needs for increased crop productivity by providing crop plants with higher inherent genetic potential. To do so requires continuous crop genetic improvement through more efficient and effective plant breeding, which exploits sources of new genes and traits from the Nation's genebanks, leading-edge breeding methods, data-mining, bioinformatic tools, and incisive knowledge of crop molecular and biological processes. ARS breeders, plant scientists, computational biologists, and many others are engaged in a global quest to transform and accelerate the pace of innovation in plant breeding and crop production.

Research done by ARS in support of Goal 3.1 will develop, and effectively apply, new knowledge of crop genes, genomes, and the control and expression of genes, to accelerate the rate of genetic improvement and product quality and value improvement through traditional and novel plant breeding methods. Through innovative research tools and approaches, ARS will manage, integrate, and deliver vast amounts of raw genetic materials (genetic resources); superior cultivars; and genetic, molecular, biological, and phenotypic information to a diverse global clientele. The ultimate goals

for these efforts are to improve the production efficiency, yield, sustainability, resilience, healthfulness, product quality, and value of U.S. crops.

The existing structure, design, and effective coordination and collaboration among the four Goals in Goal Area 4 have been strategically designed to solve the critical problems addressed by Goal 3.1. Research in these four Goals will also be a key contributor to addressing the ARS goal to "transform agriculture to deliver a 20 percent increase in quality food availability at 20 percent lower environmental impact by 2025." The products of Goal 3.1 research will ultimately deliver economically and environmentally sound technologies that improve the production efficiency, quality, health, and value of the Nation's crops.

Furthermore, ARS research in Goal 3.1 will harness the genetic potential of plants and translate that potential into crop products that generate economic gain and consumer benefits through the implementation of optimized production systems developed by crop production in Goal 3.2 and product quality and new uses research in Goal 1.3 to enhance consumer acceptance, food safety, and producer profitability. Plant health research in Goal 3.3 supports the development of plants protected from yield-limiting pathogens, and the crop protection research in Goal 3.4 supports development of plants with resistance to insect and weeds. Research in crop production and protection must also be interlinked with research in natural research and sustainable agricultural systems in Goal Area 2; nutrition, food safety, and quality in Goal Area 1; and animal production systems in Goal Area 4, all of which are addressed by ARS research programs nationwide.

The Plant Genetic Resources, Genomics, and Genetic Improvement National Program will support this Goal through research in four components: (1) crop genetic improvement; (2) plant and microbial genetic resource and information management; (3) crop biological and molecular processes; and (4) information resources and tools for crop genetics, genomics, and genetic improvement.

STRATEGIES AND MEANS FOR GOAL 3.1 (PROBLEM STATEMENTS)

- Trait discovery, analysis, and superior breeding methods.
- New crops, new varieties, and enhanced germplasm with superior traits.
- Plant and microbial genetic resource and information management.
- Fundamental knowledge of plant biological and molecular processes.
- Crop biotechnology risk assessment and coexistence strategies.
- Information resources and tools for crop genetics, genomics, and genetic improvement.

GOAL 3.2 – ENHANCE U.S. AGRICULTURAL CROP PRODUCTIVITY, EFFICIENCY, AND SUSTAINABILITY, AND ENSURE A HIGH QUALITY AND SAFE SUPPLY OF FOOD, FIBER, FEED, ORNAMENTAL, AND INDUSTRIAL CROPS FOR THE NATION

NATIONAL PROGRAM 305 - CROP PRODUCTION: 2018-2023

Sustaining and enhancing the economic viability of crop production in the United States requires new technologies and methods because input costs, such as energy, water, nutrients, pest management, and labor, are increasing. New production strategies necessitate a system approach to be economically, environmentally, and socially sustainable. This requires research products that include information, decision support tools such as software, improved devices such as more efficient spray systems, and accurate and reliable sensors. Information and tools must be integrated into overall production systems for specific crops and crop sequences, and rapidly transferred to growers. As the mechanism for delivering the genetic potential of crops from "seed to table," research supporting Goal 3.2 must continually refocus its efforts to support the research and development needs of changing production systems, climate and environmental

shifts, economic drivers affecting U.S. farmers, and the advances in plant breeding, genetics, pest and weed control, and product quality and utilization.

Goal 3.2 also includes bee pollination research, supporting one of the most important components of crop production. The honey bee (*Apis mellifera*) is the pollinator most often managed for commercial crop pollination. While the frequency of Colony Collapse Disorder has decreased, honey bee populations continue to suffer. Bee health is threatened by pests, pathogens, pesticides, and poor nutrition. New techniques for management of honey bee diseases and pests are needed to maximize pollination. There is also an important need for conservation and in some cases commercial development of non-*Apis* bees (all bees other than honey bees) that effectively pollinate crops such as alfalfa, tree fruits, or greenhouse crops. As part of that goal, scientists working on Goal 3.2 seek to maintain the health and encourage proper management of bee pollinators and honey production. These scientists also do research to develop knowledge, strategies, systems, and technologies for a diversity of crops in a range of production systems, while increasing environmental quality and worker safety.

This research program is a central pillar in the interdisciplinary study of sustainable crop production and improved management from "seed to table." The systems approach taken to address Goal 3.2 connects this goal to many other ARS research goals, including the incorporation of advances in crop genetics (Goal 3.1), and plant disease (Goal 3.3), pest, and weed mitigation (Goal 3.4) into agricultural production. Research supporting Goal 3.2 also connects to postharvest research on dietary choices (Goal 1.1), food waste, transport, and safety (Goal 1.2), and product utilization (Goal 1.3). Scientists working on Goal 3.2 connect to research on natural resources including technology for managing water quality and quantity needed for agricultural production and ecosystem services (Goal 2.1) and research on soil health, efficient nutrient management, air quality, and adaptation to the effects of changing weather patterns (Goal 2.2). Research supporting Goal 3.2 is also closely aligned with research to strengthen agroecosystems and enhancing natural resource stewardship (Goal 2.4).

The Crop Production Systems National Program will support this Goal through research in two components: (1) integrated sustainable crop production systems and (2) bees and pollination.

STRATEGIES AND MEANS FOR GOAL 3.2 (PROBLEM STATEMENTS)

- Productive and profitable systems for sustainable production of agronomic crops.
- Productive and profitable systems for sustainable production of fruit and nut crops.
- Productive and profitable systems for sustainable production of ornamental, nursery, and protected culture crops.
- New and improved automation and spray application systems for sustainable crop production.
- Bee management – improving bee nutrition and performance.
- Bee health – mitigating the impacts of pathogens, pests, and pesticides.
- Conserving bee diversity and improving bee taxonomy.

PERFORMANCE MEASURE FOR GOALS 3.1 AND 3.2

Develop knowledge, strategies, systems, and technologies that maximize the production efficiency of our annual, perennial, nursery, and greenhouse cropping systems. Develop new technologies and tools that improve these systems to meet current and future crop production needs of diversified consumers while ensuring economic and environmental sustainability and production efficiency, health, and value of our Nation's crops.

GOAL 3.3 – IMPROVE AND EXPAND OUR KNOWLEDGE OF EXISTING AND EMERGING PLANT DISEASES AND DEVELOP EFFECTIVE AND SUSTAINABLE DISEASE MANAGEMENT STRATEGIES THAT ARE SAFE TO HUMANS AND THE ENVIRONMENT

NATIONAL PROGRAM 303 - PLANT DISEASES: 2017-2021

Plant diseases are caused by many types of microbial pathogens, including fungi, oomycetes, bacteria, viruses, viroids, phytoplasmas, and nematodes. These diseases cause billions of dollars in economic losses each year to crops, landscapes, and forests in the United States. Plant diseases reduce yields, diminish product quality and shelf life, decrease aesthetic and nutritional value, and may also contaminate food and feed with toxic compounds. Control of plant diseases is essential for providing an adequate supply of food, feed, fiber, and landscape crops, but effective control requires an understanding of the biology of these disease-causing agents.

To improve plant health, the outcomes and impact of research and outreach activities supporting Goal 3.3 include growing plentiful, high quality crops for all citizens; supporting productive agricultural and forest industries; and managing healthy landscapes in our country. Additionally, proactive research addressing weather extremes and the increased global movement of plant material is necessary to combat emerging domestic and exotic diseases not yet found in this country to protect our crops as well as maintain and expand export markets for U.S. plants and plant products.

The research and outreach efforts supporting Goal 3.3 require close linkages with those supporting Goals 3.1 and 3.2. Research must also be conducted in collaboration with natural resources and sustainable agricultural systems scientists in Goal Area 2 to address the effects of environment on crop health and production. With increased global movement of plant material, the research conducted supporting Goal 3.3 must coordinate with that supporting Goal 3.4 to combat emerging threats and protect markets for U.S. plants and plant products. Goal 3.3 researchers must also work closely with those working on human nutrition (Goal 1.1), food safety (Goal 1.2), and product quality and new uses (Goal 1.3) to enhance consumer acceptance, food safety, and producer profitability.

The Plant Diseases National Program supports this Goal through research in three components: (1) etiology, identification, genomics, and systematics; (2) biology, ecology, and genetics of plant pathogens and plant-associated microbes; and (3) plant health management.

STRATEGIES AND MEANS FOR GOAL 3.3 (PROBLEM STATEMENTS)

- Diagnostics, etiology, genomics, and systematics of microbial pathogens that cause plant disease.
- Fundamental pathogen biology.
- Systems approach to pathogenesis.
- Ecology and epidemiology of diseases.
- Development and deployment of host resistance.
- Biologically based and integrated disease management.
- Alternatives to pre-plant methyl bromide soil fumigation.

GOAL 3.4 – PROVIDE TECHNOLOGY TO MANAGE PEST POPULATIONS BELOW ECONOMICALLY DAMAGING THRESHOLDS THROUGH THE INTEGRATION OF ENVIRONMENTALLY COMPATIBLE STRATEGIES THAT ARE BASED ON INCREASED UNDERSTANDING OF THE BIOLOGY AND ECOLOGY OF INSECT, MITE, AND WEED PESTS

NATIONAL PROGRAM 304 - CROP PROTECTION AND QUARANTINE: 2020-2025

The United States produces an abundance of high quality, affordable food and fiber, planting over a quarter of a billion acres of such crops worth more than $115 billion a year. While agricultural commodities represent about 6 percent of the total value of all products exported from the United States, insects, mites, and weeds cause considerable losses to these commodities, with losses estimated at tens of billions of dollars, a significant portion of the final commodity value. For example, postharvest losses for corn and wheat alone due to agricultural pests can amount to as much as $2.5 billion annually.

Pest control methods face continuous challenges from natural and human-associated events. For example, shifts in agricultural practices can create new situations in which an existing insect or plant becomes a pest or a weed. Chemical controls can lose efficacy due to pest resistance or due to removal from the market, either because of environmental concerns or changes in business plans or priorities by pesticide manufacturers. Increases in global shipping (imports and exports) and climate change have also accelerated the pace of the introduction and establishment of invasive pests and weeds. Invasive species and loss of chemical control options threaten our food, fiber, and natural ecosystems and are a mounting concern. For example, the brown marmorated stink bug and spotted wing drosophila consume agricultural crops, while other invasive insects transmit devastating bacterial and viral diseases. Some of these invasive insects, such as the Asian long-horned beetle and emerald ash borer, decimate forests and urban landscapes. Weed species have evolved resistance to many herbicides, while the pipeline for new herbicide chemistries has slowed to a trickle, with the last new mode of action commercialized in row crops in the late 1990s. Invasive weeds have reduced biodiversity, displaced native species, and cost billions of dollars to control annually.

Integrated pest management (IPM) is the desired strategy for controlling insects, weeds, and diseases. IPM combines the use of pest surveillance to identify when and where pest control strategies are best applied with multiple control methods that are integrated to work optimally, while also being economical and environmentally safe. Pest control includes cultural, biological, physical, and chemical methods. By combining the use of several control tactics and monitoring the activity and population growth of a pest, growers can best target pest populations while maintaining the

effectiveness of each control method. Maintaining an array of effective methods is important since control strategies, especially chemical methods, can be lost for a variety of reasons: pest/weed resistance, new regulatory requirements (arising from environmental or human safety issues), loss of public acceptance, and commercial considerations. The main goal of IPM methods is to systematically apply scientific knowledge to the biology of insects and weeds to achieve safe, harmonious, and economical systems that reduce pest problems below economic thresholds in a sustainable manner.

National Program (NP) 304 conducts fundamental research to create the knowledge base necessary to develop innovative control methods and IPM strategies and applied research to produce information and material products that improve pest and disease control in agriculture. The expected outcomes include reduced costs; better controlled pests with fewer non-target, human, and environmental effects; and a reduction in existing pest populations or minimize the establishment and spread of exotic organisms that may become invasive pests in agricultural production systems. These control strategies are applied in a variety of environments, from the production field to storage, shipping, and packing facilities. The development, implementation, and improvement of pest and weed management and control strategies contribute significantly to maintaining the competitiveness and vitality of U.S. agriculture and improving the quality and security of our food and fiber supply.

New solutions to protecting crops from pest insects and weeds are needed to increase the quantity and quality of consumer-palatable food and to increase usable fiber. One focus area of this goal, citrus greening, is led by scientists working on Goal 3.4 in collaboration with crop scientists working on other Goal Area 3 goals, scientists working on nutrition (Goal 1.1) and food safety (Goal 1.2) (e.g., producing resistant citrus varieties with fruit that has the desired flavor of an orange), and scientists working on natural resources and sustainable agriculture systems (Goal Area 2) (e.g., use of soil microbial communities in citrus production). Goal 3.4 scientists also work with scientists supporting Goal 3.1 to produce insect-resistant crop germplasm, with scientists supporting Goal 3.3 to combat insect vectored plant pathogens such as the bacteria that causes citrus greening, and scientists supporting Goal 3.2 to ensure healthy pollinators through development of IPM strategies that reduce bee exposure to pesticides. Further, Goal 3.2 specialty crop research depends on developing strategies that are dependent on Goal 3.4 research in protecting pollinators while simultaneously providing pest insect and weed control, such as use of pesticide-free cover crops that provide bee forage while controlling weeds.

The Crop Protection and Quarantine National Program supports this Goal through research in four components: (1) systematics and identification; (2) weeds; (3) insects and mites; and (4) protection of postharvest commodities, quarantine, and methyl bromide alternatives.

STRATEGIES AND MEANS FOR GOAL 3.4 (PROBLEM STATEMENTS)

- Systematics and identification of insects and mites, non-crop plants, and microogranisms in agriculture.
- New weed management technology discovery and development.
- Biological control and ecosystem research.
- Integrated approaches to weed management.
- Early detection, prediction, and monitoring of beneficial and pest arthropods.
- Develop new or improved management tools and knowledge to control arthropod pests.
- Integrate management strategies to control arthropod pests.

- Manage pests affecting fresh and durable commodities.
- Improve and develop postharvest and quarantine treatments.

PERFORMANCE MEASURE FOR GOALS 3.3 AND 3.4

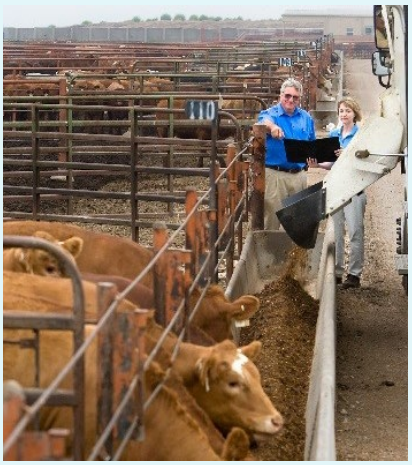
Provide scientific information to increase our knowledge of weed, pest, and pathogen genes, genomes, and biological and molecular processes to protect crops and cropping systems from the negative effects of pests and infectious diseases. Develop sustainable control strategies for crop pests and pathogens based on fundamental and applied research that are effective and affordable while maintaining food safety and environmental quality.

Goal Area 4 - Animal Production and Protection

ARS research supporting Goal Area 4, Animal Production and Protection, provides the scientific information and tools to help support the U.S. food animal industries as they supply the nutritional animal products required by the Nation, continue to compete successfully in worldwide trade, and contribute toward global food security. ARS accomplishes this goal through research to optimize production efficiency and animal health through scientific innovation and the discovery and development of new technologies focused on national priorities. Strategic public-private partnerships will be established to achieve our mission, including support of government action and scientific evidence to support regulatory agencies responsible for trade, biodefense, and global food security. Emphasis will be given to genetic improvements of traits related to production efficiencies and germplasm conservation; understanding the mechanisms of disease resistance and the development of tools to prevent, control, or eradicate diseases that threaten the U.S. food supply and public health; and identifying and developing sustainable systems for production of high-quality meat, fish, milk, and eggs that also ensure animal health and well-being. The program also produces new solutions to many veterinary problems created by arthropod pests and vectors and zoonotic diseases and will be leveraged to solve related problems affecting human health and the well-being of American citizens.

GOAL 4.1 – IMPROVE FOOD ANIMAL PRODUCTION EFFICIENCY, INDUSTRY SUSTAINABILITY, ANIMAL WELFARE, PRODUCT QUALITY, AND NUTRITIONAL VALUE WHILE SAFEGUARDING ANIMAL GENETIC RESOURCES

NATIONAL PROGRAM 101 - FOOD ANIMAL PRODUCTION: 2018-2022



The demand for food animal products will continue to increase globally as consumers seek higher quality and more nutrient-dense sources of protein, iron, and other vital nutrients. This trend will continue as the world's population continues to grow and as animal production systems increase efficiencies across varied environments and production systems. Animal production systems fit a unique and valuable niche in the global food production equation by utilizing feeds and forages not appropriate for human consumption. Animal production will continue to serve in this vital role in response to increasing demands for nutritious protein sources that are produced in environmentally sustainable food production systems across the globe.

The United States has historically been a leading source of quality animal products and has led the world in technological development and adoption. These advances have enabled the United States to develop one of the most efficient animal production systems on earth and ARS has been a vital part of that achievement. Furthermore, agriculture is being relied on to provide for a growing world

population more now than at any other time in modern history. Pressure to feed a projected nine billion plus people by 2050 makes the role of ARS critically important. To remain competitive in the face of extraordinary growth in animal production systems around the world, while at the same time decreasing the environmental footprint of animal production, U.S. animal industries must continue to focus on the development and adoption of scientific technologies. These improvements in efficiency must be sustainable with regard to animal welfare and impacts on the environment. The application of new tools in genomics, biotechnology, metagenomics, reproductive physiology, nutrition, and molecular biology in concert with animal health and in support of traditional husbandry, animal welfare, and conservation of ecosystem services will continue to improve the long tradition of global economic competitiveness and sustainability of U.S. food animal production.

Systems of agricultural animal management and production face formidable challenges. One of the most exacting challenges is successful adaptation to the accelerating demands of society that impact animal productivity and product quality. The demands placed on the national system of food animal production by a rapidly changing world include increasing population, increasing demand for animal products by developing nations, rising obesity, and increasing demands for better nutrition, with greater food safety and lower costs. Research on food animals and their production systems (management strategies, environmental impacts) is needed to meet these demands. These challenges will be met by using technologies that harness and enhance the genetic potential of animal germplasm. These technologies will be sustainable in that they cause no harm to the animals or the environment, and will be implementable by the animal production and food marketing industries. Production systems that harness animal biology in a sustainable way will maximize profits, secure supply, increase market competitiveness, sustain small and mid and large scale producers, conserve natural resources and maintain genetic diversity and consumer confidence.

Goal 4.1 scientists have substantial interrelationships with scientists working on the other ARS research goals. Interrelationships with Goal 4.3 focus on alternatives to the use of antibiotics to maintain the health and production of food animals. Interrelationships with Goal Area 1 address food animal production's contribution to human food safety (e.g., strategies to reduce pathogen transfer from animals to humans that occurs via animal products) and human nutrition (e.g. modifications of animal products to improve healthfulness to humans). Interrelationships with Goal Area 2 address mitigation of detrimental effects of food animals on the environment, including effects on air, water and soil, and enhancing beneficial effects of animal wastes on soil health. A further interrelationship addresses research to define the beneficial use of food animals on pastures and rangelands to improve ecological factors, including research to understand the role of livestock in mitigating invasive species, improving wildlife habitat, and reducing wildfire incidence.

The Food Animal Production National Program will support this Goal through research in three components: (1) increasing production and production efficiencies while enhancing animal well-being across diverse animal production systems; (2) understanding, improving, and effectively using animal genetic and genomic resources; and (3) measuring and enhancing product quality and enhancing the healthfulness of meat animal products.

STRATEGIES AND MEANS FOR GOAL 4.1 (PROBLEM STATEMENTS)

- Improving the efficiency of growth and nutrient utilization.
- Improving reproductive efficiency.
- Enhancing animal well-being and reducing stress.
- Develop bioinformatic and other required capacities for research in genomics and metagenomics.
- Characterize functional genomic pathways and their interactions.
- Preserve, characterize, and curate food animal genetic resources.
- Develop and implement genetic improvement programs using genomic tools.

- Systems to improve product quality and reduce variation in meat animal products.
- Improving the healthfulness and nutritional value of meat products from traditional and non-traditional production systems.

GOAL 4.2 – IMPROVE DOMESTIC AQUACULTURE PRODUCTION EFFICIENCY AND PRODUCT QUALITY WHILE MINIMIZING IMPACTS ON NATURAL RESOURCES

NATIONAL PROGRAM 106 - AQUACULTURE: 2020-2024

Aquaculture is the production of aquatic animals under controlled conditions for all or part of their lifecycles. Interest in aquaculture production is on the rise because of the harvest of wild-caught seafood has leveled off and demand for seafood and other products of aquaculture continues to grow. The ability for U.S. aquaculture producers to meet that demand requires development of technologies to reduce the cost of production while maintaining and improving product quality. Producers, processors, and breeders are in need of systems that maximize aquatic animal production, reduce environmental impacts, increase market competitiveness, sustain producers, and earn consumer confidence. Research in the disciplines of genetics, nutrition, health, and physiology will support the biological improvement of animals, while ecology, water quality, engineering, and food science will support the improvement of systems and products to ensure sustainability.

The research supporting this Goal is intended to develop and ensure an abundant, safe, and affordable supply of seafood products for the 300 million U.S. consumers produced in a healthy, competitive, and sustainable aquaculture sector, a sector supported by 2,932 aquaculture farmers producing in excess of $1.5 billion dollars' worth of goods annually.

ARS aquaculture research will contribute to cross-disciplinary opportunities by developing technologies that increase the availability of healthy animal proteins through responsible use of our natural resources. To achieve this will require interactions with scientists working on other ARS Goals that impact aquaculture production systems, including:

1) Developing crops that are optimized for use as fish feed ingredients that reduce the demand on ingredients from wild-caught fisheries (Goal 3.1);
2) Modifying production systems and developing technologies that ensure product quality (Goal 1.3), healthfulness (Goal 1.1), and food safety (Goal 1.2);
3) Modifying production systems and developing technologies that optimize agricultural uses of water (Goal 2.1) and identify beneficial uses of fish waste (Goal 2.4); and
4) Developing technologies that improve fish health and welfare by developing alternatives to antibiotics while reducing on-farm use of antibiotics (Goals 4.1 and 4.3).

The Aquaculture National Program will support this Goal through research in five components: (1) improving the efficiency and sustainability of catfish aquaculture; (2) improving the efficiency and sustainability of salmonid aquaculture; (3) improving the efficiency and sustainability of hybrid striped bass aquaculture; (4) enhancing shellfish aquaculture; and (5) developing marine finfish seedstocks.

STRATEGIES AND MEANS FOR GOAL 4.2 (PROBLEM STATEMENTS)

- Improve catfish aquaculture production efficiency.
- Reduce the impacts of disease in catfish aquaculture.
- Improve catfish product quality.
- Improve salmonid aquaculture production efficiency and ensure product quality.
- Reduce the impacts of disease in salmonid aquaculture.
- Enhance hybrid striped bass aquaculture production.
- Enhance shellfish aquaculture production.
- Develop marine finfish seedstocks optimized for aquaculture production efficiency.

PERFORMANCE MEASURE FOR GOALS 4.1 AND 4.2

Provide scientific information to maximize the production efficiency of our food animal production systems. Develop new technologies and tools contributing to improved systems to meet current and future food animal production needs of diversified consumers while ensuring economic and environmental sustainability and animal well-being.

GOAL 4.3 – PROTECT AND ENSURE THE SAFETY OF THE NATION'S AGRICULTURE AND FOOD SUPPLY THROUGH IMPROVED DISEASE DETECTION, PREVENTION, AND CONTROL

NATIONAL PROGRAM 103 - ANIMAL HEALTH: 2017-2022

Animal health research investments are vital to a resilient U.S. economy and food supply, public health, and global food security. Animal disease outbreaks can cost U.S. producers millions to billions of dollars and, if these diseases are also zoonotic (transmissible to humans), can have significant public health consequences.

Many factors contribute to the emergence of new pathogens, the re-emergence or reintroduction of previously controlled pathogens, and the evolution of pathogens to be resistant to traditional treatments. Addressing these 21st century challenges will demand a "systems biology" approach in which knowledge obtained from pathogens, animal genomes, functional genomics, clinical trials, and epidemiology are integrated in the discovery and development of countermeasures for preventing and controlling disease outbreaks.

Research supporting ARS Goal 4.3 will further support ARS cross-cutting priorities, including research projects directly addressing antimicrobial resistance and increasing the understanding of the microbiome on animal health. Further collaborations with scientists working on animal production (Goal 4.1); veterinary, medical, and urban entomology (Goal 4.4); and food safety (Goal 1.2) will be used to facilitate the systems biology approach to addressing these goals.

The Animal Health National Program will support this Goal through seven research components: (1) biodefense; (2) antimicrobial resistance; (3) zoonotic bacterial diseases; (4) respiratory diseases; (5) priority production diseases; (6) parasitic diseases; (7) transmissible spongiform encephalopathies.

STRATEGIES AND MEANS FOR GOAL 4.3 (PROBLEM STATEMENTS)

- Strengthen preparedness for foreign animal and emerging diseases through improved understanding of disease pathogenesis, diagnostic, and countermeasure development.
- Increase the understanding of antimicrobial resistance ecology and develop alternatives to antibiotics.
- Improve knowledge of zoonotic bacterial pathogenesis to inform novel prevention, diagnostic, and control strategies.
- Improve knowledge of respiratory diseases in production animals to inform novel prevention, diagnostic, and control strategies.
- Improve knowledge of parasitic diseases in production animals to inform novel prevention, diagnostic, and control strategies.
- Improve knowledge of priority endemic production diseases to inform novel prevention, diagnostic, and control strategies.
- Improve knowledge of prion diseases in ruminants to inform novel prevention, diagnostic, and control strategies.
- Genetics of prion disease susceptibility.

- Transmissible spongiform encephalopathy diagnostics, detection, and prevention.

GOAL 4.4 – ELIMINATE ARTHROPOD VECTORS AND THE DISEASES THAT THEY TRANSMIT TO LIVESTOCK, HUMANS, AND OTHER ANIMALS AND NULLIFY THEIR ECONOMIC IMPACT

NATIONAL PROGRAM 104 - VETERINARY, MEDICAL, AND URBAN ENTOMOLOGY: 2019-2024

Damage and disease associated with biting and stinging arthropods affect humans and livestock in the United States and around the world. Economic losses from arthropod damage, including crop losses, exceed one hundred billion dollars annually. Human globalization, international trade, local movement, and altered ecosystems facilitate the introduction of new disease vectors and pathogens into the United States, promote new parasitic arthropod-wildlife-livestock interactions, enable atypical arthropod vector-host-pathogen interactions, and expose humans to new vectors and pathogens. The research supporting Goal 4.4 seeks to reduce arthropod damage to animals, humans, and structures. This work will target (1) arthropods transmitting pathogens that cause diseases in humans and animals, (2) pests that directly harm human heath by feeding or stinging, and (3) nesting pests that damage structures. Due to the interconnection between the health of animals, people, and the environment, the program employs a "One Health" approach, which is the collaborative effort of the human health, animal health and environmental health communities. Through this collaboration, USDA supports sustained health outcomes for both animals and people.

Research supporting Goal 4.4 also supports other ARS research goals. Research that results in the reduction of livestock disease and the improvement of livestock production (Goal 4.3) is also aligned with Goal 4.4 research addressing arthropod control and the reduction of direct arthropod damage and stress to animals. A more specific example of the association between these two goals is their shared focus on livestock disease vectors (biting midges, mosquitoes, ticks) and the diseases that they transmit, e.g. Blue Tongue, Rift Valley fever, and Babesiosis. Scientists working on Goal 4.4 cooperate with scientists working at the European Biological Laboratory to support Goal 3.4 research on developing solutions to protect deployed U.S. military personnel. Scientists working on Goal 4.4 also collaborate with scientists working on Goal 1.3, who are investigating new microbial and plant-based agents for mosquito control, to develop entomopathic fungi for mosquito control. These combined efforts produce solutions that increase animal production (Goal 4.1).

The Veterinary, Medical, and Urban Entomology National Program will support this Goal through research in three components: (1) veterinary entomology; (2) medical entomology; and (3) fire ants and other invasive ants.

STRATEGIES AND MEANS FOR GOAL 4.4 (PROBLEM STATEMENTS)

- Improved integrated pest management of ticks of veterinary importance.
- Improved integrated pest management of stable flies that feed on livestock.
- Improved integrated pest management of house flies that harm livestock.
- Improved risk assessment, biological understanding, and control of horn flies.
- Improved integrated pest management of the new world screwworm.
- Improved integrated pest management of mosquitoes of veterinary importance.

- Improved risk assessment, biological understanding, and control of biting midges of veterinary importance.
- Improved integrated pest management of mosquitoes of medical importance.
- Improved integrated pest management of house flies of medical importance.
- Improved integrated pest management of sand flies of medical importance.
- Improved surveillance and control of ticks of medical importance.
- Improved risk assessment, biological understanding, and control of invasive fire ants.
- Improved integrated pest management of invasive crazy ants.
- Improved integrated pest management of other invasive pest ants.

PERFORMANCE MEASURE FOR GOAL 4.2, 4.3, AND 4.4

Provide scientific information to protect animals, humans, and property from the negative effects of pests and infectious diseases. Develop and transfer tools to the agricultural community, commercial partners, and government agencies to control or eradicate domestic and exotic diseases and pests that affect animal and human health.

CHAPTER THREE: PROGRAM MANAGEMENT GOALS

Program Management Goal 1: Ensuring the Quality, Relevance, and Performance of ARS Research

The Office of Management and Budget (OMB) established government-wide research and development investment criteria that are designed to assess the relevance, quality, and performance of federally funded research; ARS adopted these criteria as a tool to measure its research. To establish the relevancy of the Agency's research programs, ARS relies on organized interactions with customers, stakeholders, and partners. Peer reviews conducted by the Office of Scientific Quality Review (OSQR) and the Research Position Evaluation System (RPES) ensure the quality of the Agency's research and scientific workforce. All research projects are assessed annually to determine the number of currently approved milestones that were met or not met during the preceding fiscal year. Near the end of the 5-year program cycle, national programs are subject to retrospective reviews, which verify the scientific impact and programmatic relevance of the work conducted under each national program action plan. See Appendix 1 for more information about national research program management in ARS.

PM GOAL 1.1 - RELEVANCE: ARS' BASIC, APPLIED, AND DEVELOPMENTAL RESEARCH PROGRAMS ARE WELL- CONCEIVED, HAVE SPECIFIC PROGRAMMATIC GOALS, ADDRESS HIGH PRIORITY NATIONAL NEEDS, AND HAVE DIRECT RELEVANCY IN ACHIEVING ARS' LONG-TERM GOALS.

To ensure the relevance of ARS research, ARS obtains stakeholder input, evaluates it along with input from the Administration and Congress, and carefully considers this input as it designs its research programs and projects.

STRATEGIES AND MEANS FOR PM GOAL 1.1

- Gather external input on the agricultural research needs and scientific challenges relevant to the national program through stakeholder, technical, and commodity-specific workshops.
- Evaluate input obtained from the workshops along with input from Congress, the White House, the Department, and other Federal agencies in the design of every national program's 5-year action plan.
- Consider all input in the design of the individual research projects supporting the national program action plan.

PM GOAL 1.2 - QUALITY: ARS' RESEARCH PROJECTS ARE REVIEWED FOR QUALITY BY NATIONAL PROGRAM USING INDEPENDENT EXTERNAL PEER REVIEW PANELS PRIOR TO THE BEGINNING OF THE 5-YEAR NATIONAL PROGRAM CYCLE.

OSQR manages the ARS peer review system for research projects and gives researchers the opportunity to obtain constructive feedback from their external peers. These reviews are conducted by panels made up almost entirely of non-ARS scientific professionals, including an external chairperson with expert knowledge pertinent to the research being reviewed. In their evaluations, panels assess each project plan's research methodology, probability of success, and scientific merit. The peer review panel provides comments and scores each project as needing "no revision," "minor revision," "moderate revision," and "major revision," or as "not feasible." Low scoring plans are given a single opportunity to revise and, if they do not improve, are not initiated.

STRATEGIES AND MEANS FOR PM GOAL 1.2

- Provide training and guidance to ARS scientists so that they prepare high quality project plans.
- Peer review all ARS project plans for research quality prior to their initiation.

PM GOAL 1.3 - PERFORMANCE: ARS RESEARCH PROJECTS ARE ANNUALLY REVIEWED AND ARS NATIONAL PROGRAMS ARE REVIEWED AT THE END OF THE 5-YEAR NATIONAL PROGRAM CYCLE FOR PERFORMANCE AND IMPACT

All research projects are assessed annually to determine the number of currently approved milestones that were met or not met during the preceding fiscal year. Information as to why a milestone was not met (including mitigating circumstances) is collected and will be used for making program management decisions. Each national program is assessed by individuals from outside ARS near the end of its 5-year national program cycle. This assessment results in a written report on the quality of accomplishments and the impact of the research. Approximately 20 percent of national programs are reviewed annually.

STRATEGIES AND MEANS FOR PM GOAL 1.3

- Conduct an annual assessment of projects to determine if they have maintained direct relevance in achieving ARS' long term goals and the priority needs of U.S. agriculture. Those projects considered of lower relevance will be redirected into higher priority research areas/objectives. *(Relevance)*
- Receive summary information from OSQR, using a statistical rolling average, of the results achieved during the initial panel review. *(Quality)*
- Receive a summary each year of peer reviews that RPES conducts on ARS scientists. *(Quality)*
- Assess each project's progress against each approved milestone, indicating whether it was fully met, substantially met, or not met with an explanation for the latter two ratings. Line management will review and concur in these assessments. Each year, ONP will review these assessments to validate their conclusions. *(Performance)*
- Assess national programs to gauge the level of past performance and establish the research priorities and direction of the program for the next 5-year cycle. This process provides valuable input to the writing teams that are drafting action plans for the next 5-year program cycle. *(Performance)*

Program Management Goal 2: External Partnerships and Collaborations

PM GOAL 2.1 – LAND-GRANT UNIVERSITY AND DOMESTIC PARTNERSHIPS

ARS has a long history of successful scientific collaboration with the nation's state universities, land-grant colleges, and historically black universities. The Agency collaborates extensively with universities and research organizations across the country, and more than one-third of ARS locations are co-located on university campuses. ARS considers its university partners to be among its strongest cooperators and stakeholders, together accomplishing more than either entity could alone.

Additionally, ARS partners with the private sector and industry, entities that often serve as the essential delivery mechanism and intermediary between ARS research and the realization of public benefit. Private sector partners facilitate technology transfer by providing the complementary assets needed for the adoption of research outcomes.

PM GOAL 2.2 – INTERNATIONAL ENGAGEMENT AND PARTNERSHIPS

Thanks to decades of successful public and private sector research and development coupled with hard-working agricultural communities, the United States enjoys a healthy, competitive agricultural system. But many crops and animals—and the threats to them—originate outside our borders and recognize no boundaries. The nature of many agricultural problems—including emerging and re-emerging plant and animal diseases, food safety threats, invasive species, changing environmental conditions, access to genetic resources and scientific collections—drives ARS scientists towards international research cooperation with the ultimate goal of ensuring safe, adequate, nutritious production of food and other agricultural products. USDA scientists leverage increasingly scarce resources to develop solutions by collaborating with like-minded scientists and their institutions and expand the breadth and impact of their research to prevent or prepare for problems before they arrive in the United States. USDA international research cooperation provides solutions to current and future agricultural productivity and sustainability challenges, beyond what can be achieved through purely domestic research.

STRATEGIES AND MEANS FOR PM GOALS 2.1 AND 2.2

- Catalyze and manage domestic and international partnerships that enhance the Agency's national programs to address critical needs of U.S. agriculture.
- Manage ARS' overseas biological control laboratories that identify and collect natural enemies of invasive species in the United States.
- Network with other U.S. government agencies and the international community to promote the Agency's interests.
- Engage in ARS communication and outreach by highlighting ARS achievements in domestic and international research collaborations.

Program Management Goal 3: Ensure Provision and Permanent Access of Quality Information

PM GOAL 3.1 – PROVIDE PERMANENT ACCESS TO QUALITY INFORMATION

The ARS National Agricultural Library (NAL) facilitates the creation of agricultural knowledge needed to solve agricultural challenges today and in the future. NAL sustains the American agricultural enterprise through public access and effective stewardship of agricultural data, literature, and other information resources. NAL and its information resources are essential to USDA's identity as a facts-based, data-driven, and customer-focused Department.

As one of five national libraries and the library of the USDA, NAL manages the world's largest collection of agricultural information, including more than eight million physical items and a wide array of digital assets such as databases and datasets, born-digital full-text journals and monographs, and a growing body of retrospectively digitized USDA and other agriculturally oriented content.

NAL's website is the primary entry point to all its online resources, including:

- AGRICOLA, USDA's online catalog and index to the agricultural literature;
- PubAg and Ag Data Commons, USDA's "one-stop-shop" for public access to scholarly literature and data funded by the Department;
- National Agricultural Library Digital Collections, including digitized content from NAL's Special Collections; and

- DigiTop, the online resource for USDA staff that provides 24/7/365 access to licensed electronic resources such as journals, databases, newspapers, and e-books.

Libraries provide the physical and virtual environments that nurture collaboration, innovation, and creative problem-solving. Librarians, domain specialists, and information management professionals acquire, curate, and disseminate the content that customers expect and rely upon to create new knowledge or make decisions. Librarians, domain specialists, and information management professionals are more important than ever in 21st century libraries, even though processes are increasingly automated and most content is delivered online. These 21st century libraries provide the foundation for future generations to solve tomorrow's most vexing intellectual and practical challenges through their content, infrastructures, and sophisticated technology savvy staffs.

NAL staff members collaborate and innovate with stakeholders on products and services to meet the evolving needs of its customers across the spectrum of agricultural activity, ranging from researchers and policymakers to members of the general public. NAL's domain experts maintain information centers aligned with ARS' scientific areas and other USDA customer and stakeholder needs in agricultural law, alternative farming, rural development, and other areas. NAL also provides data management planning, data curation, and other information management services for ARS, the Department, and collaborators in the academic community.

STRATEGIES AND MEANS FOR PM GOAL 3.1

OBJECTIVE: Support the Department's strategic goals for fact-based, data-driven decision-making through NAL's information products and services.

STRATEGIES

- Deliver timely information products and services concerning "hot topics" and emerging issues of critical national importance.
- Deliver training to optimize use of NAL programs and services.
- Recruit and retain a customer service-focused, results-oriented, and technologically-adept diverse workforce.
- Develop shared technical standards that align with national policies, ARS research priorities, and the broader needs of the Department.
- Extend and enrich PubAg and AGRICOLA, increasing public access to online full-text manuscripts and open access publications and the continued enhancement of the NAL Thesaurus.

OBJECTIVE: Deliver unified, easy-to-use, convenient 24/7/365 digital services that are customer-focused and meet customers' expectations and needs.

STRATEGIES

- Understand the information needs of NAL customers, stakeholders, and other beneficiaries through surveys, focus groups, and other forms of assessment.
- Establish partnerships across USDA and with other Federal agencies to develop information services to meet targeted customer needs.
- Foster a culture of collaboration and innovation that delivers customer-focused products and services to a wide variety of consumers of agricultural information.

OBJECTIVE: Work efficiently and effectively, with integrity and customer-focus.

STRATEGIES

- Improve information delivery to underserved customer audiences.

- Increase advocacy and outreach initiatives, and market NAL products and services to specific audiences and customer groups.
- Explore and analyze the agricultural information landscape to identify new and not-yet-discovered users, and take action to meet their current and future needs.
- Expose NAL content to more audiences through collaborations and partnerships with leading academic, cultural, industry, and research institutions.
- Optimize NAL's organizational structure, information technologies, and workflows to support the continued transition to digital services.

OBJECTIVE: Provide leadership in agricultural and research library communities to build capacity for providing effective stewardship of information resources and improving access to agricultural information supporting the Department's mission to do right and feed everyone.

STRATEGIES

- Continue to lead and participate in national and international alliances and partnerships that support the acquisition, curation, and dissemination of agricultural information.
- Secure the Nation's agricultural heritage through the conservation and preservation of rare and at-risk items in NAL's physical and special collections.
- Broaden and deepen NAL collections without regard for format, with access and preservation in mind.
- Expand the audience for and content of the NAL digital collections.

Program Management Goal 4: Support Modern ARS Science

PM GOAL 4.1 – SUPPORT MODERN ARS SCIENCE

The nature of the science supporting the ARS mission is changing rapidly. In the past, scientific methods were often labor-intensive and consumed considerable time and effort to adequately address a single scientific question. Scientists are now generating vast amounts of high-quality data rapidly and relatively inexpensively. This fundamental change in the nature of science is presenting new challenges and demanding new approaches to maximize the value extracted from these large and complex datasets. This dramatic growth in data volume, variety, and velocity has come to be known as Big Data.

As a result of these changes, a new paradigm is emerging in science that is characterized by its data intensity. Previous methods for data collection, storage, and analysis are inadequate for handling the scale and complexity of this avalanche of new data. Therefore, ARS has a new goal to support scientific computing that efficiently combines disparate information for scientific discovery and enables the transfer of that knowledge quickly and efficiently to other scientists and to the public.

In addition to this agency-wide Big Data Initiative, ARS will use informatics tools and approaches to accelerate the field's understanding of genomic diversity and the breeding gains achieved for a larger suite of crop and animal species. These efforts include the ARS Breeding Insight Platform, an informatics program for increasing the efficiency of specialty crop and animal breeding programs, and the Earth BioGenome project, an international effort to sequence the genomes of all 1.5 million known complex species on earth.

STRATEGIES AND MEANS FOR PM GOAL 4.1

- Implement ARS Big Data initiative:
    - Create a scientific network for research data transfers (SciNet).

    - Establish hybrid high-performance computing and storage.
    - Develop a virtual research support group.
- Launch the ARS Breeding Insight Platform
    - Develop an understanding of the specific needs of a select few specialty crop and animal breeding programs
    - Leverage existing genome analysis tools to develop an informatics and breeding pipeline suited to these crops and animals
    - Scale the platform to meet the needs of dozens of breeding programs
- Participate in the Earth BioGenome project
    - Support the i5k project, an international effort to sequence 5,000 arthropod genomes
    - Launch the Ag100Pests project, an ARS-led effort to sequence the genomes of the top 100 agricultural pests in the United States

Program Management Goal 5: Adoption of Research Outcomes

Successful transfer of research outcomes is one of the most essential functions of ARS. The full impact of the research may not be realized without successful technology transfer.

PM GOAL 5.1 – ENSURE THAT TECHNOLOGY TRANSFER REMAINS AN ESSENTIAL PART OF THE ARS RESEARCH ENTERPRISE

Legislation creating technology transfer functions at Federal laboratories was passed in the 1980s and technology transfer is referenced in ARS mission statement: delivering scientific solutions to national and global agricultural challenges.

At ARS, technology transfer is accomplished through many mechanisms:

- Developing written information for customers and stakeholders, including scientific publications, publications in trade journals, and reports to stakeholders;
- Releasing plant germplasm to the public;
- Transferring research materials to scientists outside of ARS;
- Entering into formal partnership agreements, such as Cooperative Research and Development Agreements (CRADAs), and other cooperative agreements;
- Judicious use of intellectual property and licensing (patents, Plant Variety Protection Certificates, and biological materials);
- Participating in meetings with industry organizations and universities and workshops and field days; and
- Distributing information to the public via the ARS Office of Communications, the National Agricultural Library, and other sources.

Sometimes, research results can be transferred directly from ARS to end users or the general public. More often, the private sector serves as the essential delivery mechanism and intermediary between ARS research and the realization of public benefit. Private sector partners facilitate technology transfer by providing the complementary assets needed for the adoption of research outcomes. Such assets may include unique research and manufacturing expertise, capabilities, and facilities; marketing and distribution expertise and capacity; product registration and/or regulation expertise; and investment capital. By providing these assets, private sector partners make investments to increase the impact of ARS research by ensuring research outcomes are widely available.

Because the ARS mission is to transfer technologies for broad public use by the most effective mechanism, ARS pursues patents and licensing principally to incentivize commercialization and to facilitate technology transfer to the marketplace. This is usually the case when complementary investment by the private sector is necessary to commercialize a product, and patent protection is required to protect this investment. In licensing practices, ARS reserves the right to allow use of any intellectual property protected technology for research purposes (non-commercial).

ARS has also been delegated authority by USDA for leadership of the technology transfer program of all USDA agencies. As part of this departmental leadership, ARS publishes an annual report on technology transfer that reports on the technology transfer of all USDA agencies, including ARS.

STRATEGIES AND MEANS FOR PM GOAL 5.1

- Create a culture that understands and fosters entrepreneurship and innovation.
- Maintain intellectual property policies and technology transfer mechanisms.
- Ensure an understanding and awareness of technology transfer policies and best practices.
- Communicate the strategic value of technology transfer internally and externally.
- Judiciously use intellectual property rights to enhance adoption of research outcomes.
- Develop and maintain flexible technology transfer mechanisms that correspond to scientific needs.
- Continue leadership of and participation in the Agricultural Research Partnerships (ARP) Network.
- Continue leadership of and participation in the Agricultural Technology Innovation Partnership (ATIP) Foundation.
- Support small businesses by coupling funds and technologies in collaboration with the Small Business Innovation Research Program of the USDA National Institute of Food and Agriculture.
- Promote an entrepreneurial culture by piloting the National Science Foundation's Innovation Corps at ARS.
- Recognize and incentivize participation in technology transfer activities.
- Stay current on Federal policies and best practices in technology transfer.
- Encourage the implementation of innovative methods of conducting technology transfer.

Program Management Goal 6: Strategic Communication

PM GOAL 6.1 - STRATEGIC COMMUNICATION WITHIN AND OUTSIDE ARS

Strategic communication and engagement informs the public and stakeholders of the importance of researching high priority challenges in food and agriculture and how the products of this research can be made useful. Further, by marketing to potential partners who can adopt ARS research outcomes, ARS can realize its impact in the marketplace. Ultimately, through communicating with—and garnering feedback from—customers, partners, and stakeholders, ARS can build the relationships necessary to have impact in the food and agriculture community.

ARS is a vibrant, technologically forward-looking Agency, and this should be reflected in the Agency's public-facing products. A multifaceted approach to communications is necessary for effectively reaching the Agency's diverse audience of partners and stakeholders. The crowded media landscape makes it essential for ARS to use the right communication strategies to maximize the likelihood that the Agency's messaging will be seen or heard, understood, and acted upon. To ensure that ARS communications are evolving with the changing media landscape, the Agency will gather metrics and use them to tailor communications tactics to each of its audiences.

ARS is an agency with wide reach and even wider impact. The 8,000 ARS employees are strategic assets for amplifying ARS messaging and strengthening relationships in their respective food and agriculture communities. By improving the coordination of communication among our employee messengers and giving them the tools and resources (templates, trainings, and toolkits) to support their roles as ARS ambassadors, ARS can efficiently and effectively reach larger audiences.

In addition to leveraging its employees, ARS must reach important influencers who can amplify messaging about the impact of ARS in food and agriculture. These influencers include ARS partners and stakeholders who support Agency programs, build coalitions, and play a critical role in influencing the agricultural issues of today and tomorrow. Additionally, through strategically building relationships and sharing information with the media, an important

intermediary for amplifying ARS messaging, ARS increases the likelihood that the Agency's partners and stakeholders find, access, and share information about ARS science.

STRATEGIES AND MEANS FOR PM GOAL 6.1

- Increase the versatility of ARS external communications vehicles, adapting communications products to the changing capabilities of the digital landscape.
- Use data-driven decision-making to tailor communications tactics to better reach our diverse audience of partners, stakeholders, and customers most efficiently and effectively.
- Facilitate decentralized, coordinated communication through engaged and empowered messengers from across ARS, providing information products and templates for use by all employees of ARS as appropriate to further the communications mission.
- Leverage partners to amplify ARS messaging.

CHAPTER FOUR: ADMINISTRATIVE MANAGEMENT GOALS

Administrative Management Goal 1: Engaging Employees

AM GOAL 1.1 – ENGAGING EMPLOYEES

ARS values employee engagement as an engine for change, a source for solutions, and ultimately as a way to make ARS a better place to work. The ARS Engagement Council will provide coordination, guidance, and leadership for employee engagement activities across ARS. Membership includes representatives from the areas, locations, headquarters program management units, Office of Outreach, Human Resources; Office of the Administrator, Research Leader Advisory Council, and National Advisory Council of Office Professionals.

STRATEGIES AND MEANS FOR AM GOAL 1.1

- Establish a network throughout ARS where employee activities and any corresponding data is easily communicated and readily available between Engagement Council representatives and Headquarters.
- Coordinate feedback of information on engagement activities from Areas and Headquarters to the Employee Engagement Coordinator for use in multiple reports and activities designed to share best practices and ideas throughout the Agency.
- Create a more informed and engaged environment to aid in raising Federal Employee Viewpoint Survey participation and scores.

Administrative Management Goal 2: High Performing, Efficient, and Adaptable Administrative Systems

The ARS Administrative and Financial Management (AFM) provides administrative services and solutions for the USDA Research, Education and Economics Mission Area. As such, AFM's goal is to provide outstanding customer service efficiently, effectively and with integrity, in alignment with the Secretary of Agriculture's goals.

The whole continuum of administrative and financial management service in ARS and the REE agencies has recently undergone a transformation and emerged more accountable, connected, and empowered, for science, as were the goals of the ACES project. ACES derived its legitimacy, ideas, and horsepower from the employees of ARS and REE. Ideas documented in the ACES Strategic Framework will continue to drive innovation and business process engineering in AFM in the coming years.

AFM expects to achieve through its strategic priority:

- Improved agility;
- Increased productivity; and
- Improved quality.

AM GOAL 2.1 - IMPROVE HUMAN CAPITAL MANAGEMENT

AFM governs the Agency's human resources programs. Services include program administration, policy and guidance development, human resources information systems development and maintenance, and training. The purpose of AM Goal 2.1 is to ensure efficient and effective delivery of these functions.

STRATEGIES AND MEANS FOR AM GOAL 2.1

- Ensure data-driven human resource management and policy decision-making.
- Identify current and future skill gaps through an effective workforce planning process.
- Deliver human resources services through the implementation of e-HR tools.
- Improve individual and organizational performance through the development of position descriptions, standard performance plans, and training and knowledge management.
- Expand the use of the Agency's learning management system (AgLearn) by increasing employee access to online training resources.

AM GOAL 2.2 - IMPROVE FINANCIAL MANAGEMENT AND AGREEMENTS

AFM manages the Agency's financial management and agreement programs. Services include program administration, policy and guidance development, financial and agreement system development and maintenance, and training. The purpose of AM Goal 2.2 is to ensure efficient and effective delivery of these functions.

STRATEGIES AND MEANS FOR AM GOAL 2.2

- Ensure that ARS meets all appropriation level accounting and reporting requirements, all reports continue to indicate an accurate financial status, and reporting difficulties are mitigated expeditiously.
- Continue to improve financial systems business processes and financial reporting capabilities.
- Provide quality support to ARS travelers through the maximization of web-based travel systems.
- Ensure that extramural agreements are awarded in an efficient and timely manner, they are legally and fiscally sound, and they are in full compliance with established policies and procedures.
- Ensure management and employees are continually kept abreast of financial policies and procedures.
- Aggressively seek every opportunity to eliminate and prevent improper payments.

AM GOAL 2.3 - OPTIMIZE THE AGENCY'S ASSET MANAGEMENT PROGRAMS

AFM administers the Agency's facilities, safety, real property, and space management programs. Services include conducting the requirements of these programs, providing service delivery, and program oversight for compliance. The purpose of AM Goal 2.3 is to ensure efficient and effective delivery of these functions.

STRATEGIES AND MEANS FOR AM GOAL 2.3

- Update the Agency's capital investment strategy to adequately address facility needs as well as program needs.
- Expand research and data-driven asset management and policy decision making.
- Provide management information to determine the appropriate levels of investment.
- Use appropriate public and commercial benchmarking and best practices to improve asset management.
- Provide a safe, secure, and healthy workplace through the administration of a robust safety and health program.

AM GOAL 2.4 - ENSURE EFFECTIVE ACQUISITION AND PERSONAL PROPERTY MANAGEMENT

AFM is required to administer and carry out many facets of the Agency's acquisition and personal property program. Services include conducting acquisition requirements, providing acquisition and personal property related services, and oversight. The purpose of AM Goal 2.4 is to ensure efficient and effective delivery of these functions.

STRATEGIES AND MEANS FOR AM GOAL 2.4

- Deliver contracting solutions to generate customer savings through effective strategic sourcing efforts.
- Promote the use of standard solutions and pricing with qualified suppliers to make it easier for the Agency to meet their acquisition needs with minimal administrative demands.
- Track and monitor purchases to ensure regulatory requirements are followed.
- Continue to develop and refine the Agency's personal property process and oversee the implementation of an automated inventory and tracking system known.

Administrative Management Goal 3: High Performing, Efficient, and Adaptable Information Systems

AM GOAL 3.1 - PROVIDE MODERN IT TOOLS AND INFRASTRUCTURE

Enable consistent, reliable access by all ARS employees to desktop and network-based resources necessary to perform their routine job functions.

STRATEGIES AND MEANS FOR AM GOAL 3.1

- Upgrade location bandwidth, networks, and phone systems.
- Upgrade ARS website content management system.
- Integrate the ARS Active Directory with USDA.
- Ensure effective coordination of information technology (IT) operations among staff of the Office of the Chief Information Officer, Business Service Center, and location IT staff

AM GOAL 3.2 - PROTECT IT OPERATIONAL INFRASTRUCTURE AND DIGITAL DATA

Use modern cybersecurity tools and capabilities Agency-wide to ensure appropriate confidentiality, integrity, and access of ARS information and assets and meet mandated cybersecurity requirements.

STRATEGIES AND MEANS FOR AM GOAL 3.2

- Provide clear and consistent information policies and standards.
- Ensure compliance with Federal cybersecurity requirements.
- Actively monitor systems and networks.
- Take proactive measures to reduce security risk.
- Maintain effective response capability to resolve cybersecurity incidents.

AM GOAL 3.3 - INVEST IN ARS IT PROFESSIONALS

Ensure that ARS IT professionals have the necessary skills and training to enable effective support of ARS IT services.

STRATEGIES AND MEANS FOR AM GOAL 3.3

- Provide training and development for ARS IT professionals to enable effective support of changing modern information technologies.
- Provide ongoing cybersecurity training for ARS IT professionals to prevent, detect, and respond to evolving security threats.

AM GOAL 3.4 - PROVIDE EXCELLENCE IN IT CUSTOMER SERVICE

Provide the highest possible quality of technical support for ARS customers.

STRATEGIES AND MEANS FOR AM GOAL 3.4

- Document Help Desk processes to streamline headquarters customer service.
- Document common support solutions and share knowledge with Agency-wide IT community.

AM GOAL 3.5 – PROVIDE MODERN FACILITIES AND INFRASTRUCTURE

Provide all ARS employees with quality and reliable facilities and infrastructure to enable the performance of world-class research and routine administrative functions to support it.

STRATEGIES AND MEANS FOR AM GOAL 3.5

- Assess and document facility conditions using modern approaches.
- Continue to execute a prioritized Agency Capital Investment Strategy based on research program priority and facility condition.
- Expedite disposal of excess owned and leased assets.

CHAPTER FIVE: CIVIL RIGHTS AND DIVERSITY

ARS strives to improve the quality of life for every American and inhabitant of the world through scientific and innovative advances in the growing, raising, protecting, and delivering of food. Since this mission impacts everyone regardless of race, color, national origin, religion, gender, economic or social status, geographical location, and philosophical perspective, everyone should be involved in the labor force that drives this mission. In a nutshell, achieving workforce diversity is the active pursuit of getting everyone affected by the work involved in doing the work. Just as every strand of DNA defines the organism, tapping into the wealth of each unique segment of the population cannot be omitted from the fabric of the ARS workforce. Optimal success of the Agency depends on achieving equity and diversity goals.

Civil Rights and Diversity Goal 1: Ensure Equity and Diversity

Civil Service is a higher calling. Each Civil Servant serves the public—not just a portion of it, but all of the public. ARS cannot serve the public agricultural needs of all if the Agency operates with bias or favoritism. Civil Service is the commitment to improving the lives of all. Credibility, integrity, and workplace efficacy improves when everyone has a place, a voice, and a responsibility. To develop this inclusive environment, both the practices of equity and diversity must be vigilantly pursued. There is a distinction between equity and diversity. Equity is required by the laws, regulations, and policies that guarantee all individuals' rights to equal opportunity in the workplace. Conditions of employment at ARS must be free from discrimination. On the other hand, diversity is the effort to promote inclusion in its broadest context in the workforce. Diversity recognizes not just differences in appearance, but also differences in culture, education, wealth, and personal and philosophical perspectives.

STRATEGIES AND MEANS FOR CRD GOAL 1

- Achieve equity and diversity in recruitment and hiring.
- Ensure inclusion of all employees regardless of stereotypes, subconscious biases, or historical operational practices into all areas of work at all levels.
- Ensure equity and diversity in employee retention and succession planning.

Civil Rights and Diversity Goal 2: Address Barriers to Diversity

In ARS, many of our barriers are related to our research mission. As a scientific organization, the Agency is led by research scientists and technical supporters of those scientists. Due to historical disadvantages, some segments of the U.S. population may be lacking required training and advanced education in the fields relevant to ARS' research mission. While this certainly does not provide excuses to abandon diversity efforts, it does create inherent challenges to hiring a diverse scientific workforce.

The most important factor in overcoming barriers in the workforce is first convincing all hiring managers and supervisors as to the benefits of diversity. It is not affirmative action. Although the law requires it, no diversity plan will thrive if the only reason for pursuing diversity is because the law requires agencies to do so.

STRATEGIES AND MEANS FOR CRD GOAL 2

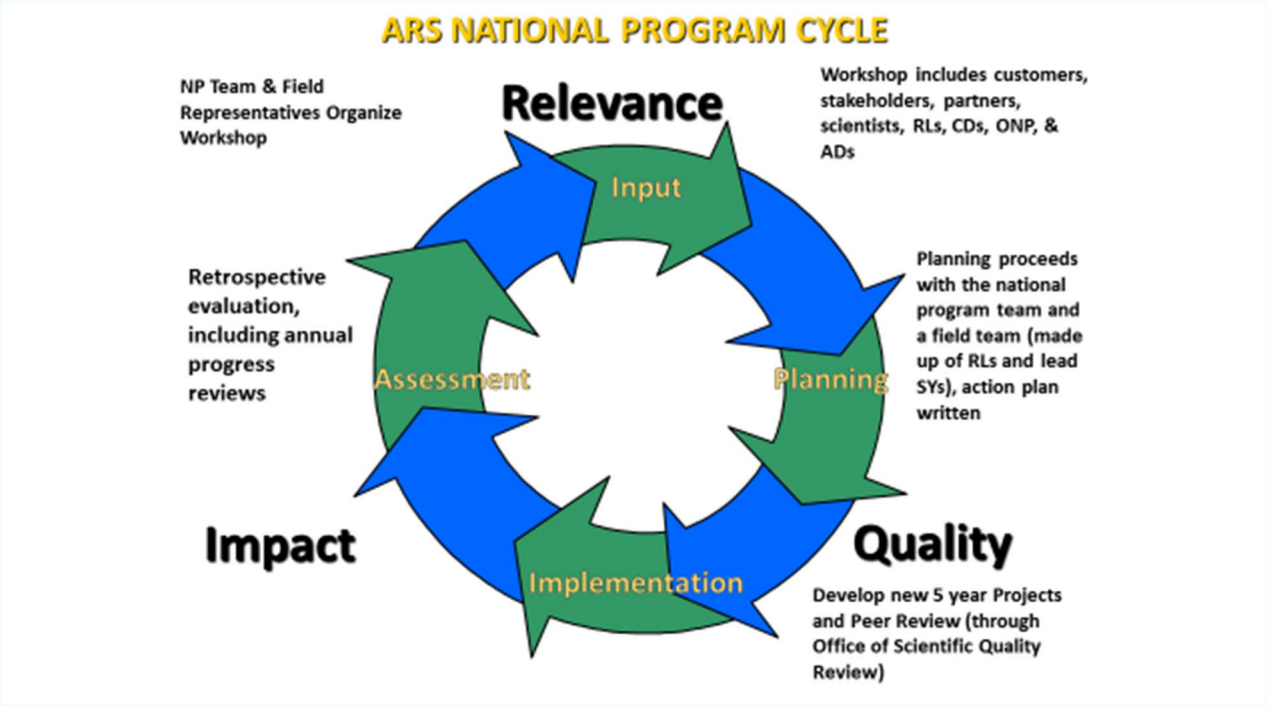
- Identify shortfalls within the ARS workforce regarding diversity.
- Identify barriers to creating and maintaining a diverse ARS workforce.
- Develop solutions to address shortfalls in diversity.
- Track the progress of diversity plan actions using quantitative measures.

APPENDIX ONE - NATIONAL RESEARCH PROGRAM MANAGEMENT IN ARS

The 2,000 ARS scientists from around the country work on approximately 690 research projects that are aligned into 15 national programs encompassing all ARS research. These national programs are grouped into four program areas that align with the four major goals of this strategic plan: Animal Production and Protection (Goal Area 4); Crop Production and Protection (Goal Area 3); Natural Resources and Sustainable Agricultural Systems (Goal Area 2); and Nutrition, Food Safety, and Quality (Goal Area 1). Each of the four program areas is managed by a Deputy Administrator and each program is led by a team of National Program Leaders (NPLs). Some 25 NPLs are responsible for planning and developing research strategies to address critical issues affecting American agriculture. Nearly 200 Research Leaders work with 5 geographically-based Area Directors to implement the coordinated research objectives issued by the NPLs.

Implementation of the 5-Year National Program Cycle

The overarching objectives of the national programs are ***relevance, quality,*** and ***impact*** of ARS research, all important elements of improved accountability. Research must be ***relevant*** to the highest priority problems, the goals and outcomes of the research should significantly ***impact*** the problems, and the science must meet the highest standards of ***quality.*** To ensure that these objectives could be achieved, ARS implemented the national program cycle, which embodies a series of recurring program planning and accountability activities.



This 5-year national program cycle ties together program planning and priority setting; peer review; project implementation; program coordination; and assessment activities in a recurring 5-year sequence to ensure effective and efficient program and project management within ARS.

Ongoing monitoring of project quality and performance takes place throughout the program cycle, and adjustments are made when necessary to improve performance or meet emerging challenges. At the end of the program's 5-year cycle, a

rigorous national program retrospective review is convened to ensure, based on feedback from an outside group of experts (made up of academics, stakeholders, and government), that the research is being conducted as indicated in the national program action plan. The next cycle begins with stakeholder workshops to gain advice and insight from these same experts as to their needs, which guide future research directions.

Relevance, Quality (Prospective and Retrospective), and Performance—these objectives are what a research organization must promote to be successful. Program Planning and Priority Setting, Scientific Merit Peer Review, Project Implementation and Coordination, and Program Assessment prescribe the actions the Agency undertakes carefully, thoroughly, and with outside review to demonstrate our research is of the highest quality. See Program Management Goal 1: Ensuring the Quality, Relevance, and Performance of ARS Research for additional information about ARS' commitment to providing the best research for addressing U.S. agricultural problems.

Strategic Consultations and Inter-Agency Working Groups

ARS regularly consults with external groups—from customers to policy experts, to industry and consumer groups—about the effectiveness of its programs and the need for improvement. While many of these consultations are not conducted expressly for the purpose of the strategic plan, they influence strategic goals, objectives, strategies, and targets. ARS Associate Administrators, Deputy Administrators, and NPLs serve on many committees, taskforces, and interagency working groups where they lend their expertise to solving agricultural problems on both a domestic and global scale.