ARS Annual Performance Report for FY 2013 and Performance Plan for FY 2014 - 2016

Introduction

Mission Statement

ARS conducts research to develop and transfer solutions to agricultural problems of high national priority and provide information access and dissemination to:

- ensure high-quality, safe food, and other agricultural products
- assess the nutritional needs of Americans
- sustain a competitive agricultural economy
- enhance the natural resource base and the environment, and
- provide economic opportunities for rural citizens, communities, and society as a whole.
- provide the infrastructure necessary to create and maintain a diversified workplace

Vision Statement

The ARS vision is to lead America towards a better future though agricultural research and information.

Core Values

Our success depends on:

- **Inclusion** — Providing opportunities for ARS constituents to shape and improve those services provided by the Agency.
- **Collaboration** — Working cooperatively at all governmental levels domestically and internationally on policy matters affecting a broad audience.
- **Accountability** — Ensuring that the performance of all employees is measured against the achievement of the Agency's strategic goals.
- **Customer Focus** — Serving ARS' constituents by delivering programs that address their diverse needs.
- **Professionalism** — Building and maintaining a highly skilled, diverse, and compassionate workforce.
- **Results Orientation** — Measuring performance and making management decisions to direct resources to where they are used most effectively.

Strategic Plan Framework

Formed in 1953 as USDA's chief scientific research agency, ARS is one of the four component agencies of the Research, Education, and Economics (REE) mission area. The Agency's mission centers around conducting the basic and applied research needed to solve problems of national importance for American agricultural producers, Government action agencies, and the general public and, increasingly, for producers and consumers worldwide. This work covers a wide range of needs, ranging from animal and crop protection and production to human nutrition, food safety, and natural resources conservation. Today, with a staff of over 8,500 employees, ARS carries out research at over 100 laboratories throughout the Nation and in several foreign countries.

Outlining the major needs and corresponding goals for the next five years, this new Strategic Plan will help guide the Agency's scientific activities and the accompanying transfer of ARS research products to producers, consumers, action and regulatory agencies, the private sector, and other customers and stakeholders.

The Agency's research focuses on achieving the goals identified in the USDA and Research, Education, and Economics (REE) mission area Strategic Plans. The Government Performance and Results Act (GPRA) mandates each agency to establish general goals that will contribute to achieving beneficial societal outcomes that shape and drive the work of the Agency during the five years covered by the plan.

Goal Areas

Echoing ARS' National Program structure, the Plan is organized into five main Goal Areas: Nutrition, Food Safety, and Quality, Natural Resources and Sustainable Agricultural Systems, Crop Production and Protection, Animal Production and Protection, and Equal Employment Opportunity. These Goal Areas—and the goals, performance measures, and actionable strategies identified within them—align with the components of the REE Action Plan and the USDA Strategic Plan Goals as follows:

ARS Goal Area	ARS Strategic Goal	REE Action Plan Goal	USDA Strategic Goal Objective (s)
1: Nutrition, Food Safety & Quality	1.1 Human Nutrition	4	4.2
	1.2 Food Safety	5	4.3
	1.3 Quality & Utilization of Ag Products	2B, 7	1.3
2: Natural Resources & Sustainable Ag Systems	2.1 Water Availability & Watershed Mgmt	3A	2.2 & 2.3
	2.2 Climate Change, Soils & Emissions Research	2A	2.1, 2.2 & 2.3
	2.3 Bioenergy	2B	1.1
	2.4 Agricultural & Industrial Byproducts	3B	1.3, 2.1 & 4.3
	2.5 Rangeland, Pasture & Forages	3B	2.1
	2.6 Agricultural Competitiveness & Sustainability	2A, 2B, 3B	1.3, 2.1, 2.2 & 2.3
3: Crop Production & Protection	3.1 Plant Genetic Resources, Genomics, Genetic Improvement, and Crop Production	1A, 1C	1.3, 3.1 & 4.4

	3.2 Plant Diseases, Crop Protection & Quarantine, and Methyl Bromide Alternatives	1B, 1C	4.4
4: Animal Production & Protection	4.1 Animal Production	1A, 1B, 1C	1.3 & 3.1
	4.2 Prevention and Control of Pests and Animal Disease that Threaten Agriculture	1B, 1C	1.3, 3.1, 4.3 & 4.4
5: Equal Employment Opportunity	5.1 Develop a Model Equal Employment Opportunity (EEO) Program		MI 2

Goals

Each Goal Area (with the exception of EEO/CR, an overarching Agency Goal Area) includes specific goals that are aligned groupings of ARS' 18 National Programs, derived from the Agency's specific mission, as outlined in each 5-year National Program Action Plan. In developing their individual Project Plans, each ARS scientist will, in turn, align his or her research objectives with the overarching goals identified in this portion of the ARS Strategic Plan, thereby ensuring continuity with the USDA, REE, and ARS vision for agricultural research.

Performance Measures – Explaining the Numbering System

The 14 performance measures describe specific measurable achievements, which indicate progress toward reaching the broader objectives and goals. The first digit of the performance measure ties it to the primary USDA Strategic Goal that is being addressed, the next digit represents the ARS goal area, while the 3rd digit together with the ARS goal area, represents the specific ARS goal.

Performance Targets

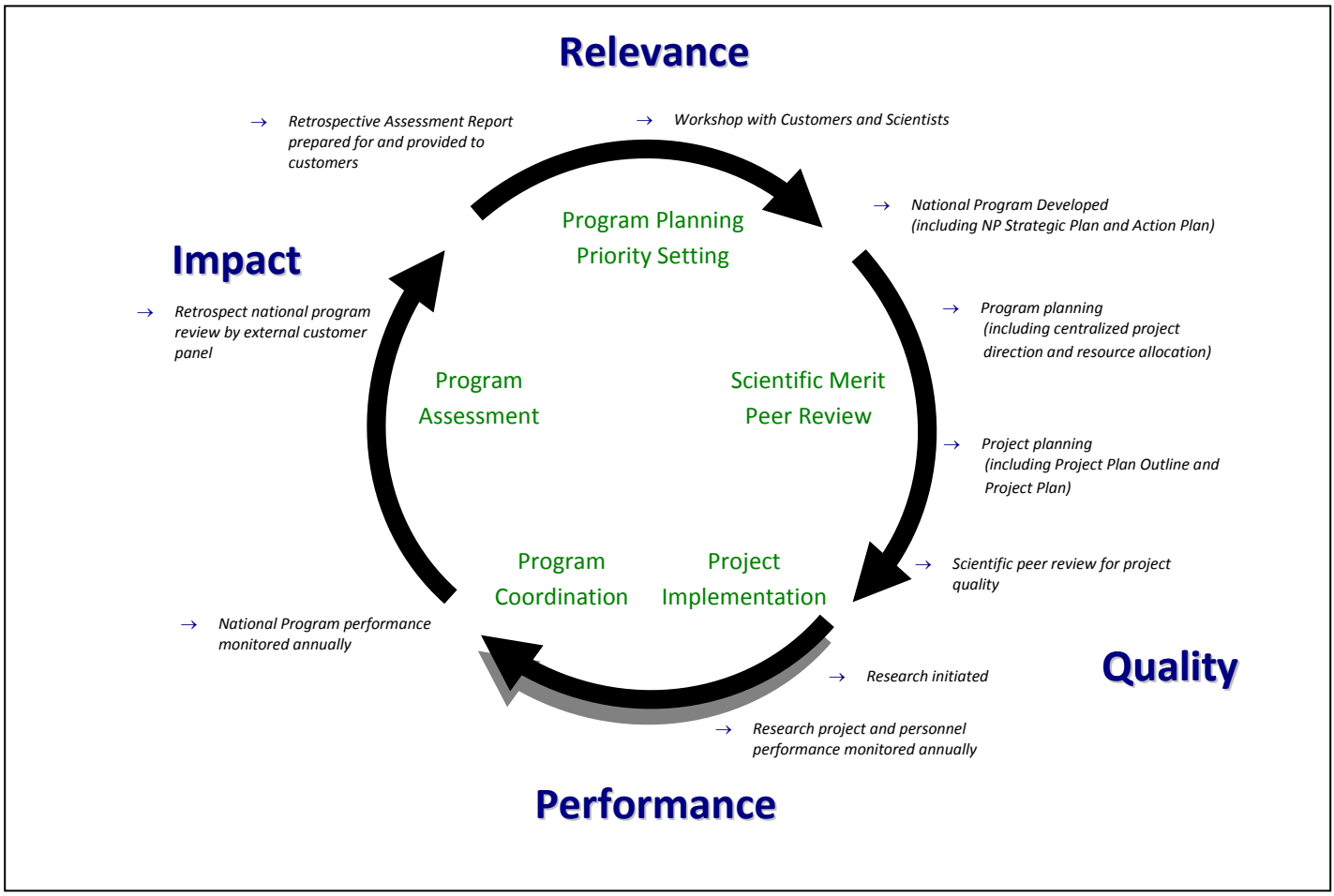
There are a number of performance targets that will be used to achieve each performance measure. These are research components broken down to more clearly align research products and accomplishments with the appropriate performance measure, with a baseline and target to be reached by 2017.

Strategies and Means

These include some of the specific research activities that ARS anticipates conducting during the next 5 years to address each Performance Measure.

National Research Program Management in ARS

Approximately 800 research projects from around the Country are aligned into 18 National Programs that encompass all the research of the Agency. The National Programs are grouped into four program areas: Animal Production and Protection, Crop Production and Protection, Natural Resources and Sustainable Agricultural Systems, and Nutrition, Food Safety, and Quality. 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 30 NPLs are responsible for planning and developing research strategies to address critical issues affecting American agriculture. Nearly 200 Research Leaders work with 8 geographically-based Area Directors to implement the coordinated research objectives issued by the National Program Leaders.



Implementation of the Five-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, a cycle of phases embodying a series of recurring activities.

The 5-year program management cycle illustrates the activities by which ARS conducts its research: program planning and priority setting, peer review, project implementation, program coordination, and assessment. The cycle ties these activities together 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. The purpose is two-fold: 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 Action Plan; and to gain advice and insight from these same experts as to the future direction of the research.

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 that the Agency undertakes carefully, thoroughly, and with outside review to demonstrate that our research is of the highest quality.

Increasing Communication within and outside ARS

By definition, the planning and implementation of National Program research is designed to be a participatory process requiring significant input from the broad sources of expertise and experience within and outside the Agency. Through coordinated efforts that emphasize communication with valued partners and scientists, ARS can ensure that public resources are expended in a targeted and synchronized fashion on scientifically and programmatically relevant problems.

Further, by gathering input from outside users of ARS research, the Agency meets the ever-increasing demand for public accountability. ARS solicits input from the Administration, regulatory and action agencies, producers and producer groups, university communities, and non-governmental organizations, often through face-to-face exchanges. By accounting for the needs and priority issues of these customers, stakeholders, and partners, ARS develops responsive research that emphasizes meeting short-term emergencies or requirements as well as long-term sustained research to address problems of regional, national, and international scope and importance.

Emphasis on communication and coordination ultimately ensures that the physical, financial, and human resources of ARS are deployed appropriately to address high-priority agricultural, food, and environmental research needs of the Nation.

Because agricultural research is not the exclusive domain of any public or private entity, the very specific and the wide variety of needs that farmers, producers, ranchers, and industry stakeholders have must be met in a broad collaborative and cooperative effort. ARS has developed and continues to utilize an extensive network of research relationships among researchers with universities, industry, and other Federal government agencies to meet the research needs of U.S. agriculture. First among those Federal relationships is the USDA National Institute for Food and Agriculture (NIFA), USDA's extramural research agency. ARS and NIFA national program leaders work closely together to ensure that research funded by each agency is complimentary, and not duplicative. For example, ARS and NIFA national program leaders have collaborated on utilizing intramural and extramural research to develop joint action strategies for research on plant diseases and pests (i.e., citrus greening), animal diseases, and water and soil conservation.

National Programs

ARS organizes its research activities under 18 National Programs under four broad categories: Nutrition, Food Safety and Quality; Natural Resources and Sustainable Agricultural Systems; Crop Production and Protection; and Animal Production and Protection. To best address issues of agricultural importance, ARS makes regular adjustments to this program structure. The structure appears below.

Nutrition, Food Safety, and Quality

- Food Safety (Animal and Plant Products)
- Human Nutrition
- Quality and Utilization of Agricultural Products

Natural Resources and Sustainable Agricultural Systems

- Water Availabiity and Watershed Management
- Climate Change, Soils and Emissions Research
- Bioenergy
- Agricultural and Industrial Byproducts
- Pasture, Forage and Rangeland Systems
- Agricultural System Competitiveness and Sustainability

Crop Production and Protection

- Plant Genetic Resources, Genomics and Genetic Improvement
- Plant Biological and Molecular Processes
- Plant Diseases
- Crop Protection and Quarantine
- Crop Production
- Methyl Bromide Alternatives

Animal Production and Protection

- Food Animal Production
- Animal Health
- Veterinary, Medical , and Urban Entomology
- Aquaculture

General Comments: In January 1998, ARS requested a waiver from the Office of Management and Budget's (OMB) requirement "to describe specific and tangible products, steps, intermediate goals, and/or accomplishments that will demonstrate that the Agency has successfully met each Performance Measure/Goal in a given fiscal year." With OMB's concurrence, ARS is able to use narrative descriptions of intermediate outcomes and indicators of progress instead of numerical metrics as specified in GPRA. The research and technology transfer activities listed in this report are not all inclusive of the Agency's work. The reported accomplishments reflect, but do not adequately capture, the broad range of basic applied and developmental research that underpins the Agency's work.

Only Federal employees were involved in the preparation of this report.

Strategic Goal Area 1:
Nutrition, Food Safety and Quality

The Nutrition, Food Safety and Quality research and information area 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 – ENABLE AMERICANS TO MAKE HEALTH-PROMOTING, SCIENCE-BASED DIETARY CHOICES: HUMAN NUTRITION (107)

To improve the nutrition and health of the American people, ARS conducts research on the quality of the American diet and on related health behaviors. Distinctive aspects of this research include an emphasis on a food-based approach to improving health; the core capability to sustain long-term research in areas deemed of high priority for the Nation's health; the availability of state-of-the-science equipment and facilities for human research across the lifecycle; and the conduct of multidisciplinary research to improve the nutritional value of the American diet and food supply. The mission of the Human Nutrition Program is to define the role of food and its components in optimizing health throughout the life cycle for all Americans by conducting high national priority research. This research emphasizes study of essential nutrients and nonessential, health-promoting components in foods; evaluating the nutritional value of diets eaten by people in America; determining how consumption of specific foods or food components can enhance health; and developing strategies to improve food choices and lifestyle factors. Increasingly, research focuses on addressing over-consumption and caloric imbalance with incorporation of cutting-edge genomic and metabolomic technologies to carry out research. Research addresses four overarching components: nutrition monitoring, the scientific basis for dietary recommendations, obesity prevention, and life stage nutrition and metabolism. Information dissemination programs operated by the National Agricultural Library address general and specific human nutrition issues and audiences and include general Web portals such as www.nutrition.gov as well as the targeted Web sites of the Food and Nutrition Information Center.

Performance Measure

4.1.1 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.

Indicator 1:

During 2013, ARS will survey, release data on, and analyze national food consumption patterns of Americans.

FY 2013 Accomplishments*:*

ARS scientists determined experimentally that the USDA Automated Multiple-Pass Method used to assess food intake in the What We Eat in America dietary survey from NHANES accurately assesses sodium intake of the US population and published this result in a peer-reviewed article in the American Journal of Clinical Nutrition (DG Rhodes et al, 97:958-964, 2013). This group also published a detailed explanation of how salt adjustment levels were made to the NHANES survey since 1985 in the Journal of the Academy of Nutrition and Dietetics (RS Sebastian et al, 113:942-949, 2013).

> ***Impact*:** The increased interest in reducing sodium in the food supply by other government agencies particularly the Centers for Disease Control and Prevention and FDA, food companies, and consumers requires accurate assessment of baseline intake and values that have generated intense debate about actual sodium intake among researchers. These two articles inform the research community that we accurately measure sodium in the only nationally representative nutrition and health survey and how they can use historical data to track changes in sodium.

An ARS scientist collaborated with a colleague from the Food and Drug Administration and an academic researcher to evaluate phosphorus content of the food supply, how its intake relative to calcium affects health and identified future data needs to help regulatory agencies determine if the amount of phosphorus in the US food supply from both naturally occurring sources in food or that added during food processing contributes to poor health. This was reported in a peer-reviewed publication (MS Calvo et al, Adv Nutr, 5:104-113, 2014).

> ***Impact*:** Because there has been so little research on the phosphorus level of the food supply, this will certainly generate many studies by epidemiologists on dietary intake and various health endpoints. Improved data and research designs will allow researchers to identify potential risks on chronic disease outcomes so that health professionals can better advise patients on healthy diet and health maintenance. FDA has expressed particular interest in possible adverse effects of added phosphorus.

Indicator 2:

During 2013, ARS will develop new methods, conduct food composition analyses, and compile databases for known, emerging, and new classes of nutrients.

FY 2013 Accomplishments*:*

ARS scientists compiled and released the USDA National Nutrient Database for Standard Reference, Release 26.

> ***Impact*:** This database is the gold standard used by all commercial suppliers of nutrient data and many other countries. It is used by the public, researchers, clinicians, and other Federal agencies, including NIH, CDC, FDA, and USDA/FNS and CNPP, EPA, and the Department of Defense.

The popularity of botanical supplements to augment the US diet has provided a strong economic impetus for adulteration. Ginkgo biloba extract is a frequently used supplement that people take for purported enhanced cognitive function. Scientists at USDA in Beltsville, Maryland, measured 22 flavonol glycosides in three National Institute of Standards and Technology reference materials and 20 commercially available supplements using several techniques. Half of the commercial supplements were found to be adulterated with one of two inexpensive compounds (quercetin or quercetin rutinoside). Analysis was

easily accomplished with a simple methanol-water extraction and direct analysis by UV spectrophotometry.

> ***Impact*:** This method provides the analyst with an inexpensive method for detecting adulterants and potentially provides the industry and regulatory authorities, primarily the Food and Drug Administration, with a powerful tool to detect adulteration.

The ARS Nutrient Data Laboratory in collaboration with the beef industry and various universities analyzed many recently purchased samples of beef obtained around the country that represents typical production practices which have changed over time. This information was used to release version 3.0 of the USDA Nutrient Data Set for Retail Beef Cuts.

> ***Impact*:** This data set provides retailers with easier access to the most current and accurate beef nutrient data for the purpose of on-pack nutrition labeling as required by the Food Safety and Inspection Service.

Indicator 3:

During 2013, ARS will identify dietary and lifestyle intervention strategies to prevent obesity and promote healthy food choices and eating behaviors.

FY 2013 Accomplishments*:*

Obesity prevention through dietary restriction is difficult to achieve for some people, particularly for those who overeat in response to emotions or mood. Unsuccessful dieters may have reduced ability to inhibit or control emotional eating, which can result in dietary relapse. A study conducted by ARS scientists in Davis, California, showed for the first time that those with greater amounts of diet-induced weight loss also displayed higher scores on a cognitive test of assessing self-control and strategic decision-making.

> ***Impact*:** The results suggest that differences in obesity prevention success may depend in part on person-to-person differences in higher brain cognitive pathways that influence, or are altered by, dieting and weight loss.

ARS supported scientists examined variation in food portions served to almost 800 African-American and Hispanic-American pre-school children aged 3-5 years attending Head Start programs in Houston, Texas. Plate waste was 43% of all food served but variation in that and in amounts served of different food categories was substantial. Amounts served were directly associated with amounts consumed. Larger portion sizes served are associated with both greater consumption and greater waste. This was documented in a peer-reviewed publication (TA Nicklas et al, Public Health Nutr, 16:2169-2177, 2013).

> ***Impact*:** Proper serving sizes based on children's energy needs have the potential to reduce the considerable amount of wasted food and to reduce the number of calories taken in by children who are at higher risk of developing obesity. The DHHS Administration for Children & Families can make use of this information to improve both the cost-effectiveness of this program and to reduce the risk of obesity in participating children.

Food insecurity in the U.S. is a problem that, despite record numbers of SNAP participants, remains a major issue. ARS scientists studied the effects of food insecurity in children who are HIV positive, a group that has very high health care costs. Food insecurity was significantly associated with lower counts of white blood cells known as CD4 cells and with 4-fold higher odds of incomplete suppression of the HIV

virus. This latter finding has major implications for USDA food assistance programs' ability to decrease health care costs in this specific population.

> *Impact*: The demonstration that food insecurity may adversely impact pediatric HIV outcomes has profound impact on making USDA-sponsored food assistance available to families in which these children live through both WIC and SNAP. The dramatic increase in incomplete suppression of the virus in food insecure children likely presages increased future health care costs. This is a clear example for prevention being far less expensive than treatment.

Indicator 4:

During 2013, ARS will determine the functions, bioavailability, interactions, and requirements for known, emerging, and new classes of nutrients across the lifecycle.

FY 2013 Accomplishments*:*

A longitudinal investigation at of the ARS Arkansas Children's Nutrition Center in Little Rock, Arkansas, is studying development of breast-fed, soy formula-fed, and cow's milk formula-fed infants. Findings in 465 infants based on measures of resting heart rate across the first 2 years of life revealed that vagal tone – a parameter of the autonomic nervous system that regulates cardiac function by slowing heart rate – was within the normal range across groups but was lower after 6 months in breast-fed than formula-fed infants. Variations in vagal tone have been related to mental development and emotional behavior in infants, children, and adults. This finding was published in a peer reviewed journal (RT Pivik et al, Int. J. Psychophysiol 90:311-320, 2013).

> ***Impact*:** Although the long-term consequences of these observation require additional follow-up to determine later health effects, these findings provide new information regarding the influence of early infant diet on development of the nervous system that has potential for major impact on several systems of the body.

Although there have been hundreds of studies on cells and in animals, there is no scientific consensus on how different dietary fatty acids influence the human immune system. Diets containing five different soybean oils that varied in their content of polyunsaturated fatty acid (PUFA) were fed to volunteers for 35 days each by scientists at the USDA/ARS Human Nutrition Research Center on Aging at Tufts University in Boston, Massachusetts, and standard tests of the immune system were performed at the end of each test period. The ratio of two PUFA designated omega-6 and omega-3 had the strongest effect on proliferation of immune cells.

> ***Impact*:** Since soybean growers are changing most strains grown to reduce specific fatty acids and soybean oil is the largest single source of fat in the diet, it is critical to know how these changes might affect the health of consumers.

ARS supported researchers supplemented vitamin D at about 1.7 times the recommended amount to 4-8 year old children for 8 weeks. The main outcome was calcium absorption before and after supplementation. Although vitamin D levels in the blood increased and parathyroid hormone levels decreased following supplementation, there was no effect on calcium absorption. This study was documented in a peer-reviewed publication (SA Abrams et al, Am J Clin Nutr, 97:217-223, 2013).

> ***Impact*:** These results indicate that the current Recommended Dietary Allowance for children in this age range is likely correct and that increasing it is not justified despite many calls for that from both some researchers and the public. Since the Dietary Reference Intakes are sponsored

by multiple U.S. and Canadian federal agencies, including multiple USDA, DHHS, and DoD agencies, this first experimental result in children of this age range supports the current recommendations set by the two governments.

Indicator 5:

During 2013, ARS will publish new findings on metabolic processes that are affected by nutrient intake.

FY 2013 Accomplishments*:*

Vitamin K is a well-known factor involved in blood clotting but emerging evidence suggests that it has other functions. Coronary calcium progression, which is a characteristic of severe heart disease, has not been well studied in humans with respect to vitamin K. To address this gap in knowledge, ARS-funded researchers at Tufts University in Boston, Massachusetts, in collaboration with scientists from Wake Forest Medical Center, measured the vitamin K concentrations in blood samples from men and women participating in the Multi Ethnic Study of Atherosclerosis, and determined their association with coronary calcium progression.

> ***Impact*:** The overall findings suggest those with low vitamin K concentrations were more likely to have coronary calcium progression. Among participants who were taking blood pressure medication, those with low vitamin K were even more likely to have coronary calcium progression. These data support the need to review vitamin K dietary requirements in context of health outcomes beyond that of vitamin K's established role in blood clotting.

Pregnant women are encouraged to consume prenatal vitamins with extra folic acid. While adequate folate helps prevent many neural tube defects, there is concern about high doses having an adverse effect. Since such a study cannot ethically be done in humans, scientists supported by ARS in Boston, Massachusetts, fed mice folate at 10 times the recommended amount, which is similar to the level recommended for pregnant women, and the mice had increased fetal loss, embryonic delays and higher incidence of heart defects in offspring.

> ***Impact*:** These results indicate that moderately high supplementation of folic acid adversely affects fetal mouse development. It will be critical to follow up this work to determine if there should be concern by pregnant women for the folate levels in prenatal vitamins.

Fat accumulation in the liver has increased dramatically as the American population has gained excess weight. However, factors that determine which obese individuals will develop fatty liver have yet to been identified. Scientists at the Grand Forks Human Nutrition Research Center found that high-fat diets leading to obesity in mice also dramatically changed the types and amounts of bacteria in the colon.

> ***Impact*:** If the same relationship holds in humans, this will provide new understanding of how fatty liver develops and how we can modify the diet to shift the balance of microorganisms that will reduce deposition of fat in the liver.

Indicator 6:

During 2013, ARS will discover genetic or epigenetic factors that influence physiologic responses to diet or changes in gene expression in response to dietary intake.

FY 2013 Accomplishments*:*

Cardiovascular disease (CVD) is the leading cause of death and permanent disability in the United States. CVD has a significant genetic component that makes some people more susceptible than others to the disease. Thus, identifying these genetic factors has become a key component of cardiovascular prevention. Previous work by this group has identified about 100 genes driving the genetic risk of CVD in White populations, however, there is no such information available for minorities. ARS-funded researchers at Tufts University, in Boston, Massachusetts, in collaboration with an international consortium have performed deep genetic analysis of 2,000 most relevant genes for CVD risk in 7,657 African-Americans, 1,315 Hispanics and 841 East Asians. These analyses confirmed 16 lipid loci previously established in European populations. The work in African-American individuals confirmed two novel genes associated with total cholesterol and low-density lipoprotein cholesterol (LDL-C) and another one associated with HDL-C levels.

> ***Impact*:** These findings support the notion that differences in CVD risk across ethnic groups may be driven in part by genetic variants. This knowledge represents an important step in the fight to reducing health disparities.

Because food and nutrient availability varies greatly in some rural African locations, ARS scientists and multiple international collaborators took advantage of this natural experiment to study the influence of nutrient exposure to epigenetic changes in DNA, which is measured by methylation patterns of the DNA. The class of nutrients considered methyl donors includes riboflavin, folate, choline, and betaine; all of these varied significantly with the rainy season which correlated with food availability. These differences in dietary methyl donors led to similar changes in blood levels of metabolites that depend on these being in the diet. This year-long study was documented in a peer-reviewed publication (P. Dominguez-Salas et al, Am J Clin Nutr, 97:1217-1227, 2013).

> ***Impact*:** Identifying temporary, reversible changes in the methylation status of DNA allows researchers to identify the amounts and types of nutrient that should be made available to counter such effects. DNA methylation changes lead to difference in gene expression which control normal development, propensity to obesity and multiple chronic diseases. This study has profound implications for international aid programs as well as improving health of well-nourished Americans.

ARS researchers and collaborators identified genetic variants responsible for susceptibility to obesity and its complications among Hispanic children. A study of over 800 children was conducted in which a genome-wide association study was performed that genotypes over 1.1 million gene variants called single nucleotide polymorphisms (SNPs). A number of genes found in other populations that increase risk of obesity or related disorders were confirmed, three novel gene variants were localized in relevant biological pathways, and two new genes with unknown function were also associated with obesity. This study was published in a peer-reviewed journal (AG Comuzzie et al, PLOS One, 7:e51954, 2012).

> *Impact*: Hispanic-American children are at high risk of obesity and this study indicates that changes in genes are related to that propensity. While these genes are not yet confirmed as causal, they are clearly indicators of increased risk. This study contributes to the body of science that personalized prevention will likely be more successful than the current single-message public health approach. Informing individuals that they are at greater risk of obesity and disease can be a considerable motivator to improve diet and exercise behaviors.

Performance Targets

1.1.A Monitor Nutrient Composition of the Food Supply and Consumption by Americans

Baseline 2012	Target 2017
Three datasets on food composition and dietary intake were released by ARS and used by customers to establish Federal dietary policy guidelines, food assistance and feeding programs, and food labeling to safeguard the health of the American people.	Cumulatively, 15 databases developed and released to ARS customers.

1.1.B Strengthen the Scientific Basis for Dietary Guidance for Health Promotion and Disease Prevention

Baseline 2012	Target 2017
Four research studies on health effects of foods or nutrients published in peer-reviewed scientific journals that contribute evidence used in Dietary Reference Intake reports or the Dietary Guidelines for Americans.	Cumulatively, 20 studies published and released to ARS customers.

1.1.C Develop Strategies for Prevention of Obesity and Related Diseases

Baseline 2012	Target 2017
Five papers in peer-reviewed scientific journals that test innovative approaches to preventing obesity or related conditions.	Cumulatively, 25 papers documenting these discoveries added to the scientific literature on this topic.

1.1.D Conduct Research on Life Stage Nutrition and Metabolism

Baseline 2012	Target 2017
Five studies published in peer-reviewed journals that increase knowledge of nutrient requirements in the youngest and oldest Americans, how nutritional status relates to health, and how genes and epigenetic mechanisms contribute to this interplay.	Cumulatively, 25 scientific discoveries will be documented in scientific publications.

Measure 4.1.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2013:

During FY 2013, ARS reported on 2 new technologies adopted for uses that provide (enter description here)

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
USDA National Nutrient Database for Standard Reference, Release 26	Nutrient content of more than 8,000 foods freely available on the ARS website.	FDA, FSIS, FNS, CNPP, EPA, food industry, academic researchers, consumers	This information enables USDA feeding programs to meet nutrient requirements by knowing how much food is needed to meet requirements.
USDA Nutrient Data Set for Retail Beef Cuts, version 3.0	Updated nutrient content of retail beef cuts that reflects current production methods.	FSIS and the food industry	This freely available information allows enforcement of USDA labeling standards and helps the beef industry meet the requirements for labeling.

Measure 4.1.1: 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.

During FY 2014, ARS will

survey, release data on, and analyze national food consumption patterns of Americans.

develop new methods, conduct food composition analyses, and compile databases for known, emerging, and new classes of nutrients.

identify dietary and lifestyle intervention strategies to prevent obesity and promote healthy food choices and eating behaviors.

determine the functions, bioavailability, interactions, and requirements for known, emerging, and new classes of nutrients across the lifecycle.

publish new findings on metabolic processes that are affected by nutrient intake.

discover genetic or epigenetic factors that influence physiologic responses to diet or changes in gene expression in response to dietary intake.

During FY 2015, ARS will

survey, release data on, and analyze national food consumption patterns of Americans.

develop new methods, conduct food composition analyses, and compile databases for known, emerging, and new classes of nutrients.

identify dietary and lifestyle intervention strategies to prevent obesity and promote healthy food choices and eating behaviors.

determine the functions, bioavailability, interactions, and requirements for known, emerging, and new classes of nutrients across the lifecycle.

publish new findings on metabolic processes that are affected by nutrient intake.

discover genetic or epigenetic factors that influence physiologic responses to diet or changes in gene expression in response to dietary intake.

During FY 2016, ARS will

survey, release data on, and analyze national food consumption patterns of Americans.

develop new methods, conduct food composition analyses, and compile databases for known, emerging, and new classes of nutrients and for branded food items.

identify dietary and lifestyle intervention strategies to prevent obesity and promote healthy food choices and eating behaviors.

determine the functions, bioavailability, interactions, and requirements for known, emerging, and new classes of nutrients across the lifecycle.

publish new findings on metabolic processes that are affected by nutrient intake.

discover genetic or epigenetic factors that influence physiologic responses to diet or changes in gene expression in response to dietary intake.

GOAL 1.2 – PROTECT FOOD FROM PATHOGENS, TOXINS, AND CHEMICAL CONTAMINATION DURING PRODUCTION, PROCESSING, AND PREPARATION: FOOD SAFETY (108)

The safety of the food supply continues to be a highly visible public health issue and a national priority for the Federal government. The continued priority is partly due to the diverse and complex system of production, processing, and distribution of food in the U.S. and the increasing global distribution. Outbreaks of foodborne illness are seen as a major cause of morbidity and mortality, and economic costs, both nationally and internationally. The full extent of the disease burden is still unknown, even with recent CDC estimates. Foodborne illnesses can be caused by microbial pathogens, parasites, viruses and an array of foodborne contaminants such as chemicals or toxins. The cause of every outbreak is still unknown, but persistent outbreaks of major commodity-specific foods that may directly affect public health, regulations, industry, and trade, require our immediate attention.

ARS has developed an integrated approach to food safety, that is, food production is seen as a continuous process from production, through harvesting and processing, to retail and the consumer. Pre- and post-harvest are not separated but considered an integrated production system of safe and quality food. Interventions and controls that are applied to one phase will ultimately affect the other segments of food production and processing. Food safety research has also changed during the past decade, having moved past simple, surveillance/prevalence studies to asking more complex questions. Consequently, researchers are required to think creatively to solve problems, which means considering alternate perspectives, exploiting new opportunities and technologies, and crossing conventional boundaries. Multidisciplinary collaborations, especially between Centers/Institutes, nationally and internationally are an absolute necessity.

ARS provides the intramural infrastructure and expertise to address short and long-term needs in food safety. Because of the infrastructure, ARS is uniquely poised to respond quickly to emerging and critical food safety issues. ARS also collaborates closely with Federal regulatory agencies as well as industry, professional, and international stakeholders to assist in addressing their specific food safety needs.

Performance Measure

4.1.2 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.

Indicator 1:

During 2013, ARS will determine how population systems in animals, plants, or the environment, or any combination of these influence the safety of food. Determine the conditions under which microorganisms exist. Determine how microorganisms may in turn influence the conditions prevailing in the environment. Ensure that these technologies can be utilized by regulatory agencies, producers and/or processors to help assure safe food products.

FY 2013 Accomplishments*:*

Some classes of antibiotics are critically important to human medicine and are prescribed for the treatment of serious E. coli and Salmonella infections. Concerns have been raised that therapeutic treatment of feedlot cattle with antibiotics in the same classes as those used for humans increases the prevalence of resistant E. coli. A herd of feedlot cattle were sampled by ARS at Clay Center, Nebraska, over a 10 month period before, during, and after antibiotic treatment for disease. A baseline, low level of antibiotic resistant E. coli was detected in cattle upon arrival at the feedlot, and antibiotic resistance temporarily increased after antibiotic treatment. However, resistance levels returned to baseline levels

after several weeks.

> ***Impact:*** Genetic analysis of resistant E. coli isolates demonstrated that the baseline level of resistant E. coli in this cattle herd was more likely due to the persistence of a few feedlot-adapted resistant E. coli strains rather than the transfer of the genes conferring resistance between E. coli strains. This study is significant since it indicated that antibiotic treatment of disease in cattle feedlots does not increase the prevalence of antibiotic-resistant E. coli in those cattle when they are harvested.

Clostridium difficile infections are historically nosocomially associated. Unexpectedly more virulent strains that are transmissible outside of hospital environments have recently emerged. The origin of the new strains is unknown, and there has been some speculation and concern of an association with the consumption of certain animal meats. ARS at College Station, Texas, collaborating with Texas A&M University established the distribution and antimicrobial resistance characteristics of C. difficile in human wastewater and swine feces from populations of humans and swine having close geographical and occupational contact with each other. The research indicated that C. difficile isolated from swine sources had less antimicrobial resistance than those isolated from human sources, and that resistance in C. difficile isolated from sources of human swine workers was no different than from non-swine workers.

> ***Impact:*** The study was critically important for regulatory agencies, industry, and producers, because it provided strong evidence that C. difficile is not transferred from swine to humans, and that swine are not the source of C. difficile antibiotic resistance in humans.

Recalls of leafy greens due to Salmonella contamination have economically impacted produce growers in California. Cold-blooded vertebrates could be a source of microbial contamination of produce since they are known carriers of Salmonella. ARS at Albany, California, in collaboration with scientists at University of California, Davis, sampled amphibians and reptiles and associated waters for the presence of Salmonella in a major produce growing region of California.

> ***Impact*:** The study revealed a varied incidence from 1-60% of Salmonella. Most of the animal isolates and a small subset of the water isolates were S. enterica subsp. Diarizonae, but of concern was the finding that many animal isolates were resistant to one or more antibiotics. The findings provide industry and State and Federal public health regulatory agencies with valuable epidemiological data for risk assessment for this important agricultural region.

The composition of diets that are fed to cattle can impact the types, concentrations, and relative proportions of different bacteria that live in the gastrointestinal tract and are shed in the feces (the “fecal bacterial microbiome”). ARS at Clay Center, Nebraska, used cutting edge next-generation high-throughput sequencing technology to examine the differences in the fecal microbiome of beef cattle fed three different diets with varying amounts of forage and grain. The study showed that the fecal microbiomes were greatly affected by diet, particularly between high forage- and high grain-based diets.

> ***Impact*:** This research provides the most comprehensive data set developed to date that describes diet effects on the diversity of cattle fecal microbiome. The data provide important information that will be used to examine both diet effects and fecal microbiome effects on human bacterial pathogens that are shed by cattle. Further, the research is anticipated to identify potential dietary approaches for reducing the occurrence and numbers of pathogens in cattle, in particular Shiga-toxigenci E. coli thereby reducing the risk of human foodborne illness associated with beef consumption.

Despite appreciable efforts by food safety professionals to eliminate Listeria monocytogenes in ready-to

eat foods (RTE) in the 1990's and early 2000's, foodborne illnesses caused by the bacterium continue. ARS at Wyndmoor, Pennsylvania, participated in a multi-agency, multi-disciplinary study to establish the relative occurrence, levels, and subtypes of Listeria monocytogenes in higher-volume, higher-risk foods purchased at retail. Over a 2-year period, some 23,000 foods were purchased in four FoodNet sites across Maryland, Georgia, Connecticut, and California. Of the foods sampled, the estimated prevalence ranged from 0-1.2%. Moreover, the estimated prevalence of Listeria monocytogenes was noticeably higher for foods made/sliced in stores compared with similar foods that were pre-packaged by the manufacturer.

> ***Impact*:** This represent the most comprehensive study on the association of Listeria monocytogenes with RTE foods over the past decade and, as such, it is significant from a public health perspective that the recovery rate of Listeria monocytogenes reported in the study is appreciably lower in comparison to previous studies of similar scope and magnitude published a decade earlier. The data from this study will be used to update the 2003 Interagency Risk Assessment on RTE foods conducted by the Food and Drug Administration and the USDA-Food Safety Inspection Service.

Indicator 2:

During 2013, ARS will develop an understanding of bacterial, viral, and fungal pathogenicity through a systems biology approach. Utilize this data for pathogen intervention and control, modeling, and providing data for the development of risk assessments by regulatory agencies. Ensure that these technologies can be utilized by regulatory agencies, producers and/or processor to help assure safe food products.

FY 2013 Accomplishments*:*

Fusarium head blight is caused by species of the fungus Fusarium which produce trichothecene mycotoxins. Trichothecenes are factors in the severity of the disease, and the type of trichothecene produced by the fungus may also be a factor in the severity of the disease. Although North American Fusarium usually produces the trichothecene 15-ADON, strains that produce a related toxin, 3-ADON, have been increasingly found in North America. ARS at Peoria, Illinois, in collaboration with scientists at Agriculture and Agri-Food Canada found that wheat cultivars with moderate disease resistance had both more disease and higher toxin levels in the seed after infection with 3-ADON strains.

> ***Impact*:** Wheat growers will use this information to plant more highly resistant cultivars in regions where 3-ADON-producing Fusarium strains have been found.

On-site control of E. coli O157:H7 is essential to prevent contamination of produce grown in proximity to feedlots and dairies. ARS at Albany, California, observed that monensin, a commonly used feed supplement, inhibits certain protozoa, thereby extending the survival of E. coli O157:H7 in dairy wastewater. This antibiotic feed supplement also altered the community structure of both protozoa and bacteria in wastewater.

> ***Impact*:** These data suggest prudent use of antibiotic dietary supplements is warranted as such treatment enhances the persistence of E. coli O157:H7 in the agricultural environment. The findings identify for the industry and State and Federal public health regulatory agencies, a risk factor in the contamination of produce in areas where animal and crop production are geographically intertwined.

Campylobacter and Arcobacter are bacteria that can cause human bacterial gastroenteritis and/or disease in food animals. These organisms colonize a wide variety of mammalian and avian hosts and can be isolated from meat, water, milk, and shellfish. ARS at Albany, California, have completed the genome sequences of validly-described Campylobacter and Arcobacter species, subspecies and biovars, in addition to multiple novel species, isolated mainly from California agricultural regions.

> ***Impact:*** The comparative genomics of these completed genomes will provide further insights into the genetic basis of host association, pathogenicity, and the ability to survive in the environment. Such information is critical in the development of risk assessments, detection and intervention technologies, and regulation policy development.

Besides E. coli O157:H7, cattle could also be colonized by six other E. coli types (O16, O103, O111, O121, O145, and O45) recently declared as adulterants in beef by the USDA-Food Safety and Inspection Service (FSIS). Human infections result from the consumption of beef, water, and produce contaminated with feces of cattle. ARS researcher at Ames, Iowa, examined the mechanisms of intestinal colonization in cattle by these E. coli types, data which is essential for developing pre-harvest interventions.

> ***Impact:*** The study demonstrated that the non-O157 E. coli adhere to and colonize intestinal tissues using protein factors different from those used by E. coli O157:H7. These findings are critically important for designing of vaccines/therapies to target these six E. coli types to enhance both the safety of foods produced from cattle and to mitigate the risk of transfer of these bacteria to humans and resulting human illnesses.

Indicator 3:

During 2013, ARS will develop innovative methods and advanced technology systems that rapidly and accurately detect, identify, and differentiate the most critical and economically important foodborne bacterial, viral, and protozoan pathogens. Ensure that these technologies can be utilized by regulatory agencies and/or producers to help assure safe food products.

FY 2013 Accomplishments*:*

Parasitic infection with species of Trichinella, a well-known foodborne parasite is only rarely reported among American consumers of conventionally raised pork. However, the parasite remains of high concern for consumers of wild game and has been raised as an emerging concern for organic and free-range pork. Of major concern is that the earliest stages of infection can go undetected because immature parasites fail to make their presence known to the immune system and certain parasites never develop the structures most irritating to our immune systems. ARS at Beltsville, Maryland, in collaboration with colleagues from China and France, identified antigens expressed at particular stages of parasite development in order to overcome such limitations.

> ***Impact*:** The identification of these antigens and the development of a rapid test is a major accomplishment, and provide the means to reduce the risk of “false-negative” tests for this parasite, that will further help ensure the safety of organic and free-range pork, and wild game.

The BARDOT sensor (bacteria rapid detection using optical scattering technology) was developed with our collaborators in the Center for Food Safety Engineering at Purdue University, West Lafayette, Indiana). BARDOT involves shining a laser light through the bacterial colony on a plate and collecting images of the light that passes through. The resulting pictures of these colonies contain descriptive characteristics which can be used to identify bacteria by comparing the resulting image with a library of previously collected images.

Impact: We report the development of a portable, cost effective, BARDOT instrument by the CFSE and the delivery of an instrument to USDA for validation. The new instrument is easy to use, and can rapidly identify known pathogenic bacteria, including pathogenic E. coli, Salmonella, and Listeria monocytogenes. The pathogen identification capabilities coupled with the portability of this new BARDOT instrument has tremendous potential for improving the response to foodborne illness outbreaks because the technology can travel to the source thereby reducing the time to detection. The BARDOT instrument is patented and larger models are produced in association with the CRADA partner.

Campylobacterosis is the commonest form of bacterial gastroenteritis in the industrial world, and routine microbiological isolation and characterization of the bacteria is extremely difficult. A new medium was formulated by ARS at Athens, Georgia, to support aerobic growth of the bacterium. Current methods for growing this pathogen require expensive equipment to produce atmospheres containing less oxygen and more carbon dioxide than normal atmospheres. Comparative studies under aerobic and microaerobic conditions showed no differences in recovery.

Impact: The studies indicated that the medium will provide an alternative to current procedures (mandated by food safety regulatory agencies) of incubating Campylobacter under microaerophilic conditions; thereby, eliminating the additional expense and training required for the use of specialized atmospheres in routine culturing Campylobacter. This new medium is under patent consideration, and the new technology translated to the food safety programs regulatory stakeholders.

Norovirus (HuNov) is considered the most common etiologic agent of foodborne illness outbreaks, both by such foods as produce, or on cruise ships. The problem is that routine norovirus detection methods do not differentiate between infectious and nonviable virus particles. ARS at Albany, California, have developed a new in situ capture quantitative Real-Time Polymerase Chain Reaction (ISC-qRT-PCR) method to concentrate HuNoV from food and environmental samples that distinguishes infectious and inactivated viruses. Using this approach, they also demonstrated inactivation conditions for HuNov and observed that HuNov is more heat- and ethanol-resistant, but more sensitive to chlorine treatment relative to its commonly used surrogates.

Impact: This innovative technology resulted in a patent application because of its high value to national and international public health agencies and private laboratories that perform testing for the industry, and to the biotechnology industry that develops equipment and molecular biology kits for detection of norovirus.

Indicator 4:

During 2013, ARS will develop intervention and control strategies will help to significantly decrease or eliminate pathogens in food animals and their derived products (eggs/milk), seafood and plant crops (produce/grains/tree nuts) during critical periods of production and processing. Develop and subsequently combine new/innovative processing technologies using the intelligent hurdle concept. Ensure that these technologies can be utilized by producers and/or processors to help assure safe food products.

Consumption of contaminated shell eggs is responsible for major outbreaks of foodborne illness. Currently, only about 1 percent of eggs are currently pasteurized (by heat) because the process is costly and damages the egg white appearance. ARS at Wyndmoor, Pennsylvania, developed a new innovative intervention process using radio frequency (RF) energy that eliminates 99.999 percent of Salmonella that

may be present in eggs. The RF process is significantly faster than the current pasteurization process, by more than 50 percent, and the egg whites look perfect.

> ***Impact:*** A patent has been filed and several companies have expressed interest in licensing the technology. Pasteurization of all shell eggs in the U.S. would substantially reduce the threat of illness from uncooked and undercooked shell eggs, for example, Salmonella illnesses by approximately 110,000 annually allowing consumers to enjoy their favorite recipes and styles. The monetary value of implementing this innovation, in terms for example of medical costs would be in the billions of dollars.

Shellfish hatcheries in the U.S. have experienced high larval mortalities due to an unusual pathogen Vibrio tubiashii, a bacterium that is highly infectious to shellfish larvae. ARS at Dover, Delaware, identified specific bacteriophages (bacterial viruses) that kill the V. tubiashii. Collaborative studies showed that a mixture of several bacteriophages was > 95% effective in eliminating larval mortalities in East Coast oyster larvae.

> ***Impact:*** A patent was applied for and granted, and a CRADA established with Intralytix, an industry leader in commercializing the bacteriophage-based intervention treatments. Adoption and application of these bacteriophages by industry in shellfish hatcheries will significantly reduce shellfish mortalities for an industry valued at well over $100 million, leading to less interruption in the supply of seed oysters and clams for commercial planting operations.

For shelf stable (room temperature) acidified food products that are not heat processed, there is a need to define processing options that will assure that pathogens are removed, to address industry concerns, and to meet FDA process filing requirements for producers of dressings and related products where they must demonstrate a 5-log reduction in bacterial pathogens. Studies are required relative to the time, temperature, salt, and acid concentrations needed to achieve a five log reduction in vegetative bacterial pathogens remains unknown. ARS at Raleigh, North Carolina, developed acid and pH processing conditions that are based on the concentration of acetic acid and benzoic acid. Studies showed that benzoic acid can be used to significantly accelerate acid killing of vegetative bacterial pathogens, and helps establish a scientific basis for using preservative to meet food safety requirement.

> ***Impact:*** This research when implemented shows industry how a 5-log reduction can be achieved using common ingredients in a variety of products, preventing the need for extensive testing of many different products. More importantly the technology meets the new FDA requirements for producers under the new Food Safety Modernization Act.

Salmonella infections are a critical issue in the swine industry and development of an intervention to protect pigs against disease and reduces transmission is a critical need. This need is because most foodborne disease agents are transferred to humans from animals/animal products, and interventions in the animal reservoir are necessary to fully optimize control strategies. This is especially important as livestock production systems continue to increase in size and complexity, and antibiotic usage in feed becomes increasingly controversial. ARS in Ames, Iowa, have designed and demonstrated the effectiveness of a vaccine for Salmonella.

> ***Impact:*** The live vaccine can both protect swine from Salmonella that cause systemic pig disease and also reduce the transmission of Salmonella that cause foodborne disease in humans. Furthermore, the vaccine was designed to be able to tell the difference between vaccinated and infected animals. This dual use Salmonella vaccine is intended to not only protect the health status of the herd to reduce production costs, but also support food safety and public health by reducing the spread of human foodborne Salmonella. It is anticipated that other livestock

industries will also benefit from the cross-protective vaccine.

The fresh-cut produce industry currently does not have the capacity to maintain stable sanitizer concentration during commercial operation. Washing produce without effective sanitizer concentration could drastically spread disease-causing bacteria leading to significant increases in human illness from consumption of contaminated produce. Working closely with the industry, ARS at Beltsville, Maryland, conducted a comprehensive analysis of the relationship between sanitizer loss in produce wash operation and the spread of bacteria. They demonstrated that the sanitizer concentration in the industry's food safety program is insufficient for preventing bacteria survival and spread. Additionally, they proved that re-washing contaminated produce is not an effective corrective action as it does not eliminate the presence of bacteria.

Impact: These studies revealed the clear risks in current industry practices, and further provided the quantitative data for the FDA to develop science-based food safety regulations for preventive controls against bacterial contamination under the new Food Safety Modernization Act. Industry is currently using the findings to revise wash operational procedures. The information is also used by the Homeland Security Department to develop counter bioterrorism programs.

Indicator 5:

During 2013, ARS will develop bioinformatic databases and tools, and predictive user-friendly models to understand pathogen behavior and acquisition of virulence characteristics under various stress conditions. Determine the key risk factors of human pathogens in foods, and evaluate systems interventions for their impact, which will enable regulatory/action agencies to make critical food safety decisions that impact public health.

FY 2013 Accomplishments*:*

Predictive microbiology is an area of research that applies mathematical models to predict the growth and survival of foodborne pathogens undergoing complex environmental changes. Predictive models are the building blocks for microbial food safety risk assessments. ARS at Wyndmoor, Pennsylvania, developed an easy-to-use integrated data analysis and model development tool that can be used by students and scientists, without any programming knowledge, to develop accurate mathematical models for microbial shelf-life prediction and risk assessments conducted by regulatory agencies and industry.

Impact: This software package is offered as a free tool to scientists and risk modelers around the world. The program can also be used in colleges and universities to train students for predictive microbiology research. The software can be downloaded at http://www.ars.usda.gov/Main/docs.htm?docid=23355.

The risk of Shiga-toxigenic non-O157 Escherichia coli strains has become a growing public health concern. ARS researchers at Wyndmoor, Pennsylvania, examined (at the request of the UK Food Standards Agency) the effects and interactions of temperature, pH, and water activity on the growth kinetics of E. coli O104:H4, and developed predictive models to estimate its growth potential in foods. This strain is critically important having caused the sprouts foodborne illness outbreak in Europe which affected 3,950 people with 53 dead.

Impact: The models which were also transferred to the UK-FSA, and developed for lag phase durations, exponential growth rates, generation times, and maximum population densities will provide risk assessors and food safety managers a rapid means of estimating the likelihood that the pathogen, if present, would grow in response to the interaction of the three variables

assessed.

Modeling of microbial water quality is dependent on estimates of microorganisms entering surface waters as well as their subsequent survival. ARS at Beltsville, Maryland, have developed the world's largest database on E. coli inactivation in surface waters. The data have been analyzed using predictive microbiology to simulate the dependence of E. coli inactivation rates on water temperature for different types of surface waters used in irrigation and recreation.

> ***Impact:*** These results will contribute to improved accuracy of microbial water quality models used for assessment and predictions for recreational and irrigation water sources.

Adequate heat treatment destroys the bacterial pathogen Listeria monocytogenes. Heat is the most effective means to guard against the potential hazards in cooked meat products; however, due to public health concerns associated with high salt levels in the diet, consumers these days are increasingly demanding processed meats with reduced salt levels. ARS at Wyndmoor, Pennsylvania, found that the addition of green tea 60% polyphenol extract levels up to 1.5% interacted with salt and reduced the protective effect of salt on heat resistance of the pathogen.

> ***Impact:*** Food processors can use the predictive model to design an appropriate heat treatment for inactivating Listeria monocytogenes in cooked products without adversely affecting the quality of the product.

Indicator 6:

During 2013, ARS will develop innovative methods and advanced technology systems that rapidly and accurately detect, identify, veterinary drugs, chemical residues, heavy metals, persistent organic pollutants, and biological toxins derived from bacteria, fungi and plants. Evaluate contaminant toxicity, and mechanism of action. Provide data which will enable regulatory/action agencies to make critical food safety decisions that impact public health.

Changing concepts of dietary arsenic risk to humans threatens the safety of U.S. rice, the only grain which accumulates substantial levels of arsenic. It has been determined that flooding rice soils causes arsenite to be generated from soil arsenate. Soil arsenite then can be accumulated by rice, as can dimethylarsinic acid, a less toxic organic form of arsenic generated by soil microbes. ARS at Beltsville, Maryland, in collaboration with the University of Arizona measured levels of arsenic and cadmium in grains with six different irrigation schemes. Study found that rice grown with traditional flooding, which lowers soil aeration, contained highest arsenic and lowest cadmium levels. Any soil oxidation promoted cadmium accumulation, while making the soil nearly fully aerobic was required to reach minimal arsenic concentrations in grain.

> ***Impact*:** The study concluded that growing rice aerobically rather than by traditional flood culture can substantially lower grain arsenic and yield substantially, and increases grain cadmium. Three different rice cultivars were tested and while each varied in arsenic accumulation, they all had similar changes with irrigation management. The results provide growers and the Food and Drug Administration with information needed to meet market regulatory arsenic limits in areas with naturally high soil arsenic levels. Further, the data makes growers aware the need to ensure the best cultivar is used within each production system.

Fluoroquinolone antibiotics are used to treat humans and they are often the last defense against antibiotic-resistant microorganisms. The use of the drugs in veterinary medicine is of particular concern in regulatory monitoring programs worldwide. Current screening tests using microbial inhibition for

antibiotics do not respond well to fluoroquinolones, and a new screening method is needed for these drugs. ARS at Wyndmoor, Pennsylvania, developed a novel application of dispersive liquid-liquid microextraction followed by terbium-sensitized luminescence for screening the approved fluoroquinolones, enrofloxacin and its metabolite ciprofloxacin, in swine liver (the regulatory target tissue). The approach met the US-tolerance detection level and was demonstrated in analyses of spiked samples.

> ***Impact:*** Adoption of this method by regulatory and industry monitoring laboratories in the U.S. and worldwide to screen for these important drugs will ensure proper veterinary practices and reduce the chances of transfer of antibiotic microbial resistance.

Incidents in recent years of profit-driven adulteration of milk and wheat ingredients subsequently used to make dairy products and pet foods have highlighted the need for non-destructive methods to screen food ingredients for contaminants that can pose significant food safety hazards. A Raman chemical imaging system and method were developed by ARS at Beltsville, Maryland, for detecting multiple adulterants in dry skim milk powder. Spectral image processing methods were developed to remove interference from background fluorescence, and to create Raman chemical images visualizing the distribution of the different adulterants in the milk powder using unique Raman peaks of the adulterants.

> ***Impact:*** A correlation was found between adulterant concentration and the number of adulterant pixels identified in the images, demonstrating the utility of this method for regulatory and industry use in the quantitative analysis of adulterants in milk powder. A U.S. patent 8,467,052 ("System and Methods for Detecting Contaminants in a Sample") was granted in May 2013.

As part of an intense research effort to develop detection reagents, vaccines and therapeutics for biothreat agents, ARS at Albany, California, developed high-affinity monoclonal antibodies (mAbs) for the sensitive detection of botulinum neurotoxins (BoNTs) and other toxins. New methods using electrochemiluminescence were developed. Some of the mAbs were also tested for their ability to provide therapeutic protection. The timing of antibody neutralization in animal models revealed windows of opportunity for antibody therapeutic treatment as well as information on the movement of BoNTs between blood and other tissues.

> ***Impact:*** The new technology has been transferred to Federal and State laboratories via cooperative work with the Department of Homeland Security, participation in the Pacific Southwest Regional Center of Excellence, and other agreements. These reagents better equip the nation for assuring food safety and biosecurity.

Immunoassay-based method for the multi-contaminant detection of pollutants in fish. Rapid screening assays for chemical contamination of food products are in high demand by government agencies. In collaboration with scientists from RIKILT- Institute of Food Safety, Netherlands, ARS at Fargo, North Dakota, developed an immunological assay method capable of simultaneously determining three of the most common types of environmental contaminants that are of major food safety concern; i.e. polychlorinated biphenyls, polybrominated diphenyl ethers, and polycyclic aromatic hydrocarbons.

> ***Impact:*** The new technology was successfully tested on various seafood products with different fat contents, with sensitivity levels capable of meeting regulatory limits. The new platform, which is more compact and affordable than the current instrumental method, works well for multiplex measurements of priority pollutants in food samples. The technology will likely find utility by regulatory agencies in the United States and Europe.

Performance Targets

1.2.A Develop detection methodologies for food-borne pathogens and technologies for the rapid and sensitive detection of toxins, chemicals, and biologics that can be implemented for improved food safety and food defense.

Baseline 2012	Target 2017
Develop and transfer one new technology to ARS customers to detect, identify, and control foodborne pathogens and contaminants along the food production continuum.	Cumulatively, five new technologies will be developed and transferred.

1.2.B Conduct and evaluate research that will lead to effective control and intervention strategies for the reduction of microbial, chemical, and other contaminants of the food supply, as well as elucidation of the molecular and physiological mechanisms that allow for persistence, survival, and transmission of foodborne pathogens in the populations and environment.

Baseline 2012	Target 2017
Identify and evaluate potential control and intervention strategies for the reduction and control of foodborne pathogens and contaminants along the food production continuum.	Identify and evaluate potential control and intervention strategies for the reduction and control of foodborne pathogens and contaminants along the food production continuum.

Measure 4.1.2 Summary of the Major Technologies Developed, Transferred, and Used in FY 2013:

During FY 2013, ARS reported on 6 new technologies adopted for uses that provide (enter description here)

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
2-year national survey of pathogens in ready-to-eat (RTE) foods	Data collected and estimated prevalence of Listeria monocytogenes	FDA, FSIS; UK-Food Standards Agency, EFSA-European Food Standards Agency;	New data indicates the Listeria prevalence is lower than expected indicating that

		other international food agencies	interventions implemented 10 years ago worked impacting public health. FDA and FSIS will revise the current risk assessment for RTE foods.
Developed new BARDOT biosensor equipment	Validated a portable, cost effective BARDOT biosensor instrument for bacterial pathogens	USDA, FDA, CDC, Industry, Military, defense agencies: national and international public health agencies	New stand alone, portable, BARDOT has tremendous potential for improving the response to foodborne illness outbreaks because the technology can travel to the source thereby reducing the time to detection.
Developed new PCR based technology for Norovirus	Validated a new, cost-effective simple method for the detection of infectious Norovirus	USDA, FDA, CDC, Industry, Military, defense agencies: national and international public health agencies, private health labs	Innovative technology resulted in a patent application because of its high value to national and international public health agencies and private laboratories that perform testing for the industry, and to the biotechnology industry that develops equipment and molecular biology kits for detection of norovirus.
Developed a Raman based detection system for chemical contaminants	Validated a Raman based detection system for detecting multiple adulterants	USDA, FDA, CDC, Industry, Military, defense agencies: national and international regulatory agencies: UK-FSA, EFSA	Technology will find immediate national and international regulatory use for monitoring foods for contaminants such as melamine. US Patent 8,467,052
Developed a new method for screening antibiotics	Validated novel application of dispersive liquid-liquid microextraction followed by terbium-sensitized luminescence method for approved antibiotics	USDA-FSIS, FDA-Center for Veterinary medicine and other international regulatory agencies	Technology will be implemented by the FSIS National Residue Program and evaluated by international bodies such as the AOAC for international regulatory use.

Measure 4.1.2: 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.

During FY 2014, ARS will

determine how population systems in animals, plants, or the environment, or any combination of these influence the safety of food. Determine the conditions under which microorganisms exist. Determine how microorganisms may in turn influence the conditions prevailing in the environment. Ensure that these technologies can be utilized by regulatory agencies, producers and/or processors to help assure safe food products.

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develop intervention and control strategies will help to significantly decrease or eliminate pathogens in food animals and their derived products (eggs/milk), seafood and plant crops (produce/grains/ tree nuts) during critical periods of production and processing. Develop and subsequently combine new/innovative processing technologies using the intelligent hurdle concept. Ensure that these technologies can be utilized by producers and/or processors to help assure safe food products.

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develop innovative methods and advanced technology systems that rapidly and accurately detect, identify, veterinary drugs, chemical residues, heavy metals, persistent organic pollutants, and biological toxins derived from bacteria, fungi and plants. Evaluate contaminant toxicity, and mechanism of action. Provide data which will enable regulatory/action agencies to make critical food safety decisions that impact public health.

During FY 2015, ARS will

determine how population systems in animals, plants, or the environment, or any combination of these influence the safety of food. Determine the conditions under which microorganisms exist. Determine how microorganisms may in turn influence the conditions prevailing in the environment. Ensure that these technologies can be utilized by regulatory agencies, producers and/or processors to help assure safe food products.

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develop innovative methods and advanced technology systems that rapidly and accurately detect, identify, veterinary drugs, chemical residues, heavy metals, persistent organic pollutants, and biological toxins derived from bacteria, fungi and plants. Evaluate contaminant toxicity, and mechanism of action. Provide data which will enable regulatory/action agencies to make critical food safety decisions that impact public health.

During FY 2016, ARS will

determine how population systems in animals, plants, or the environment, or any combination of these influence the safety of food. Determine the conditions under which microorganisms exist. Determine how microorganisms may in turn influence the conditions prevailing in the environment. Ensure that these technologies can be utilized by regulatory agencies, producers and/or processors to help assure safe food products.

develop an understanding of bacterial, viral, and fungal pathogenicity through a systems biology approach. Utilize this data for pathogen intervention and control, modeling, and providing data for the development of risk assessments by regulatory agencies. Ensure that these technologies can be utilized by regulatory agencies, producers and/or processor to help assure safe food products.

develop innovative methods and advanced technology systems that rapidly and accurately detect, identify, and differentiate the most critical and economically important foodborne bacterial, viral, and protozoan pathogens. Ensure that these technologies can be utilized by regulatory agencies and/or producers to help assure safe food products.

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GOAL 1.3 – ENHANCE THE ECONOMIC VIABILITY AND COMPETITIVENESS OF U.S. AGRICULTURE BY MAINTAINING THE QUALITY OF HARVESTED AGRICULTURAL COMMODITIES OR OTHERWISE ENHANCING THEIR MARKETABILITY, MEETING CONSUMER NEEDS, DEVELOPING ENVIRONMENTALLY FRIENDLY AND EFFICIENT PROCESSING CONCEPTS, AND EXPANDING DOMESTIC AND GLOBAL MARKET OPPORTUNITIES THROUGH THE DEVELOPMENT OF VALUE-ADDED FOOD AND NONFOOD TECHNOLOGIES AND PRODUCTS, EXCEPT ENERGY AND FUELS. (QUALITY AND UTILIZATION OF AGRICULTURAL PRODUCTS – 306)

This research 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. The research in this National Program will also generate new information on health promoting components of foods and assess their effects on important human diseases and obesity, in cooperation with the Human Nutrition National Program (NP 107) 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 27% of food produced in the U.S. 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. NP 306 research will develop technologies that improve quality, extend product shelf life, reduce waste, and decrease costs.

Research is being conducted 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. Thus, biobased products can reduce our dependency on petroleum and provide a more sustainable technology for the future. Biobased products that were once too expensive to commercialize may now be affordable. There is some public concern that biobased products could contribute to the rising cost of food in the U.S. This program seeks opportunities to develop biobased products from agricultural feedstocks that do not compete with food, in cooperation with other ARS national programs and partners. ARS also supports quality and processing research on crop fiber, such as cotton, and animal hides, 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 to compete in a global market.

Performance Measure

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

Indicator 1:

During 2013, ARS will develop technologies leading to new or improved products from bio-based (agricultural) renewable resources, residues, and wastes.

FY 2013 Accomplishments*:*

Although stripper-type cotton harvesters are used on approximately half of the U.S. crop, their non-selective harvesting mechanism collects excessive amounts of foreign material along with the cotton fiber. To increase efficiency in stripper harvesters, ARS engineers developed a new design for the on-board cleaners. The benefits of the new design have been validated in field trials, and the single manufacturer of stripper harvesters is evaluating use of the ARS design in their products.

> ***Impact*:** The ARS design increases the cleaner's material throughput capacity by 20% without increasing fiber rejection rates and so increases harvesting productivity by $5 to $10 per bale.

ARS researchers developed a low-salt preservation formulation for hides using crude glycerol, a low-cost byproduct of biodiesel production, and low molecular weight polyethylene glycol. In addition, the leathers produced from hides preserved with the low-salt method were softer, more stretchable, and stronger compared to materials produced from hides preserved in traditional high-salt brine.

> ***Impact*:** Raw hides are currently preserved with high levels of salt (brine) for storage and shipment to tanneries, a practice that significantly increases waste water treatment costs at tanneries. The ARS-developed preservation method should reduce waste-treatment costs at tanneries by 50-60%, and the U.S. Hides and Leather Association is recruiting a meat packer that will validate the ARS technology at commercial scale.

ARS researchers at Wyndmoor, Pennsylvania, modified gelatin with a tannin from the tara plant (*caesalpinia spinosa*) to produce a filler for leather processing. The resulting filler is almost colorless; an advantage in production of light colored leather, and imparts light-fastness to leather. In addition, filler-treated leathers exhibit improved softness and fullness without impacting the mechanical properties of the leather.

> ***Impact*:** The production of leather generates significant amounts of inedible gelatin, so this research enables the utilization of a low-value byproduct of leather production to increase the value of leather products. An industrial partner is evaluating the process at commercial scale.

Indicator 2:

During 2013, ARS will develop new or improved methods to measure or predict marketable and or nutritional quality, or to sort by quality.

FY 2013 Accomplishments*:*

Microgreens which are leafy vegetables, older than sprouts but much younger than baby greens, were tested by ARS scientists using 25 different commercially available microgreens varieties and discovered that microgreens possess 2 to 4 times higher nutrient content in Vitamins C, E, K and carotenoids than the same plant's mature leaves. These nutritional data will serve as a reference for health agency recommendations and as a healthy food alternative for consumers of fresh microgreens. In addition, these scientists optimized growing and harvesting conditions, and improved storage life from 3-5 to 14 days. This significant shelf life extension will enable

microgreen growers to ship their product by ground transportation instead of air transit, with considerable cost reduction.

> ***Impact*:** This research provides the first scientific-based nutritional assessment of the emerging food microgreens showing they are a powerhouse of human bionutrients.

Urinary tract infections cause millions of doctor visits annually by women, who suffer from this recurrent bacterial infection, with some women starting in their early twenties and lasting their entire life. Previously, the cranberry juice compounds phenolic compounds (anthocyanidins) associated with its red color were thought to be solely responsible for preventing Escherichia coli, a bacterium that causes the infection, from attaching to the urinary tract cells (epithelium). Instead, ARS scientists described the composition of sugars, derived from and unique to cranberry pulp, that prevented the adherence of E. coli to urinary tract cells.

> ***Impact*:** This research clarifies that cranberry fruit sugars are the control agent in urinary tract infections.

During frying oils, which otherwise are high in healthy polyunsaturated fatty acids, like soybean oil, quickly react with oxygen causing darkening, foaming, and a reduction in the nutritional value. Synthetic antioxidants are currently used to protect oils during frying, but many synthetic antioxidants have come under scrutiny because of potential negative health effects. ARS scientists have formulated phytosteryl ferulates, natural antioxidants found in corn, rice, wheat, and rye, combined with Vitamin E, another important antioxidant found in oils. They found that phytosteryl ferulates and Vitamin E protect each other, and work together to protect the oil during frying, so that both the oil and the antioxidants last longer. With this combination, soybean and other healthy oils can be used for a longer time when frying which saves money for food processors and restaurants. For consumers, fried foods will absorb more Vitamin E because it has been maintained in the oil for a longer period of time resulting in healthier fried foods.

> ***Impact*:** This research discovered that plant antioxidants blended with frying oils reduces oxidation allowing the oil to last longer and be healthier.

Oat and barley ß-glucan are well known for lowering blood cholesterol and preventing coronary heart disease. Less well known are the abundant omega-3 polyunsaturated fatty acids found in chia seeds (an ancient super-seed from Latin America) and flaxseeds. ARS are creating new potentially healthy foods by combing oats with chia seeds, and barley with flaxseeds. The combination of oat-chia and barley-flaxseeds gave improved texture and water holding capacities in processed foods (e.g. chips) derived from these combined grain-seed products. These unique products are applicable and useful for developing healthy functional foods, including drinks and various bakery products. These combined grain-seed products and their properties appear to have great potential in functional foods for health concerned consumers. Besides the nutritional aspects of oat-chia and barley-flaxseed composites, their functional hydrocolloids could be valuable for developing new functional food products with useful health benefits for decreasing heart problems, diabetes, and obesity.

> ***Impact*:** These findings help improve human health through creative combinations of oats and chia seeds, and barley and flaxseed snack products.

Allergies to nuts appear to be on the rise, especially in children, according to the U.S. Centers for

Disease and Prevention. Controlling the genetic regulation of allergens could be the key to controlling nut-based food allergens. ARS scientists, in cooperation with Louisiana State University scientists, found that gene expression of pecan nut allergens peaks at the young 'dough-stage' during nut development. The expression of pecan allergens was characterized during pecan nut development through transcript levels of the Car i 1, Car i 4, and pecan 7S vicilin genes in the 'Desirable' and 'Sumner' cultivars. These transcriptors peaked during the September growing season at the dough stage. Both cultivars had similar expression patterns and levels of transcripts during nut development.

***Impact*:** Uncovering the genes to lower nut allergens could assist plant breeders in developing cultivars with little or no allergens.

Performance Targets

1.3.A Develop Methods and Technologies to Better Define, Measure, Preserve, or Enhance Quality and Improve Utilization of Food Crops and Animals

1.3.B Develop Methods and Technologies to Better Define, Measure, Preserve, or Enhance Quality and Improve Utilization of Agricultural Fibers

1.3.C Develop Non-Food, Non-Fuel Biobased Products and Sustainable Technologies/Processes

The following baselines and targets apply to all three performance targets listed above.

Non-food, non-fuel biobased products derived from renewable agricultural resources represent a small fraction of the market for petroleum-based industrial products and some are not yet economically competitive. Also, many agricultural products are marketed as low-value commodities, with postharvest spoilage decreasing return to producers. Healthy foods are often not convenient or readily accepted by significant numbers of consumers. Quality of agricultural fibers needs to be assured in an increasingly competitive global market.

Baseline 2012	Target 2017
Four new biobased or fiber products and food items with improved quality, nutritional or functional characteristics were developed by ARS and used by customers, both domestic and foreign.	Cumulatively, 20 new technologies developed by ARS and adopted for uses that provide food crops and products with higher quality and extended shelf life; convenient and acceptable healthy foods; non-food, non-fuel biobased products with cost and performance features comparable or superior to petroleum-based products; high quality agricultural fibers; and valuable co-products from agricultural residues and processing wastes.

Measure 1.1.3 Summary of the Major Technologies Developed, Transferred, and Used in FY 2013:

During FY 2013, ARS reported on 8 new technologies adopted for uses that provide (enter description here)

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Improve cleaners on stripper-type cotton harvesting machines	Harvester manufacturer is testing the modified cleaner	Cotton farmers	Increases harvester productivity by $5 to $10 per bale
New low-salt hide preservation process	Recruiting meat packer is validating the ARS preservation method at commercial scale	Cattle slaughter houses	At least 50% lower water treatment costs in leather production
Utilize low-value leather by-product to improve leather quality	Leather tannery is evaluating the ARS technology at commercial scale	Leather producers	Increased profitability for U.S. leather manufacturers
Microgreens: the new food that is a powerhouse of human bionutrients.	Technology is being tested by industry.	Growers, and food service industry	This research provides the first scientific-based nutritional assessment of the emerging food microgreens.
Cranberry fruit sugars are the control to urinary tract infections.	Technology is being patented and tested by industry.	Juice industry and health professionals	This research clarifies that cranberry fruit sugars are the control agent in urinary tract infections.
Extending the life of frying oils with plant antioxidants.	Technology is being patented.	Food service industry	This research discovered that plant antioxidants blended with frying oils reduces oxidation allowing the oil to last longer and be healthier.
New healthy foods: combining oats and chia seeds, and barley and flaxseed.	Technology is being patented.	Grain growers, and snack food industry	These findings help improve human health through creative combinations of oats and chia seeds, and barley and flaxseed snack products.
Uncovering the genes to lower nut allergens.	Technology is being shared with university scientists.	Plant breeders	Uncovering the genes to lower nut allergens could assist plant breeders in developing cultivars with little or no allergens.

Measure 1.1.3 : Develop methods and technologies to better define, measure, preserve or enhance qulaity and improve utilization of food crops, animals and agriculutral fibers, as well as non-food, non-fuel biobased products and sustainable technologies/processes.

During FY 2014, ARS will

Develop technologies leading to new or improved products from bio-based (agricultural) renewable resources, residues, and wastes

Develop new or improved methods to measure or predict marketable and or nutritional quality, or to sort by quality

During FY 2015, ARS will

Develop technologies leading to new or improved products from bio-based (agricultural) renewable resources, residues, and wastes

Develop new or improved methods to measure or predict marketable and or nutritional quality, or to sort by quality

During FY 2016, ARS will

Enable commercially-viable post-harvest technologies for non-food biobased products and for value-added non-food processing

Develop new or improved methods to measure, predict, enhance or reduce impacts to food marketability, nutritional quality, new bioactives and functional foods, and/or food processing technologies

Strategic Goal Area 2:

Natural Resources and Sustainable Agricultural Systems

We conduct 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 regimes and environmental conditions;
- Providing agricultural products and co-products as renewable, bio-based alternatives to petroleum as inputs to manufacturing and generating energy;
- Developing new, valuable, environmentally sound uses for agricultural and industrial byproducts.

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 U.S.; identification of safe uses of agricultural wastes and byproducts in generating energy/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 and rangelands; 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/validation of sustainability indices for agricultural production and delivery systems .

GOAL 2.1 – INTEGRATED, EFFECTIVE, AND SAFE WATER RESOURCE MANAGEMENT (WATER AVAILABILITY AND WATERSHED MANAGEMENT - 211)

There is no substitute for fresh water nor are there replacements for its essential role in maintaining human health, agriculture, industry, and ecosystem integrity. As the nation was established and expanded, it flourished in part because of its abundant and readily available water and natural resources. In the 21st century, the nation faces depleted ground water reserves, degraded water quality, and adverse climate conditions that are reducing the amount of available freshwater. At the same time, allocations of our freshwater resources are shifting among different users and different needs (e.g., from agricultural to urban uses; from storing water supplies in reservoirs to maintaining in-stream flows to support healthy aquatic ecosystems; from industrial and energy production to recreation). Our shared freshwater supply has been significantly reduced and is becoming more variable, unreliable, and inadequate to meet the needs and demands of an expanding population.

Today, agriculture is the largest user of fresh water yet offers opportunities for conserving water supplies and improving water quality for drinking, swimming, and fishing.
Agriculture faces new challenges—the increasing demand for water by our cities, farms, and aquatic ecosystems; the increasing reliance on irrigated agriculture for crop and animal production and farm income; and changing water supplies due to groundwater depletion in some areas, climate variability, and global change. Science can provide the tools needed by water planners and managers to accurately predict the outcomes of proposed water management decisions, and new technologies can widen the range of options for future water management. The factual basis for decision-making includes an understanding of effectiveness, potential unintended consequences, and a plan for getting water users and agencies to adopt the most effective technologies. The Nation has the opportunity to use science and technology to build a strong economy and to improve human and ecological health.

Performance Measure

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

Indicator 1:

During 2013, ARS will develop new or improved guidelines, technologies, and/or knowledge to increase the effectiveness of agricultural water management.

FY 2013 Accomplishments*:*

Early warning index for flash drought. The flash droughts of 2012 in the U.S. Corn Belt were rapid onset events fueled by below-normal precipitation levels and a lingering heat wave that essentially "baked" moisture reserves from the soil profile. ARS scientists in Beltsville, Maryland, developed a satellite-based drought product called the Evaporative Stress Index (ESI) that provided early warning of the deteriorating crop and moisture conditions in 2012, preceding signals of increasing drought severity recorded by the U.S. Drought Monitor and many other standard drought indicators by several weeks. The ESI depicts areas of anomalously low water use and availability, derived from measurements of evapotranspiration (ET) generated with thermal infrared satellite imaging systems (NP211, C4, PS4d, PM 6.1.1, Project No 1245-13610-028-00D).

> ***Impact*:** Robust early warning of impending drought provides growers additional time to adjust cropping and marketing strategies during the growing season. ARS scientists are also working with researchers at the USDA National Agricultural Statistics Service to establish the utility of using ESI records of seasonal crop stress to improve estimates of at-harvest yield. With minimal reliance on ground-based observations, the ESI shows good potential for monitoring food and water security at the global scale.

Long-term data from an ARS experimental watershed validates NASA satellite-based rainfall estimates. Water is a critical resource in rapidly developing arid and semiarid regions. Accurate rainfall estimates are essential to effective management of agricultural production and critical water resources, but in many parts of the world, rugged terrain limits the deployment of rain gauges, while simultaneously blocking ground-based radar estimates of rainfall. Working with colleagues from the National Aeronautics and Space Administration (NASA), ARS researchers in Tucson, Arizona, compared rain gauge observations from the densely instrumented ARS Walnut Gulch Experimental Watershed, with rainfall intensity estimates from the Tropical Rainfall Measurement Mission (TRMM) satellite for the period 1999

to 2010. Results showed a very good agreement between the two sets of rainfall rate estimates, underscoring the importance of ARS long-term research sites and the data sets they enable (NP211, C4, PS4d, PM 6.1.1, Project No 5342-13610-011-00D).

> ***Impact*:** Rainfall is not well measured over large parts of the globe. The TRMM satellite design is the basis for NASA's new Global Precipitation Mission. Validation of TRMM satellite technology presages success for this new NASA Mission, significantly enhancing the accurate quantification of precipitation worldwide, with important implications for improving the world's capacity for food production in light of expected population growth and climatic uncertainty.

New version of PhenologyMMS improves simulation of plant developmental responses to water deficits. Crop models help farmers manage water efficiently for optimal crop production. Modeling spatial relationships in plant growth and yield at field-to-watershed scales requires the accurate simulation of crop development across the landscape in response to variations in soil water, temperature, and other factors. To address this need, ARS scientists at Fort Collins, Colorado, developed and released Version 1.3 of the Phenology Modular Modeling System (MMS) decision support tool. The new version has an enhanced user interface and improved underlying science code. It also adds new crop species, a larger set of default parameters, and more historical weather data. (NP211, C1, PS1a, PM 6.1.1, Project No 5402-13660-008-00D).

> ***Impact*:** PhenologyMMS Version 1.3 allows farm crop management practices to be synchronized with crop development stage, increasing agricultural production while reducing adverse environmental impacts. PhenologyMMS has already been downloaded by over 1500 researchers, farmers, and agribusinesses, is being used by commodity groups such as the Colorado Association of Wheat Growers, is being tested on Nebraska farms as part of the Nebraska Water Balance Alliance, and has resulted in numerous requests for additional information, including from the popular press.

Sunflower—an alternative crop for lands with marginal irrigation capacity in the Central High Plains. As water availability in the Ogallala Aquifer decreases, new crops and/or farming practices will be needed to efficiently use the irrigation water that is available. Because of its shorter growing season and therefore lower overall irrigation needs, sunflower is a crop of interest in the Ogallala region. In collaboration with researchers at Kansas State University, ARS scientists in Bushland, Texas, studied the response of sunflower grown in northwest Kansas to three irrigation regimes. Sunflower seed yields were not appreciably affected by decreasing the irrigation regime from 1 inch every 4 days to 1 inch every 12 days. These results suggest that optimal sunflower seed yields can be achieved while conserving one-third to one-half of the irrigation water. Sunflower appears to be a good candidate for cropping in Central High Plains regions with marginal irrigation capacity (NP211, C1, PS1a, PM 6.1.1, Project No: 6209-13000-014-00D).

> ***Impact*:** Farmers in the Central High Plains are provided with an alternative crop (i.e., sunflower) that uses significantly less water, allowing them to maintain crop production and associated economic returns as water availability declines and the costs of irrigating increase.

Indicator 2:

During 2013, ARS will develop new or improved guidelines, technologies, and/or knowledge to reduce erosion and sedimentation from agricultural lands and/or improve water quality.

FY 2013 Accomplishments*:*

Reducing the export of reactive nitrogen from agricultural lands in the Chesapeake Bay watershed. The wide-spread adoption of no-till crop production practices has resulted in significant reductions in soil erosion and associated nutrient loss, but N losses associated with the volatilization of ammonia from manure can be comparatively high in the absence of soil nitrogen (N) incorporation through tillage. ARS researchers at University Park, Pennsylvania, evaluated several low-disturbance manure incorporation technologies to determine their capacity to reduce ammonia-based nitrogen losses. Shallow disk injection consistently reduced ammonia emission by more than 90% with little disruption of the soil surface. In contrast, manure incorporation using a rolling-tine aerator consistently reduced ammonia losses only when the implement was configured to aggressively mix soil (NP211, C3, PS3e, PM 6.1.1, Project No 1902-13000-012-00D).

> ***Impact*:** Farmers are provided with a technology that allows the use of manure as a fertilizer in no-till crop production that minimizes ammonia volatilization, thereby reducing reactive nitrogen inputs from agriculture to the environment. Extension presentations helped disseminate these findings to farmers throughout the Chesapeake Bay region, influencing the development of interim NRCS practice standards for manure injection in Pennsylvania, and in other states in the Chesapeake Bay watershed.

The Water Erosion Prediction Project model improves erosion prediction while expanding applications. The Water Erosion Prediction Project (WEPP) is a process-based model used to estimate soil erosion and sediment deposition on hillslopes, incorporating climate, water balance, plant growth, runoff routing, and sediment detachment and deposition components. ARS researchers at West Lafayette, Indiana, improved the WEPP model by adding new routines for channel flow routing, water percolation to lower layers (which can be used to estimate watershed baseflow), and tile drainage. The team also conducted a series of sensitivity and uncertainty analyses, and demonstrated how to calibrate and validate the model using measured data (NP211, C4, PS4b, PM 6.1.1, Project No 3602-12130-001-00D).

> ***Impact*:** The USDA Natural Resources Conservation Service (NRCS) has requested help from the ARS team to further develop the WEPP model for incorporation into their conservation toolkit. As a result, state and local NRCS offices will have the capability to use the most advanced erosion prediction technology in their conservation planning. To further utilize the spatial capability of this model, the ARS team is cooperating with scientists from the U.S. Forest Service, Washington State University, and the University of Idaho to develop Geographic Information Systems (GIS) interfaces for the WEPP model, to make erosion assessments in the Great Lakes and Lake Tahoe Basins. Geospatial WEPP applications have already been successfully used to assess watershed hydrology and sediment loss in two forested watersheds in West Virginia. The U.S. Forest Service has also been using this technology to more efficiently select remediation practices after wild fires in the western U.S.

State-wide network of sites will monitor agricultural water quantity and quality. Working with State partners, ARS scientists in Jonesboro, Arkansas, established a network of edge-of-field monitoring sites to collect water resources information in 30 fields across 12 farms, representing Arkansas's major agricultural commodities (NP211, C1, PS1c, PM 6.1.1, Project No 6408-13000-024-00D).

> ***Impact*:** Understanding agriculture's impact on water resources is imperative to improving management and policy associated with the production of food, fiber, feed and fuel. As producers begin to understand the makeup of the runoff from their fields, the information collected from these sites will help to improve management practices and to reduce excess nutrients and sediment entering local and regional waterways.

Indicator 3:

During 2013, ARS will develop new or improved knowledge, tools, technologies, guidelines, and/or conservation practices to better protect water resources, improve the overall effectiveness of USDA conservation programs, and/or improve watershed management and ecosystem services in agricultural landscapes.

FY 2013 Accomplishments*:*

Assessing feasibility and sustainability of bioenergy crop production. In collaboration with their university partners, ARS scientists in Temple, Texas, parameterized the ARS-developed plant growth model, ALMANAC, for representative ecotypes of switchgrass, to evaluate their potential as alternative second-generation bioenergy crops in the eastern and central United States. This allowed them to assess the feasibility and sustainability of biofuel production in these regions in the face of growing energy production demands and climate change. Under both current and future climate change scenarios, switchgrass productivity showed substantial variation both within regions and over time. In particular, the southern U.S. has the highest current biomass production potential, but is predicted to have the largest future decrease in productivity, because temperature is predicted to increase (and precipitation decrease), in this region. Thus if future climate predictions are accurate, current estimates of biomass energy production potential associated with switchgrass cultivation in the southern United States are not likely to be sustainable. These results help develop a better understanding of the possibility for large-scale biofuel production from perennial grasses in the eastern and central U.S. (NP211, C4, PS4a/e, NP212, C3, PS3a, PM 6.1.1, Project No 6206-13610-007-00D).

> ***Impact*:** These results help develop a better understanding of the potential for large-scale biofuel production from perennial grasses in the eastern and central U.S., and how that potential may change with time due to predicted changes in regional climate.

More effective reduction in nutrient export via a new precision conservation toolkit. Individual conservation practices can improve water quality if they are placed in appropriate locations, but conservation at the watershed scale is most effective when suites of practices are placed so that they work in concert to achieve maximum conservation benefits. An ARS scientist at Ames, Iowa, has proposed a combination of precision conservation techniques that comprise a flexible framework appropriate for Midwestern landscapes and applicable to small watersheds of $\leq$ 30,000 acres. The framework is based on a set of computerized landscape analyses that use newly available, detailed elevation data to identify where different types of conservation practices can be placed to most effectively improve water quality (NP211, C3, PS3b, PM 6.1.1, Project No 3625-13000-010-00D).

> ***Impact*:** Development of this new precision conservation toolkit helps both conservation planners and landowners develop sets of planning alternatives that map how selected suites of conservation practices can be distributed to address key pollutant pathways in both surface and subsurface-drained landscapes. These scenarios provide the flexibility needed for local conservation planning decisions to be viable at the farm level, while being based on the best available technology and on local goals for environmental improvement. The framework was described in a recent feature article in the Journal of Soil and Water Conservation, the journal's most downloaded paper in September and October 2013, and tests of this framework are being initiated in Iowa, Indiana, and Minnesota

Models help guide wetland placement in agricultural watersheds to reduce nutrients. The wide installation of nutrient removal wetlands in tile-drained watersheds of the Midwest may represent the best opportunity to reduce nitrate loads in the Mississippi River Basin and mitigate Gulf of Mexico

hypoxia with a single conservation practice. Suitable locations to place wetlands must be identified, however, and their potential impact on nutrient load reductions quantified at the watershed scale in order to implement this approach effectively. ARS scientists at Oxford, Mississippi, and Ames, Iowa, used the results of an aerial laser altimetry survey to develop a detailed topographic map of a Hydrologic Unit Code 12 (HUC-12) (16,000 acre) watershed in Illinois. They applied a conservative set of criteria, modified from a wetlands program in Iowa, to identify eleven sites that could readily be converted to wetlands with minimal loss of productive cropland, and that could intercept and treat tile drainage from 30% of the watershed. A modeling exercise estimated that these wetlands could reduce nitrate loads from the watershed by as much as 16%, but load reductions among the wetland locations varied considerably, depending on watershed-to-wetland area ratios, land use in the upslope area, and nitrate loads generated under that land use. (NP211, C3, PS3b, PM 6.1.1, Project No: 6408-13660-007-00D).

> ***Impact*:** These procedures provide policy makers with key information to assist in developing incentive structures to encourage wetland construction and/or restoration at the watershed scale, including to support the establishment of nutrient trading schemes

Herbicide transport depends on timing of application, enhanced degradation rates, and presence of buffers. Agrichemical transport to coastal waters can have adverse ecological impacts. As part of the Conservation Effects Assessment Project (CEAP), ARS researchers at Tifton, Georgia, used a combination of field studies and simulation modeling to understand atrazine fate and transport in a watershed adjacent to Puerto Rico's Jobos Bay National Estuarine Research Reserve. Most of the atrazine that moved toward the estuary was carried in surface runoff from tropical storms. Modeling studies demonstrated that the majority of atrazine transported was in dissolved form, and that under high rainfall and runoff conditions, riparian buffers were less effective at intercepting the herbicide before it reached the estuary. Transport to the estuary was also limited by rapid atrazine dissipation in field (crop) soils, suggesting that atrazine runoff is most likely to occur when a tropical storm event immediately follows atrazine application. (NP211, C1, PS1a, PM 6.1.1, Project No 6602-13000-026-00D).

> ***Impact*:** Understanding the conditions under which atrazine and other herbicides are likely to be transported from agroecosystems to sensitive coastal waters helps farm managers develop practices that can reduce or eliminate the negative impacts of agrichemicals on important estuaries like Jobos Bay.

Performance Targets

2.1.A Develop Tools and Technologies to Improve the Effectiveness of Agricultural Water Management.

Baseline 2010	Target 2017
ARS released new FAO water quality guidelines for irrigation with marginal waters and treated wastewaters, replacing earlier guidelines that: did not consider pH; and underestimated the effects of sodium absorption on water infiltration. The new guidelines were used by	Cumulatively, 17 models, tools, databases, sets of guidelines, or design criteria developed and released to ARS customers.

customers to improve the ability to evaluate the infiltration of hazards associated with the application of marginal waters or treated wastewaters, ensuring safer use of saline waters for irrigation and increasing the water available to support irrigated agriculture.	

2.1.B Improve the Scientific Understanding of Erosion, Sedimentation, and Contaminant Transport Processes from Agricultural Fields and Landscapes to Facilitate the Development of Tools and Technologies to Better Protect the Agricultural Water Quality.

Baseline 2010	Target 2017
ARS released version 2010.1 of the Water Erosion Prediction Project (WEPP) model, to users in the US and throughout the world. Customers include land managers and conservationists charged with predicting runoff, soil loss, and sediment yield from hill slopes and small watersheds. The new version gives improved performance especially in areas experiencing substantial erosion from snowmelt on thawing soils.	Cumulatively, 16 technologies, databases, tools, models, or sensor-based monitoring systems developed and released to ARS customers.

2.1.C Develop Strategies to Improve the Effectiveness of Agricultural Conservation Efforts by Developing New or Improved Conservation Practices, Improving Practice Placement to Maximize Effectiveness and Minimize Cost, and Developing a Better Understanding of the Effects of Agricultural Conservation at the Landscape Scale.

Baseline 2010	Target 2017
Three tools to enhance conservation effectiveness released by ARS and used by customers to improve conservation management.	Cumulatively, 10 tools, technologies, models, databases, or improved conservation practices developed and released to ARS customers

2.1.D Conduct Research to Improve Watershed Management and Ecosystem Services in Agricultural Landscapes.

Baseline 2010	Target 2017
Two tools to enhance watershed management and ecosystem services in agricultural landscapes released by ARS and used by customers to improve flash flood forecasting and set design standards for flood and transport infrastructure, erosion estimates, storm characteristics, and other watershed processes.	Cumulatively, 10 tools, models, databases, or technologies developed and released to ARS customers

Measure 2.2.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2013:

During FY 2013, ARS reported on 5 new technologies adopted for uses that provide (enter description here)

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
A satellite-based drought product called the Evaporative Stress Index (ESI).	ARS scientists are working with NOAA to improve the U.S. Drought Monitor, and with NASS to establish the utility of using ESI records of seasonal crop stress to improve estimates of at-harvest yield.	NOAA; NASS	Robust early warning of impending drought provides growers with additional time to adjust cropping and marketing strategies during the growing season. Due to its minimal reliance on ground-based observations, the ESI shows good potential to improve the monitoring of food and water security at the global scale.
Comparative evaluation of several low-disturbance manure incorporation technologies designed to reduce ammonia-based nitrogen losses.	Findings disseminated through extension presentations to farmers throughout the Chesapeake Bay region, influencing the development by USDA Natural Resources	NRCS; Chesapeake Bay regions farmers.	Farmers are provided with a technology that allows the use of manure as a fertilizer in no-till crop production that minimizes ammonia volatilization, thereby reducing

	Conservation Service (NRCS) of interim practice standards for manure injection in Pennsylvania and other states in the Chesapeake Bay watershed.		reactive nitrogen inputs from agriculture to the environment.
New routines for channel flow, routing, water percolation to lower layers, and tile drainage added to the ARS Water Erosion Prediction Project (WEPP) model.	USDA NRCS requested help from ARS to further develop the WEPP model for incorporation into their conservation toolkit.	NRCS	State and local NRCS offices will have the capability to use the most advanced erosion prediction technology in their conservation planning.
New version (1.3) of the Phenology Modular Modeling System decision support tool developed by ARS scientists. The tool models spatial relationships in plant growth and yield at field-to-watershed scales.	Downloaded by more than 1500 researchers, farmers, and agribusinesses; being used by commodity groups (e.g., Colorado Association of Wheat Growers) and by the Nebraska Water Balance Alliance.	Research scientists, farmers, agribusinesses, commodity groups (e.g., Colorado Association of Wheat Growers), and the Nebraska Water Balance Alliance.	Allows farm crop management practices to be synchronized with crop developmental state, increasing agricultural production while reducing adverse environmental impacts.
ARS scientists developed a flexible framework for small Midwestern watersheds (< 30,000 acres) based on a set of computerized landscape analyses using newly available, detailed elevation data to identify where different types of conservation practices can be placed to most effectively improve water quality.	The framework was described in a recent feature article in the Journal of Soil and Water Conservation, the journal's most downloaded paper in September/October 2013.	Conservation planners and landowners in the Midwestern U.S.	The framework provides the flexibility needed to support local conservation planning decisions.

Measure 2.2.1: Develop technology and practices to promote improvement of integrated, effective and safe water resource management.

During FY 2014, ARS will

develop new or improved guidelines, technologies, and/or knowledge to increase the effectiveness of agricultural water management.

develop new or improved guidelines, technologies, and/or knowledge to reduce erosion and sedimentation from agricultural lands and/or improve water quality.

develop new or improved knowledge, tools, technologies, guidelines, and/or conservation practices to better protect water resources, improve the overall effectiveness of USDA conservation programs, and/or improve watershed management and ecosystem services in agricultural landscapes.

During FY 2015, ARS will

develop new or improved guidelines, technologies, and/or knowledge to increase the effectiveness of agricultural water management.

develop new or improved guidelines, technologies, and/or knowledge to reduce erosion and sedimentation from agricultural lands and/or improve water quality.

develop new or improved knowledge, tools, technologies, guidelines, and/or conservation practices to better protect water resources, improve the overall effectiveness of USDA conservation programs, and/or improve watershed management and ecosystem services in agricultural landscapes.

During FY 2016, ARS will

develop new or improved guidelines, technologies, and/or knowledge to increase the effectiveness of agricultural water management.

develop new or improved guidelines, technologies, and/or knowledge to reduce erosion and sedimentation from agricultural lands and/or improve water quality.

develop new or improved knowledge, tools, technologies, guidelines, and/or conservation practices to better protect water resources, improve the overall effectiveness of USDA conservation programs, and/or improve watershed management and ecosystem services in agricultural landscapes.

GOAL 2.2 – IMPROVE QUALITY OF ATMOSPHERE AND SOIL RESOURCES, UNDERSTAND EFFECTS OF CLIMATE CHANGE (CLIMATE CHANGE, SOILS AND EMISSIONS RESEARCH – 212)

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 (GHG) concentrations. While GHG emissions are a result of the natural cycling of carbon (C) and nitrogen (N), these emissions also contribute to climate change.

A changing climate impacts agriculture, range and pasture systems, and soils through alterations of precipitation and temperature patterns. Increased atmospheric carbon dioxide (CO2) 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 NP212 research. Formal and informal Cross Location Research (CLR) projects including the Greenhouse gas Reduction through Agricultural Carbon Enhancement network (GRACEnet), the Renewable Energy Assessment Project (REAP), and field campaigns focused on air quality are successful examples. Synthesis and integration of information, including sources outside NP212 research projects, increases the utility and impact of ARS research for producers, land managers and policy-makers. Efficient assimilation of data from NP212 projects into existing and future collaborative data bases enhances synthesis and integration analyses and expands research opportunities.

Performance Measure

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

Indicator 1:

During 2013, ARS will assess the potential risks and benefits to agricultural systems from climate change, and develop agricultural management practices and decision support strategies that enable producers to take advantage of the beneficial effects, and adapt to the adverse effects of climate change.

FY 2013 Accomplishments:

Potato shows promise for meeting climate change challenges to food production. Climate change predictions include the likelihood of less rain in many agricultural regions. Such drought may impact potato production as it typically relies on natural precipitation as it water source. ARS scientists in Beltsville, MD, applied short-term drought periods to potato grown under different carbon dioxide

levels. Averaged across all drought treatments, potatoes grown under elevated carbon dioxide levels had as much as 60% greater tuber yield, and also used water more efficiently.

***Impact*:** Results give potato growers information about how they can adapt to changing carbon dioxide levels by adjusting their irrigation practices. Results will also help policy makers develop future plans for agricultural management plans that ensure local food production can adapt to climate change and meet nutritional needs of a growing population. NP212, C3, PS3A, PM 2.2.2, Project No. 1245-61660-006-00D.

Elevated CO_2 increases invasive plants in semi-arid rangeland. In dry regions, elevated atmospheric carbon dioxide (CO_2) can influence plants both directly, by increasing carbon needed for photosynthesis, and indirectly, by increasing water use efficiency. ARS scientists in Ft. Collins, CO, found that direct and indirect CO_2 effects combined to dramatically increase success of the invasive plant, Dalmatian toadflax (Linaria dalmatica). Toadflax biomass and seed production were 13-fold and 32-fold greater, respectively, with elevated CO_2 than without.

***Impact*:** Findings show that dry regions are likely to be particularly vulnerable to invasive plants as climate change proceeds. Information will help rangeland producers better adapt to climate change by allowing them to predict which species are most likely to invade, and which areas are most likely to be invaded under future climates. NP212, C3, PS3A, Project No. 5409-11000-005-00D.

Elevated carbon dioxide and drought alter plant defense against pathogen attack. Along with rising atmospheric carbon dioxide (CO_2), climate change is predicted to also intensify drought. ARS scientists in Gainesville, FL, studied the effects of elevated CO_2 and drought stress on susceptibility of corn to stalk rot pathogen. Drought at ambient CO_2 reduced pathogen growth, but the combination of drought and elevated CO_2 increased pathogen proliferation and production of a fungal toxin, and decreased plant-produced defenses against the pathogen.

Impact: The research allows scientists and producers to develop future disease management strategies that can effectively cope with biotic stresses and conditions of rising CO_2 and increased drought stress. NP212, C3, PS3B, PM 2.2.2, Project No. 6615-11220-001-00D.

Indicator 2:

During 2013, ARS will develop management practices and decision tools to improve soil quality, protect the environment, and contribute to the sustainability of agricultural systems.

FY 2013 Accomplishments*:*

New soil nitrogen test creates economic and environmental benefits. Current soil nutrient tests do not account for all sources of plant-available nitrogen. Fertilizer recommendations based on these tests frequently overestimate application amounts, leading to an unnecessary fertilizer cost for farmers, and loss of excess nitrogen to the environment. Cooperation between ARS scientists in Temple, Texas and industry has led to the development and commercialization of a new method to rapidly and inexpensively determine the total plant available nitrogen in soils.

Impact: Since its introduction in 2010, the new test, known as the "Haney Soil Health Test", has been adopted by 40 university and commercial soil testing laboratories. The 2012 estimated nitrogen fertilizer savings from reduced application was $2.5 million. he Haney Soil Health Test is a major advancement towards sustainable agriculture because it boosts agricultural economic

viability and environmental quality, without sacrificing yields. NP212, C4, PS4D, PM 2.2.2, Project No. 206-11220-005-00D.

Sustainable crop rotations increase farm economic sustainability. Producers often make crop management decisions based only on short-term economic factors such as grain price, which can be detrimental to economic, social, and environment sustainability goals. ARS scientists in Ames, IA, compiled and analyzed yield data from a 27-year tillage and crop sequence study to provide information for more sustainable crop management decisions in the Corn/Soybean Belt. To account for fluctuations in annual crop price and grain yield throughout the study, average grain prices for a nine-year (2003 to 2011) period were multiplied by crop yield for 1988 through 2006 to determine gross income. Management costs for various tillage practices were also accounted for.

Impact: Results showed that a corn-soybean rotation was twice as profitable as continuous corn. While crop rotations have been promoted and adopted for soil conservation and environmental purposes, this analysis gives producers a major economic justification to use crop rotations. NP212, C4, PS4C, PM 2.2.2, Project No. 3625-12000-013-00D.

New method to determine the bioavailability of legacy pesticides in soil. DDT and dieldrin are pesticides that were banned during the 1970s due to toxic effects on wildlife. However, these compounds still exist in some soils and their bioavailability is determined via expensive, laborious analysis of earthworms. ARS researchers in Beltsville, MD, developed a rapid, accurate, and inexpensive alternative method to determine the bioavailability of DDT and dieldrin in soils. Results from the newly developed, thin-film-solid phase extraction method (TF-SPE) were highly correlated with the more laborious and expensive earthworm bioassay.

***Impact*:** The TF-SPE method greatly enhances the ability of land managers and regulatory agencies to determine the presence of legacy pesticides in agricultural soils, and to monitor the effectiveness of soil remediation practices, thus improving environmental quality. NP212, C1, PS1A, PS1B, PM 2.2.2 , Project No. 1245-12610-001-00D.

Indicator 3:

During 2013, ARS will assess the greenhouse gas emissions from agricultural systems and develop methods for reducing the emissions.

FY 2013 Accomplishments*:*

ARS agricultural greenhouse gas and biofuel sustainability database available to public. Data management systems are needed to expand the availability of vast amounts of data generated by field studies. ARS researchers at Fort Collins, CO, collaborating with ARS scientists nationwide, created, reviewed, and revised a general data entry template designed to accommodate comprehensive data from cropping, biofuel, and grazing studies from the ARS Geenhouse Gas Reductions through Agricultural Carbon Enhancement network (GRACEnet) and Renewable Energy Assessment (REAP) projects. Currently, data from 35 ARS units have been populated in the template, quality controlled, and uploaded to a relational database, and a subset of this data is now publically available.

Impact: Making this database easily accessible is critical for researchers and policy makers to perform meta-analyses, test existing and develop new GHG flux and crop growth models, which in turn allow more accurate assessments of agriculture's ability to adapt to climate change and provide renewable biofuels. This effort greatly increases the stewardship and utility of ARS data,

and thus the return on investment in ARS research. NP212, C2, PS2C, PM 2.2.2, Project No. 5402-11000-010-00D.

Models more accurately estimate soil GHG fluxes. Most nations use simple Intergovernmental Panel on Climate Change (IPCC Tier 1) methods based on emission factors to estimate greenhouse gas (GHG) fluxes from agriculture for national inventories and reports to the United Nations Framework Convention on Climate Change (UNFCCC). ARS Researchers in Fort Collins, CO, showed the DayCent ecosystem model (IPCC Tier 3 methodology) accurately predicted N_2O flux for 13 sites in the U.S. and Australia and soil carbon changes from North American 47 field sites.

Impact: Using the DayCent model improved the reliability of national-scale GHG fluxes reported by the U.S. to the UNFCCC and published by EPA in 2013 (Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2011). NP212, C2, PS2B, PM 2.2.2, Project No. 5402-11000-010-00D.

Performance Targets

2.2.A Enable Improvements of Air Quality via Management and Mitigation of Emissions from Agricultural Operations.

Baseline 2010	Target 2017
Integrated Farm Systems Model (IFSM) and Dairy Greenhouse Gas Emissions Model (DairyGEM) developed with focus on NE US agricultural systems, as a prototype for on-farm decision support technology.	Protocols implemented for standardized air quality research data collection and storage with transport parameters and emission rates for emission and transport model improvement, evaluation, and validation. IFSM and DairyGEM calibrated and tested for other regions of US.

2.2.B Develop Knowledge and Technologies for Reducing Atmospheric Greenhouse Gas Concentrations Through Management of Agricultural Emissions and Carbon Sequestration.

Baseline 2010	Target 2017
Cumulative GRACEnet project production of 208 scientific publications on GHG emissions and carbon sequestration in US croplands and rangelands.	Agriculture product/production system/-specific decision support tools and management strategies for balancing production goals, environmental stewardship objectives, GHG emission reductions, and C sequestration.

2.2.C Enable Agriculture to Adapt to Climate Change.

Baseline 2010	Target 2017
Data revealing anticipated impacts of climate change on crop production, weeds, pathogens, food and forage quality.	Prototype decision support tools that enable sustainable agriculture under conditions of changing climate

2.2.D Develop Technologies for Maintaining and Enhancing Soil Resources.

Baseline 2010	Target 2017
Data on effects of biochar amendments and crop rotations on soil biomass, carbon cycling and enzymes.	Develop guidelines and practices to lower production costs, improve soil quality and health, and reduce use of energy and petroleum-based products.

Measure 2.2.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2013:

During FY 2013, ARS reported on 4 new technologies adopted for uses that provide (enter description here)

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Methodology for improved nitrous oxide emissions measurements.	Guidance document distributed internationally via the website of the Global Research Alliance (GRA).	Scientists and technicians from around the world engaged in research related to agricultural nitrous oxide emissions.	More accurate and precise measurement of nitrous oxide emissions from croplands and grazing lands by developed and developing nations participating in GRA.
Improved version of Yield Editor 2 computer model	Made publicly available through the internet.	Scientists, crop advisors, agribusiness, producers	Provided large number of users with efficient methods to analyze precision agriculture datasets and develop improved management recommendations
Decision Support System for Agrotechnology Transfer (DSSAT)	Software made available to users via workshops and Internet download	Students, researchers and private sector crop forecasting enterprises from over 100	Enables users to more accurately simulate potential effects of climate, soils,

Version 4.6	(www.DSSAT.net).	countries.	management and other factors, leading to improved decisions for agricultural management.
Educational DVD video titled: "Soil Erosion by Wind and Its Control".	More than 170 copies of the video were delivered at the request of customers.	NRCS personnel, elementary to university educators and researchers, private consultants, and national, state and local government agencies	Improved and expanded education about the wind erosion problem, its processes, and methods for its control.

During FY 2014, *ARS will*

assess the potential risks and benefits to agricultural systems from climate change, and develop agricultural management practices and decision support strategies that enable producers to take advantage of the beneficial effects, and adapt to the adverse effects of climate change.

develop management practices and decision tools to improve soil quality, protect the environment, and contribute to the sustainability of agricultural systems.

assess the greenhouse gas emissions from agricultural systems and develop methods for reducing the emissions.

During FY 2015, *ARS will*

assess the potential risks and benefits to agricultural systems from climate change, and develop agricultural management practices and decision support strategies that enable producers to take advantage of the beneficial effects, and adapt to the adverse effects of climate change.

develop management practices and decision tools to improve soil quality, protect the environment, and contribute to the sustainability of agricultural systems.

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assess the potential risks and benefits to agricultural systems from climate change, and develop agricultural management practices and decision support strategies that enable producers to take advantage of the beneficial effects, and adapt to the adverse effects of climate change.

develop management practices and decision tools to improve soil quality, protect the environment, and contribute to the sustainability of agricultural systems.

assess the greenhouse gas emissions from agricultural systems and develop methods for reducing the emissions.

GOAL 2.3 – DEVELOP TECHNOLOGIES TO ENABLE SUSTAINABLE COMMERCIAL PRODUCTION OF BIOFUELS (BIOENERGY - 213)

The ARS Bioenergy program develops technologies to enable sustainable commercial production of biofuels by the agricultural sector in ways that enhance our natural resources without disrupting existing food, feed, and fiber markets. Research will optimize both the production of plant feedstocks and the biorefining of agricultural materials to bioenergy and value-added coproducts. This research will strengthen rural economies, provide increased supplies of renewable transportation fuel, enhance energy security, and improve the U.S. balance of trade.

The growth and long-term viability of bioenergy production in the Nation is impeded by a number of technical and commercial barriers. ARS leverages its unique strengths and capabilities to pursue technical barriers that can be overcome by ARS resources.

In addition to tackling specific technical barriers and leveraging ARS core competencies, ARS bioenergy research is consistent with relevant non-technical considerations associated with public policy, general resource constraints, and overall practices/trends within the bioenergy industry.

Performance Measure

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

Indicator 1:

During 2013, ARS will enable technologies that can reduce business risks, increase the value of co-products, and/or expand the number of revenue streams for existing biorefineries.

FY 2013 Accomplishments*:*

Lactic acid bacteria frequently contaminate commercial fuel ethanol fermentations, reducing yields and decreasing biorefining profitability. Current practice to control these bacterial contaminations involves antibiotics, but there is concern about the fate of these antibiotics in waste water and in ethanol co-products used for livestock feed. ARS researchers discovered antibacterial enzymes called phage endolysins that inhibit lactobacilli; and they expressed the genes for endolysins in ethanol-producing yeast. ARS has applied for a patent for this technology.

> ***Impact*:** With this ARS-developed technology, ethanol biorefineries can prevent bacterial contaminations without using antibiotics.

ARS scientists developed a low-waste bioabatement process to remove byproduct compounds generated during the pretreatment of biomass but which inhibit subsequent cellulose hydrolysis.

> ***Impact*:** The ARS-developed bioabatement technology results in a 20-50% increase in the yield of fermentable sugars from cellulosic biomass and will help to enable the nascent biomass-biorefining industry.

Using genomic techniques, ARS scientists discovered a new feruloyl esterase enzyme that eliminates the chemical crosslinks between lignin and cellulose, expressed the enzyme in *E. coli* (a bacteria used

industrially to produce enzymes), and confirmed the enzyme's effectiveness when applied to rice bran, wheat bran, corn fiber, switchgrass, and corn bran (in order of decreasing activity). A patent application was filed, and an industrial partner is considering using the technology to produce livestock feed.

***Impact*:** Breaking the chemical crosslinks between the lignin and fiberous carbohydrates in biomass will greatly increase the value of lignocellulosic biomass for use either as a biorefinering feedstock or in ruminant livestock feed.

Indicator 2:

During 2013, ARS will enable technologies for the production of new biofuels which are compatible with the Nation's existing fuel distribution infrastructure.

FY 2013 Accomplishments:

ARS researchers developed and are patenting a relatively simple non-catalytic process utilizing tail gas from a pyrolysis reactor to reduce the oxygen content of product bio-oil from 35% to 12%. The new process doubles the yield of distillate product from pyrolysis and yields a more narrow range of products (5-10 compounds) vs. traditional pyrolysis (hundreds of compounds).

***Impact*:** By providing an economical means of reducing the oxygen content of bio-oil, this ARS-developed technology helps to enable the commercial deployment of pyrolysis-based biorefineries that convert biomass into a petroleum-like material that can be refined into drop-in substitutes for gasoline and diesel fuels.

Performance Targets

2.3.A Enable New Varieties and Hybrids of Bioenergy Feedstocks with Optimal Traits.

Baseline 2012	Target 2017
ARS will characterize 2 important feedstock traits, make progress on one enhanced germplasm pool, and establish one significant public-private partnership for advancing feedstock variety improvement.	By 2017, ARS will characterize 10 important feedstock traits, create three enhanced germplasm pools, and establish five significant public-private partnerships for advancing feedstock variety improvement.

2.3.B Enable New Optimal Practices and Systems that Maximize the Sustainable Yield of High-Quality Bioenergy Feedstocks.

Baseline 2012	Target 2017
ARS will incorporate at least one new technology that enables production of biomass and will contribute to the introduction of a new region-based system.	By 2017, ARS will incorporate six new technologies and introduce three new region-based systems that enable the production of biomass feedstocks to help achieve U.S. goals for meeting legislated mandates for blending biofuels. We will provide 10 science-based practices suitable for developing NRCS conservation plans.

2.3.C Enable New, Commercially Preferred Biorefining Technologies.

Baseline 2012	Target 2017
ARS will commercialize one biorefining and /or co-products technology which was enabled by ARS research.	By 2017, industry will commercialize five biorefining and/or co-products technologies which were enabled by ARS research.

Measure 1.2.3 Summary of the Major Technologies Developed, Transferred, and Used in FY 2013:

During FY 2013, ARS reported on 4 new technologies adopted for uses that provide (enter description here)

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Non-antibiotic method for controlling contamination in biochemical-based biorefineries	ARS filed for a patent	Any biochemical-based biorefiner, including bioethanol producers	Reduce risks and increase profitability of biorefining
Bioabatement process to remove compounds that inhibit cellulose depolymerization	Technology to be published in the open literature	Any cellulosic biorefinery producing an intermediate sugar solution	Significantly increase the profitability of biochemical-based biorefining
Enzyme that cleaves the chemical crosslinks	ARS filed for a patent	Cellulosic biorefineries, and producers of	Greatly increase the value of cellulosic

between lignin and cellulose		ruminant livestock feed	biomass for use either as a biorefinering feedstock or in ruminant livestock feed
Pyrolysis process that reduces the oxygen content of bio-oil	ARS filed for a patent	Pyrolysis-based biorefiners	Greatly increases the utility bio-oil in the production of substitutes for petroleum-based fuels

Measure 1.2.3 : Develop technologies to enable sustainable commercial production of bioenergy feedstocks and other biofuels.

During FY 2014, ARS will

enable technologies that can reduce business risks, increase the value of co-products, and/or expand the number of revenue streams for existing biorefineries.

enable technologies for the production of new biofuels which are compatible with the Nation's existing fuel distribution infrastructure.

During FY 2015, ARS will

enable technologies that can reduce business risks, increase the value of co-products, and/or expand the number of revenue streams for existing biorefineries.

enable technologies for the production of new biofuels which are compatible with the Nation's existing fuel distribution infrastructure.

During FY 2016, ARS will

enable technologies that can reduce business risks, increase the value of co-products, and/or expand the number of revenue streams for existing biorefineries.

enable technologies for the production of new biofuels which are compatible with the Nation's existing fuel distribution infrastructure.

GOAL 2.4 – EFFECTIVELY AND SAFELY MANAGE AND USE MANURE AND OTHER AGRICULTURAL AND INDUSTRIAL BYPRODUCTS IN WAYS THAT MAXIMIZE THEIR POTENTIAL BENEFITS WHILE PROTECTING THE ENVIRONMENT AND HUMAN AND ANIMAL HEALTH. (AGRICULTURAL AND INDUSTRIAL BYPRODUCTS - 214)

Improvements are needed in animal feeding and management regimens in order to increase the proportion of dietary nutrients retained in the animal or animal products while decreasing the quantity of dietary nutrients excreted and lost to the environment. Basic research is needed to evaluate the fate and transport of manure nutrients in the major soil-crop systems common to animal agriculture. This is the foundation for developing Best Management Practices (BMP). Application methods are needed that can improve nutrient use efficiency and incorporate manure to conserve N while maintaining adequate crop residue to protect the soil from erosion and runoff. These practices, and their associated nutrient management plans, must be based on sound understanding of the fate and transport of specific nutrients for major soils, hydrologic conditions, and cropping systems. Information is needed on pathogen inactivation and die-off as well as their potential for regrowth as functions of environmental conditions (e.g., temperature, moisture, etc.) during all stages of waste management. Technologically sound methods are needed for utilizing byproducts that will be characterized as beneficial and can result in products that are commercially sustainable. This includes blending, composting, and amending byproducts as well as developing land application and management techniques that will improve soil, water, and air quality in addition to improved plant growth. In addition, improved formulations of agriculture byproducts feed stock for use in industrial as well as agricultural applications are needed.

Performance Measure

2.2.4 <u>Effectively and safely manage and use manure and other agricultural and industrial byproducts in ways that maximize their potential benefits while protecting the environment and human and animal health.</u>

<u>Indicator 1:</u>

During 2013, ARS will increase utilization of manure nutrients and resources

FY 2013 Accomplishments*:*

<u>New model for cattle barnyards and feedlots helps reduce phosphorus abatement costs.</u> Pollution of rivers, lakes, and bays by phosphorus from both urban and agricultural sources is an issue throughout the country. Government agencies are developing 'water quality trading' programs as a cost effective way to reduce phosphorus pollution. In these programs, urban facilities save money by paying local farmers to reduce pollution instead of paying for expensive new technologies, but they have to quantify how much less phosphorus is lost from farms. An ARS scientist in Madison, WI, developed and tested a user-friendly computer model that quantifies annual runoff, sediment loss, and phosphorus loss from barnyards and feedlots on cattle farms.

> ***Impact*:** The model can be used throughout the country, and is already being adapted by the Wisconsin Department of Natural Resources for its water quality trading program in areas with many dairy cattle barnyards, and the Madison Metropolitan Sewerage District estimates the trading program can save them as much as $65 million in its efforts to reduce phosphorus pollution. NP214, C1, PS1c, and PM2.2.4, Project No. 3655-12630-003-00D.

<u>New technology automatically monitors feedlot runoff pond pollution.</u> Holding ponds are used to store

runoff and prevent pollution from animal feedlots, but leakage from ponds can contaminate underlying soil and groundwater. Working with the Nebraska Cattlemen's Association, Nebraska Department of Environmental Quality and AgraTek LLC, ARS scientists at Clay Center, NE, developed a technology to monitor pollution in leachate below feedlot holding ponds.

> ***Impact***: The technology uses resistivity arrays that detect small changes in sub-surface soil and water quality as impacted by pond leakage. A controller was developed to automate the monitoring, communicate information through a cell phone modem to a central data base, and alert personnel of potential environmental risks. Scientist also developed geophysical tools that assess sub-surface soil and water quality and can be integrated with the automated system. These tools provide better information to understand subsurface contamination, assess site historic contamination, and delineate contaminant movement. NP214, C1, PS1c, and PM2.2.4, Project No. 5438-41630-001-00D.

Poultry litter applied in subsurface bands provides more soil fertility. Unlike inorganic nitrogen fertilizers, poultry litter and other manures provide crop nutrients in soil beyond the year of application. Management practices are needed to maximize manure nutrient availability. ARS scientists in Mississippi State, MS found that how poultry litter is applied affects how long nutrients are available after application.

> ***Impact***: Cotton planted in soil that received poultry litter in subsurface bands two years prior produced more lint (yield) than cotton planted in soil that received the same amount of litter by surface broadcast. Scientists also developed a new method for taking soil samples that measures soil fertility more accurately than traditional sampling when litter is applied in subsurface bands. Combined, subsurface banding and accurate fertility measures can increase profit and reduce fertilizer costs for cotton and other row crops in the southern and southeastern U.S. NP214, C1, PS1c, and PM2.2.4, Project No. 6406-12630-006-00D.

New methods improve phosphorus indexes. The phosphorus index (PI) is a simple tool used by most states to evaluate the risk of phosphorus loss from agricultural fields, which can be a major source of pollution for local water bodies. While the PI is commonly used, most state PIs have not been rigorously evaluated against diverse and accurately measured P loss data to determine how well the PI predicts P loss risk across varying environmental conditions. ARS scientists from Bowling Green, KY, developed a method to evaluate a PI by using output from a more complex P loss model.

> ***Impact***: The scientists identified several weaknesses in how many current PIs are calculated and developed methods to fix those weaknesses. These methods provide an approach states can use to meet the requirements of NRCS 590 nutrient management standards for PI evaluation, and have already been adopted in Kentucky, Maryland, Oregon, and Washington. NP214, C1, PS1c, and PM2.2.4, Project No. 6445-12630-004-00D.

Indicator 2:

During 2013, ARS will reduce manure pathogens and Pharmaceutically Active Compounds (PACs)

FY 2013 Accomplishments*:*

Chlorophyll derivatives alter the resistance of pure bacterial cultures to antibiotics. Bacteria commonly present in swine feces and stored manure may have antibiotic resistance traits that can be transferred to other pathogens on these farms. ARS scientists in Peoria, IL, investigated if providing derivatives of the plant pigment chlorophyll to the gut of swine and stored manure can be a natural method for reducing some types of antibiotic resistance. Two metabolites of chlorophyll reduced the resistance of certain

bacteria to antibiotics in pure culture.

***Impact*:** Scientists will use these results in future research to naturally reduce bacterial antibiotic resistance on swine farms, which will benefit swine producers, environmental agencies, health officials, and residents that live near swine facilities. NP214, C2, PS2c, and PM2.2.4, Project No. 3620-63000-005-00D.

Antibiotic carbadox stimulates antibiotic resistance gene transfer from Salmonella. As a leading cause of foodborne disease, Salmonella can colonize the intestinal tract of food-producing animals (cattle, swine, poultry). Some Salmonella isolates contain bacterial viruses (prophage) in their DNA that can transfer genetic material from the host Salmonella to another Salmonella recipient. Carbadox is often given to young pigs in the U.S. to stimulate growth and protect against disease-causing bacteria such as Salmonella. ARS Researchers in Ames, IA, demonstrated that multidrug-resistant Salmonella exposed to the antibiotic carbadox can produce viruses that transfer DNA, including antibiotic resistance genes, to other Salmonella.

***Impact*:** Results raise concerns about the potential consequences of carbadox use in swine and antibiotic resistance. This research provides swine producers with information that may impact management choices and scientists with information for developing ways to decrease antibiotic resistance in bacteria. NP214, C2, PS2c, and PM2.2.4, Project No. 3625-31000-004-00D.

Antibiotic resistance can spread rapidly on a poultry farm. Antibiotic resistant bacteria in broiler and other animal feeding operations are influenced by antibiotic use, transfer from outside the operation, and vertical carriage through hatching and birthing procedures. Once present in a new poultry operation, antibiotic resistance can spread rapidly within a house and between houses and affect thousands of birds. ARS Scientists in Starkville, MS, traced the colonization of antibiotic resistant Salmonella in two new broiler houses. Salmonella established and colonized within the first 3 weeks of operation. Salmonella genotypes within the new houses were relatively few and uniform at the start of operation, but expanded, becoming more diverse with successive flocks, and stabilized by the third flock. Concurrently, antibiotic resistance continued to increase to include greater numbers of antibiotics, as the Salmonella population began to stabilize.

***Impact*:** This research demonstrates that a pathogen, such as Salmonella, can quickly colonize a new poultry operation from older houses on a farm and through the hatching process. Likewise, the presence of antibiotic resistance, despite no perceived use of antibiotics, can increase rapidly as a dominant population of Salmonella establishes itself. Research will help scientist and producers develop management practices to prevent antibiotic resistance spread. NP214, C2, PS2a, and PM2.2.4, Project No. 6406-12630-006-00D.

Pathogens and antibiotic resistance genes measured in land applied manure. Animal manure contains pathogenic microorganisms that can cause illness and death in humans, and land applied manure can be a source of pathogens in the environment. ARS scientists in Bowling Green, KY, applied poultry litter and dairy manure to forage grasses under conventional and no till management to investigate survival of pathogens over time. Even when pathogens like Campylobacter and Salmonella were initially present in manures at high concentrations, they were rarely detectable following land application. Indicator organisms like enterococci were measurable but the common indicator Escherichia coli (E. coli) was not. Antibiotic resistance (AR) genes were very high in poultry litter before application and remained high following land application.

***Impact*:** Detection of AR genes, pathogens and indicators following manure application was irregular, suggesting that factors such as moisture and temperature influence survival. This information will

inform risk assessment models as well as producers and the public about the risks of AR genes and potential pathogens in livestock manures that are land applied to forage grasses. NP214, C2, PS2c, and PM2.2.4, Project No. 6445-12630-004-00D.

Indicator 3:

During 2013, ARS will reduce atmospheric emissions from animal production facilities

FY 2013 Accomplishments*:*

New technologies capture ammonia from broiler houses. Over half of the nitrogen excreted by broiler chickens is lost to the atmosphere as ammonia before manure is removed from the barn. This is a huge loss of a potential fertilizer nutrient resource, and further pollutes air and water. Scientists at Fayetteville, AR, developed the ARS Air Scrubber to reduce the ammonia, bacteria, dust, and odors from animal housing air exhaust, and found that potassium bisulfate was by far the best acid that could be used in the Scrubber. In related research, ARS scientists in Florence, SC, developed gas-permeable membranes as components of a new process to capture ammonia volatilized from litter.

***Impact*:** These new technologies can capture 70 to 97% of the ammonium volatilized from poultry litter. The benefits of these technologies include cleaner air inside poultry houses, better bird growth and performance, reduced ventilation costs, and a concentrated liquid ammonium salt that can be used as a fertilizer for crop production. These technologies also significantly decrease the ammonia volatilization into the atmosphere, reducing pollution and decreasing the environmental impact of the poultry industry. NP214, C1, PS1b, and PM2.2.4, Project Nos. 6657-13630-005-00D and 6226-63000-003-00D.

A new system estimates enteric methane production from feedlot cattle. Ruminant cattle can be an important source of methane emissions to the atmosphere and climate change. Current models to estimate cattle enteric methane emissions were developed using animals fed high-forage diets, and can greatly overestimate emissions from cattle fed high-concentrate finishing diets. An ARS scientist in Bushland, TX, developed an improved model to estimate enteric methane production from feedlot cattle based on their feed intake, dietary fat levels, grain processing method, and dietary grain concentration.

***Impact*:** The new model more accurately estimates methane emission than existing models and allows producers to estimate dietary effects on emissions. This model has been integrated into the USDA-Office of Chief Economist's tool for producers and regulators to use in estimating greenhouse gas emissions from agriculture, and provides the feedlot industry with an improved tool to help decrease the environmental footprint of the beef industry. NP214, C3, PS3a, and PM2.2.4, Project No. 6209-31630-003-00D.

Microbial-based inoculants reduce nitrous oxide emissions from nitrogen fertilizer. Excessive applications of nitrogen fertilizers can increases nitrous oxide (N_2O) emissions from agricultural soils and contribute to climate change. Microbial-based inoculants, known to promote root growth and nutrient uptake, may be able to reduce emission of N_2O in the presence of nitrogen fertilizers. ARS scientists in Auburn, AL, conducted experiments with three microbial-based treatments: SoilBuilder (SB), a metabolite extract of SoilBuilder (SBF), and a mixture of four strains of plant growth-promoting Bacillus spp; and two N fertilizers: urea, and urea ammonium nitrate (UAN). After 29 days of incubation, cumulative emissions of N_2O from UAN were reduced 80% by SoilBuilder and 44% by SoilBuilder metabolite. Bacillus significantly reduced N_2O at one and two days of incubation with UAN. N_2O emissions were not reduced at all from urea.

***Impact*:** Results provide producers with scientifically-based information on the use of inoculants to improve fertilizer N use and reduce N_2O emissions. Improving N use reduces fertilizer costs for producers and energy use to generate N fertilizers. Less N_2O emissions will help mitigate atmospheric greenhouse gas accumulation. NP214, C3, PS3c, and PM2.2.4, Project No. 6420-12000-010-00D.

Ammonia losses from poultry houses greater near watering lines. Ammonia loss to atmosphere from poultry houses represents a loss of a fertilizer nutrient resource, and pollutes air and water. ARS scientists in Starkville, MS, discovered the critical litter moisture content where ammonia generation is maximized and found that ammonia loss in broiler houses can be reduced by 38 to 77% if litter near watering lines is managed similar to litter near feeders and sidewalls.

***Impact*:** Management practices were developed and distributed in popular articles to show producers how to measure litter moisture and barn ammonia concentration in order to know if improved litter management is needed. Easily adaptable practices to reduce ammonia loss included appropriate attention to watering line management, and treatment of litter in zones of greatest moisture while birds are in the house. Farmers can immediately implement this information to produce healthier birds, reduce environmental concerns due to ammonia release, and improve profits. NP214, C3, PS3c, and PM2.2.4, Project No. 6406-12630-006-00D.

Indicator 4:

During 2013, ARS will develop beneficial uses of agricultural, industrial, and municipal byproducts

FY 2013 Accomplishments*:*

Industrial and agricultural byproducts mixture is a fertilizer for peanut production. Two available by-products in the U.S. are flue gas desulfurization (FGD) gypsum from power plants and ash generated from burning poultry litter to generate electricity. Developing uses for these byproducts prevents their disposal in landfills; and because they are rich in phosphorus, calcium, magnesium and potassium, they are potential fertilizers for peanut production, which requires large amounts of soluble calcium and phosphorus. ARS scientists in Beltsville, MD, demonstrated that broiler litter ash and FGD gypsum were as effective for peanut production as super phosphate fertilizer and FGD-gypsum. Peanut kernel arsenic, cadmium, copper, manganese and zinc concentrations were within the recommended levels for human and animal consumption.

***Impact*:** Use of these two byproducts for peanut production could save farmers over $1 million per year in commercial phosphorus fertilizer and mined gypsum, and electrical power companies over $8 million per year in landfill cost. Use of these byproducts as soil amendments also helps protect the environment by keeping them from potentially leaching out of landfills. NP214, C4, PS4a, and PM2.2.4, Project No. 1245-12000-040-00D.

Revegetation of barren asbestos emitting superfund site using compost and gypsum. Wind and water erosion at a 300 acre abandoned asbestos-mining Superfund site in Vermont represents a continuing risk to nearby populations. Without a comprehensive vegetative cover, the site will continue to erode asbestos and be a health threat to human populations in the area. However, the current conditions at this site severely limit plant growth, and many areas are completely barren of vegetation due to infertility and soil contamination issues. ARS scientists in Beltsville, MD conducted a 3-year study in which they evaluated applications of a manure compost plus a gypsum byproduct and fertilizers to obtain an effective vegetative cover of the soil. Results showed the surface-applied amendments produced extensive vegetative cover of clover and grasses while control plots receiving simple fertilization remained barren.

***Impact*:** Protocols are being developed to reclaim this site as well as other similar sites around the U.S. The U.S. Environmental Protection Agency (EPA) has estimated that revegetation by adding two feet of topsoil over existing soil on such sites would cost $220 million. However revitalizing the existing contaminated soil using these soil amendments would cost only $25 million, resulting in great savings to the public. NP214, C4, PS4a, and PM2.2.4, Project no. 1245-12000-040-00D.

Compost and biochar prevent accumulation of DDT and DDE in earthworms. Soils in old fruit orchards may contain excessive residues of DDT and DDE from historic pesticide sprays. This increases the risk of DDT and DDE accumulation in earthworms and earthworm-consuming birds and mammals. ARS scientists in Beltsville, MD, conducted growth chamber and field experiments and found that amending soils with different manure composts and biochar significantly reduced the availability of DDT and DDE residues and their bioaccumulation in earthworms during a 45-day exposure period. A full field test of this approach was initiated using fresh and aged manure composts. Scientists also found that complementary soil tests of DDT and DDE residues could predict earthworm bioaccumulation.

Impact: Compost and biochar amendments can sufficiently reduce earthworm bioaccumulation to achieve substantial cost savings in remediation of DDT and DDE contaminated soils. NP214, C4, PS4a, and PM2.2.4, Project No. 1245-12000-040-00D.

Industrial by-products reduce environmental impact of poultry manure. Ammonia volatilization and nutrient loss are major forms of environmental pollution associated with land application of poultry manures as fertilizer. Both of these problems might be reduced by adding a byproduct that can reduce nutrient mobility. ARS scientists in Starkville, MS, found that amending manure with Flue Gas Desulfurization (FGD) gypsum reduced the leaching potential of water soluble nitrogen by 83%, carbon by 71%, and phosphorus by 53%. When gypsum-amended manure was applied to soils, phosphorus, copper, and zinc loss in subsurface leachate was reduced 51%, with the same or increased crop productivity. Scientists also found that adding zeolite to poultry manure reduced ammonia emissions by 30%. In related research, ARS scientists in Auburn AL, found that applying FGD gypsum to soils amended with poultry manure decreased phosphorus in runoff by 51%.

Impact: Results provide scientifically-based information that industrial byproducts can significantly reduce nutrient loss from soils amended with poultry manure. This use of byproducts will reduce costs and environmental impacts of their disposal in landfills, and will help protect water quality from agricultural nutrient inputs. NP214, C4, PS4a, and PM2.2.4, Project Nos. 6406-12630-006-00D and 6420-12000-010-00D.

Performance Targets

2.4.A Increase Utilization of Manure Nutrients and Resources.

Baseline 2012	Target 2017
Data of the effectiveness of current practices.	Manure treatment/handling systems and management strategies for maximizing effective nutrient utilization and environmental stewardship objectives.

2.4.B Reduce Manure Pathogens and Pharmaceutically Active Compounds (PACs).

Baseline 2012	Target 2017
Data on environmental fate and transport of pathogens and PACs.	Animal production strategies for reducing excretion of pathogens and PACS. Manure treatment/utilization systems minimizing introduction of pathogens and PACs into the environment.

2.4.C Reduce Atmospheric Emissions from Animal Production Facilities.

Baseline 2012	Target 2017
Initial datasets of emissions from animal production operations and facilities.	Manure treatment/handling systems and animal production/management strategies for minimizing emissions.

2.4.D Develop Beneficial Uses of Agricultural, Industrial, and Municipal Byproducts.

Baseline 2012	Target 2017
Reuse of some materials and disposal of the majority	Ten new economical and environmentally beneficial products created from materials previously considered to be wastes. Examples include new fuels, structural materials, and soil amendments.

Measure 2.2.4 Summary of the Major Technologies Developed, Transferred, and Used in FY 2013:

During FY 2013, ARS reported on 6 new technologies adopted for uses that provide (enter description here)

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
User-friendly spreadsheet model that estimates annual	The model was made available directly to the Wisconsin Department	Wisconsin Department of Natural Resources	The model can be used throughout the country, and is being

sediment bound and dissolved P loss in surface runoff from cattle barnyards and feedlots.	of Natural Resources, who plan to use it as part of their new water quality trading and adaptive management programs.		adapted by the Wisconsin Department of Natural Resources for its water quality trading program in areas with many dairy cattle barnyards. The Madison Metropolitan Sewerage District estimates the trading program can save them as much as $65 million in its efforts to reduce phosphorus pollution.
High performance nitrifying sludge for high ammonium concentration and low temperature wastewater treatment.	U.S. Patent 8,445,253 B2 issued May 21, 2013.	Livestock producers, industrialists, extension practitioners, other scientists.	This technology effectively treats wastewater contaminated with animal fecal waste and/or ammonia, which is particularly difficult in winter months. The high performance nitrifying sludge contains bacteria that are highly effective for wastewater nitrification at very low temperatures (5 degrees Celsius).
Use of cover crops to reduce residual nitrate resulting from the summer drought of 2012.	Webinars and published information bulletins	Public and private Nutrient Managers, NRCS agents, Extension Service agents, Fertilizer dealers, farmers and farm managers, State Dept. of Agric. program managers, and applied research scientists in ARS and Land Grant Univ.	Update and educate customers on the value of using cover crops to capture residual nitrogen following the 2012 drought, thus reducing nitrate losses to ground- and surface-waters of the country.
Evaluation of inexpensive anaerobic digesters for small dairies.	Two anaerobic digestion workshops conducted at the ARS Beltsville dairy.	Dairy producers, agricultural extension agents, university researchers, and representatives of the solid-waste industry.	Help develop affordable digesters for the majority of U.S. dairies to treat manure and generate on-farm energy.
The use of quantitative microbial risk assessment and its application to agricultural and environmental scenarios	Scientific information transferred via webinar and online source material.	Extension personnel, farmers, educators, and students visit	Provides customers with real-world interpretations of pathogens resulting from common agricultural operations.

Field isolates of Enterococcus bacteria,	Material Transfer Agreement, provided directly to the customer	University of Nebraska-Lincoln	Strains used as part of a research project funded by the National Pork Board examining antibiotic resistance genes in agricultural settings.
Air Scrubber that uses potassium bisulfate to capture ammonia from poultry and swine barns, resulting in an ammonium potassium sulfate fertilizer.	Patent application filed 05/15/2013.	Poultry and swine producers.	Adoption of this technology could result in the capture of a significant fraction of the nitrogen being lost to the atmosphere as ammonia, which would improve the agricultural sustainability, while protecting air and water resources.

Measure 2.2.4: Effectively and safely manage and use manure and other agricultural and industrial byproducts in ways that maximize their potential benefits while protecting the environment and human and animal health.

During FY 2014, ARS will

increase utilization of manure nutrients and resources

reduce manure pathogens and Pharmaceutically Active Compounds (PACs)

reduce atmospheric emissions from animal production facilities

develop beneficial uses of agricultural, industrial, and municipal byproducts

During FY 2015, ARS will

increase utilization of manure nutrients and resources

reduce manure pathogens and Pharmaceutically Active Compounds (PACs)

reduce atmospheric emissions from animal production facilities

develop beneficial uses of agricultural, industrial, and municipal byproducts

During FY 2016, ARS will

increase utilization of manure nutrients and resources

reduce manure pathogens and Pharmaceutically Active Compounds (PACs)

reduce atmospheric emissions from animal production facilities

develop beneficial uses of agricultural, industrial, and municipal byproducts

GOAL 2.5 - 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. (RANGELAND, PASTURE & FORAGES – 215)

This program develops and integrates improved management practices, germplasm, and land-use strategies to optimize productivity, economic viability and environmental enhancement in managing vegetation, livestock and natural resources on private and public grass and forage lands. Research activities include: enhancing conservation and restoration of ecosystems and agro ecosystems through improvements based on the application of ecological principles; improving management of fire, invasive weeds, grazing, climate change and other agents of change; developing grazing-based livestock systems that reduce risk and increase profitability in existing and emerging markets; developing improved grass and forage legume germplasm for livestock, conservation, turf and bioenergy and bioproduct systems; improving the sustainability of turf management; and improving decision-support systems including improving inventory, monitoring, and assessment tools.

Performance Measure

2.2.5 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.

Indicator 1:

During 2013, ARS will provide improved germplasm and cultivars that can be released for pasture, harvested forages, turf, biofuels, rangeland restoration, and conservation.

FY 2013 Accomplishments*:*

Improved smooth bromegrass strain increases beef cattle gains on pastures. Improved cool-season grasses are needed in the Midwest and Northern Great Plains to improve stagnant pasture beef cattle gains per acre and beef enterprise profitability. ARS scientists in Lincoln, NE, in collaboration with University of Nebraska used a 3-year grazing trial with beef yearlings to evaluate an improved smooth bromegrass strain developed for increased forage yield and digestibility.

Impact: Cattle grazing the improved bromegrass had 3-year average daily gains of 3.1 lbs per head per day during spring grazing. The 3-year average body weight gain of 349 lbs per acre during the spring grazing season was 12% greater than that for the widely used smooth bromegrass parent cultivar, demonstrating that the genetic improvements in smooth bromegrass can have significant economic value when used in well managed pastures. The smooth bromegrass experimental strain is in seed increase for potential release as a new cultivar and will be available for use to meet the demand for improved cool-season pastures in the Midwest and Northern Plains. NP 215, C2, PSC2.f, and PM2.2.5, Project No: 5440-21000-030-00D.

Improved bioenergy type switchgrass cultivar with high biomass yield tested and increased for use in the

northern USA. Switchgrass cultivars for the northern half of the U.S. have been limited to upland ecotype cultivars because traditional lowland cultivars have poor winter survival in the region. Lowland switchgrass cultivars, however, have the potential to produce greater biomass yields, if they had better winter survival rates. A new lowland type switchgrass cultivar 'Liberty' was released in 2013. Liberty was developed by ARS researchers at Lincoln, Nebraska by crossing northern upland and southern lowland plants followed by three generations of breeding selection for improved winter survival, high biomass yield, and low stem lignin concentration. Over a three year period in trials in Nebraska, Wisconsin, and Illinois, Liberty had excellent winter survival, and in eastern Nebraska and northern Illinois had biomass yields that were 2 tons per acre greater than the best available upland cultivars. The experimental strain is in the ARS cultivar release process and has been planted in a foundation seed increase field. It will be the first bioenergy type cultivar for the Midwest and the northern Great Plains and will likely be adapted to the Northeast states as well.

> ***Impact***: When processed in a biorefinery, the increased biomass yield will result in an additional 160 gallons of ethanol per acre which could fuel an economy car for an additional 5000 miles. (NP 215, C2, PSF.2.d, and PM4.3.2, Project No. 5440-21000-030-00D)

Improved genetic selection technology for complex grass genomes. Genetic selection programs to improvement economically valuable traits of forage grasses with complex genomes (polyploids) has been hindered by a lack of technologies to effectively target specific genetic markers and associated gametes. In response to this critical limitation researchers at El-Reno, OK have developed a "gamete-selection" approach for tall fescue and rye grass that now provides forage breeders with breeding technologies similar to those so effectively used to increase the yield and adaptability of corn and other commodity crops. This technology has the capacity to revolutionize grass breeding by increasing the rate of genetic progress several-fold over conventional breeding strategies by identifying truly elite germplasm for use in subsequent generations; through the development of dihaploid selection lines. This technology may also be used to evaluate the specific interaction of tall fescue with both toxic and non-toxic fungal endophytes. It has been well established that there is a very precise interaction and careful balance between the fungal endophyte and the nuclear genome of the individual plant. However, that relationship is not well understood. If the interaction is not good, the fungal endophyte stunts the growth and development of the plant. If the endophyte-nuclear genome interaction is complementary, then the plant thrives.

> ***Impact*:** This technology would enable much more precise evaluation of the relationship between specific genotypes and fungal endophytes to promote those that are highly resilient and productive, but not toxic to grazing animals. Additionally, the gamete-selection approach is inexpensive and low input. It is now being disseminated to industry and is providing excellent achievement in identifying and generating superior tall fescue materials with industry collaborators. NP 215, C2, PSF.2.d, and PM4.3.2, Project No. 6218-21410-003-00D.

Improved germination and stand establishment in forage kochia benefits the livestock industry. Forage kochia is an introduced high quality and nutritious, semi-shrub that has been seeded on western U.S. rangelands for fall and winter forage. However, its widespread acceptance has been reduced by its poor seedling germination and subsequently reduced stands. ARS scientists in Logan, UT, showed that two subspecies of forage kochia B. prostrate (grisea and virescens), along with age of seed, and planting date all affected forage kochia seed germination in the field. At 45 days after planting, when germination was at or near maximum, current year's harvested seed of subspecies grisea had field germination of 85%. This was higher than subspecies virescens, and significantly higher than year-old seed of both subspecies, which germinated at less than 15% during the same planting dates of January through April. Thus, planting in January or February using current year's harvested seed of subspecies grisea provided the

best forage kochia germination, and increased the likelihood of a successful stand.

***Impact*:** These results were disseminated to livestock producers through several regional meetings in Montana, Wyoming, and Utah during the winter of 2013. The use of forage kochia during the fall and winter grazing periods reduces overall animal feeding costs by up to 25% on some ranches through reductions in stored forage and extension of the grazing season. NP 215, C2, PSF.2.d, and PM4.3.2, Project No. 5428-21000-014-00D.

Indicator 2:

During 2013, ARS will *provide forage, pasture, and rangeland management technologies and strategies that reduce inputs while improving livestock performance and sustaining the environment.*

FY 2013 Accomplishments*:*

Rapid DNA-based paternity testing assay for alfalfa will speed rate of alfalfa improvement. Alfalfa is the fourth most widely grown crop following corn, soybeans, and wheat in the United States with over 20 million acres harvested in 2012. In alfalfa variety development programs, the pollen donors of plants being evaluated are mostly unknown. This lack of paternal identity leads to slower genetic improvement from alfalfa breeding programs. ARS researchers in Madison, WI collaborated with an industry stakeholder to develop a low-cost, rapid DNA-based paternity testing laboratory assay for alfalfa, including necessary computational software.

Impact: This new technology will double the amount of genetic information available to alfalfa breeders allowing them to target and select specific genetic lines and significantly increase the yield and adaptability of existing and developing alfalfa varieties. NP 215, C2, PSF.2.d, and PM4.3.2, Project No. 3655-21000-056-00D.

Effect of weather on growth of beef cattle in the Northern Great Plains. Weather and climate are known to affect forage quantity and quality and animal stress, yet predictions of climate effects on livestock production are hindered by limited analyses comparing long-term climate and cattle production data. ARS researchers at Miles City, MT, reported relationships between weather and calf weaning weight from 76-year records. As expected, calves grew faster with long, cool growing seasons. However, precipitation during late winter (Feb 6-22 – late gestation) was associated with significantly reduced calf weaning weights possibly as a result of maternal negative energy balance or some yet unexplained factors (imprinting, etc), suggesting the additional feed or shelter for late gestation cows in late winter might be beneficial to cattlemen even with normal calving rates and calf birth weights. Additional analyses indicate that, as expected, high temperatures during the first two weeks of summer were negatively related to calf growth. However, long cool grazing seasons – which typically produced the best calf weaning weights – tended to start earlier in the year. These finding are counter to global warming predictions and fears about observed earlier springs and cattle performance. The conventional wisdom is that an earlier spring means a hotter growing season and earlier plant maturity (reduced forage quality). ARS data suggest that earlier springs provided more cool growing-degree days before hot summer temperatures arrived, potentially refuting the supposition that earlier green-up leads to earlier plant maturity and lower forage quality.

Impact: This work facilitates forecasting of climate effects on beef production and has led to collaborative research examining weather relationships with cow and steer performance with ARS researchers in Cheyenne, WY, and Mandan, ND. NP 215, C2, PSC1.a, and PM2.2.5, Project No: 5434-

21630-003-00D.

Developing improved plant materials for the Western U.S. rangelands. The invasion of weedy annual grasses following disturbance (grazing, wildfires, or human) is increasing on western rangelands. More annual grasses contribute to greater wildfire frequency that destroys rangeland diversity, increases soil erosion, decreases air quality, and degrades wildlife and livestock habitat and forage, costing billions of dollars to the U.S. agricultural economy. Currently there is a lack of improved perennial plant materials available for commercial use that will successfully establish, persist, and compete against invasive annual grasses. To meet these demands, scientists in Logan, UT, developed and released improved plant materials of Indian ricegrass, Snake River wheatgrass, basin wildrye, bottlebrush squirreltail, western wheatgrass, Siberian wheatgrass, crested wheatgrass, alfalfa, basalt milkvetch, western prairie clover, and forage kochia. These plant materials have consistently demonstrated improved ability to establish, persist, and reduce the invasion of weedy annual grasses on range sites that experience frequent drought, hot temperatures, disturbance, and frequent wildfires.

Impact: These plant materials provide additional options for public and private land managers in their fight to restore western rangelands to a stable productive ecosystem. Seed is now available commercially for most of these plant materials. NP 215, C1, PSC1.c, and PM2.2.5, Project No: 5428-21000-012-00D.

A grazing strategy to reduce impact of lupine induced crooked calf syndrome on western rangelands. ARS scientists in Logan, UT, determined that intermittent grazing of lupine could potentially mitigate or substantially reduce the impact of lupine as a primary cause of crooked calf syndrome. Lupine derived crooked calf syndrome is a result of complete fetal inactivity which results in severe skeletal deformations. In this study pregnant cows were fed lupine in a “ten day on - 5 day off” regiment for 30 days and then compared with cows fed lupine daily for 30 days. Cows fed lupine for 30 days uninterrupted gave birth to severely deformed calves, all of which were humanely euthanized. Cows fed lupine on the intermittent regiment produced calves that were marginally affected (i.e. slight contractures which resolved spontaneously) or normal calves.

Impact: This study confirms that removing cattle from lupine exposure, even for a short period, allows calves to regain normal fetal movement and prevents the most severe birth defects. This method has been implemented by cattle ranchers in Washington State with great success allowing producers to utilize these productive high risk pastures and reduce the impact from lupine. NP 215, C1, PSC1.b, and PM2.2.5, Project No: 5428-31320-005-00D.

Performance Targets

2.5.A Develop Practices and Technologies to Improve Rangeland Productivity and Ecological Services.

Baseline 2012	Target 2017
3 practices and technologies that improve livestock production and the effectiveness of conservation and	Cumulatively, 15rangeland practices and technologies developed and released to

restoration including reducing the risk of wildfires, invasive weeds and climatic uncertainty to improve profitability and enhance ecological services	ARS customers

2.5.B Develop Practices and Technologies to Improve Pasture Productivity and Ecological Services.

Baseline 2012	Target 2017
2 practices and technologies that improve livestock production and the effectiveness of conservation on pasture lands including reducing the risk of climatic uncertainty and enhancing water resources and other ecosystems services	Cumulatively, 10 pasture practices and technologies developed and released to ARS customers

2.5.C Developed Sustainable Harvested Forage Systems for Livestock, Bioenergy and Bioproducts.

Baseline 2012	Target 2017
2 practices and technologies that improve harvested forage production for livestock and bioenergy while reducing the risk of climatic uncertainty and enhancing water resources and other ecosystems services	Cumulatively, 10 pasture practices and technologies developed and released to ARS customers

2.5.D Develop Improved Germplasm and Management Practices for Sustainable Turf Systems.

Baseline 2012	Target 2017
1 improved germplasm that enhances turf management including improving the environment and reducing the risk of climatic uncertainty	Cumulatively, 5 improved germplasm releases or improved management practices developed and released to ARS customers

Measure 2.2.5 Summary of the Major Technologies Developed, Transferred, and Used in FY 2013:

During FY 2013, ARS reported on 8 new technologies adopted for uses that provide (enter description here)

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Develop a surfactant seed coating (SSC) formulation that is effective in treating soil water repellency, increasing soil water availability, and improving seedling establishment in wildland, turfgrass, and agricultural systems.	Advancements have been made in determining appropriate surfactant loading rates for wildland and turfgrass applications. Laboratory and greenhouse results have indicated that SSC can increase soil water infiltration, percolation, and retention within the microsite surrounding the seed, which subsequently leads to improved seedling emergence and plant survival.	The technologies in this CRADA have broad application for customers planting in areas with limited irrigation and/or rainfall.	The potential for improved moisture availability along with improvements in plant establishment will play a pivotal role in restoring areas affected by severe drought and/or wildfire conditions.
The third issue of the International Journal of Poisonous Plant Research is currently in the process of accepting manuscripts.	This is a world class, unique online-only journal published semi-annually by the USDA-ARS. Manuscript submissions relate to the broad field of poisonous plants research, including original research, case reports, field observations in domestic and wild animals, and scientific reviews. (2) Editors-in-chief, (1) Editorial assistant, (4) Editorial Board members, and (5) Editorial Advisory Board members reside within the Poisonous Plant Research Laboratory.	Authors wishing to submit their publications, case reports, and field observations to a peer-reviewed journal specifically targeted towards poisonous plant research. Veterinarians, diagnosticians, stakeholders, producers, extension agents, and consumers also utilize this publication to enhance their knowledge and manage livestock based on published data and recommendations.	A one-stop location for current information regarding poisonous plant research.
Develop a surfactant seed coating (SSC) formulation that is effective in treating soil water repellency,	Advancements have been made in determining appropriate surfactant loading rates for	The technologies in this CRADA have broad application for customers planting in rangeland areas with	The potential for improved moisture availability along with dramatic improvements in plant establishment

increasing soil water availability, and improving seedling establishment in wildland, turfgrass, and agricultural systems.	wildland and turfgrass applications. Laboratory and greenhouse results have indicated that SSC can increase soil water infiltration, percolation, and retention within the microsite surrounding the seed, which subsequently leads to improved seedling emergence and plant survival.	limited irrigation and/or rainfall.	will play a pivotal role in restoring areas affected by severe drought and/or wildfire conditions on western rangelands and similar ecosystems.
The release of seed of a new smooth bromegrass cultivar to Barenbrug Seeds, Albany, OR, for evaluation and determination of its seed production potential.	Seed was transferred to Barenbrug Seeds, Albany, OR., that is more productive, efficient and resilient than conventional varieties.	Livestock producers interested in utilizing an improved smooth bromegrass variety for reclamation, pasture, and grazing.	The eventual impact and outcome following the production, licensing, and marketing of this new forage cultivar through Barenbrug Seeds will be increased beef and milk production in grazing livestock.
Appropriate management practices, unique forage quality characteristics, and cultivar selection, planting dates, and expected yields for livestock grazing fall-grown oat forages.	A series of three "Focus on Forage" cooperative extension factsheets, posted on the University of Wisconsin-Cooperative Extension Website.	Dairy and livestock producers, county & state extension personnel.	To provide emergency forage options for livestock producers versus traditional forages and to provide an option for extending the grazing season 30-60 days to lessen the need and expense of harvested forages.
Molecular resources for diagnostics of plant-parasitic nematodes of regulatory and/or economic concern in alfalfa and other crop species.	Primers, DNA sequences, protocols, nematode specimens and DNA were shared with international researchers in Kashmir, Greece, Egypt, and Argentina and with diagnosticians from Minnesota.	Scientists, regulatory personnel, germplasm companies, extension agents who need to identify plant-parasitic nematodes.	Provides molecular resources necessary for thorough validation of molecular diagnostic assays for plant-parasitic nematodes, thereby enabling diagnosticians to quickly and accurately identify nematode species damaging alfalfa and food/forage crops.
Release of Liberty, a high yielding biomass energy type switchgrass that is adapted to the Midwest USA. It is the first switchgrass cultivar developed for	Release of a an improved switchgrass variety with superior biomass and biofuel yield, adaptability and resiliency for use in the central-upper region of the U.S.	Biofuels Industry stakeholders and farmers/producer needing options to improve switchgrass yield and biofuels capacity in the central-upper Midwest region	This new switchgrass release provides farmers and the biofuel industry with an improved option for producing biofuels in the Midwest as an alternative to corn

use as bioenergy crop in the Midwest.		of the U.S.	based ethanol and other bio-based cropping systems.
Development of Tall Fescue Forage Germplasm for Pastures and Turf	Approximately 200 potential dihaploid tall fescue lines were transferred to Barenburg. First generation hybrids were developed and evaluated in Albany, OR. A more efficient, modified approach for generating dihaploids was implemented. A synthetic population developed from the agreement was requested for licensing by Barenburg seeds, USA.	MTA to Barenburg Seeds-USA, Albany, Oregon, USA.	Generation of new plant materials for the development of new improved tall fescue cultivars that are more efficient, adaptive and productive for livestock and turf industry stakeholders.

Measure 2.2.5: 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.

During FY 2014, ARS will

provide improved germplasm and cultivars can be released for pasture, harvested forages, turf, biofuels, rangeland restoration, and conservation.

provide forage, pasture, and rangeland management technologies and strategies that reduce inputs while improving livestock performance and sustaining the environment.

During FY 2015, ARS will

provide improved germplasm and cultivars can be released for pasture, harvested forages, turf, biofuels, rangeland restoration, and conservation.

provide forage, pasture, and rangeland management technologies and strategies that reduce inputs while improving livestock performance and sustaining the environment.

During FY 2016, ARS will

provide improved germplasm and cultivars can be released for pasture, harvested forages, turf, biofuels, rangeland restoration, and conservation.

provide forage, pasture, and rangeland management technologies and strategies that reduce inputs while improving livestock performance and sustaining the environment.

GOAL 2.6 – DEVELOP INTEGRATED SOLUTIONS TO SOLVE CHALLENGES RELATED TO AGRICULTURAL SYSTEM PRODUCTIVITY, PROFITABILITY, ENERGY EFFICIENCY, AND NATURAL RESOURCE STEWARDSHIP. (AGRICULTURAL COMPETITIVENESS & SUSTAINABILITY – NP 216)

Profitable farms are the basis of vibrant rural economies. Consumers benefit from agricultural production that provides abundant choices of products at relatively low costs. Even though commodity prices are now high, many farms still have difficulty responding to changing market conditions, and the high costs of fuel and other purchased inputs. In addition, there is increasing competition from overseas markets where production costs are comparatively low. At the same time, continued advancement of conservation goals is needed to enhance the natural resource base upon which the nation not only depends for food, feed, fiber, and renewable energy, but also for supplies of fresh water, clean air, and healthy ecosystems. The challenges producers face regarding productivity, profitability, and natural resource stewardship are complex, so the solutions to these challenges will not be simple.

Producers and natural resource managers need holistic solutions to the complex problems they face. Not only do they need to decide what the best production methods, improved varieties, and advanced technologies to use, they want to know how these innovations can be best incorporated into their operations and whether their investment will increase their ability to compete in the market. Though many of the problems producers face are the same across the country, it is accepted that each region and every farm is different, so there are no "one-size-fits-all" solutions.

These challenges are not unique to the United States. The United Nations Food and Agriculture Organization (GAO) addressed similar issues in their Strategic Framework 2010-2019 (ftp://ftp.fao.org/docrep/fao/meeting/017/k5864e01.pdf). Strategic Objective A – Sustainable Intensification of Crop Production – seeks to increase production per unit land area to meet world food needs and "requires the integration and harmonization of all appropriate crop production policies and practices aimed at increasing crop productivity in a sustainable manner, thereby meeting key millennium development goals aimed at reducing hunger and preserving the natural resources and environment for future use."

Interdisciplinary systems research provides an approach to understand how different kinds of farm enterprises function, and how changing or introducing new technology will affect their productivity, profitability, energy efficiency, and natural resource stewardship. Finding the best combinations of practices will help producers achieve their production goals, while enhancing the environmental goods and services derived from agricultural lands. Diverse and dynamic agricultural systems are needed that can adjust to changing environmental and market conditions to increase the long-term financial viability and competitiveness of farms, enhance natural resource quality, contribute to the vibrancy of rural communities, and increase the food, fiber, and energy security for the Nation and the world. This research will contribute to making sustainable intensification of agriculture a reality.

Performance Measure

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

Indicator 1:

During 2013, ARS will develop integrated solutions to solve challenges related to agricultural

system productivity, profitability, energy efficiency, and natural resource stewardship.

FY 2013 Accomplishments*:*

New combine technology increases profits for wheat growers. Some crops are sold under a quality payment system that rewards growers for maximizing the protein concentration of their grain. Conventionally harvesting grain in one bin on a combine lessens the ability of growers to capture price premiums for high protein wheat. On-combine optical sensing creates an opportunity to segregate grain by protein concentration during harvest. Scientists in Pendleton, OR, developed an on-combine system that uses a multispectral optical probe to automatically separate wheat by grain protein. Field tests showed it is possible to use grain protein to effectively separate grain into different bins on a combine without prior knowledge of harvesting zones. The scientists also developed the publically available "Grain Segregation Profit Calculator" software to calculate the cutoff value to use for segregating wheat into two lots so prices received for average protein levels in the lots are maximized.

> ***Impact:*** Dollar returns from grain segregation are sensitive to the average level of a field's protein, the protein variability within a field, and prices being paid in the marketplace. These technologies hold great promise for helping wheat producers increase their efficiencies and profits. NP216, C2, PS2a, and PM1.2.6, Project No. 5356-21610-001-00D.

Gasification biochar improves soil health and promotes wheat growth. Grass seed farms in the Pacific Northwest may be able to produce their own electricity through gasification of crop residues. Gasification heats biomass at high temperatures without combustion, producing a synthetic gas fuel, as well as high organic matter biochar as a coproduct. Biochar can be a valuable soil amendment to improve soil properties and sequester carbon, which helps reduce atmospheric greenhouse gasses. ARS scientists at Corvallis, OR, incorporated biochar from gasification of Kentucky bluegrass residues into a low pH farm soil in eastern Washington where crop yields can be severely limited by low soil pH and low soil moisture. Adding biochar improved wheat growth and yield by over 1.5-fold compared to untreated soil. The biochar improved soil water holding capacity, raised soil pH, and provided added mineral nutrition to the wheat crop when compared to lime-treated and untreated soils.

> ***Impact:*** This research demonstrates that biochar has added economic value to the producer and improves soil and crop sustainability. Development of on-farm gasification will help reduce dependency on fossil fuels and their related environmental impacts, promote greater sustainability of farm economics, soil health, and crop productivity. NP216, C1, PS1b, and PM1.2.6, Project No. 5358-21410-003-00D.

New geospatial databases assess crop and production patterns in the Northeast. Developing effective regional food systems has enormous potential to address health, nutrition, and poverty problems. In the Northeast, however, better policy and management decision tools are needed to analyze current and future food production capacity in order to improve the access, affordability, and appropriateness of locally-produced food. ARS researchers from Orono, ME, in cooperation with the ARS in Beltsville, MD, developed a collection of geodatabases that provides county-level, five-year production footprints for key indicator crops (corn, potato, small grains, broccoli, cabbage, soybean, alfalfa, and 'other hay') throughout the entire 13-state northeast region.

> ***Impact:*** The databases bring together all available spatial information on cropping systems and crop production, soils, land use and quality, and water resources. These spatially-layered, user-friendly map products provide integrated information on past and present farmland extents and productivity. They are currently playing a key role in forecasting models to improve future farm and crop productivity. NP216, C1 and C2, PS1a and PS2a, and PM1.2.6, Project No. 1915-62660-002-00D.

Oat and rye cover crops substantially reduce nitrate losses in drainage water. Loss of nitrogen in groundwater from agricultural systems can increase nitrate in freshwater streams, which can lead to environmental problems such as hypoxia in the Gulf of Mexico and economic problems such as more expensive drinking water treatment. Much of the nitrate in the Mississippi River comes from land used to produce corn and soybean, especially if it has been drained with subsurface drainage systems. Cover crops grown in the fall and winter can capture nitrogen that would otherwise be lost from fallow fields, and make the nitrogen available to the next year's crop. During a five-year period, ARS scientists at Ames, IA, showed that a cereal rye winter cover crop reduced the concentration of nitrate in drainage water by 48%, and an oat fall cover crop reduced nitrate concentrations by 26%.

Impact: Both oat and rye cover crops are viable management options to keep nitrogen available to crops, which should decrease grower fertilizer costs for corn and soybean and reduce nitrate losses to the Mississippi River and the Gulf of Mexico. NP216, C1, PS1a, and PM1.2.6, Project No. 3625-21610-001-00D.

Diverse Agricultural Systems are more complex, but more productive and stable. Greater demands for agriculture to provide food, feed, fiber, and fuel increase pressure on farmers to intensify their production without compromising environmental quality. To improve the resilience of agricultural systems, ARS scientists at Mandan, ND, examined the role of biodiversity in the management of agricultural systems. The use of a complex cropping system, such as different combinations of crops grown in different places depending on field conditions and producer goals, increased spring wheat yield up to 10 -20% and reduced yield variability compared to fixed crop rotations. Similarly, increasing diversity by integrating crops and livestock reduced bred cow overwintering costs by up to 32% compared to conventional haylot feeding.

Impact: These new systems require new tools for management and for conducting trade-off analysis, so management may become more complex. However, the systems can improve crop and animal productivity and consistency, while reducing risk by being more resilient to outside changes. They can also provide multiple ecosystem functions and increase the sustainably of agricultural systems. NP216, C3, PS3a, and PM1.2.6, Project No. 5445-21660-002-00D.

Performance Targets

2.6.A Develop new strategies and technologies to reduce production costs and risks of economic losses for agronomic and bioenergy crop production systems.

Baseline 2012	Target 2017
Description of baseline systems for regional agronomic crop production systems.	Identify five new region-specific agronomic crop production system configurations that utilize on-farm resources and natural ecosystem processes to reduce the need for purchased inputs and reduce whole-system costs and risks.

2.6.B Develop new specialty crop management strategies to reduce production costs but have neutral or

positive impacts on yield, product quality, and risk of economic loss.

Baseline 2012	Target 2017
Description of baseline condition for region-specific specialty crop production systems.	Identify four new region-specific production system configurations for new crops that utilize on-farm resources and natural ecosystem processes to reduce the need for purchased inputs and reduce whole-system costs and risks.

2.6.C Develop new strategies that integrate crop and livestock production elements to reduce risks of economic loss, diversify income, and enhance environmental benefits.

Baseline 2012	Target 2017
Description of baseline conditions for integrated crop-livestock production systems.	Identify two enhanced region-specific system configurations that take advantage of the complimentary benefits of combining crop and livestock production enterprises to reduce the need for purchased inputs and reduce whole-system costs and risks.

2.6.D Develop and integrate technology and decision support tools to increase production system efficiency.

Baseline 2012	Target 2017
Single natural resource and plant growth assessment models calibrated for local conditions.	Natural resource assessment and plant growth models applied to regional crop production systems and integration of economic factors.

<u>Measure 1.2.6 Summary of the Major Technologies Developed, Transferred, and Used in FY 2013:</u>

During FY 2013, ARS reported on 6 new technologies adopted for uses that provide (enter description here)

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
The Cover Crop Chart (v. 1.3)	Made available to clientele via a free downloadable file from the ARS Products and Services webpage.	Producers, extension specialists, scientists, general public	The chart serves as a user-friendly tool for determining the suitability of cover crops for addressing different production and natural resource goals. Since release of v. 1.1 in 2010, the chart has been downloaded over 1700 times by users in 22 countries.
Grain Segregation Profit Calculator (GSPC) software	Interactive web-based application	Scientists, students, growers, and agri-consultants.	The GSPC software is available to the public for assessing potential profit opportunities of segregating grain by protein concentration.
Decision aide for selection of cover crops for Iowa	Web-based decision tool	Scientists, producers, extension personnel, NRCS personnel, general public	Informed choices of cover crops for cropping systems in Iowa and other Midwestern states.
Irrigator Pro for Peanuts, Corn, and Cotton; irrigation scheduling model which recommends timing and amount of irrigation.	Distribution via web downloads and CDs. Also training demonstrations conducted at industry meetings.	Peanut, corn, and cotton farmers, crop consultants, NRCS (Irrigator Pro is EQIP approved), Georgia Soil and Water Conservation Commission.	Increased crop yield, sustainable irrigation scheduling, cost share payment incentives via EQIP, increased farm revenues.
FarmSuite WholeFarm farm planning system	Distribution via web downloads and CDs. Also training demonstrations conducted at industry meetings.	Peanut, corn, and cotton farmers, crop consultants, agricultural lenders.	Improves farm planning decisions and optimizes crop rotation sequencing from an economic standpoint.
Production guidelines for recently released sunn hemp cultivars.	Alabama Agricultural Experiment Station Bulletin.	Scientists, producers, general public.	Improved understanding of agronomic production practices associated with new sunn hemp cultivars capable of producing seed in the southeast.

Measure 1.2.6: Develop integrated solutions to solve challenges related to agricultural system productivity, profitability, energy efficiency, and natural resource stewardship

During FY 2014, ARS will

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

During FY 2015, ARS will

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

During FY 2016, ARS will

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

Strategic Goal Area 3:
Crop Production and Protection

Research conducted by ARS's Crop Production and Protection Program (CPP) National Programs will deliver science-based information and technologies to meet

- Producers' needs for increased crop productivity and quality, 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;
- Worker's 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, genomics, and genetic improvement; 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. The research of the Crop Production and Protection National Programs is well integrated with other ARS research in Animal Protection and Production; Natural Resources and Sustainable Agricultural Systems; and Nutrition, Food Safety and Quality. Through the National Invasive Species Information Center and Alternative Farming Systems Center of the National Agricultural Library, key information will be disseminated to agricultural producers, the research and education community, and the general public.

GOAL 3.1 – PROTECT, EXPAND, AND ENHANCE THE UNITED STATES' CROP GENETIC RESOURCE BASE, INCREASE SCIENTIFIC KNOWLEDGE OF CROP GENES, GENOMES, BIOLOGICAL PROCESSES AND SYSTEMS, AND DELIVER ECONOMICALLY AND ENVIRONMENTALLY SOUND TECHNOLOGIES THAT IMPROVE THE PRODUCTION EFFICIENCY, QUALITY, HEALTH AND VALUE OF THE NATION'S CROPS. (PLANT GENETIC RESOURCES, GENOMICS, AND GENETIC IMPROVEMENT – NP 301 & 305).

Crop Improvement

U.S. crop production depends on new and improved varieties of crops—developed faster and for less cost—that are competitive in the market, increasingly tailored to meet the complex demands for food, feed, fiber, ornamentals, and energy; and adapted to an increasingly challenging global climate. To do so, ARS research will harness the inherent genetic potential of plants. This research will develop, and effectively apply, new knowledge of crop genes, genomes, and the control and expression of genes, to accelerate productivity and improve the quality of crops; realized via traditional and novel plant breeding methods.

Genetic resources are the foundation of our agricultural future. ARS crop gene banks contain the sources of resistance to biotic and abiotic stresses and new genes to improve the quantity and quality of food, feed, energy, fiber, and ornamental crops. To ensure that these genes are available for research and breeding, ARS will continue to acquire and conserve crop genetic resources, develop more effective screening methods for identifying superior traits, characterize the genetic profiles of gene bank holdings, ensure that genetic resources are distributed where and when they are needed, and safeguard these collections and their associated information for future generations.

New ARS genetic technologies will address the specific needs for higher crop yields; more durable and effective tolerance to abiotic stresses including drought, heat, cold, freezing, and flooding; more efficient crop use of key inputs such as water and nutrients; more durable and effective pest and disease resistance; control of flowering time; enhanced product composition and nutritional quality; value-added traits; and conversion efficiency to biofuels. ARS research will elucidate how crop traits are controlled by underlying genetic systems, how these traits are affected by environmental factors during crop production, and how to enhance traits by incorporating novel sources of genetic variation from underexploited genetic resources or by genetically-engineering such traits. ARS will devise new crop genetic improvement methods that incorporate advances in genome sequencing and analysis, molecular genetics, computational biology, and metabolic engineering. New crop breeding theories and strategies will be developed to more effectively capture the intrinsic genetic potential of germplasm—especially to improve key agronomic and horticultural traits—resulting in crops tailored for consumer and producer needs.

ARS will continue to lead the development of crop genetic and genomic information management and database systems that broadly support and enhance crop research, from germplasm improvement and breeding to genetic and genomic analyses. New tools will be generated to efficiently incorporate valuable new data into databases, extract key information from the massive quantity of data safeguarded in those databases, identify the important properties of genes, apply that knowledge to crop improvement, and build on genetic advances in one crop so as to accelerate genetic gains in others.

Crop Production

The Nation's economic vitality depends on the ability of U.S. crop producers to grow and market food, fiber, ornamentals, industrial products, feed, and fuels profitably; while enhancing the natural resource base on which crop production depends. Future economic success for U.S. producers depends on increased productivity, access to new markets for specialized products, new technologies that generate new opportunities for U.S. farmers, and new tools and information to mitigate risks and enable rapid adjustments to changing market conditions. The agricultural sector is challenged by a wide variety of resource, climatic, economic, and social factors that require an equally diverse array of strategies and solutions for successfully meeting those challenges.

Contemporary U.S. crop enterprises for annual, perennial, and greenhouse crop production are complex and depend on access to and successful integration of highly diverse components, such as a steady stream of superior crop varieties, new strategies for mitigation of crop losses from biotic and abiotic stresses, and mechanization and automation of undesirable or labor intensive activities. The development of successful new production systems to sustain or increase crop yield and quality requires focusing on 1) productive and profitable crop management strategies for new and traditional crops that conserve natural resources; 2) efficient and effective integrated management strategies for multiple pests; 3) mechanization of management activities to address labor constraints; and 4) improved crop management models and decision aids.

Pollination is a critical element in agriculture as well, because honey bees pollinate more than 130 crops in the United States and add $15 billion in crop value annually. Declining honeybee populations and honey production due to Colony Collapse Disorder (CCD) require special attention. CCD has now increased honey bee mortality to more than 30 percent. Also, as new crops are introduced and stresses on honeybees increase, pollinators will be continuously required for specific crops or protected environments.

Improved production systems must address the needs of small, intermediate, and large field-, greenhouse-, orchard-, and vineyard-based farming enterprises for more efficient conventional, organic, and controlled-environment production methods and strategies. New crop production technologies must increase production efficiency, conserve energy and natural resources, and provide resilience in the face of abiotic and biotic stresses; while maintaining or enhancing productivity and product quality.

Key Outcome: New technologies (such as superior crop varieties; enhanced breeding stock; more effective crop and pest management strategies; improved sensors, robotics, and spray application equipment; improved decision support systems; more efficient production systems) and information that sustain U. S. crop production and enable producers to compete more effectively in the global market place. The U. S.'s national capacity to exploit the genetic potential of crops efficiently and effectively is maintained, and U.S. crop productivity and efficiency are enhanced.

Performance Measure

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

Indicator 1:

During 2013, ARS will breed superior new crops, varieties, and enhanced germplasm.

FY 2013 Accomplishments*:*

'Sunpreme' raisins dry themselves. Eliminating the processing step of tray-drying in the field would help maintain the quality of raisins and reduce the need for costly additional post-harvest processing. ARS researchers in Parlier, California, have developed 'Sunpreme,' a new raisin grape that dries naturally on the vine without the grapes requiring cutting and drying in trays.

> ***Impact:*** 'Sunpreme' is particularly well-suited for mechanical harvesting, thereby significantly reducing production costs. Unlike Thompson Seedless, the major grape variety used for tray-dried raisin production, 'Sunpreme' can be spur-pruned, further reducing grower costs.

'Flavorfest' strawberry cultivar released. Mid-Atlantic strawberry growers face an increasing problem from plant loss and fruit-rot from the current leading strawberry variety because of its susceptibility to the fungal disease, anthracnose. ARS scientists in Beltsville, Maryland, have released the 'Flavorfest' strawberry that is resistant to plant and fruit-rot anthracnose, has a similar season to the current leading variety, and delivers up to a two-fold higher yield of large berries with excellent flavor and creamy texture.

> ***Impact*:** Mid-Atlantic strawberry crop consultants and extension agents are advising growers to try 'Flavorfest' and consider it a replacement for the current leading variety.

'Mesa,' first Russian wheat aphid-resistant winter feed barley variety released. Russian wheat aphid, an invasive pest of small grains, is a major problem for small grain production, requiring repeated applications of the most environmentally detrimental pesticides as a control measure. ARS researchers in Stillwater, Oklahoma, developed a new barley variety, 'Mesa,' with high levels of inherent resistance to both the U.S. types of Russian wheat aphid and those found in other parts of the world.

> ***Impact*:** With continued soil erosion in the western United States and new demands for a feed alternative to corn, Russian wheat aphid-resistant barley represents an advantageous environmental and economic crop option for High Plains growers.

Genes from wild soybeans in USDA-ARS soybean collection incorporated into adapted soybean breeding lines for the first time. Genes from the wild soybean had not previously been exploited for increasing soybean yield because of the wild soybean's undesirable plant growth habit, seed type, and other traits. ARS researchers at Urbana, Illinois, applied marker-assisted plant breeding to develop high yielding soybean lines that yielded as much as the adapted soybean parents but contained much of the genetic diversity from the wild soybeans. Analyses with more than 1,500 DNA markers determined that these lines were genetically unique, with some of the high yielding lines containing more than 30 percent of the genes from the wild soybean source, a much higher level than the expected 12 percent.

> ***Impact*:** These lines are serving as new breeding stocks for expanding the genetic diversity and increasing yield in future U.S. soybean varieties.

Development and release of wheats with novel end-use properties. ARS scientists at Lincoln, Nebraska, developed wheat with altered grain quality properties in-demand by the food processing industry. Developed materials include the cultivar 'Mattern' and an extensive array of common and durum wheat breeding lines with waxy (amylose-free) starch. Additionally, ARS scientists identified a gene affecting wheat grain polyphenol oxidase levels. Low levels of polyphenol oxidase are required in newly released hard white wheat cultivars; the previously unidentified gene was discovered in Australian wheats developed in the 1930's, and maintained by the USDA-ARS National Small Grains Collection in Aberdeen, Idaho. It effectively eliminates grain polyphenol oxidase in common wheat.

> ***Impact*:** Discoloration in fresh and frozen products developed from hard white winter wheats can be avoided, and U.S. markets potentially expanded.

Indicator 2:

During 2013, ARS will devise innovative approaches to crop genetic improvement and trait analysis.

FY 2013 Accomplishments*:*

Discovery of genes for drought tolerance in common bean. Drought strongly reduces the yields of dry beans in the Northern Plains (North Dakota and Minnesota), Great Lakes (Michigan), and other regions which rely primarily on rainfall for crop growth. Consequently, dry beans with tolerance to drought are critical for those regions, and for adapting this globally important crop to climate change. ARS researchers in Prosser, Washington, and their university colleagues identified two major genes (also known as quantitative trait loci or QTL) that strongly governed drought tolerance in dry beans. The two genes showed positive effects when the dry beans were cultivated in multiple drought-stress environments.

> ***Impact*:** This research will enhance capacity for marker-assisted breeding to accelerate development of drought-tolerant beans by seed companies and public-sector breeders in the United States and worldwide.

Novel multi-seeded mutants identified that might substantially increase sorghum grain yield. ARS researchers in Lubbock, Texas, have identified novel sorghum mutants that might significantly increase sorghum grain yield. The multi-seeded mutants have more and larger primary and secondary flower branches bearing more types of floral organs that develop into seeds. Compared to current sorghum cultivars, these mutants have triple the number of seeds and double the seed weight.

> ***Impact*:** The mutants are being evaluated in the field for their ability to substantially increase

sorghum grain yield.

Wheat gene Mds-1 governs susceptibility to Hessian fly. Hessian fly stunts and kills wheat seedlings and causes adult plants to fall over, or lodge. Wheat resistance genes against Hessian fly are rapidly overcome by new genetic biotypes of the Hessian fly, so new strategies are needed to combat this pest. ARS researchers in Manhattan, Kansas, and their university colleagues found a wheat gene, Mds-1, which confers susceptibility to Hessian fly. When this gene was deactivated experimentally, wheat plants became immune to all biotypes of Hessian fly.

***Impact*:** Modification of susceptibility genes such as Mds-1 may confer to wheat a potentially broad and durable resistance to Hessian fly and other insects.

High-resolution genetic maps for grapevine. Plant breeders and geneticists place DNA markers on genetic maps to track the location of genes underlying key traits, such as disease resistance and fruit quality. Akin to mile markers on highways, DNA markers reveal the context of the destination (the trait), and more numerous markers result in more precision in reaching the destination. ARS researchers at Geneva, New York, and Ithaca, New York, adapted a new genetic technology that resulted in a ten-fold increase in the number of DNA markers in grapevine, at a cost that is affordable to grape breeders. As a result, traits such as powdery mildew resistance, flower sex, seedlessness, and berry color are being tracked in traditional grape breeding programs with dramatically improved precision.

***Impact*:** These markers enable breeders to identify and discard undesirable progeny within months of seed germination, saving years of effort and expense in the breeding and evaluation process.

Increasing vitamin A content in maize by manipulating plant metabolism. Vitamin A deficiency results in progressive blindness, increased infant mortality, and depressed immunological responses. ARS scientists in Ithaca, New York, and university collaborators genetically mapped and identified metabolic pathway genes in maize germplasm for dramatically increasing pro-vitamin A levels in the grain. Maize breeders in Africa applied DNA markers and selection for grain color (β-carotene) to enhance pro-vitamin A levels by conventional breeding.

***Impact*:** New hybrid maize varieties containing more Vitamin A in their kernels were released in Africa in 2012 and 2013.

Indicator 3:

During 2013, ARS will expand crop genomic information resources and advanced bioinformatic capabilities.

FY 2013 Accomplishments*:*

40,000 new genetic markers for evaluating the diversity in the USDA soybean germplasm collection. New genetic tools are needed to accelerate the pace of mining germplasm collections for valuable genes for breeding and research. ARS researchers in Beltsville, Maryland, mapped more than 40,000 single nucleotide polymorphism (SNP) DNA markers to specific chromosomal locations on the soybean genome to facilitate identifying genes that control traits of interest. These extensive data were deposited in SoyBase, the ARS soybean genome database, which is consulted heavily by public and private-sector researchers worldwide. The researchers applied the suite of 40,000 SNP DNA markers to analyze the 18,000 soybean samples in the ARS germplasm collection to identify an optimal core subset that would increase the effectiveness of genebank management. In doing so, they identified more than 4,300

samples that were 99.9 percent genetically identical and could be omitted from further study. With the remaining samples, a core subset of about 1,400 samples was chosen that represented 79 percent of the total genetic diversity of the entire collection.

> ***Impact*:** This core subset enables soybean breeders and geneticists to search for key traits from a relatively small and manageable number of samples representing most of the genetic variability of the entire collection.

Metabolic pathway information grows at MaizeGDB. Understanding how plant genes function helps researchers create knowledge-based strategies for crop improvement. ARS researchers in Ames, Iowa, in collaboration with ARS scientists in Columbia, Missouri; Albany, California; and Cold Spring Harbor, New York, as well as university collaborators, expanded the Maize Genetics and Genomics Database (MaizeGDB) metabolic network resources – MaizeCyc and CornCyc – including high quality representations of agronomically important pathways from the published literature.

> ***Impact:*** MaizeGDB hosts approximately 136,000 visitors per year, 97,000 of which are repeat users. Growth of the database enables researchers to more efficiently improve corn to meet consumer needs.

Indicator 4:

During 2013, ARS will conserve and encourage the use of plant and microbial genetic resources and associated information.

FY 2013 Accomplishments*:*

Genetic relationships and area of origin identified for carrots. The genetic relationships and geographical origins of crop varieties and their wild relatives provide key information for guiding crop breeding, genetic research, and genetic resource conservation. Genetic marker research conducted by ARS scientists at Madison, Wisconsin, and their university colleagues identified the area of origin (Central Asia) for carrots and determined that wild carrots from the United States were most closely related to European wild carrots.

> ***Impact:*** Carrots are one of the most important sources of Vitamin A worldwide, and this new information about populational genetic structure can accelerate the progress of carrot breeding and improve the efficacy of carrot genetic resource management.

Three genepools for tomato identified. Tomato, one of the most important vegetable crops worldwide, is a key source of vital vitamins and micronutrients for human diets. Tomato breeding requires new sources of genetic variability to accelerate genetic improvement for higher yield and important fruit quality traits. ARS researchers in Geneva, New York, and in Albany, California, and their university cooperators analyzed variability in SNP genetic markers and fruit quality traits from the USDA-ARS National Plant Germplasm System (NPGS) genebank collection and uncovered three distinct genepools (North American, non-North American, and cherry tomato).

> ***Impact*:** New knowledge of genetic structure and fruit quality can now be applied to choosing optimal sources of diverse traits for tomato breeding.

New citrus cryopreservation method developed. The current and future productivity and profitability of the multi-billion dollar U.S. citrus industry are threatened by virulent pests and disease, such as citrus greening and citrus canker. These pests and diseases also threaten the ARS citrus breeding stock and

genebank collections maintained in field and screen house plantings. Until now, preserving vegetatively propagated citrus germplasm under ultra-cold (cryopreservation) genebank conditions has not been feasible. ARS researchers in Ft. Collins, Colorado, and in Riverside, California, developed a novel micrografting technique that results in high survival rates of citrus germplasm maintained by cryopreservation. Furthermore, the new cryopreservation technique eliminates several graft-transmissible viruses and viroids.

> ***Impact*:** This new cryopreservation technique not only provides an effective means for safeguarding invaluable citrus germplasm, but it may also serve as a new pathogen elimination method for producing disease-free citrus propagating material.

Rich native U.S. sources of plant genetic diversity identified for crop improvement and research. The wild relatives of domesticated crops contain rich sources of genetic diversity which new genomics-assisted breeding techniques can now exploit more effectively for crop improvement. But it had long been assumed that U.S. flora contains relatively few crop wild relatives. ARS scientists in Prosser, Washington, and in Beltsville, Maryland, with international research collaborators, completed an inventory of U.S. flora that contains a rich trove (more than 4,600 different types) of crop wild relatives and wild species that could be exploited directly for food, forage, medicinal, ornamental, and industrial applications. Further comparisons of these lists with the vegetation found in parks and reserves and the holdings of the U.S. National Plant Germplasm System genebanks identified more than 800 different types of these plants as priorities for protection either in nature or in genebanks.

> ***Impact:*** This research has furnished a blueprint for urgent action to conserve the most endangered U.S. crop wild relatives.

Massive numbers of genetic markers developed for breeding and broadening the genetic diversity of U.S. corn. Maize (corn) is the most valuable crop in the United States with a current annual farmgate value of more than $75 billion, but the genetic base of the U.S. maize crop is very narrow, making it potentially vulnerable to emerging diseases, pests, and environmental extremes. New methods are required to identify and conserve maize diversity, expand the crop's genetic base, and contribute valuable new traits to the U.S. maize crop. ARS researchers in Ames, Iowa; Columbia, Missouri; Ithaca, New York; and Raleigh, North Carolina, and their university collaborators developed more than 500,000 single nucleotide polymorphism (SNP) genetic markers via next-generation sequencing methods and genotyped nearly all (2,700) of the inbred lines in the U.S. National Plant Germplasm System maize collection.

> ***Impact*:** This vast trove of genetic data helped identify misclassified samples, elucidate the genetic relationships among poorly known lines, and, combined with agronomic descriptions of those lines, identify genes that govern key maize traits. This information will be key to accelerating maize breeding that effectively incorporates valuable new genetic diversity into the U.S. maize crop.

Indicator 5:

During 2013, ARS will expand fundamental knowledge of plant biological and molecular processes.

FY 2013 Accomplishments*:*

Comprehensive set of expressed genes from oat seeds developed. Oat is an important food and forage crop that lags behind wheat and barley in genome resource development. In this study, ARS scientists in Saint Paul, Minnesota, developed a new genome resource for oat improvement. High throughput sequencing data was assembled into the first comprehensive transcriptome (complete set of expressed

genes) of oat seeds. The assembly is high quality and contains more than 50,000 expressed genes. Transcripts for all genes for vitamin E biosynthesis were detected, as were genes involved in the synthesis of other health-promoting compounds – beta-glucans and avenanthramides, unique polyphenol compounds with antioxidant activity. Many thousand potential new molecular markers for oat were also identified.

> ***Impact*:** This transcriptome assembly and the accompanying molecular markers provide new tools and resources for developing oats with higher nutritional value for human health.

Next-generation sequencing of organellar genomes in cranberry. Through next-generation sequencing technology, it is now possible to sequence whole organellar genomes of understudied, economically-important crop species such as cranberry. State-of-the-art molecular methods and computer-based approaches reconstructed the cranberry mitochondrial genome. Investigations of the cranberry mitochondrial genome are now needed to determine genome size, organization, gene content, and variation within the species and for comparison with other species. This is the first mitochondrial genome sequenced for the *Vaccinium* genus and the only one available in the entire *Ericales* order of flowering plants.

> ***Impact*:** The published whole mitochondrial genome of cranberry will help elucidate cellular energy production and characterize genome evolution and evolutionary relationships in this and other closely related plant species.

Genes can move among the separate genomes of flowering plant cells. Genes consist of DNA, most of which is located in the chromosomes of the nuclear genome. But in plants, small quantities of DNA are also found in the genomes of two sub-cellular compartments, mitochondria and plastids. ARS researchers in Madison, Wisconsin, and university colleagues found that DNA originally from the carrot mitochondrial genome has moved into the carrot plastid genome – the first report of DNA transfer between those genomes for any organism.

> ***Impact*:** These findings advance the scientific understanding of how DNA can move between separate flowering plant genomes and the possible origins of some genetic variation found both within and among different plant species.

Creating new sources of soybean genes that retard cyst nematode development. Soybean cyst nematodes attack the roots of soybean plants, causing approximately $1 to 2 billion in damage each year. These nematodes evolve into new genetic races rapidly, especially when challenged with resistant soybeans. Very few new unique sources of resistance have been found in soybean germplasm collections. To improve soybean resistance to the soybean cyst nematode and generate new genetic diversity for breeding, ARS researchers in Beltsville, Maryland, identified approximately 50 *Arabidopsis*, soybean, and nematode genes as candidates for developing partial resistance against the soybean cyst and root-knot nematodes. DNA constructs derived from these genes were incorporated (transformed) into soybean roots and challenged with either soybean cyst nematodes or root-knot nematodes. Four DNA constructs decreased the number of cysts formed by the soybean cyst nematode by 50 percent or more and decreased the number of galls formed by root-knot nematode by 60 percent or more.

> ***Impact*:** These DNA constructs are very valuable tools for understanding mechanisms of plant resistance to these nematodes and for developing genetically broad resistance against nematodes.

Orchestration of a symphony of tomato genes by the epigenome. Tomato fruit ripening is triggered by the plant hormone ethylene; however, the impact of ethylene on fruit development is restricted by unknown cues to mature fruit. ARS researchers at Ithaca, New York, demonstrated that changes in DNA

cytosine methylation, a signature feature of the epigenome, are dynamic during fruit development and ripening, and are specifically associated with the binding of key regulatory proteins that promote ripening.

***Impact*:** This finding opens an exciting new frontier for the identification of novel sources of variation for crop improvement at the epigenome level rather than DNA sequence level.

Indicator 6:

During 2013, ARS will develop more effective means for plant biotechnology risk assessment.

FY 2013 Accomplishments*:*

Distinguishing glyphosate-resistant (GR) and susceptible (GS) Palmer amaranth (pigweed) plants. A study was conducted by ARS scientists at the Crop Production Systems Research Unit in Stoneville, Mississippi, to determine if glyphosate-resistant and susceptible pigweed could be distinguished using hyperspectral imagery (imagery represented by several wavebands of light). Results showed that GS plants reflected higher light in the visible region of the spectrum compared to GR plants, while GR plants reflected higher light in the infrared region of the spectrum compared to GS plants. A combination of fourteen narrow bands provided a good classification of unknown set of GR and GS plants with a validation accuracy of 94 percent.

***Impact*:** These results demonstrate that hyperspectral imaging has potential to separate GR from GS Palmer amaranth, and this information has potential to develop a custom camera system to distinguish GR and GS plants from aircraft to allow growers to use selective spraying.

Report of the first target-site mutation in a glyphosate-resistant dicot weed species. The widespread adoption of glyphosate-resistant (GR) crops around the world has resulted in the evolution of several GR weed species, including tall waterhemp in Mississippi. ARS scientists in Mississippi discovered that the mechanism of resistance to glyphosate in a Mississippi GR tall waterhemp population is due to a combination of a target-site mutation and a non-target site based mechanism. This is the first report of an altered EPSPS-based resistance in a dicot weed species that has evolved resistance to glyphosate. The GR population absorbed and translocated less glyphosate compared to the GS population. Further, the GR and GS plants contained an equal genomic copy number of EPSPS, which was positively correlated with EPSPS gene expression, unlike EPSPS amplification in a GR biotype of Palmer amaranth (weed species closely related to and with potential to hybridize with tall waterhemp).

***Impact*:** This finding provides crop researchers new, testable hypotheses to determine how weeds become resistant to herbicides.

Indicator 7:

During 2013, ARS will develop crop production strategies to optimize crop genetic potential, mitigate losses due to biotic and abiotic stresses, and increase production efficiency.

FY 2013 Accomplishments*:*

Reducing pre-harvest germination (Vivipary) of pecan. Pecan crop loss to the germination of nuts while still on the tree (i.e., vivipary) is a major problem for many pecan farmers, especially those in hot arid climates. There is need to develop management strategies that stabilize year-to-year variability in marketable nutmeat yields due to vivipary. ARS researchers in Byron, Georgia, found that vivipary is greatly influenced by trees' exposure to moist soils, with high nitrate nitrogen during the nutmeat filling stage of fruit development and that it is regulated by the plant hormone, abscisic acid. Moist soils and high fruit nitrate prevents timely production of abscisic acid in developing seeds, which prevents seed dormancy. These findings also implicate copper and/or molybdenum deficiency as major contributing factors to vivipary through their influence on the activity of the key enzyme producing abscisic acid.

> ***Impact***: This information enables pecan, and possibly grain farmers, to tailor crop management strategies to reduce loss to pre-harvest germination.

Excessive iron triggers nickel deficiency. Nickel deficiency not only influences alternate bearing by pecan trees, but also reduces yield and quality of many other crops. Factors affecting the cellular bioavailability of nickel in plants have the potential to influence the health, yield, and quality of plant products. ARS researchers in Byron, Georgia, determined that nickel deficiency is easily induced by excessive iron fertilization or plant exposure to iron. The scientists noted that the iron acts in an antagonistic manner to nickel bioavailability and nutritional physiology.

> ***Impact***: This research identifies an important micro-nutrient interaction in plants that has heretofore been unrecognized and has the potential for practical applications in agriculture. For example, the research identified iron fertilization as a means of alleviating nickel toxicity in crops, especially those growing on highly mineralized serpentine soils. The findings also highlight the possible existence of iron-induced nickel deficiency occurring in many cropping systems in which iron is a fertilizer supplement.

Development of a precision air-assisted sprayer for tree crop production. Trees in nurseries and orchards have great variations in shapes, sizes, canopy densities and gaps between in-row trees. The variability requires future sprayers to be flexible to spray the amount of chemicals that can match tree structures. ARS researchers in Wooster, Ohio, developed a variable-rate air-assisted sprayer implementing high-speed laser scanning technology to achieve these requirements. Field tests demonstrated that the new variable-rate sprayer produced significantly more consistent spray deposit and coverage inside tree canopies than the conventional sprayers, consequently resulting in less off-target loss and less pesticide use.

> ***Impact***: Use of the new sprayer to deliver pest control agents will bring great benefits to growers economically and environmentally.

Cacao genotypic response to soil flooding. In cacao growing regions, frequent high intensity rains are causing soil flooding in the lowland areas; flooding is also a serious problem in cacao nurseries. Anaerobic conditions in the root zone created by flooding affects the biochemical and physiological processes, and these have an impact on the growth and development of cacao. Flooding decreased the net photosynthesis, stomatal conductance, and transpiration of flood tolerant and intolerant cacao genotypes. Flood susceptible genotypes showed changes in fluorescence emission, reduction in chlorophyll content, and increased activity of stress enzymes. Flooding also caused changes in macro and micronutrients, total soluble sugars, and starch concentrations. Stable plant traits identified in this study will be useful in the identification of cacao genotypes that have tolerance to short periods of flooding.

> ***Impact***: Findings of this study will be helpful to commercial cacao seedling growers to efficiently manage irrigation in the nursery and to farmers to improve cacao production in lowland areas where

flooding is a problem.

Indicator 8:

During 2013, ARS will improve pollinator health, bee systematics and germplasm lines, and pollination.

FY 2013 Accomplishments*:*

Varroa mite migration represents a new control challenge. Varroa mites are a major cause of colony losses in honey bees because they parasitize bees and spread viruses in the colony. ARS researchers in Tucson, Arizona, devised a treatment schedule to control Varroa based on colony and Varroa population dynamics. The researchers found that Varroa populations could be kept at low levels throughout most of the summer with this treatment schedule. However, by fall, mite populations were much larger than predicted or than could be accounted for by mite reproduction alone. The researchers determined that mites appear to be migratory and move between colonies with far greater frequency than previously thought.

> ***Impact*:** This finding led to changes in recommendations on Varroa control that include a late fall treatment, so mite populations remain low over the winter to prevent the loss of colonies in the spring.

Bee responses to agricultural chemicals. ARS researchers in Beltsville, Maryland, showed significant changes in gene expression for honey bees exposed to agricultural chemicals, indicative of a physiological impact of these chemicals. Immune system genes showed altered expression in adult bees exposed to acaricides used for mite control. Both immune and detoxification genes changed in larval bees raised with sublethal levels of a range of herbicides, insecticides, and mite control agents. These results are being compared to field and laboratory morbidity trials in order to help identify risks of bees to specific chemicals.

> ***Impact*:** The results help inform decisions on labeling and usage requirements for agricultural chemicals, protecting bees from those chemicals to which they are especially sensitive.

Interactions between honey bee disease agents and pesticides. A long-term field and experimental study pointed toward an increased susceptibility of honey bee workers toward the gut parasite Nosema ceranae after exposure to imidacloprid.

> ***Impact*:** Results suggest that beekeepers should be especially alert to Nosema risk following insecticide exposure, and should manage their bees accordingly.

Ozone fumigation as a disinfectant for honey bee comb. ARS scientists in Logan, Utah, demonstrated that ozone is useful for decontaminating honey bee hives, as it can break down pesticides, kill insect pests, and kill pathogen spores. Honey bee hives typically get moved between colonies and can potentially spread pests and disease, so a decontamination method is needed. Ozone should also prove useful as a means to fumigate alfalfa leafcutting bee nesting boards to reduce the spread of chalkbrood in this managed bee.

> ***Impact*:** This fumigation method will help safeguard the health of beekeepers hives.

Largest collection of bees in the world. ARS houses the U.S. National Pollinating Insects Collection in Logan, Utah, and it is one of the largest collections of bees in the world, containing approximately 1.1

million specimens. This reference collection is visited and used by scientists from all over the world. Data from the insect labels, including the identity, date and time of collection, host plant, gender, etc., has been entered into a specimen-level relational database for 874,548 of the specimens in the collection and is available to the scientific community.

***Impact*:** The ARS dataset is included within the larger, cooperative research tools of the Global Biodiversity Information Facility and DiscoverLife websites, making it broadly available to the scientific community.

Performance Targets

3.1.A Develop and Maintain Superior Crop Genetic Resources, Crop Production Systems, and Technologies to Harness Crops' Genetic Potential and Optimize Productivity and Profitability of U.S. Crop Production. The Preceding Will Underpin a Safe, Affordable Supply of Nutritious Foods for the U.S. and Other Nations, Protect the Environment, and Contribute Strongly to Global Market Competitiveness of U.S. Agriculture.

Baseline 2012	Target 2017
Ten new technologies are developed by ARS and used by ARS customers, leading to increased production efficiency and enhanced economic value and quality of U.S. crop production, while reducing any negative environmental impact.	Fifty new technologies are developed by ARS and used by ARS customers, leading to increased production efficiency and enhanced economic value and quality of U.S. crop production, while reducing any negative environmental impact.

Measure 1.3.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2013:

During FY 2013, ARS reported on 9 new technologies adopted for uses that provide (enter description here)

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Release of 'Columbia Star,' a thrornless trailing blackberry	ARS researchers at Corvallis, Oregon, developed, submitted for patent (S.N. 13/815,074), and released 'Columbia Star.' Every plant that was available (over 40,000) this past spring was purchased, and the nurseries are working hard to meet next year's demands.	Blackberry growers, processors, and consumers.	'Columbia Star' is a superior alternative to the current industry standards, 'Black Diamond' and 'Marion.'
Disease-resistant pea	ARS researchers in	U.S. and international pea	These new breeding tools

germplasm and genetic markers for accelerating resistance breeding in peas.	Pullman, Washington, and their university and international collaborators developed and released breeding lines highly tolerant to root rot caused by Aphanomyces, and also identified genetic markers to enable breeders to rapidly select disease-resistant breeding stock.	breeders, growers, and consumers.	and genetic material will accelerate the rate of incorporating resistance into pea to increase crop yield in Aphanomyces-affected areas worldwide.
Double-cropping with winter camelina: although double-cropping is more expensive than producing a single crop, research showed that both a biofuel and a food/feed crop can be produced on the same land in a single season, and that camelina-soybean double crop sequences were both feasible and economically attractive.	ARS researchers in Morris, Minnesota, demonstrated that camelina grown as a winter annual crop, which can serve as dedicated biofuel feedstock, can be harvested early enough in the following summer to allow production of a short-season food or feed crop such as soybean, sunflower, or millet. In one year of the two-year study, the camelina-soybean sequence resulted in net earnings of $70 to $142/acre more than growing a single crop of soybean and there was no sacrifice in seed quality of double-cropped soybean, and only a small affect on double-cropped sunflower seed quality over the two-year study.	Farmers from the Northern and Midwestern United States.	This newly developed cropping strategy allows farmers to produce both biofuel and food or feed on the same land in a single growing season, and winter camelina can serve as a "cash" cover crop.
Weed, water, and nutrient management practices for organic blackberry production.	In cooperation with researchers at Oregon State University, an ARS scientist in Corvallis, Oregon, has identified the best practices to establish and transition to organic blackberry for machine harvest and processing. The information was transferred by eOrganic to growers.	Organic blackberry growers, processors, and consumers.	Organic blackberry production will be significantly increased in the United States, particularly in the Pacific Northwest, where over ninety percent of the fruit is processed and more than half of the U.S. total is produced.
Development of methods for mass producing four western bumble bee species for use as greenhouse pollinators.	ARS scientists in Logan, Utah, developed methods for the mass production of bumble bees in response to the need for pollinators in western greenhouses.	Commerical bumble bee production companies and greenhouse crop growers in the western United States.	Growers of greenhouse crops which require bumble bee pollinators, such as tomatoes, will be able to utilize bees bred specifically as a western species.
Bioassay provides rapid assessment of the sensitivity of *Colletotrichum* isolates to fungicides.	ARS researchers tested sixteen agrochemicals that are currently used or have been used for control of strawberry pests and diseases via a	Strawberry growers, particularly in the southeastern United States.	Two new commercial formulations of fungicides are now labeled for disease control on strawberries.

	bioassay which provides rapid assessment of the sensitivity of *Colletotrichum* isolates to fungicides.		
Methods developed for propagating and releasing blue orchard bees in large, commercial orchards.	ARS scientists in Logan, Utah, developed a field incubation box, portable nesting shelters, and protocols for using blue orchard bees to pollinate almonds, apples, and cherries. In addition, methods were developed for increasing bee forage by planting early-flowering herbaceous plants in or near orchards.	Blue orchard bee producers and growers of crops such as almonds, apples, and cherries.	California almond growers have adapted these approaches to extend bee forage for honey bees.
Attractants for brown marmorated stink bug.	ARS scientists in Beltsville, Maryland developed and commercialized a new synthesis of the pheromone, methyl decatrienoate (MDT) for use in monitoring traps. ARS scientists in Beltsville and in Kearneysville, West Virginia, ran field trials which confirmed that the true male produced aggregation pheromone of the stink bug that is attractive to male and female adults and immature bugs; the pheromone was developed into a commercial version that has been transferred to the private sector.	Growers of brown marmorated stink bug-infected fruit, vegetable, and field crops, as well as anyone subjected to the infestation of this pest, both in the United States and internationally.	It is expected that the commercialization of pheromone technology will lead to effective management of the pest and new trap-and-kill techniques to reduce pesticide usage.
Relsease of the "U.S. EPA Generic Verification Protocol for Testing Pesticide Application Spray Drift Reduction Technologies for Row and Field Crops"	ARS researchers in College Station, Texas, working closely with EPA and other research and manufacturing entities, evaluated and refined application protocols and techniques, and developed a generic testing protocol that provides objective and unbiased testing of various drift reduction techniques.	This new protocol will be used by applicators to counter meteorological and other in-field conditions that can elevate drift potential.	The document is a critical regulatory resource to assure minimization of drift in agricultural spray applications.

Measure 1.3.1: Develop knowledge, strategies, systems and technologies that maximize the production efficiency of our annual, perennial, greenhouse and nursery cropping systems. Develop new technologies and tools contributing to improving these systems to meet current and future food crop production needs of diversified consumers, while ensuring economic and environmental

sustainability and production efficiency, health, and value of our nations crops.

During FY 2014, ARS will

breed superior new crops, varieties, and enhanced germplasm.

devise innovative approaches to crop genetic improvement and trait analysis.

expand crop genomic information resources and advanced bioinformatic capabilities.

conserve and encourage the use of plant and microbial genetic resources and associated information.

expand fundamental knowledge of plant biological and molecular processes.

develop more effective means for plant biotechnology risk assessment.

develop crop production strategies to optimize crop genetic potential, mitigate losses due to biotic and abiotic stresses, and increase production efficiency.

improve pollinator health, bee systematics and germplasm lines, and pollination.

During FY 2015, ARS will

breed superior new crops, varieties, and enhanced germplasm.

devise innovative approaches to crop genetic improvement and trait analysis.

expand crop genomic information resources and advanced bioinformatic capabilities.

conserve and encourage the use of plant and microbial genetic resources and associated information.

expand fundamental knowledge of plant biological and molecular processes.

develop more effective means for plant biotechnology risk assessment.

develop crop production strategies to optimize crop genetic potential, mitigate losses due to biotic and abiotic stresses, and increase production efficiency.

improve pollinator health, bee systematics and germplasm lines, and pollination.

During FY 2016, ARS will

breed superior new crops, varieties, and enhanced germplasm.

devise innovative approaches to crop genetic improvement and trait analysis.

expand crop genomic information resources and advanced bioinformatic capabilities.

conserve and encourage the use of plant and microbial genetic resources and associated information.

expand fundamental knowledge of plant biological and molecular processes.

develop more effective methods to enhance biotechnology for crop improvement.

develop crop production strategies to optimize crop genetic potential, mitigate losses due to biotic and abiotic stresses, and increase production efficiency.

improve pollinator health, bee systematics and germplasm lines, and pollination.

GOAL 3.2 – PROTECT OUR NATION'S CROPS (PLANT DISEASES, CROP PROTECTION & QUARANTINE, AND METHYL BROMIDE ALTERNATIVES – NP 303, 304 & 308)

Introduction and Background to Crop Protection: Economic losses of agricultural crops and natural ecosystems due to arthropods, plant pathogens, nematodes and weeds are considerable, with estimates in the tens of billions of dollars each year to agriculture, landscapes, and forests in the United States. Losses are due to reduced yields, lower product quality or shelf-life, decreased aesthetic or nutritional value, and food and feed contaminated with toxic compounds. Pest management strategies include cultural, biological, physical, and chemical methods. Non-chemical methods based on biological knowledge continue to expand, but the United States continues to depend heavily on chemical control to produce agricultural commodities. For instance, in 2007 over 850 million pounds of pesticides (including herbicides, insecticides, fungicides, and nematicides) were applied to agricultural crops in the United States to protect these commodities from pests and pathogens (Pesticides and Industry Sales and Usage; 2007 and 2007 Market Estimates, EPA).

Maintenance of our arsenal of valuable management strategies is a constant challenge, as inherent disease and pest resistance in crops declines while pests become resistant to chemical controls, new pest problems emerge, new regulatory requirements are enacted, and production costs increase with rising energy costs. Further, the problem of losses due to pests and plant diseases does not end in the field or with the harvest. Insects and diseases reduce the quality of stored grain and other stored products, and it is estimated that post-harvest losses to corn and wheat alone amount to as much as $2.5 billion annually. Pests and diseases can also impede foreign trade. Imported commodities as well as those destined for export must be protected from endemic and exotic pests. Exotic insect, disease, and weed pests that threaten our food, fiber, and natural ecosystems are another mounting concern, as world trade and travel continues to expand. Invasive species such as the brown marmorated stinkbug and the Asian soybean rust directly threaten our agricultural crops, while other invasive insects transmit devastating viral and bacterial diseases, like citrus greening, that threaten entire agricultural industries. Still other invasive insects such as the Asian longhorned beetle and the sudden oak death pathogen decimate our forests and urban landscapes, while invasive weeds reduce biodiversity, displace native species, and cost billions of dollars to control annually. Management of arthropod pests, plant diseases, and weeds is essential for providing an adequate supply of food, feed, fiber, and ornamental crops, but effective control depends on understanding the biology and ecology of these deleterious organisms as well as beneficial ones.

The Action Plan Guides Strategic Plan Development:

- **Plant Pathogens and Nematodes**: Numerous, diverse approaches are needed to protect our crops from arthropods, plant pathogens, nematodes and weeds. To manage plant pathogens and nematodes, ARS will: 1) develop and improve rapid and reliable methods for detection and identification of plant pathogens and nematodes.; 2) enhance knowledge of the etiology of plant diseases and systematics of their pathogens; 3) provide in-depth knowledge of the biology, ecology, and epidemiology of plant pathogens and their interactions with hosts and vectors to identify targets for new disease management strategies; 4) develop and deploy host resistance against plant diseases and nematodes, and 5) develop biologically-based and integrated disease management strategies.

- **Weeds:** To reduce the impact of weeds on the nation's agricultural and natural systems, ARS will 1) develop novel weed management solutions to control the reproduction and spread of invasive and weedy plants—based on new knowledge derived from plant genomics, biochemistry, and physiology; 2) expand integrated weed management programs by incorporating newly identified natural products or natural enemies, such as fungi, bacteria, viruses, nematodes, and insects; 3) determine the mechanisms of herbicide resistance in weeds and enhance knowledge of the biology, physiology, and ecology of weeds, so as to develop cropping system methods that mitigate herbicide resistance development and spread; 4) develop spatial models to monitor and control invasive plants in complex landscapes; 5) develop recommendations for restoring

natural systems in ways that prevent weed invasions following effective biological control; and 6) identify effective weed management solutions for reduced tillage, low herbicide input, and organic production systems.

- **Arthropods:** To ensure the cost effective management and control of native and invasive arthropod plant pests, ARS will 1) develop new bioinformatic tools that enhance insect species identification; 2) identify genetic, biological, and ecological determinants of plant insect pests that can be manipulated to improve their control; 3) determine critical factors involved in disease transmission by insects; 4) improve insect monitoring and capturing methodologies by identifying, synthesizing, and field-testing semiochemicals, 5) develop new biological, chemical, and cultural methodologies to control plant insect pests, 6) improve or develop sterile insect technique technologies to eradicate insect pests; and 7) develop systems for rearing natural enemies that have been demonstrated to be effective and safe biological control agents.

Key Outcomes: The key outcomes of this research will be the knowledge and improved capacity needed to protect plants in agricultural and natural systems –including the safe production and trade of food, feed, fiber, ornamentals, industrial products, and biofuels. This research and the transfer of resulting technologies will provide globally competitive and sustainable agricultural systems, safe and nutritious food, and healthy landscapes.

Performance Measure

4.3.2 Provide scientific information to increase our knowledge of plant 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.

Indicator 1:

During 2013, ARS will continue to identify and characterize genes of insect, nematode, and plant pathogen resistance in crop plants, closely related non-crop species, and other species, to enhance opportunities for developing host plant resistance, and to incorporate such genes into commercially acceptable varieties.

FY 2013 Accomplishments*:*

Plant defense pathway in resistance to Fusarium head blight. Fusarium head blight (FHB) is one the most significant threats to wheat and barley production in the U.S. and worldwide; however, little is known about the genetic mechanisms that can provide resistance to this disease. Plants possess multiple genetic pathways to provide defense against pathogen attack. A novel genetic assay developed by ARS researchers in West Lafayette, IN, has demonstrated that one of these pathways, known as the basal defense pathway, plays an essential role in FHB resistance.

***Impact*:** Defining which defense pathway is essential for resistance to Fusarium head blight provides crucial direction for efforts to engineer wheat and barley with improved resistance.

Nematode resistance in soybean. Genetic resistance to the attack of plants by soil-borne nematodes in soybean is controlled by three genes. ARS scientists in Madison, Wisconsin and university collaborators developed a quantitative assay to measure the expression of one of these genes. This gene protects soybeans from attack by the soybean cyst nematode, the most economically damaging pathogen of soybeans in the United States. The analysis demonstrated that all three genes contribute to genetic

resistance, with more copies of the gene resulting in stronger resistance.

***Impact*:** This finding opens significant new avenues for determining how plant genes confer resistance to plant pathogens, and how plant breeders might be able to develop soybeans with stronger resistance for growers.

Methods for identification of resistance to Polymyxa betae in sugarbeet. Rhizomania disease of sugarbeet, caused by Beet necrotic yellow vein virus (BNYVV) is transmitted by the soil-borne organism, Polymyxa betae. ARS researchers in Salinas, California, discovered that P. betae has a significant, adverse impact on sugarbeet protein expression. Experiments were conducted to optimize experimental conditions, determine presence or absence of virus, and facilitate evaluation of sugarbeet cultivars for resistance to P. betae. These methods are being used to screen sugarbeet breeding lines and wild beet varieties for sources of resistance to P. betae, as well as understand virus-vector interactions that may influence performance of resistant lines.

***Impact*:** Results should lead to identification of sugarbeet breeding lines with resistance to P. betae that may enhance performance of BNYVV resistance genes, improving sugar production.

Multi-virus resistant bottle gourd (Lagenaria siceraria) lines with potential as rootstocks for watermelon grafting. Viral diseases are one of the major factors limiting watermelon production. Several insect-transmitted viruses in the family Potyviridae, including Papaya ringspot virus watermelon strain, Watermelon mosaic virus, Zucchini yellow mosaic virus, and Squash vein yellowing virus, can cause serious damage to watermelon production. In recent years, grafting watermelon to a rootstock is gaining popularity in the U.S. However, many current commercial watermelon rootstocks are susceptible to infection by one or more of these viruses. In the present study, ARS scientists in Charleston, South Carolina, evaluated several breeding lines of bottle gourd for resistance to the four above-mentioned viruses in greenhouse trials, and confirmed their field performance for multi-virus resistance in two consecutive years at two locations in South Carolina.

***Impact*:** These breeding lines with broad spectrum virus resistance are useful materials for plant breeders focused on developing superior bottle gourd varieties that can be deployed as watermelon rootstocks. These materials will be made publically available through an ARS germplasm release.

Indicator 2:

During 2013, ARS will continue to develop fundamental knowledge about biology and ecology that provides the foundation for strategies to exclude, accurately detect and identify, and mitigate arthropod and nematode pests, weeds, and plant pathogens.

FY 2013 Accomplishments*:*

Excessive iron triggers nickel deficiency. Nickel deficiency not only influences alternate bearing by pecan trees, but also reduces yield and quality of many other crops. Factors affecting the cellular bioavailability of nickel in plants have the potential to influence the health, yield, and quality of plant products. ARS researchers in Byron, Georgia, determined that nickel deficiency is easily induced by excessive iron fertilization or plant exposure to iron. The scientists noted that the iron acts in an antagonistic manner to nickel bioavailability and nutritional physiology.

***Impact*:** This research identifies an important micro-nutrient interaction in plants that has heretofore been unrecognized and has the potential for practical applications in agriculture. For example, the research identified iron fertilization as a means of alleviating nickel toxicity in crops, especially those

growing on highly mineralized serpentine soils. The findings also highlight the possible existence of iron-induced nickel deficiency occurring in many cropping systems where iron is a fertilizer supplement.

Rootstock impacts on fruit quality parameters in grapefruit. The devastating impact of Huanglongbing on citrus fruit production has spurred increased interest in the impact of rootstocks on the tree performance in Huanglongbing affected trees. A two year study to determine the effects of rootstock on grapefruit was completed by ARS scientists in Ft. Pierce, Florida. As part of a multiyear rootstock trial, ARS scientists in Ft. Pierce, FL documented significant affects of rootstock on both time of maturity and standard fruit quality parameters (fruit size, peel thickness, fruit shape, total sugar and acid contents).

***Impact*:** The results are beneficial to citrus producers who must make decisions regarding rootstock selection when establishing new orchards.

Use of biochar as a component in greenhouse substrates. Fertilizers are becoming increasingly expensive due to the energy required to manufacture them or the cost of mining the raw materials. Phosphorus and potassium are two of the primary nutrients used in fertilizers. ARS scientists in Wooster, Ohio, determined that gasified rice hull biochar, a commercially abundant byproduct from the processing of rice, contains a high concentration of phosphorus and potassium, and has potential as an alternative source for use in commercial potting substrates for greenhouse and nursery crops. The scientists determined that the optimal rate for amendment with gasified rice hull biochar into a typical greenhouse potting substrate is 10 percent by volume. At this rate, sufficient phosphorus and potassium are provided for a variety of crop species without additional nutrients being provided.

***Impact*:** This data provides the industry with baseline information on rates of application that can be used when this product becomes available to the horticultural industry.

High fructose corn syrup and honey bee colony health. When flowering plants are unavailable, beekeepers feed colonies high fructose corn syrup to supplement their diets. ARS researchers in Tucson, Arizona, found significantly larger adult bee populations in colonies fed sucrose syrup compared with those fed high fructose corn syrup. This finding complements earlier studies showing shorter life spans in worker bees fed high fructose corn syrup compared with sucrose.

***Impact*:** This information allows commercial beekeepers to select better diets for their bee colonies to leave them less vulnerable to loss from environmental fluctuations, parasites, and pathogens.

Causal agents discovered for maize lethal necrosis disease. In 2012, a new corn disease, maize lethal necrosis, emerged in Kenya, which caused growers to experience 40 to 100 percent crop losses. While maize lethal necrosis has not yet been found in the United States, the $60 billion U.S. corn crop is vulnerable to this disease. ARS researchers in Wooster, Ohio, collaborated with scientists from the International Maize and Wheat Improvement Center and the Kenya Agricultural Research Institute to identify two viruses, Maize chlorotic mottle virus and Sugarcane mosaic virus, in diseased maize that together cause the maize lethal necrosis disease.

***Impact*:** This finding enables ARS scientists and collaborators to identify disease control measures and to develop screening protocols needed to breed disease-resistant corn hybrids.

Natural plant molecules disrupt nematode development. Safe strategies for managing plant parasitic nematodes should effectively control these target pests while having minimal impact upon the environment and nontarget species. Using the most economically important plant nematodes in the United States, the soybean cyst nematode and the root knot nematode, ARS scientists in Beltsville,

Maryland, found that plant chemicals called catechins inhibit nematode hatching and also significantly inhibit nematode enzymes called proteases. The catechins affect three specific proteases that are part of a complex structure central to nematode survival. Without proper protease function, nematodes fail to develop and will die.

> ***Impact*:** This discovery is important because it demonstrates a molecular basis for how this plant chemical can suppress plant parasitic nematode development and reproduction at low doses. In addition, it also demonstrates that catechins can be used as nematode control agents. This information will help scientists develop precision treatment strategies for controlling plant parasitic nematodes and help growers seeking to decrease synthetic chemical use in crop protection.

New species of cyst nematode. Cyst nematodes are an important group of plant pathogens because they damage the roots of many kinds of crop plants worldwide and can halt trade between countries because they may be regulated by quarantine. ARS scientists in Beltsville, Maryland, and Corvallis, Oregon, in collaboration with Oregon State University, described the detailed anatomical and molecular features of a new cyst nematode, Globodera ellingtonae, discovered in soil samples collected during surveys to detect potato cyst nematodes. The new nematode, which was first found in Powell Butte, Oregon, shares key anatomical features with two potato cyst nematodes species of regulatory concern, the pale potato cyst nematode and the golden nematode. The newly described species can confound accurate diagnosis of potato cyst nematodes because current molecular tests are not set up to identify it.

> ***Impact*:** The morphological and molecular data describing this lookalike species will help scientists, regulators, and extension agencies to more accurately identify and prevent the spread of potato cyst nematodes.

Causative agent of red blotch disease of grapevine. Red blotch disease causes significant vineyard losses due to reduced yields and grape quality. ARS scientists in Davis, California, discovered and characterized a new Gemini-like virus, associated with this disease, named Grapevine red blotch-associated virus (GRBaV). Epidemiology of Red Blotch disease suggests GRBaV exhibits insect-mediated transmission. The scientists developed red blotch-specific DNA primers to detect and quantify the virus.

> ***Impact*:** These DNA primers are now widely used by both diagnostic testing services and grapevine virologists around the world including in the United States, Australia, Canada, France, Italy, New Zealand, and South Africa.

Indicator 3:

During 2013, ARS will perform applied research and development to provide new, useful and safe products to exclude, accurately detect and identify, and mitigate arthropod and nematode pests, weeds, and plant pathogens.

FY 2013 Accomplishments*:*

First molecular phylogeny of the family Tortricidae (leaf-roller moths). Phylogenies provide working hypotheses of genealogical relationships among organisms that can be used to develop more robust and meaningful classifications, track the evolution of character states, and potentially predict behavior, host utilization, and invasiveness of plant-feeding insects. ARS scientists, working with international collaborators that included scientists from the University of Maryland and the Smithsonian Institution developed the first molecular phylogeny for the leaf-roller moth family, Tortricidae. This family includes numerous pests of crops, ornamentals, and forests worldwide. The phylogeny is based on a model that

attempts to group species according to common evolutionary ancestors. The practical implications of such a phylogeny can be that evolutionarily related species share characteristics of concern to agriculture. The study performed by ARS scientists and collaborators showed that species depositing small batches of eggs usually feed inside fruits; whereas, species laying large clusters of eggs tend to feed externally on a wide variety of plants. The internal feeders are more difficult for inspectors to detect in commodities shipped to the United States. The phylogeny gives inspectors the tool necessary to predict what species are likely to be feeding internally, therefore justifying more intense inspection.

> ***Impact*:** These findings will provide a broad-scale framework for predicting which tortricid species are most likely to cause significant economic damage to fruit and seed crops and which species may elude detection at ports of entry. Prevention of the introduction of invasive species is more efficient than attempts to control pests following their introduction. These findings will directly support USDA APHIS border protection responsibilities.

Robotic high-throughput extraction procedures for citrus pathogens. Rapid and standardized methods are needed for detection of citrus pathogens for certification and disease management programs, including nursery pathogen-free budwood certification that is critical to establish healthy citrus orchards. ARS researchers in Parlier, California, in collaboration with scientists at the University of California, Riverside, the University of Bari in Bari, Italy, and, Consiglio Nazionale Delle Ricerche Bari (National Research Council), adapted an automated procedure for nucleic acid extraction from citrus tissue. The scientists optimized homogenization and reagent concentrations for pathogens from citrus using a robot with magnetized beads. The samples contained enough pathogen RNA and DNA to allow reliable detection of pathogens in PCR assays.

> ***Impact*:** The new extraction method is being used by the California Citrus Research Board's Dimitman Laboratory for diagnosis of the pathogen associated with Huanglongbing (also known as citrus greening), as well as the University of California Citrus Clonal Protection Program in Riverside, California for citrus nursery pathogen-free budwood certification.

Reducing environmental impacts of wine grape production. Better identification of the environmental impacts of wine grape production could help growers facilitate targeted improvement in production system sustainability. ARS scientists in Davis, California, have developed a tool that helps growers and policymakers understand the full environmental impacts of an agricultural production system and identify ways to improve overall efficiency. The Life Cycle Assessment (LCA) tool has been used to assess environmental impacts of wine grape production across a range of vineyard management regimes in two important growing regions of California. The tool evaluates resource extraction; manufacturing of raw materials into products used in wine grape production (e.g., herbicide and fertilizer) and their subsequent transport to the vineyard; activities and energy required to grow the wine grapes (e.g., irrigation and harvest); and final transport of wine grapes to the winery.

> ***Impact*:** The tool helped scientists discover a number of alternative management practices, including but not limited to compost, reduced irrigation, and various cover cropping systems that will assist growers seeking to improve the energy use and air emissions of their vineyards.

Drift reduction protocol for aerial and ground spray applications. With numerous new spray technologies and methods being developed for drift reduction, standardized measurement and evaluation methods are needed to advise applicators on the degree of drift reduction. ARS researchers in College Station, Texas, working closely with the U.S. Environmental Protection Agency and other research and manufacturing entities, evaluated and refined application protocols and techniques, and developed a generic testing protocol that provides objective and unbiased testing of various drift reduction techniques.

***Impact*:** The protocol, entitled "U.S. EPA Generic Verification Protocol for Testing Pesticide Application Spray Drift Reduction Technologies for Row and Field Crops," was released by the EPA Office of Pesticide Programs in mid 2013. The document is a critical regulatory resource to assure minimization of drift in agricultural spray applications.

Chemistry of nesting attractants identified for alfalfa leafcutting bees and blue orchard bees. It has long been known that alfalfa leafcutting bees (ALB) and blue orchard bees (BOB), both solitary-nesting bees, are attracted to old nesting sites. For BOB, ARS scientists in Logan, Utah, and Fargo, No. Dakota, identified chemical cues responsible for nest selection, and then developed artificial nest attractants based on some of these compounds.

***Impact*:** A commercial product is currently being evaluated. ARS scientists found that only some components of old nests are attractive to ALB, but have not identified the critical chemical components. Attractants will allow farmers to retain more bees in desired locations.

Molecular diagnostic assay for wheat stem rust Ug99 strains. Strains of the wheat stem rust pathogen in the group Ug99 are threats to wheat production worldwide, and while these strains are not yet in the United States, U.S. wheat varieties are vulnerable to Ug99. Until now, the only way to distinguish Ug99 strains from other forms of wheat stem rust was to put the fungus spores on wheat plants and wait for disease to develop. ARS scientists in St. Paul, Minnesota, have developed a two stage assay based on fungal DNA to distinguish among rust strains. The first stage determines if the sample belongs to the Ug99 strain group, while the second stage predicts the specific strain.

***Impact*:** This assay is currently being used to track the movement of the Ug99 in Africa where the disease is endemic. Deployment of this assay in the United States would greatly enhance growers' ability to detect and identify any Ug99 introductions and to provide information for responding to potential outbreaks.

Method for the detection of Triticum mosaic virus developed. The availability of diagnostic methods for rapid, sensitive, and large-scale detection of viruses is crucial for the management of plant viral diseases. Diagnostic methods for Triticum mosaic virus, a recently reported virus from the Great Plains region, are not available. ARS scientists in Lincoln, Nebraska, produced polyclonal antibodies against the bacterially expressed coat protein of Triticum mosaic virus. In enzyme-linked immunosorbent assays (ELISA), these antibodies detected various isolates of Triticum mosaic virus in crude plant sap, but not in extracts of healthy or Wheat streak mosaic virus-infected plants. The availability of Triticum mosaic virus antibodies would provide a high-throughput ELISA-based detection method and germplasm screening in wheat breeding programs.

***Impact*:** A biotechnology company is in the process of commercializing these antibodies for the development of a Triticum mosaic virus diagnostic kit.

Varroa mite migration represents a new control challenge. Varroa mites are a major cause of colony losses in honey bees because they parasitize bees and spread viruses in the colony. ARS researchers in Tucson, Arizona, devised a treatment schedule to control Varroa based on colony and Varroa population dynamics. The researchers found that Varroa populations could be kept at low levels throughout most of the summer with this treatment schedule. However, by fall, mite populations were much larger than predicted or than could be accounted for by mite reproduction alone. The researchers determined that mites appear to be migratory and move between colonies with far greater frequency than previously thought.

Impact: This finding led to changes in recommendations on Varroa control that include a late fall treatment so mite populations remain low over the winter to prevent the loss of colonies in the spring.

Biological control of the paperbark tree in Florida. In southern Florida, the invasive Australian paperbark tree (Melaleuca quinquenervia) develops monocultures in natural areas. The weed's environmental plasticity coupled with fire resistance, high reproductive potential, and deposition of large quantities of slowly degrading litter, lowers species diversity. ARS researchers in Fort Lauderdale, Florida, with collaborators at the ARS Australian Biological Control Laboratory in Brisbane discovered three biological control agents that eat the paperbark tree: a weevil (Oxyops vitiosa), a psyllid (Boreioglycaspis melaleucae), and a midge (Lophodiplosis trifida). These agents were rigorously tested for host-specificity and released on the trees in southern Florida, where they have established. Together with an adventive (from a different region and not yet fully established) rust fungus (Puccinia psidii), the released insects have defoliated, thinned the crowns, and killed paperbark trees. In 2011, an overall assessment of research sites showed a 30-fold decline in paperbark tree density, which translated into a nine-fold increase in native plant species richness. There was rapid re-colonization of vegetation gaps created by death of the paperbark trees, with the majority of re-colonizing species being members of native plant communities, e.g., sawgrass, dahoon holly, and wax myrtle. In addition, there has been a reduction in paperbark tree seedling recruitment due to lower seed quality and quantity. Since the biological control agents were introduced, paperbark tree monotypic landscapes are being progressively transformed into more diversified, healthier, plant communities. Using these biocontrol agents, by FY13 with efforts by cooperators, the original 200,000 hectares invaded by the tree is now reduced to 100,000 hectares, with a 30 percent reduction in the Everglades, and acreage decline continues throughout the state. This is an example of successful classical biological control combined with integrated weed management.

Impact: The total benefits of paperbark control in south Florida were estimated at $23.3 million. The biocontrol ratio for agricultural lands was 7.83 to 1. Also, agricultural managers reported lower costs since they have not been treating the paperbark tree as aggressively, and therefore have a greater marginal value at this stage of their control efforts. As a result of this research, land managers and private land owners are now equipped with the tools needed to implement a biologically-based paperbark tree management program on the lands they manage. This program can legitimately be credited with saving the Everglades ecosystem. This work supported multiple federal, state, and local agencies.

Performance Target

3.2.A 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.

Baseline 2012	Target 2017
Technologies produced by ARS were transferred to growers and producers, action agencies, the research community, and exporters and importers of agronomic products to exclude, eradicate and/or better manage disease and	At least 30 new or improved technologies produced by ARS will be transferred to growers and producers, action agencies, the research community, and exporters and importers of agronomic products to exclude,

pest outbreaks as they occur in the United States or prior to their arrival on our shores.	eradicate and/or better manage disease and pest outbreaks as they occur in the United States or prior to their arrival on our shores.

Measure 4.3.2 Summary of the Major Technologies Developed, Transferred, and Used in FY 2013:

During FY 2013, ARS reported on 7 new technologies adopted.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Flat mite identification tool on the Web	ARS researchers, in collaboration with APHIS, developed an interactive online identification key with descriptors and numerous images using light microscopy and low temperature scanning electron microscopy.	Farmers, extension agents, State and university researchers, government agencies, and APHIS quarantine specialists	Controlling mites and plant diseases vectored by mites
Attractants for brown marmorated stink bug	ARS researchers developed and commercialized a new synthesis of methyl decatrienoate for use in monitoring traps and discovered the true male produced aggregation pheromone of the stink bug, confirmed it in field trials, and developed it into a commercial version that has been transferred to the private sector.	Farmers, extension agents, and State and university researchers	Effective management of the pest and new trap-and-kill techniques to reduce pesticide usage
Natural enemies against invasive giant reed in the Rio Grande valley	Identification of two biological control agents, proof that they would not harm native plants or crops, and development of mass rearing techniques	USDA APHIS and DHS Customs and Border Patrol	Improvement in water availability for agriculture, greater visibility for detection of illegal aliens and tick-bearing cattle
Combination sulfur dioxide and cold to kill spotted-wing drosophila on table	Technology transferred directly to exporters	Table grape exporting industry	Millions of dollars in commodity export shipments made possible

grapes			
Ozone treatment to remove fungicide residues on grapes	Technology transferred directly to exporters	Table grape exporting industry	Millions of dollars in commodity export shipments made possible
Validation of methyl bromide treatment of cherries for quarantine treatment	Technology transferred directly to exporters	Cherry growers and exporters	Millions of dollars in commodity export shipments made possible
Method to detect and distinguish wheat stem rust strain Ug99	Transferred to USDA-APHIS for validation	Wheat and barley producers and consumers	This new diagnostic test will serve as an early warning system to manage and contain a pathogen that could damage 45 million acres of U.S. wheat

4.3.2: Provide scientific information to increase our knowledge of plant 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.

During FY 2014, ARS will

continue to identify and characterize genes of insect, nematode, and plant pathogen resistance in crop plants, closely related non-crop species, and other species, to enhance opportunities for developing host plant resistance, and to incorporate such genes into commercially acceptable varieties.

continue to develop fundamental knowledge about biology and ecology that provides the foundation for strategies to exclude, accurately detect and identify, and mitigate arthropod and nematode pests, weeds, and plant pathogens.

perform applied research and development to provide new, useful and safe products to exclude, accurately detect and identify, and mitigate arthropod and nematode pests, weeds, and plant pathogens.

During FY 2015, ARS will

continue to identify and characterize genes of insect, nematode, and plant pathogen resistance in crop plants, closely related non-crop species, and other species, to enhance opportunities for developing host plant resistance, and to incorporate such genes into commercially acceptable varieties.

continue to develop fundamental knowledge about biology and ecology that provides the foundation for strategies to exclude, accurately detect and identify, and mitigate arthropod and nematode pests, weeds, and plant pathogens.

perform applied research and development to provide new, useful and safe products to exclude, accurately detect and identify, and mitigate arthropod and nematode pests, weeds, and plant pathogens.

During FY 2016, ARS will

continue to identify and characterize resistance genes in crop plants for insect, nematode, and plant pathogens, to enhance opportunities for developing host plant resistance, and to incorporate such genes into commercially acceptable varieties.

continue to develop fundamental knowledge about biology and ecology that provides the foundation for strategies to exclude, accurately detect and identify, and mitigate arthropod and nematode pests, weeds, and plant pathogens.

perform applied research and development to provide new, useful and safe methods and products to accurately detect, identify and diagnose, arthropod and nematode pests, weeds, and plant pathogens.

Strategic Goal Area 4:
Animal Production and Protection

The mission of the ARS Animal Production and Protection (APP) national programs is to provide the scientific information and tools to help support the U.S. food animal industries to continue to compete successfully in worldwide trade, provide the supply of nutritional animal products required by the Nation, and contribute toward global food security. APP will accomplish this mission by maximizing 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 regulatory agencies responsible for trade, biodefense, and global food security. Emphasis will be given to genetic improvements of traits related to production and production efficiencies and germplasm conservation; understanding the mechanisms of disease resistance, and the development of tools to prevent, control, or eradicate diseases that threaten our 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 portion of the program that produces new solutions to the many veterinary problems created by arthropod pests and vectors will be leveraged to solve related problems affecting human health and the well-being of American citizens.

GOAL 4.1 – PROVIDE SCIENTIFIC INFORMATION AND BIOTECHNOLOGIES TO ENHANCE MANAGEMENT PRACTICES THAT WILL ENSURE AN ABUNDANT SUPPLY OF COMPETITIVELY PRICED ANIMAL AND AQUACULTURE PRODUCTS: (ANIMAL PRODUCTION AND AQUACULTURE - NP 101 & 106)

U.S. production systems for food animals and aquaculture 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, including increased production, improved production efficiencies, economic and environmental sustainability, ensuring animal well-being and improved product quality and healthfulness for consumers.

The demands placed on the national system of food animal production by a rapidly changing world can only be met by technologies that optimally harness the inherent genetic potential of animal germplasm in concert with industry stakeholders. Production systems that successfully harness that genetic potential will maximize profits, secure supply, increase market competitiveness, sustain small and mid-sized producers, maintain genetic diversity and increase consumer confidence. These optimized production systems will also ensure the economic and environmental sustainability of animal agriculture while enabling production of animal products adequate to meet the dramatically increased demand for animal products worldwide.

Consequently, the overall mission of ARS animal production and aquaculture systems is to 1) safeguard and utilize animal and microbial genetic resources, associated genetic and genomic databases, and develop robust bioinformatics tools; 2) develop a basic understanding of the physiology of livestock, poultry, and aquaculture; 3) develop improved understanding of nutritional requirements for animals, particularly in aquaculture and improve the efficiency of nutrient utilization for animals; and 4) develop information, tools, and technologies that can be used to improve animal production systems, all to ensure an abundant, safe, and inexpensive supply of animal products produced in a healthy, competitive, and sustainable animal agriculture sector of the U.S. economy.

Performance Measure

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

Indicator 1:

During 2013, ARS will identify underlying genetic and/or physiologic mechanisms relating to food animal production and production efficiencies for traits associated with growth physiology, nutrient utilization, reproductive physiology, health, and well-being in food animals.

FY 2013 Accomplishments*:*

High survival of bacterial cold water disease resistant rainbow trout line in farm trials. Bacterial cold water disease (BCWD) is a frequent cause of farmed trout loss. ARS researchers at Leetown, West Virginia have developed a BCWD resistant rainbow trout line, through multiple generations of genetic selection for improved disease resistance. Three consecutive years of performance testing of these fish were carried out under farm conditions. In five completed trials to date, in which non-select fish were diagnosed with BCWD, survival of the select line has been 95% from initial feeding through the early rearing phase. This was significantly greater than non-selected fish grown together. In addition to greater survival, the select line had a smaller percentage of fish that tested positive for the pathogen that causes BCWD.

> ***Impact:*** These findings support the release of germplasm to stakeholders and the continued evaluation of the select genetic line in large-scale production trials. (NP106, C1, 4, PS1b, PS4b, Wiens, 005-00D)

Vaccine developed to protect tilapia against Streptococcal disease. Streptococcosis caused by *Streptococcus (S.) agalactiae* is a hyperacute systemic disease that affects cultured and wild fish in freshwater, estuarine, and marine aquatic environments. ARS researchers at Auburn, Alabama, developed a vaccine to protect tilapia against infections from multiple strains and multiple types of the bacteria *S. agalactiae*, by growing the bacteria in the presence of antibiotics.

> ***Impact:*** The vaccine provides significant protection to tilapia against infections of many strains of the bacteria *S. agalactiae,* and reduces heavy losses to this disease. (NP106, C4, PS4c, PM?, Pridgeon 024-00D)

Kaolinitic clay protects fish from columnaris disease. Columnaris disease, caused by the bacterium Flavobacterium columnare, is a costly disease of many commercially grown fish species, including channel catfish. Despite its importance, few preventatives or therapies exist for this disease. In this study, a type of clay called kaolin was evaluated for the prevention of columnaris disease. ARS scientists in Stuttgart, Arkansas, demonstrated that addition of kaolin to the water significantly improved the survival of channel catfish that were experimentally challenged with the disease, and protected the gills from damage by the bacteria.

> ***Impact:*** Data suggests that kaolin works by binding to the bacteria, thereby preventing it from attaching to the fish and initiating disease. Kaolin is a novel, non-antibiotic treatment to increase survival rates in catfish hatcheries. (NP106, C4, PS4c, Straus, 005-00D)

Understanding the variation in genetic resistance to Marek's disease (MD) in poultry. Enhancing genetic resistance to Marek's disease in chicken, a complex trait controlled by many genes, is highly desired to augment current controls through vaccines and biosecurity. Using genetic markers spaced throughout the genome, an ARS scientist in East Lansing, MI, in collaboration with Purdue University demonstrated that those markers associated with variation in gene expression account for all the genetic variation in an experimental population. If confirmed in commercial poultry lines, this would prove that genomic selection with these types of genetic markers would significantly improve elite poultry lines against MD, and is likely to be the case for genetic resistance to other infectious pathogens as well.

> ***Impact:*** Poultry producers and U.S. consumers would benefit through the production of healthier and more efficient birds yielding more economically produced poultry products. NP101, C2, PS2D, PM1.4.1, Project No. 3635-31320-009-00D

Identification of engineered antimicrobial proteins that eradicate staphylococcal mastitis pathogens in dairy. The U.S. dairy industry loss due to mastitis (infections of mammary glands) exceeds $2 billion annually. Mastitis is also responsible for the greatest use of antibiotics on the dairy farm despite an international effort to reduce antibiotic use in agriculture. The bacterial pathogen, Staphylococcus aureus (S. aureus), can evade most conventional antibiotics by invading and residing inside the cells (intracellularly) of the cow mammary gland; leading to chronic infection and increased culling of infected animals. Conventional antibiotics do not kill intracellular pathogens. Thus, novel antimicrobials that were effective at killing intracellular bacteria would benefit the dairy industry for the treatment of mastitis and help to replace antibiotics that are facing high levels of resistant strain development. ARS scientists in Beltsville, MD demonstrated that an engineered antimicrobial protein facilitates transport across the mammary cell walls into intracellular spaces. Scientists then fused the protein to a previously engineered antimicrobial protein with three distinct enzyme activities.

> ***Impact:*** The top candidate engineered antimicrobial protein, for the eradication of intracellular S. aureus in cultured cell assays, showed the ability to reduce the S. aureus infection 1000-fold in a mouse mastitis model. This technology presents a novel alternative mastitis treatment to effectively treat and potentially eliminate bovine mastitis; and thus significantly reduce the need for conventional antibiotic use on the dairy farm. NP101, C2, PS2E, PM1.4.1, Project No. 1245-31000-103-00D

Indicator 2:

During 2013, ARS will develop genomics infrastructure and tools to efficiently identify genes, their function, and interactions with environmental factors for exploitation in genome enabled improvement programs for food animals

FY 2013 Accomplishments*:*

Development of international genomic evaluations for young dairy bulls. Genomic evaluations have rapidly replaced traditional evaluation systems used for dairy cattle selection and have had tremendous impact in increasing genetic progress. However, accurate, unbiased comparison of genomic evaluations from different countries has not been possible because of differences in national methodologies and data included in evaluations. ARS scientists collaborated with the Canadian Dairy Network (Guelph, Ontario) and the Interbull Centre (Uppsala, Sweden), a genomic multitrait across-country evaluation (GMACE) system which was developed by modifying techniques used in traditional international evaluations. Initial implementation of GMACE for young Holstein bulls was completed in August 2013 by Interbull Centre.

Impact: The availability of accurate international genomic evaluations for young bulls will allow breeders to now select globally from the best animals, thereby providing access to a much larger genetic pool and increasing the rate of genetic progress for dairy production worldwide. NP101, C2, PS2D, PM1.4.1, Project No. 1245-31000-101-00D

Finding markers to predict reproduction efficiency in beef cattle using a Genome Wide Association Study (GWAS) approach. Reproductive efficiency is arguably the most economically important trait in commercial beef cattle production, as failure to achieve pregnancy reduces the number of calves marketed per cow exposed to breeding. Identification of variation in the genome with predictive merit for reproductive success would facilitate accurate prediction of daughter pregnancy rate in sires enabling effective selection of bulls whose daughters have improved fertility. Scientists at Clay Center, NE applied a Genome Wide Association Study (GWAS) approach, using a procedure based on genotyping multi-animal pools of DNA to increase the number of animals that could be genotyped with available resources. The study identified regions of the genome associated with reproductive efficiency, which are being targeted for further analysis to develop robust marker systems, and demonstrated that DNA pooling can be used to substantially reduce the cost of GWAS studies in cattle. A specific deletion of DNA along chromosome 5 in Bos indicus crossbred cattle was identified that is strongly correlated with reproductive failure, providing a potentially useful marker for breeders in sub-tropical areas that make use of these types of cattle.

Impact: These results demonstrate the ability to leverage the bovine genome sequence to improve reproductive efficiency in beef cattle for the beef industry while significantly reducing technology costs for research communities. NP101; C1,C2, PS1B,2B; PM1.4.1, Project No. 5438-31320-012-00D

Introduction of free genetic tests for inherited defects of dairy cattle. A method to identify exact locations of loss-of-function mutations and DNA sequences associated with lethal or undesirable conditions of dairy cattle was developed by ARS scientists in Beltsville, MD and automated over the past 2 years. However, results from that method could not be made available to the dairy industry because the respective DNA sequences were associated with patented genes. Genetic tests were available for some of the lethal mutations, most females were not tested because individual gene tests were expensive and not included on genotyping chips until very recently. The June 2013 U.S. Supreme Court unanimous decision that biotechnology companies cannot patent genes that occur naturally has made possible the release of information from genetic tests for bovine leukocyte adhesion deficiency (BLAD), deficiency of uridine monophosphate synthase (DUMPS), and mulefoot in Holsteins; as well as Weaver Syndrome, spinal dysmyelination (SDM), and spinal muscular atrophy (SMA) in Brown Swiss. For Holsteins, the method also can be applied to identify DNA markers associated with complex vertebral malformation (CVM) and brachyspina as well as for desired traits such as red coat color and polledness (no horns). In addition, four new deleterious DNA sequences have been identified for dairy cattle fertility, and those sequences have been incorporated into new genotyping chips.

Impact: The first release of genomic status information for the inherited defects occurred in August 2013 and is expected to provide the tools for dairy producers to reduce or eliminate costs for genetic testing, decrease the frequency of undesired traits, and increase the rate of genetic progress for desired traits through significant improvements in reproductive efficiency, health and animal well-being. NP101; C1 C2; PS1B,1C,2A,2B,2D; PM1.4.1, Project No. 1245-31000-101-00D

Significant improvements in the bovine genome sequence. Gene expression is regulated by transcription factors which link or bind to specific genes which in turn then signal the production of proteins or other gene products. Understanding the complex interaction of the genome and specific gene expression would be significantly improved with a more complete understanding of transcription factor

binding sites. ARS scientists in Beltsville, MD identified ~380,000 candidate transcription factor binding sites (TFBS) for ~8,000 annotated genes in the cattle genome and the intersection of several hundred gene mutations (SNPs) and TFBS. This novel bovine TFBS information will greatly facilitate ongoing cattle genome sequence annotation. Newly identified SNP–TFBS intersections represent high priority regions of interest for follow-up studies such as RNA-seq, QTL mapping and GWAS in order to link gene variants within TFBS to phenotypes. In related work ARS scientists developed an innovative computer approach to detect copy number variation (CNV) using novel sequencing technologies for the bovine genome sequence. CNV regions are a key source of genetic variation in cattle, but are not yet well cataloged or understood. This program generated thousands of new CNV regions, which will enable future studies of these highly variable regions in the cattle genome.

> ***Impact:*** Specifically, this software will provide a "second-generation" cattle CNV map - a crucial resource for industry and academic genotyping technologies and industry wide sequencing efforts like the 1000 Bull Genome Project. This technology will also significantly improve the cattle reference genome and its annotation by filling in novel sequence information and can be easily re-purposed for other livestock species. NP101, C2, PS2D, PM1.4.1, Project No. 1245-31000-104-00D

Indicator 3:

During 2013, ARS will develop and improve sustainable production systems for food animals; incorporating strategies to optimize production system efficiency while ensuring economic and environmental sustainability.

FY 2013 Accomplishments*:*

Intensive production of hybrid catfish. Agricultural Research Service researchers at Stoneville, Mississippi, have completed four years of research on the intensive production of hybrid catfish (a cross between channel catfish females and blue catfish males). Production of hybrids has reached over 20% of the catfish produced (nearly 200 million juveniles per year, up from only a few million 5 years ago). Research has demonstrated that hybrid catfish can tolerate a slightly lower dissolved oxygen concentration than channel catfish. They also have better tolerance to common diseases affecting catfish, resulting in a greater feed intake through spring and fall when diseases are more common.

> ***Impact:*** Continued adoption of hybrid catfish by the industry is resulting in increased profits due to faster growth (reduced production cycle), increased survival, and improved food conversion ratios. (NP106, C5, PS5b, PM?, Torrans 004-00D)

Development of an improved aerator for the catfish industry. Supplemental aeration is used by all catfish producers and it is critical to maintain dissolved oxygen at levels that support high densities of catfish grown in production ponds, especially when oxygen levels drop on warm summer nights. Paddlewheel aerators have been used for aeration in aquaculture for over 30 years and while they transfer oxygen to the water efficiently, they also move a huge volume of water so the oxygen concentration increases slowly. Thus, a great deal of equipment and a large amount of power is required to prevent low DO (dissolved oxygen) conditions in commercial ponds. Agricultural Research Service researchers at Stoneville, Mississippi, have developed a new aerator, the Power Tube Airlift (PTA) which can concentrate DO into a small zone of water in a pond using less energy than traditional methods.

> ***Impact:*** This invention has a patent application currently pending with the U.S. Patent and Trademark Office. Two commercial-scale PTA's were installed in an 8-acre catfish production pond and gave promising results. This new equipment will both lower energy costs and enable higher production densities. (NP106, C5, PS5b, PM?, Torrans 004-00D)

Copper sulfate effectively controls fungus on and increases survival of sunshine bass eggs. Fungus in sunshine bass hatcheries can cause decreased hatch rates of bass eggs and decrease profits. A collaborative study with ARS scientists in Stuttgart, Arkansas, and Keo Fish Farm, Inc. (Keo, Arkansas) addressed sunshine bass egg mortality from fungal growth. This study determined the optimum concentration of copper sulfate needed to prevent fungus from destroying the eggs while allowing the hatched larvae to thrive.

> ***Impact:*** This finding has lead to improved larval survival and reduced time and effort in the hatchery, having an immediate economic benefit to the farmer with this inexpensive treatment. The majority of the industry is now using this treatment. (NP106, C4, PS4b, Straus, 005-00D)

Influence of calving date on reproductive traits in beef cattle. Studies conducted by ARS researchers at Clay Center, NE, in collaboration with South Dakota State University and the University of Nebraska confirmed that heifers that calve early in their first season remain in the production herd longer increasing the profitability and viability of a beef production enterprise. Earlier calving heifers weaned heavier calves through their first six pregnancies, resulting in increased revenues of $500-$2000 per heifer across varying herd sizes and production systems. Additional results demonstrated that heifers that calved later and were culled from the herd earlier had smaller ovaries, and reduced uterine horn diameters along with fewer follicles in their ovaries.

> ***Impact:*** Collectively, these results indicate that pre-breeding ultrasonic evaluation of the reproductive tract can be a useful tool for removing less productive heifers from the herd prior to first breeding; and promoting early season calving for heifers; will significantly improve reproductive efficiency in the cow herd. NP101, C1, PS1B, PM1.4.1, Project No. 5438-31000-093-00D

Lysozyme is an alternative to antibiotics for young pigs consuming manufactured liquid diets. Antibiotics have been fed at subtherapeutic levels as growth promoters for more than 50 years and the majority of swine produced in U.S. receive antibiotics in their feed at some point during the production process. The addition of antibiotics to swine diets benefits producers by improving feed efficiency and decreasing susceptibility to bacterial infections. Recently, however, swine producers have been pressured to reduce or remove dietary antibiotics in response to concerns relating to the development of antimicrobial resistance in swine production. The identification of suitable alternatives to antibiotics will enable the swine industry to effectively transition away from dietary antibiotic use. ARS scientists at Clay Center, NE determined that feeding a natural antimicrobial, lysozyme, to young pigs consuming a liquid diet was as effective as antibiotics in increasing growth performance, improving gastrointestinal health, and decreasing pathogen shedding.

> ***Impact:*** This research has demonstrated an effective alternative to traditional antibiotics in swine diets for improved health, well-being, growth and efficiency.

Indicator 4:

During 2013, ARS will characterize nutrient requirements of food animals; measure nutrient availability of traditional and non-traditional feedstuffs; and develop strategies for improving nutrient use efficiency.

FY 2013 Accomplishments*:*

Fish meal-free diets developed for Coho salmon and Yellowtail. Fish meal has been the primary protein ingredient in fish feeds for decades but increasing demand and static supply is driving the search for

alternative ingredients to support expansion of aquaculture production. Scientists with the Small Grains and Potato Germplasm Research Unit in Aberdeen, Idaho, applied research and technology developed with rainbow trout to two popular marine species, Coho salmon and yellowtail (amberjack). Feeding studies with each species demonstrated that as long as all essential nutrients are supplied in a balanced diet, fish meal is not needed for optimal growth and health of the fish.

> ***Impact:*** Reducing or eliminating the dependence of aquaculture feeds on expensive marine harvested ingredients will increase profitability and sustainability of aquaculture. (NP106, C3, PS3b, Barrows, 004-00D)

Bacterial communities in the rumen differ in high-efficiency versus low-efficiency dairy cows. Milk production in cows is influenced by a number of factors, including diet, host genetics, and the bacterial communities in the rumen. Rumen bacteria are directly responsible for the production of volatile fatty acids (VFA) that are used by the cow as precursors for milkfat synthesis. ARS researchers in Madison, WI, in collaboration with the University of Wisconsin, characterized the total ruminal bacterial community and VFA profiles in eight Holstein dairy cows. These cows were separated into high- and low-production efficiency groups, and both rumen solids and liquids were analyzed for total bacterial community structure. The researchers identified significant differences in bacterial community composition between high- and low-efficiency groups and between the solid and liquid fractions. They also identified a core set of bacterial species shared among all high-efficiency cows, but no similar core set was found among the low-efficiency animals. Chemical profiles between high- and low-efficiency groups were similar, but propionic acid concentration was significantly higher in low-efficiency cows, and succinic acid was significantly higher in high-efficiency cows.

> ***Impact:*** These results showed that there is a specific ruminal bacterial community associated with feed efficiency in dairy cows, but these differences cannot be detected by simple chemical analysis of rumen contents. Further research is needed to leverage these results to promote improved nutrient utilization efficiencies for the dairy industry. NP101, C2, PS2A, PM1.4.1, Project No. 3655-31000-024-00D

Copper sulfate and zinc oxide differ in induction of cross-resistance of bacteria in growing pigs. Increased pressure to move away from antibiotic use in swine makes it imperative that alternatives which promote health, growth and efficiency be discovered. Copper sulfate and zinc oxide have been extensively used as alternatives to antibiotics for health and growth promotion in animal production. However, concerns regarding bacterial cross-resistance between these compounds and antibiotics are emerging. ARS researchers at West Lafayette, IN, discovered that copper sulfate and zinc oxide differed in their ability to induce antibiotic resistance. Zinc did not affect bacterial responses to antibiotics, however copper sulfate had varied effects, depending on the targeted bacterial strain.

> ***Impact:*** These results indicate that zinc supplementation will not affect antibiotic use in pigs whereas supplementation with copper may allow for bacteria to become resistant to antibiotics compromising animal health and well-being as well as growth and efficiency. NP101, C1, PS1C, PM1.4.1, Project No. 3602-32000-010-00D

Discovery of genetic markers associated with feed efficiency in beef cattle. Residual feed intake (RFI), the difference between the amount of feed that an animal is expected to consume and the actual amount consumed, is a measure of feed efficiency. Feed is the highest cost of beef cattle production. Consequently the ability to select animals genetically that are more efficient results in cost savings for producers, as these animals will consume less feed per unit of performance. ARS scientists in Clay Center, NE, identified six novel genetic markers that are predictive for differences in feed efficiency in beef steers located on bovine chromosome 14. These markers were also evaluated for their effects on meat quality

and carcass traits to determine whether they would impact weight and eating quality. The markers were not associated with marbling and tenderness, and are thus unlikely to impact beef quality.

Impact: The markers identified are being further validated by ARS and should be useful to the beef industry for the genetic selection of improved feed efficiency in beef cattle. NP101, C2, PS2B, PM1.4.1, Project No. 5438-31000-092-00D

Identification of physiological mechanisms and genes controlling feed intake, reproduction and growth in swine. Feed costs account for approximately 72% of the variable cost of pork production. ARS researchers in Clay Center, NE, discovered that the protein nesfatin-1 controls appetite in the pig and found that genetic markers in the nesfatin-1 gene were significantly correlated with body weight at puberty.

Impact: These new genetic markers will be used in marker assisted selection to improve feed efficiency, better manage growth and target weights for breeding gilts, resulting in improved reproductive and production efficiencies in the pork industry. NP101, C1, PS1B, PM1.4.1, Project No. 5438-31000-091-00D

Indicator 5:

During 2013, ARS will characterize food animal germplasm for traits of importance and continue to increase the inventory of germplasm stored within the National Animal Germplasm Repository to preserve biodiversity.

FY 2013 Accomplishments*:*

Yellow perch females are more valuable than males. Females yellow perch are larger fish and the smaller fish are males that typically fail to thrive. Gender identification is extremely difficult until fish mature, which can take up to two years. This makes it difficult to separate fish for efficient production, managing brood stock for reproduction and it inhibits genetic improvement efforts. Brian Shepherd, a physiologist at our ARS Dairy Forage and Aquaculture Research Unit in Milwaukee, Wis., and his colleagues have developed criteria, based on the shape and color of the external reproductive openings, to identify the gender of yellow perch during early growth stages. The gender identification algorithm provides a systematic way to reliably identify males from females, ranging from about 3 inches and above in total length. The process is quick, easy and involves a check list of questions: the size of the fish, the shape of specific parts and other criteria to distinguish males from females.

Impact: This innovative method is more than 97 percent accurate and provides a useful and practical tool to cost-effectively sort males from females so it can be used to develop and manage yellow perch brood stocks, conduct experiments targeting gender-specific differences and to identify the fastest growing females and males for genetic programs to improve growth performance. ((NP106, C2, PS2b, PM?, Shepherd 002-00D)

New semen extender supplement improved the fertility of turkey semen. The turkey industry relies exclusively on artificial insemination, a time and labor-intensive process, to reproduce birds in commercial operations. When producers use freshly collected semen for artificial insemination, fertility rates are typically 94-98%; however, if semen is held for longer than 6 hours prior to insemination, fertility rates drop to 40%. ARS scientists in Beltsville, MD evaluated the biological basis for this drop in fertility, and have shown that the sugar residues on the surface of the sperm membrane change when semen is held for longer than 6 hours. To address this issue, an intensive evaluation of the concentration of different sugars, as well as the effect of time and temperature on these sugars was conducted.

Impact: Results indicate that providing extra sialic acid (sugar) in the semen extender can boost the fertility rates of semen held at a cool temperature (4C) for 24 hours from 40% to 85%. This represents a significant advance in poultry semen storage technology that will save producers time and money when reproducing flocks. NP101, C1, PS1B, PM1.4.1, Project No. 1245-31000-105-00D

Development of semen cryopreservation methodology for a unique commercial turkey line. Cryopreserved turkey semen historically yields very low fertility rates (0-5%) that prevent any meaningful application of commercial semen repositories for the long-term preservation of genetics. ARS scientists in Beltsville, MD tested semen freezing and resulting fertility rates on a specialized line of turkeys that was no longer needed for production but might be valuable in the future. After examining 14 variations in semen freezing methods, a novel approach was discovered that increased fertility rates to 26% over 3 consecutive weeks, with 100% of the fertile eggs hatching live, healthy poults.

Impact: This breakthrough resulted in sperm from the first commercial turkey line to be cryopreserved and stored in the USDA's National Germplasm Facility with proven potential for future line regeneration for the turkey industry. NP101, C1, PS1B, PM1.4.1, Project No. 1245-31000-105-00D

First national genomic evaluations for Ayrshire dairy cattle. The national genetic evaluations of the Holstein, Jersey, and Brown Swiss dairy breeds in the United States have benefited from the inclusion of genotypic information since 2009, but too few Ayrshires have been genotyped to allow genomic evaluation. ARS scientists in Beltsville, MD, using data from over 1,100 genotyped Ayrshires with performance and pedigree records in the North American database, developed the first genomic evaluations for Ayrshires. Compared with traditional parent averages, those evaluations improved accuracy of prediction of genetic merit by 8.2 percentage points over all traits (17 percentage points for milk and protein yields and 16 percentage points for stature). The availability of genomic information also made breed determination possible using procedures that had been implemented for other breeds. In addition, a DNA segment (haplotype) that decreases fertility was discovered on autosomal chromosome 17; sire conception rate was 3.0 percentage points lower for carriers of the haplotype, and the carrier frequency for genotyped Ayrshires is 23%.

Impact: Ayrshire breeders will be able increase the rate of genetic gain for economically important traits and improve fertility as a result of improved knowledge of the genomic makeup and merit of their animals. NP101, C1, C2, PS1C, PS2A, PS2D, PM1.4.1, Project No. 3602-32000-010-00D

FY 2013 Accomplishments*:*

Performance Targets

4.1.A Provide scientific information to maximize the production efficiency of our food animal production systems.

Baseline 2012	Target 2017
Seven research studies on production efficiency published in peer-reviewed scientific journals that contribute evidence to improve food animal production systems.	Cumulatively, 35 new scientific papers will be published in this area of research.

4.1.B Develop new technologies and tools contributing to improved precision animal production systems to meet current and future food animal production needs of diversified consumers, while ensuring economic and environmental sustainability and animal well-being.

Baseline 2012	Target 2017
One new technologies developed and used by ARS customers to increase production efficiency and enhance the economic value and well-being of U.S. food animal production while decreasing the environmental footprint of production systems.	Cumulatively, five new technologies developed and used by ARS customers

Measure 1.4.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2013:

During FY 2013, ARS reported on 8 new technologies adopted .

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Single Nucleotide polymorphisms that predict fertility in dairy cattle.	ARS identified unique genetic mutations (SNPs) associated with fertility in the dairy cow.	Commercial DNA genetics laboratories will provide testing for dairy industry stakeholders and producers.	Permit the identification of animals with superior fertility and animals with poor fertility that will enable selection programs to increase the production and efficiency of the dairy industry.
Triple acting antimicrobials that are refractory to resistance – patent application	Novel antimicrobial for use against Staphylococcus (S.) aureus. Invention disclosure describing novel staphylococcal antimicrobial for eradicating staphylococci that will hopefully lead to a patent and commercialization by a pharmaceutical company.	Dairy farms with S. aureus infected herds, a common challenge for dairy producers.	S. aureus is notorious for developing resistance to antibiotics. S. aureus account for ~30% of mastitis infections in United States dairy herds. Anticipated impact would be to provide a non-antibiotic cure for bovine mastitis that is highly refractory to resistance development.
Beef Industry Weight	Direct collaboration	Beef industry	Better understanding

Traits Project – implementation of molecular enhanced selection in producer herds.	with 24 seedstock breeders, 7 breed associations and a DNA testing company. Direct reports on the predictive ability of the tests to the collaborating breeders and breed associations. Annual symposium in Clay Center, NE to present results to the public.	producers, breeders, breed associations, DNA testing companies, extension specialists.	by the industry of the opportunities, challenges, and practical considerations in the application of DNA testing for the genetic improvement of economically important traits. The project has demonstrated the importance of customizing DNA tests for each breed.
Understanding, using, and applying improved carbohydrate analysis methods developed by ARS for evaluating animal feedstuffs.	Four invited conference talks, one presentation for feed company nutritionists.	Other scientists, analysts (feed analysis)/commercial and state feed analysis laboratories, animal nutritionists, and state regulators.	Informed understanding of nutritional relevance of feed analytical methods, their accuracy, and factors affecting their utility to the livestock feeding community.
The use of soybean meal in aquatic feeds is limited due to the presence of anti-nutritional factors in the meals. These factors can be processed out, but an alternative approach to selective breed for improved nutritional value is being employed by Schillinger Genetics. The improved soybeans, Navita-AQ, have higher protein, low oligosaccharides and lower trypsin inhibitor.	A series of studies have been conducted and that information is supplied to potential buyers of the product. Other studies are designed to evaluate enhanced soybean varieties with higher field production rates. This information is used to direct the breeding program.	Principal beneficiaries of this research include fish farmers and feed manufacturers, but also soy farmers through increased markets.	This technology will improve the nutritional value of soybean meal for aquaculture, the most abundant source of animal protein available to producers worldwide.
Methods to increase the value of co-products from ethanol production. These co-products have the potential for use in aquaculture and animal feeds.	Feeding trials with rainbow trout demonstrated that both products are highly digestible and palatable. The current commercial ethanol production method can be easily modified to reclaim valuable phosphorus and protein, thus increasing the overall flexibility,	Principal beneficiaries of this invention are the ethanol and aquaculture producers and industry stakeholders.	This technology has the potential for increasing the value of co-products of ethanol production increasing the production capacity and efficiency of the ethanol and aquaculture industries..

	economic value, and sustainability of ethanol production, and provide valuable nutrients to the aquaculture and animal industries. This invention disclosure has led to a patent application and discussions with several companies interested in licensing the technology.		
Developed an arctic charr line selected for faster growth and delayed sexual maturity.	Germplasm was released through a Material Transfer Agreement CRADA to a commercial producer.	Commercial arctic charr producers and industry stakeholders	Utilization of improved germplasm will increase the profitability and sustainability of coldwater.
Use of a type of clay called kaolin (Al2Si205(OH)4) as a prophylactic or therapeutic agent for the prevention or treatment of bacterial diseases affecting cultured fish.	Transferred through an invention disclosure and manuscripts describing the technology for industry producers.	Catfish industry producers and industry stakeholders.	The addition of kaolin to the water significantly improved the survival of channel catfish that were experimentally infected with the disease and protected the gill from damage by the bacteria. We found that kaolin worked by binding to the bacteria, thereby preventing it from attaching to the fish and initiating disease.

Measure 1.4.1: Provide scientific information to maximize the production efficiency of our food animal production systems. Develop new technologies and tools contributing to improved those systems to meet current and future food animal production needs of diversified consumers, while ensuring economic and environmental sustainability and animal well-being.

During FY 2014, ARS will

identify underlying genetic and/or physiologic mechanisms relating to food animal production and production efficiencies for traits associated with growth physiology, nutrient utilization, reproductive physiology, health, and well-being in food animals.

develop genomics infrastructure and tools to efficiently identify genes, their function, and interactions with environmental factors for exploitation in genome enabled improvement programs for food animals

develop and improve sustainable production systems for food animals; incorporating strategies to optimize production system efficiency while ensuring economic and environmental sustainability.

characterize nutrient requirements of food animals; measure nutrient availability of traditional and non traditional feedstuffs; and develop strategies for improving nutrient use efficiency.

characterize food animal germplasm for traits of importance and continue to increase the inventory of germplasm stored within the National Animal Germplasm Repository to preserve biodiversity.

During FY 2015, ARS will

identify underlying genetic and/or physiologic mechanisms relating to food animal production and production efficiencies for traits associated with growth physiology, nutrient utilization, reproductive physiology, health, and well-being in food animals.

develop genomics infrastructure and tools to efficiently identify genes, their function, and interactions with environmental factors for exploitation in genome enabled improvement programs for food animals

develop and improve sustainable production systems for food animals; incorporating strategies to optimize production system efficiency while ensuring economic and environmental sustainability.

characterize nutrient requirements of food animals; measure nutrient availability of traditional and non traditional feedstuffs; and develop strategies for improving nutrient use efficiency.

characterize food animal germplasm for traits of importance and continue to increase the inventory of germplasm stored within the National Animal Germplasm Repository to preserve biodiversity.

During FY 2016, ARS will

identify underlying genetic and/or physiologic mechanisms relating to food animal production and production efficiencies for traits associated with growth physiology, nutrient utilization, reproductive physiology, health, and well-being in food animals.

develop genomics infrastructure and tools to efficiently identify genes, their function, and interactions with environmental factors for exploitation in genome enabled improvement programs for food animals

develop and improve sustainable production systems for food animals; incorporating strategies to optimize production system efficiency while ensuring economic and environmental sustainability.

characterize nutrient requirements of food animals; measure nutrient availability of traditional and non traditional feedstuffs; and develop strategies for improving nutrient use efficiency.

characterize food animal germplasm for traits of importance and continue to increase the inventory of germplasm stored within the National Animal Germplasm Repository to preserve biodiversity.

GOAL 4.2 - PREVENT AND CONTROL PESTS AND ANIMAL DISEASES THAT POSE A THREAT TO AGRICULTURE, PUBLIC HEALTH, AND THE WELL-BEING OF AMERICAN CITIZENS (ANIMAL HEALTH, VETERINARY, MEDICAL & URBAN ENTOMOLOGY, AND AQUACULTURE NP – 103, 104 & 106)

Investments in animal protection research are critical to the growth and resilience of the supply of food for tomorrow and feed the future initiatives. Enhancing the health of animals in agricultural production systems will directly impact food quality and ensure a sufficient supply of macro and micro-nutrients to meet people's basic needs worldwide. When combined with other investments in agricultural development, research-based innovations will address some of the fundamental constraints that give rise to food insecurity by reducing production risks associated with pests and diseases.

Achieving results in animal protection research in the 21st century will demand a systems biology approach in which knowledge obtained from animal genomes, functional genomics, clinical trials, and epidemiology are integrated in the discovery and development of countermeasures for preventing and controlling disease outbreaks.

Entomological research will concentrate on priority problems affecting animal production, human health, and the well-being of American animals and citizens. The research aims to dedicate 30% of resources to basic research that provides relevant information about target pests and 70% to applied research and product development. The program seeks to attain a balance of skills among its scientists so that it can take full advantage of the latest developments in biology at the same time as applying its efforts to solution of practical problems.

Accordingly, the goal of the ARS animal protection research programs is to protect and ensure the safety of the Nation's agriculture and food supply through improved disease detection, prevention, control, and treatment. Basic and applied research approaches will be applied to solve animal health problems of high national priority. Emphasis will be given to methods and procedures to control animal diseases through the discovery and development of:

- Diagnostics and tools for identification of pests/vectors
- Vaccines
- Biotherapeutics
- Pesticides, repellents, attractants, traps, and other innovative products for pest/vector control
- Animal, pest, and vector genomics applications
- Disease management systems and integrated pest/vector management systems
- Animal disease models
- Farm biosecurity measures
- Applications of global information systems
- Chemical ecology of pests and vectors

Animal protection national programs have eight strategic objectives:

1. Develop an integrated animal, arthropod, and microbial genomics research program
2. Launch research programs to provide alternatives to antibiotics in food animal production
3. Build a technology-driven vaccine and diagnostic discovery research program
4. Develop core competencies in field epidemiology and predictive biology
5. Develop expert collaborative research laboratories recognized by the World Organization for Animal Health (OIE) and the United Nation's Food and Agriculture Organization (FAO)

6. Develop a model technology transfer program to achieve the full impact of our research discoveries
7. Perform the full spectrum of research for improvement of veterinary, public, and military entomology
8. Develop safe and effective methods for prevention of damage caused by arthropods to homes and households

Performance Measure

4.4.2 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.

Indicator 1:

During 2013, ARS will describe 5 new discoveries or developments significant for their scientific or applied value.

FY 2013 Accomplishments*:*

H7N9 outbreak in China: Animal investigations and U.S. animal health preparedness activities
On March 29, 2013, the Chinese Center for Disease Control and Prevention completed laboratory confirmation of three human infections with an avian influenza A(H7N9) virus not previously reported in humans. By April 26, reports from the China Ministry of Agriculture indicated that the H7N9 virus had been confirmed in chickens, ducks, pigeons (feral and captive), and environmental samples in four of the eight provinces and in Shanghai municipality, confirming that the source of human infections were poultry markets. The USDA set up a Situational Awareness Coordination Unit with a core team of subject matter experts and other USDA representatives, including the Animal and Plant Health Inspection Service (APHIS), the Agricultural Research Service (ARS), the Food Safety and Inspection Service, and the Foreign Agricultural Service. USDA and CDC worked collaboratively to understand the epidemiology of H7N9 infections among humans and animals in China. To date, there is no evidence of this strain of avian influenza A(H7N9) virus has entered the United States. ARS scientists at the Southeast Poultry Research Laboratory, Athens, Georgia, and the National Animal Disease Center, Ames, Iowa, rapidly conducted animal studies to characterize the virus pathogenicity and transmission properties of this virus in avian and swine species. Results from studies performed on poultry and pigs in ARS high-containment facilities indicated that chickens and quail showed no signs of illness but were shedding avian influenza A (H7N9) virus. Pigs infected with the H7N9 virus on the other hand did not amplify or shed the virus. ARS scientists also rapidly developed new diagnostic tests to ensure the virus could be quickly detected, and completed antigenic mapping studies to help identify virus isolates that could be used to develop a vaccine for poultry if needed.

> ***Impact*:** This information and tools were critical to prepare first responders in case this new and emerging virus reaches the United States.

A safe leaderless Foot-and-Mouth Disease vaccine platform with two negative markers for differentiating infected from vaccinated animals.
ARS scientists at the Plum Island Animal Disease Center identified that the lead sequence, if removed, renders the FMD virus harmless to animals while still leaving it capable of growing in cell culture. This basic scientific information has contributed to our understanding of how the FMD virus amplifies, interacts with an animal host, evades the host defense mechanism, and how different parts of the virus genome function. Importantly, ARS scientists used this information to produce a new “leaderless” FMD vaccine virus. This vaccine is safer than current FMD vaccine technologies, which use naturally occurring

(wild-type) virus, because the leaderless attenuated FMD vaccine virus does not cause disease in animals. In addition, the leaderless FMD vaccine has been genetically modified to include two negative markers to differentiate it from wild-type virus found in animals during a disease outbreak. A patent has been filed for this new technology, which is currently being developed in partnership with a multinational pharmaceutical company.

> ***Impact*:** This is a major milestone in vaccine technologies in that it will enable the safe production of FMD vaccines, eliminating concerns that FMD vaccine viruses might escape from a manufacturing plant and cause an FMD disease outbreak. This will be especially beneficial for FMD-free countries like the United States, providing the capability to rapidly manufacture millions of FMD vaccine doses without fear of vaccine virus escapes.

Complete genome sequences of new emerging Newcastle disease virus strains isolated from China.
Five virulent Newcastle disease virus (NDV) strains were isolated from geese in China. The complete sequences of two NDV strains and the sequences of the envelop glyprotein genes of three other strains were determined. Phylogenetic analysis classified them into a new genotype, designated as genotype XII, which were genetically distinct from genotype VII, the predominant genotype responsible for most outbreaks of Newcastle disease in China in recent years.

> ***Impact*:** This is the first report of complete genome sequences of new emerging genotype XII NDV strains isolated from geese in China. This basic scientific information is critical to ensure current molecular diagnostic tests can detect emerging viruses that may migrate from China and pose a threat to the United States.

Complete Closed Genome Sequences of Mannheimia haemolytica Serotypes A1 and A6, Isolated from Cattle
Mannheimia haemolytica is a respiratory pathogen affecting cattle and related ruminants worldwide. *M. haemolytica* is commonly associated with bovine respiratory disease complex (BRDC), a polymicrobial multifactorial disease. ARS scientists at the U.S Meat Animal Disease Center, Clay Center Nebraska, and the Center for Grain and Animal Health, Manhattan, Kansas, completed the first two complete closed genome sequences of this important respiratory pathogen of cattle.

> ***Impact*:** This genome sequence information will enable the application of a new approach called reverse vaccinology where the complete identification of all the genes will allow the rational design of next generation of highly effective vaccines.

Efficacy of BVD vaccines against HoBi like viruses
Evaluation of protection afforded, by current vaccines, against a newly emerging virus related to bovine viral diarrhea viruses (BVDV). Recently a new group of viruses, known as HoBi like viruses, have been isolated from cattle in Brazil, Italy and Thailand. HoBi like viruses are related to bovine viral diarrhea viruses (BVDV) and cause very similar diseases in cattle. Introduction of HoBi like viruses into North America could result in significant economic loss by cattle producers. There are no vaccines available for the prevention of infection of cattle by HoBi like viruses. ARS researchers at Ames, Iowa performed studies to determine if cattle vaccinated using BVDV vaccines would be protected against infection with HoBi like viruses. It was found that cattle vaccinated against BVDV would have little or no protection against infection with HoBi like viruses.

> ***Impact*:** The results of this study indicate that new vaccines, specific for HoBi like viruses, will need to be developed to control this emerging pathogen.

Determination of the genetic basis by which Haemophilus parasuis causes disease and development of more efficacious vaccines.

Haemophilus parasuis is a bacterium that causes Glässer's disease in swine, a disease characterized by chronic debilitation and often death that costs the swine industry millions in losses annually. However, not all strains of the bacterium cause disease. To date, little is known about genetic differences among *H. parasuis* strains and the genetic factors that contribute to its ability to cause disease. ARS scientists at the National Animal Disease Center in Ames, Iowa identified 10 strains of *H. parasuis* with varying ability to cause disease and then determined the DNA genomic sequence of these strains. Subsequent studies have demonstrated that strains that don't cause disease can be used as vaccines against strains that do and are leading to improved vaccines against *H. parasuis* for pigs.

> ***Impact*:** Comparative genomic analysis of the different strains has identified several significant differences that likely contribute to the variability in disease caused by these strains.

Development of a Brucella suis vaccine for feral swine

USDA continues to work to control brucellosis since it initiated an eradication program in the 1950's. However, persistence of Brucella in wildlife reservoirs (bison, elk, and feral swine) pose a risk for reintroduction to domestic livestock. New vaccines and diagnostics that can be applied to wildlife are needed. Brucellosis is not currently a problem in domestic swine. However, Brucellosis is common in the millions of feral pigs present in the United States. Surveillance has shown that up to 35% of some herds of feral pigs can be positive for Brucella. In addition, transmission from infected feral pigs, which shed the organism in their urine to cattle has resulted in dairy herds in the South Eastern U.S. becoming positive for Brucella. ARS scientists at the National Animal Disease Center, Ames, IA, have developed an experimental vaccine that has been shown to be protective against brucellosis in feral swine when administered orally or parentally. More work needs to be done to determine the optimal dose and efficacy data.

> ***Impact*:** This experimental Brucellosis vaccine shows promise to reduce the risk of Brucella infection to humans and domestic livestock from feral swine.

Elimination of persistent infection and transmission risk following the re-emergence of Theileria equi in the United States.

Theileria equi is a tick-borne disease of horses that can cause severe acute disease characterized by fever, anemia, hemoglobinuria and in some cases death. Infected horses that recover from the acute disease become persistently infected for life. Disease caused by *T. equi*, called piroplasmosis, has been eradicated from the United States. In 2009, an outbreak of piroplasmosis occurred in Texas. Until recently, horses diagnosed with piroplasmosis were either euthanized or quarantined for life due to the persistence of infection. ARS scientists in Pullman, WA, developed a treatment regimen using imidocarb dipropionate to eliminate *T. equi* from naturally infected horses and removed the risk of transmission of the pathogen to other horses.

> ***Impact*:** This new treatment has allowed horses infected with *T. equi* to resume their previous lives and has facilitated international movement of horses between piroplasmosis infected countries and non-infected regions.

Determining the protective mechanisms for resistance and protection immunity to helminth infection in ruminants.

Parasites are important economically to the cattle industry. Recently, it has been determined that many helminthes (intestinal parasitic worms) have increasingly become resistant to current drug control strategies. Understanding the protective mechanisms is critical to develop new strategy to control internal parasites. ARS scientists at the Beltsville Regional Laboratories, Beltsville, MD, characterized the

transcriptome of parasite-resistant cattle using high-throughput technology. They identified cellular networks and biological pathways related to parasite resistance. In addition, three antimicrobials were identified that are likely involved in regulating host-parasite interactions.

> ***Impact*:** This information provides important insights into the immune regulation of host-parasite interactions and molecular mechanism of host resistance in cattle. This information facilitates applied breeding for parasite resistant animals and potentially vaccines that may confer protection against parasites.

Genome Sequencing of Ovine Isolates of Mycobacterium avium subspecies paratuberculosis Provide Insight into Host Association

Paratuberculosis (Johne's Disease) is a chronic progressive enteric disease characterized clinically by chronic or intermittent diarrhea, emaciation and death. Johne's has worldwide distribution and economic impact on ruminant livestock production. The host responses to *Mycobacterium avium* subspecies *paratuberculosis* (MAP) are complex, so understanding the host-pathogen interactions will allow the development of new diagnostic tools and intervention strategies. Recent research by ARS scientists at the National Animal Disease Center, Ames, IA, found that goats and sheep are susceptible to MAP infection. Results of genome sequencing showed significant differences in the genome of cattle and sheep isolates of MAP. Using next-generation sequencing technology combined with optimal mapping, additional novel regions of difference between cattle and sheep MAP were determined.

> ***Impact*:** Tracking genetic difference between MAP isolates allows understanding of the pathogenesis of Johne's between cattle and small ruminant animal species. This work will facilitate development of improved diagnostic assays more aligned with specific ruminant species that could have worldwide relevance in identifying infected animals and preventing production losses.

DEET mosquito repellent works by taste as well as by smell

Current mosquito repellents are effective if used correctly, but dosages applied to the skin are very high. Prevention of disease transmission using repellents is a problem because people are reluctant to use unpleasant products until they have already been bitten. Ideally, a repellent active ingredient would be developed that functions at the kinds of concentrations usually observed in the pharmaceutical industry – approximately 1000 times more effective than DEET. ARS scientists at Beltsville, Maryland, have been working to understand the physiological mode of action of repellents. Unexpectedly, they found that DEET not only affects odor receptors on the antennae, but also taste receptors on the mouthparts. The new understanding that taste and odor are involved in the function of this effective repellent opens the door to more precisely targeted exploration for repellent active ingredients that work at much lower concentrations.

> ***Impact*:** This discovery will change the way that new repellent active ingredients are evaluated and ultimately produce highly effective products that have a greater chance of preventing infection than current repellents. It will be particularly beneficial for the Department of Defense' preventive medicine programs.

Biting midge gene expression

Biting midges are important vectors of livestock diseases, including some that have recently emerged. The northward extension of bluetongue virus in Europe and the appearance of Schmallenberg virus suggest that changing conditions may be increasing the importance of biting midges as vectors of animal diseases. In addition, biting midges transmit epizootic hemorrhagic disease, a deadly syndrome that threatens the deer farming industry in much of the United States. Because of the difficulty of working with these small insects, relatively little research has been done on them compared to more prominent

biting insects like mosquitoes. ARS scientists in Manhattan, Kansas, in collaboration with Clemson University Genomics Institute, have worked to observe the genetic mechanisms of biting midges responsible for key biological processes. Looking at gene expression, they have discovered genes involved in blood feeding, defense, digestion, transport of materials within the insect, development, and reproduction.

> ***Impact*:** Pinpointing the role genes play in the life of the midge will contribute toward faster, more accurate assessment of vectorial competence and may lead to completely new modes of action for insecticides.

Chromosomal origin of fire ant social forms revealed

Introduced fire ants exhibit two colony social forms that differ in the number of reproductive queens per colony, as well as many other traits. Remarkably, many individual and life-history traits associated with social organization are correlated with a single gene, Gp-9. ARS researchers at Gainesville, Florida, found that Gp-9 is embedded in a group of genes that are resistant to reassortment and that therefore tend to stay attached to each other (i.e., a supergene). The pair of supergenes that make up the two alleles of an individual are located on separate, dissimilar chromosomes. Most genes associated with social forms of the ants are located on these two chromosomes, which are similar to sex chromosomes in structure. These findings highlight how genomic rearrangements can maintain divergent adaptive social phenotypes involving many genes acting in concert by locally limiting recombination. This understanding of basic gene mechanics has great scientific interest and may also lead to better ways to alter the social forms of these invasive ants.

> ***Impact:*** This understanding of basic gene mechanics has great scientific interest and may also lead to better ways to alter the social forms of these invasive ants. The work forms the basis for innovative ways to control this pest as part of USDA APHIS programs.

Indicator 2:

During 2013, ARS will form new partnerships and continue old partnerships with industry, universities, and other government agencies in order to promote production and marketing of new methods for detection and identification of animal pathogens, arthropods that transmit pathogens, and arthropods that destroy property; including genetic markers, new methods of detecting gene sequences or antibodies or proteins, and comprehensive guides to morphological identification.

FY 2013 Accomplishments*:*

Detection of house flies with genetic signal for immune response

House flies breed in environments such as garbage and manure, where both maggots and adults are exposed to numerous species of bacteria. Many of those bacteria are human or animal pathogens. Remarkably, house flies are seldom harmed by the soup of bacteria in which they live. The interaction of the fly's own immune system and the bacteria in the environment and ingested by adult flies underlies the fly's ability to acquire, harbor and transmit bacteria to livestock and humans. In collaboration with Clemson University, ARS scientists in Manhattan, Kansas, sequenced genes that were activated in immune-stimulated house flies, and identified several sequences that coded for molecules that protect the flies from bacteria. Production of these substances allows house flies to live and thrive in contaminated environments. The sequences of these genes induced by immune challenge have been made public.

> ***Impact*:** The relative risk of bacterial transmission by house flies can be estimated by detecting

the genetic signal for their immune response**.**

Indicator 3:

During 2013, ARS will form new partnerships and continue old partnerships with industry, universities, and other government agencies in order to promote production and marketing of inventions that protect animals from pathogens or manage arthropods that transmit pathogens or damage property.

FY 2013 Accomplishments*:*

Gene silencing technology leads toward safe mosquito control

There are a very limited number of public health pesticides available for controlling medically important vectors, such as mosquitoes and sand flies. This novel approach is based on the technology that allows for the specific silencing of genes critical to survival of the target vector species. This technology uses double stranded RNA (dsRNA) and the process of RNA interference (RNAi) to prevent the synthesis of specific proteins in cells. By choosing the right target, it is possible to debilitate mosquito vectors of disease. ARS researchers in Gainesville, Florida, have demonstrated that a dsRNA construct targeting a gut-expressed gene effectively shut down production of that protein when fed to the adult yellow fever mosquito. The dsRNA was fed to the mosquitoes in a sugar meal and stopped the protein in 12 or 24 hours. Oral delivery of dsRNA to mosquitoes could be a very practical way to deliver this new technology. The specificity of the dsRNA would prevent any danger to other insects, including pollinators. Also, only tiny quantities of dsRNA would be required, reducing costs.

> ***Impact*:** This work will lead to products that have no non-target effects and that are perfectly safe for humans and the environment. It will be particularly beneficial for the Department of Defense' preventive medicine programs.

Viruses as powerful new way to control fire ants

Fire ants have become a problem in the United States and Asia because they do not have the complex of natural enemies that keeps them in check in their native South America. ARS researchers at Gainesville, Florida, have worked with the Foundation for the Study of Invasive Species, Hurlingham, Argentina, for years to find and import small flies that parasitize fire ants. Those efforts are associated with an approximately 30% reduction of fire ants in Florida and Georgia. More recently, the two laboratories discovered the first viruses in any ant, one of which is particularly deadly for fire ants. This virus can be administered in bait and then sustains itself in a population through natural transmission.

> ***Impact*:** Adaptation of this product to area-wide programs will further reduce fire ant populations in the United States and lessen the impact of their range expansion associated with climate change. The product will improve efforts by USDA APHIS to control this pest.

Sequencing the genome of the cattle fever tick

Two species of cattle fever ticks that transmit babesiosis used to be responsible for the death and poor yield of cattle throughout the southern United States. They remain an important problem throughout the tropics. Beginning in 1912, a systematic program of dipping cattle and quarantining pastures totally eradicated the tick from the United States. The ticks are kept out of the United States through border inspection, inspection and treatment on farms in South Texas, and interception of infested cattle that wander across the border. The current acaricide used in the program is one of the few remaining organophosphates still on the market. Alternatives exist, but in Mexico there is resistance to any one of them. ARS scientists at Kerrville, Texas, in collaboration with researchers at Murdoch University, Perth, Australia, and the National Center for Genome Resources, have sequenced the genome of the cattle tick.

Impact: Data from the genome sequence has resulted in the identification of anti-tick vaccine candidates that should provide an effective tool for the supplementation of acaricides. The sequence will also be valuable for rapid development of new acaricides targeted at new physiological processes. This is expected to accelerate acaricide research and development within USDA and the global animal health industry. The products resulting from this work will make the USDA APHIS and Texas Animal Health Commission's Cattle Fever Tick Eradication Program more effective.

Performance Targets

4.2.A Provide scientific information to protect animals, humans, and property from the negative effects of pests and infectious diseases.

Baseline 2012	Target 2017
Seven research studies that had significant impact on the scientific community and/or will lead to new technologies for protection of humans, property, and livestock from harm due to pests or diseases.	Cumulatively, 35 new scientific papers will be published in this area of research.

4.2.B 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.

Baseline 2012	Target 2017
One technology used by the commercial and/or government sectors relevant to the protection of humans, property, and domestic animals.	Cumulatively, transfer five technologies to the commercial and/or government sectors.

Measure 4.4.2 Summary of the Major Technologies Developed, Transferred, and Used in FY 2013:

During FY 2013, ARS reported on 4 new technologies adopted.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Etofenprox all crop tolerance	Working with IR4 to complete registration of new mosquito adulticide	Mosquito abatement districts and the Department of Defense	New tool to prevent transmission of mosquito-borne diseases, like West Nile, dengue, and

			chikungunya
Areawide strategy for control of the Asian tiger mosquito	Results of five year project synthesized into a cogent strategy	Mosquito abatement districts and communities	Foundational system for control of a mosquito that has not been susceptible to traditional mosquito abatement procedures; potential lessening of impact of chikungunya epidemic
Rapid diagnostic Assays for emerging H7N9 Chinese influenza virus	Tests transferred to NVSL, USDA-APHIS	USDA action and regulatory agency	These tools are critical to prepare first responders in case this new and emerging virus reaches the United States.
Genetically-engineered FMD vaccine	Cooperative Research and Development Agreement with industry partner	Livestock producers	This is a major milestone in vaccine technologies in that it will enable the safe production of FMD vaccines providing the capability to rapidly manufacture millions of FMD vaccine doses without fear of vaccine virus escapes.

Measure 4.4.2.: 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.

During FY 2014, ARS will

describe 5 new discoveries or developments significant for their scientific or applied value.

form new partnerships and continue old partnerships with industry, universities, and other government agencies in order to promote production and marketing of new methods for detection and identification of animal pathogens, arthropods that transmit pathogens, and arthropods that destroy property; including genetic markers, new methods of detecting gene sequences or antibodies or proteins, and comprehensive guides to morphological identification.

form new partnerships and continue old partnerships with industry, universities, and other government agencies in order to promote production and marketing of inventions that protect animals from pathogens or manage arthropods that transmit pathogens or damage property.

During FY 2015, ARS will

describe 5 new discoveries or developments significant for their scientific or applied value.

form new partnerships and continue old partnerships with industry, universities, and other government agencies in order to promote production and marketing of new methods for detection and identification of animal pathogens, arthropods that transmit pathogens, and arthropods that destroy property; including genetic markers, new methods of detecting gene sequences or antibodies or proteins, and comprehensive guides to morphological identification.

form new partnerships and continue old partnerships with industry, universities, and other government agencies in order to promote production and marketing of inventions that protect animals from pathogens or manage arthropods that transmit pathogens or damage property.

During FY 2016, ARS will

describe 5 new discoveries or developments significant for their scientific or applied value.

form new partnerships and continue old partnerships with industry, universities, and other government agencies in order to promote production and marketing of new methods for detection and identification of animal pathogens, arthropods that transmit pathogens, and arthropods that destroy property; including genetic markers, new methods of detecting gene sequences or antibodies or proteins, and comprehensive guides to morphological identification.

form new partnerships and continue old partnerships with industry, universities, and other government agencies in order to promote production and marketing of inventions that protect animals from pathogens or manage arthropods that transmit pathogens or damage property.

Strategic Goal Area 5:
Equal Employment Opportunity

GOAL 5.1 - DEVELOP A MODEL EQUAL EMPLOYMENT OPPORTUNITY (EEO) PROGRAM THAT WILL PROVIDE INFRASTRUCTURE NECESSARY TO CREATE AND MAINTAIN A DIVERSIFIED WORKPLACE FREE FROM DISCRIMINATION, HARASSMENT, OR RETALIATION, AND CHARACTERIZED BY AN ATMOSPHERE OF INCLUSION AND CAREER DEVELOPMENT OPPORTUNITIES.

Performance Measure

2.5.1 Implement a Civil Rights Program that is fully compliant with all Civil Rights laws, rules, and regulations including DR 4300-010, Civil Rights Accountability Policy and Procedures and EEOC's MD-715 and other USDA and ARS regulations, policies and guidelines.

Baseline 2012	Target 2017
The FY 2011 Area Management Directive 715 (MD 715), Annual EEO Program Report was used as a management tool to identify potential barriers to creating and maintaining a diversified and qualified workplace, and to develop action plans to reduce/eliminate barriers.	Reduce/eliminate barriers identified in the MD-715, Annual EEO Program Report.

Strategies and Means

- Review and issue annual policy statements regarding EEO/civil rights, anti-harassment, and sexual harassment to promote an environment free from discrimination, sexual or non-sexual harassment, and retaliation to 100 percent of ARS employees.
- Develop and submit annual EEO Program Status reports to EEOC and the Department aimed at eliminating barriers to hire women, underrepresented groups based on the Civilian Labor Force (CLF), and persons with disabilities.
- Expand outreach activities in K-12 schools, universities/colleges, minority serving institutions and organizations that cater to persons with disabilities providing education about scientific research to increase percentage of underrepresented groups based on the CLF. ARS' goal is to increase the annual percentage of new hires by 75 percent of the following groups compared to the new hire FY 2011 data (goal is noted in parentheses): White females (49); Hispanic male (3); Hispanic female (2); African American male (11); African American female (18); and persons with targeted disabilities (1).
- Use Schedule A hiring authority for persons with disabilities and Veteran Hiring Authorities as part of strategy to recruit and retain a diverse workforce. ARS' goal is to increase the annual percentage of veteran new hires by 75 percent or 62 veterans.
- Provide EEO/civil rights information and counseling and advice to 100 percent of the employees requesting the information through a variety of sources to reduce EEO complaints.
- Ensure that all employees complete mandatory and recommended EEO training.
- Conduct civil rights impact analyses as required.
- Offer the ADR process to all employees in all stages of the EEO complaint process. ARS' goal is to increase the annual usage of ADR by 50 percent or 18.

ARS Management Goals

ARS is continually assessing the relevance, quality, and performance of its research, providing agricultural information to the public through the National Agricultural Library and print and electronic media, ensuring adequate facilities to support Agency research, and ensuring a workplace conducive to personal and professional development.

MANAGEMENT GOAL 1: ENSURING THE QUALITY, RELEVANCE, AND PERFORMANCE OF ARS RESEARCH (COVERS ALL RESEARCH OBJECTIVES)

The Office of Management and Budget (OMB) has established Government-wide R&D Investment Criteria that are designed to assess the relevance, quality, and performance of Federally funded research, and ARS adopted the R&D Investment 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/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.

Performance Measures

MG 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.

Baseline 2012	Target 2017
As assessed against the Program Action Plans, the Agency's long-term goals, and the priority needs of U.S. agriculture, 97.1% of ARS' projects were conducting highly relevant research.	100% of ARS' projects will be conducting highly relevant research.

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

On average, one fifth of the Agency's Research Projects are reviewed annually by external peer panels. Most projects receive initial scores of needing "No Revision", "Minor Revision", or "Moderate Revision" and are certified after any needed revisions, based on review panel comments, are made. The remaining projects, rated as needing "Major Revision" or as "Not Feasible", receive detailed comments from the review panel and are revised. When these revised projects are examined again by the panel, the majority receives scores of "No", "Minor", or "Moderate" revision needed. Those few projects (approximately 3% of all projects) still rated as needing "Major Revision" or "Not Feasible" after a second review is terminated and resources redirected to High Priority projects. A strength of this Peer Review process is the opportunity to incorporate recommendations of peer panels and enhance ARS research. The Research Position Evaluation System (RPES) conducts Peer Reviews of all ARS scientists on a three-to-five-year cycle. RPES is designed to ensure that ARS will continue to classify and evaluate scientists through a peer process to ensure the highest quality scientific workforce.

Baseline 2012	Target 2017
Using an average based on cumulative scores for the past 5 years, 80% of projects received scores of No, Minor, Moderate revision need upon initial review and, overall, 98% received such scores by the completion of the review.	Using a cumulative five-year average, 85% of the projects reviewed will receive initial scores of No, Minor, or Moderate revision needed and 99% will receive such scores by completion of the review.

Baseline 2012	Target 2017
As assessed against the Program Action Plans, the Agency's long-term goals, and the priority needs of U.S. agriculture, 97.1% of ARS' projects were conducting highly relevant research.	100% of ARS' projects will be conducting highly relevant research.

OSQR and the Peer Review Process

The Office of Scientific Quality Review (OSQR) manages the ARS peer review system for research projects, which 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".

MG 1.3 PERFORMANCE: ARS WILL MONITOR THE PERCENTAGE OF ANNUAL RESEARCH PROJECT MILESTONES MET.

All research projects are assessed annually to determine the number of currently approved milestones that were met/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. ARS projects a 10 percent baseline level of milestones not met due to personnel attrition. Thus, the maximum achievable milestone target is reduced in real terms to 90 percent. Each National Program is reviewed by external review panels at the end of its 5-year National Program cycle. The panel provides a written report on the quality of accomplishments, impact of the research, and thorough constructive critique recommendations for the next National Program cycle. Twenty percent of National Programs are reviewed annually.

Baseline 2012	Target 2017
89% of project milestones were fully or substantially met.	94% of project milestones will be fully or substantially met.

Baseline 2012	Target 2017
Office of National Programs (ONP) completed National Program Retrospective Reviews for all Programs in the first 5-year cycle and began reviews for the programs currently in the second 5-year cycle.	ONP will complete National Program Retrospective Reviews for remaining programs in the second 5-year cycle and begin reviews for programs in the third 5-year cycle.

National Program Assessment Process

The Office of Scientific Quality Review (OSQR) manages the ARS peer review system for research projects, which 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".

Strategies and Means

- 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 five-year cycle. This process, covering approximately 20 percent of the Agency's research program each year, provides valuable input to the writing teams that are drafting Action Plans for the next five-year program cycle. *(Performance)*

MANAGEMENT GOAL 2: INTERNATIONAL ENGAGEMENT AND PARTNERSHIPS: EXTEND THE CAPACITY OF THE NATIONAL PROGRAMS TO ADDRESS PROBLEMS CONFRONTING U.S. AGRICULTURE

In recognition that agriculture, and agricultural research, is now a global enterprise, ARS' international office enhances the productivity, effectiveness, and impact of ARS National Programs through mutually beneficial international research activities. The United States directly benefits from international collaboration in agricultural research through access to new ideas and technologies, global germplasm collections, crucial international foreign research sites, enhancement to domestic research, and increased trade. The increasingly transboundary nature of many agricultural problems, such as emerging and re-emerging plant and animal diseases, control of invasive species through discovery and importation of biological control agents, scientific collections including genetic resources preservation, and the need to increase productivity to ensure adequate supplies of agricultural products, provides a strong incentive for greater international cooperation. International agricultural research cooperation addresses global food security by providing solutions to current and future agricultural productivity and sustainability challenges. By sharing knowledge and technology through close collaboration with national and international research institutions in other countries and in the United States to increase institutional research capacity and speed technology development, ARS collaborations enhances international relationships and provides a benign face to U.S. trade and diplomacy.

Crop Production and Protection (CPP): Because USDA does not have the capacity to maintain collections for the entire world's vital crop germplasm, international cooperation plays a critical role in germplasm conservation. In addition, USDA must continue to cooperate with several foreign and international research institutions to fully realize the promise of genomics and genetics research. To also address the concern of food security, additional, long term cooperation is needed in research to continue increasing productivity, availability and utilization of food. International cooperation is also critical for the U.S. to address the control of invasive species (diseases, weeds and insect pests) detrimental to crops, forests, and other natural areas.

Animal Production and Protection (APP): International cooperation enhances the goals of this area by increasing access to different livestock species which enables research to understand the mechanisms of disease resistance. International cooperation helps to develop and test tools to prevent, control, or eradicate diseases that threaten our food supply or public heath, and identifying and developing sustainable systems for production of high quality meat, milk, and eggs. International cooperation is particularly important in the area of animal diseases and their vectors since the approaches to controlling exotic diseases are not as well tested outside of areas where they occur endemically. It plays a key role in animal and aquaculture genomics and should continue to focus on development of tools and resources to meet productivity, efficiency and sustainability needs. International cooperation also provides access to management systems and animal species that have been developed or evolved in tropical and semi-tropical climates and manifest much greater stress and disease tolerance.

Natural Resources and Sustainable Agricultural Systems (NRSAS): Scientists from around the world are drawn to work with ARS in this arena given our current capacities and successes in developing and applying natural resources management strategies and models. ARS gains from these collaborations with additional data which helps scientists improve these techniques and models over time and prove their application in different environments. In addition, sharing these applications helps extend the impact of these technologies in a world facing critical challenges to manage natural resources, particularly water. This also extends to addressing Climate Change and how to manage its impact on U.S. agricultural production as well as how it is impacted by agricultural practices. Finally, to try and meet U.S. bioenergy targets through research on biomass production, we continue to engage our international partners to address biomass use, productivity, management and sustainability.

Nutrition, Food Safety and Quality (NFSQ): Because this area addresses many issues of concern to consumers and because of the global nature of agriculture, international cooperation can help provide a scientific foundation, both for research and to address regulatory, trade, and consumer issues. Because of the diversity of the American population and food consumption patterns, international collaborations can leverage and greatly enhance U.S. nutrition research.

Performance Measures

MG 2.1 DYNAMIC INTERNATIONAL ENGAGEMENT THROUGH PROGRAMS, PROJECTS, CO-PUBLICATIONS AND OTHER ACTIVITIES THAT SUPPORT ACHIEVING THE ARS NATIONAL PROGRAM GOALS.

MG 2.2 EFFECTIVE ENGAGEMENT IN MULTILATERAL AND BILATERAL FORUMS IN WAYS THAT CAN HELP CATALYZE, OR PREVENT OR REDUCE IMPEDIMENTS TO, SCIENTIFIC OR ECONOMIC COOPERATION AND TRADE.

Strategies and Means

- Catalyze and implement international programs and projects that help the Agency to address critical threats to U.S. agriculture, including foreign animal and plant diseases and pests and invasive species.

MANAGEMENT GOAL 3: ENSURE PROVISION AND PERMANENT ACCESS OF QUALITY AGRICULTURAL INFORMATION FOR USDA, THE NATION, AND THE GLOBAL AGRICULTURAL COMMUNITY VIA THE NATIONAL AGRICULTURAL LIBRARY.

The National Agricultural Library (NAL) has statutory mandates to identify, collect, preserve in perpetuity, and provide access to quality information relevant to agriculture; serve as one of four national libraries; serve as USDA's library; provide leadership in developing and operating a comprehensive agricultural library and information network; and provide specialized information services through such NAL information centers and programs as AGRICOLA, the LCA Digital Commons, the Animal Welfare Information Center (AWIC), Alternative Farming Systems Information Center (AFSIC), Food and Nutrition Information Center (FNIC), Food Safety Research Information Office, National Invasive Species Information Center, Rural Information Center (RIC), and Water Quality Information Center (WIC). The world's largest agricultural library and a member of the Association of Research Libraries, NAL serves a large and broad customer base, including such audiences as policymakers, researchers, agricultural specialists, farmers, members of the library, educational and agribusiness sectors, food stamp recipients, and the general public. NAL and NAL customers benefit from participation in a number of partnerships and alliances, including the Agriculture Network Information Center (AgNIC), Nutrition.gov, and CENDI.

NAL Service Delivery

The National Agricultural Library manages the world's largest agricultural information collections, designated as a USDA heritage asset, which include more than 50 million physical items as well as extensive digital information products including databases, digital full-text journals and digital full-text books and maps. AGRICOLA (AGRICultural OnLine Access), NAL's online catalog and index to the agricultural literature, serves as the finding tool for these collections and is made available free of charge by NAL at http://agricola.nal.usda.gov and by a number of commercial companies. In addition to extensive reference, research, information center, and document delivery services delivered to a global clientele, NAL provides 24/7 access for USDA staff worldwide to a large and growing array of digital information products via DigiTop (NAL's Digital DeskTop Library for USDA). NAL has initiated development of a digital collection system to preserve for perpetuity USDA publications and other essential agricultural information assets.

Performance Measures

MG 3.1 THE SERVICES AND COLLECTIONS OF THE NATIONAL AGRICULTURAL LIBRARY CONTINUE TO MEET THE NEEDS OF ALL CUSTOMERS.

Baseline 2012	Target 2017
The National Agricultural Library total annual volume of customer service transactions exceeded 95 million.	The National Agricultural Library total annual volume of customer service transactions will exceed 130 million.

Strategies and Means

- Understand the information needs of NAL beneficiaries, customers, stakeholders, and partners by conducting large-scale as well as targeted surveys, focus groups, and other assessment instruments in order to meet and anticipate needs.
- Deliver unified, easy to use, convenient 24/7 digital services designed to meet customer needs and preferences.
- Deliver rapid information and services concerning "hot topics" and emerging issues of critical national importance.
- Improve information delivery to underserved customer audiences.
- Develop NAL brands to raise visibility.
- Market NAL services to specific audiences.
- Increase advocacy and outreach initiatives.
- Deliver training to optimize use of NAL programs and services.
- Optimize NAL structure, information technologies, and workflows to reflect increased movement to digital programs and services.
- Recruit and retain a service-oriented, technologically-adept workforce.
- Foster a culture of innovation and creativity within NAL.
- Partner with important technology concerns to expose NAL content and to develop shared technical standards in conformance with national policies.
- Extend partnerships with USDA and other Federal agencies to develop targeted information services.
- Continue to participate in and lead national and international alliances and partnerships
- Conserve the rare and at-risk items in the NAL physical collection to secure the Nation's agricultural heritage.
- Broaden and deepen the NAL physical and digital information collections.
- Extend and enrich AGRICOLA, including through links to online full-text publications and the continued enhancement of the NAL Thesaurus.
- Expand the audience and content for the NAL Digital Collections
- Advance NAL preservation and digitization programs.

Indicator 1:

During 2013, NAL will continue to expand and improve services based on customer usage and satisfaction data.

FY 2013 Accomplishments*:*

1. Delivering Information and Research Services.

NAL provides free access to agricultural information, primarily through its core Web site, http://www.nal.usda.gov/. In FY2013, the library provided nearly 7,000 reference transactions, fulfilled more than 1.3 million full-text article requests and satisfied more than 7,000 requests for interlibrary loans. Examples of accomplishments and progress include:

- In FY2013, NAL obtained contributions from across USDA to purchase nearly $4.5 million in licensed full-text and databases for NAL's DigiTop (Digital Desktop for USDA) service to support research and scientific discovery. The Navigator component of DigiTop allows cross searching of multiple bibliographic databases. This system includes AGRICOLA, AGRIS, BIOSIS, CAB Abstracts, Fish, Fisheries & Aquatic Biodiversity Worldwide, Food Science and Technology Abstracts, GEOBASE, GeoRef, MEDLINE, Wildlife & Ecology Studies Worldwide, Scopus and Zoological Record. The Navigator service allows researchers to access nearly 75 million records at once and is updated weekly.
- NAL's Food and Nutrition Information Center (FNIC) Web and Reference Team facilitated the hosting of the first of a two-part webinar series for the Food and Nutrition Service (FNS). The series, "Creating Inspiring Nutrition Education Tools!" attracted more than 5,000 people for the first session.
- FNIC's SNAP-Ed Connection team updated or contributed to the development of the following resource lists in FY2013: Nutrition Assistance Resource Guide (and Supplement); Weight Management and Obesity; Older Adults; Food Allergies and Intolerances; and Cultural and Ethnic Food and Nutrition Education Materials. Also in FY2013, a dietetic intern of the University of Maryland, College Park completed her five-week information technology rotation with SNAP-Ed Connection. The intern created several Web pages for the SNAP-Ed Connection site, including a page for Spanish language materials and one on resources for community and collaborative approaches. The intern also worked on the FNIC Food Allergies resource list and mocked up ideas for a web-based SNAP-Ed guidance.
- NAL's Animal Welfare Information Center (AWIC) co-sponsored a symposium titled "Social Housing of Laboratory Animals," held at the Natcher Center on the campus of the National Institutes of Health in Bethesda, Maryland. AWIC has been working with the NIH Office of Laboratory Animal Welfare and the Johns Hopkins Center for Alternatives to Animal Testing.

***Impact*:** Services were expanded and approved.

2. Developing Decision Support Tools for Science-Based Sustainability Practices.

NAL's LCA Digital Commons web site offers the public access to a broad inventory of peer-reviewed, standard-formatted United States Life Cycle Assessment data. Data for 536 U.S. commodity crop unit processes including corn, wheat, soybeans, cotton, oats, peanuts, and rice have been uploaded and are fully searchable at http://www.lcacommons.gov. In FY2013, carbon footprint data for fluid milk of the United States dairy industry resulting from a study commissioned by the Innovation Center for U.S. Dairy were added and are available for download. Supporting interoperability for life cycle assessment data and systems was a major thrust for the program in FY2013. Cross-walks were developed to link the USDA crop production data in the LCA Digital Commons to related upstream Ecoinvent and National Renewable Energy Laboratory (NREL) unit process data. The cross-walk unit processes will be released in early FY2014. Longer term and more sustainable linking solutions are in development using semantic technologies. This work is underway in collaboration with the Environmental Protection Agency (EPA).

***Impact*:** Services were expanded and approved.

3. Developing Public Awareness and Partnerships.

• *AgNIC*: NAL serves as the secretariat for the Agriculture Network Information Center (AgNIC) Alliance, a voluntary, collaborative partnership that hosts an international distributed network of discipline-specific agricultural information Web sites (http://www.agnic.org). In 2013, NAL hosted representatives from national and international AgNIC member institutions for its 18th annual meeting. The participants, many of whom represented U.S. land grant institutions, related current activities through lightning talks, discussion sessions and an open lab. AgNIC utilizes Open Source technologies which are all freely available. AgNIC provides access to high-quality agricultural information selected by its 53 AgNIC partners, including land-grant universities, NAL, and other institutions around the world. Together they offer more than 80 information and subject specialists, more than 60 topics covered comprehensively, and links to more than 5 million full-text and bibliographic items.

• *VIVO:* NAL collaborated with ARS, other REE Agencies, and the Forest Service to establish a semantic, open-source web application, VIVO, which enables scientists to network—and share their research, grants, patents, publications and more—across the USDA science agencies. NAL hosts VIVO for USDA at http://vivo.usda.gov/. The USDA VIVO ingests public data from systems of record such as ARS, ARIS, the NIFA Current Research Information System (CRIS), and the U.S. Forest Service Research Information Tracking System (RITS) databases. As of the end of 2013, the system includes more than 6,000 scientists and researchers, more than 47,000 publications, patents and reports, and more than 6,000 research projects. New content is ingested several times each year.

• *Interagency partnerships*: NAL continued to be very active in developing and maintaining partnerships to provide digital information services. Nutrition.gov, invasivespeciesinfo.gov, science.gov, and worldwidescience.org are multi-agency and multi-national Web portals to which NAL contributes digital content and leadership. ARS and NAL continue to work toward the development of an integrated system linking life cycle-related data from across the U.S. federal government by providing database and infrastructure support to partners such as the Department of Energy (DOE) and Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Survey (USGS), and Nuclear Regulatory Commission. NAL also continued to participate actively in other interagency groups such as PHPartners (Public Health) and CENDI (scientific and technical information management) to promote and leverage NAL's work.

***Impact*:** Services were expanded and approved.

4. Progress Continues Toward a Transformation to a Digital Library

After decades of providing *some* services and content digitally, NAL in the midst of a transformation to deliver information about *all* NAL programs and services digitally and to deliver as much content and as many services digitally as are permitted by law, technology, and funding. Because NAL's resources are limited, its customer needs and expectations are broad, and the digital information landscape is constantly changing, practical steps have been identified to advance the development of "Digital NAL." The Library's information technology infrastructure is being reinforced and brought up to date. An automated indexing application was installed, integrated into existing IT systems, and passed quality testing. This application combines semantic analysis, machine learning, and human rules to automatically assign subject terms to journal articles that reside in the AGRICOLA Index of agricultural literature. The software passed a rigorous testing procedure and is now being tuned to increase output. The indexers developed semantic tools that fine tune and drive the quality control process so that the goal of increasing annual production to more than 250,000 articles in the next year with acceptable quality will be realized. The NAL collection development policy was revised to exclude the purchase of print monographs and increase the acquisition of commercially available

digital content and ramp up the digitization of items in the library's collection, beginning with USDA publications. The revision process involved input from ARS, USDA, and the scholarly community. The policy guides NAL's activities in serving USDA, the U.S. Government as a whole, the scholarly community, and the general public. (http://www.nal.usda.gov/about/policy/collection_development/NAL_Col_Dev_Policy_2012.pdf)

• *Digitization of NAL Collections:* NAL initiated its first large-scale digitization project to digitize agricultural literature and provide online access to the general public. Important and unique items were selected from the NAL collection, with initial focus on USDA scientific reports and bulletins. In FY 2013, NAL successfully digitized and provided descriptive metadata for 19,500 USDA publications (1,023,382 pages), 3,099 nursery catalogs, and 53 World War I and World War II posters. Publications are accessible at https://archive.org/details/usdanationalagriculturallibrary.

• *NAL Digital Collections:* NAL launched a digital repository of full-text content in 2007. In 2011, NAL migrated the content to a more robust platform in preparation for the current digitization effort. To date, this system includes nine (9) collections of full-text content including nearly 50,000 peer-reviewed journal articles authored by USDA researchers. NAL is preparing to accept the outcomes of federally-funded agricultural research and open it to relevant research collections from universities and others.

***Impact*:** Services were expanded and approved.

MG 3.1.1: The services and collections of the National Agricultural Library continue to meet the needs of all customers.

During FY 2014, NAL will continue to expand and improve services based on customer usage and satisfaction data.

During FY 2015, NAL will continue to expand and improve services based on customer usage and satisfaction data.

During FY 2016, NAL will continue to expand and improve services based on customer usage and satisfaction data.

MANAGEMENT GOAL 4: DEVELOP OUTREACH ACTIVITIES THAT WILL ENABLE ARS TO BETTER SUPPORT THE USDA INITIATIVE TO INCREASE SERVICES TO LIMITED RESOURCE, SOCIALLY DISADVANTAGED, AND/OR HISTORICALLY UNDERSERVED FARMERS AND RANCHERS.

USDA has identified a number of issues related to how it serves or fails to serve that segment of the U.S. agricultural community that has been historically underserved by many Government programs. These studies did not identify specific issues or problems in the USDA research programs, but in 2000, ARS decided to take a more active approach to see how the knowledge and technologies developed through its intramural research activities could be made available to Outreach target populations (historically underserved, limited resource, and/or socially disadvantaged).

Performance Measures

MG 4.1 BRING THE BENEFITS OF ARS RESEARCH TO UNDERSERVED POPULATIONS AND ORGANIZATIONS SERVING THESE TARGET POPULATIONS BY PROVIDING THEM WITH ACCESS TO ARS-GENERATED KNOWLEDGE AND TECHNOLOGY THAT ENABLES THEM TO INCREASE THEIR PRODUCTIVITY AND PROFITABILITY.

Baseline 2012	Target 2017
ARS has an Agency Outreach Coordinator and an Outreach Coordinator in every Area. The Agency Outreach Coordinator will answer directly to the Associate Administrator of ONP. The Outreach Coordinators are responsible for actively seeking ways to reduce/eliminate internal barriers that prevent target populations from accessing ARS research products.	Area Outreach coordinators will identify organizations and individuals that serve the underserved populations who are potential users of ARS research and work to reduce/eliminate barriers to their participation.

MG 4.2 IDENTIFY SIGNIFICANT OUTREACH ACTIVITIES AND REPORT THEM ANNUALLY TO THE USDA OFFICE OF OUTREACH.

Baseline 2012	Target 2017
ARS identified 20 significant Outreach activities and reported them to the Departmental Office of Outreach as requested.	ARS will cumulatively report 100 significant Outreach Activities to the USDA Office of Outreach and through the GPRA Annual Performance Report.

Strategies and Means

- Provide leadership to forge interagency efforts to better serve underserved populations (partnerships within USDA, and with other Federal agencies, State agencies, universities, and private organizations)
- Increase extramural agreements with organizations that serve underserved populations.
- Increase the number of invitations extended to representatives of underserved populations to participate in program workshops, symposia, project/program reviews, and site/location reviews.
- Increase the number of research collaborations and technology transfer activities focused on meeting the special needs of this target population.
- Identify good examples of recent research that can or will be useful to target populations and ways to help them access this information.
- Ensure that appropriate employees are aware of the outreach initiative and their responsibilities in it.
- Promote knowledge of the outreach initiative to new employees, as appropriate.

ARS Administrative and Financial Management (AFM) Initiatives

OVERVIEW OF AFM INITIATIVES

ARS' Administrative and Financial Management (AFM) initiatives link with USDA's management initiatives to support more efficient program operations and deliver scientific excellence and public service.

AFM expects to:

- Ensure an efficient, high performing, high quality, diverse workforce to fully accomplish the ARS mission and work cooperatively with partners and the private sector.
- Ensure ARS sustains a clean annual audit opinion and provides access to quality financial information through financial systems that meet the needs of their users.
- Enhance ARS effectiveness through effective and automated services for acquisition, personal property, and administrative management.
- Link budget decisions and program priorities more closely with program performance and consider the full cost of programs.
- Reduce improper payments by establishing targets and corrective actions.
- Efficiently and effectively manage real property through good stewardship (*i.e.*, acquisition, maintenance, and disposal) of ARS' real property assets.
- Award extramural agreements in an efficient and timely manner, and ensure they are legally and fiscally sound and in full compliance with established policies and procedures.
- Ensure systems fully meet needs for AFM information and guidance in support of the President's Management Agenda and E-Gov initiatives.

Below is a brief summary of AFM's priorities.

Performance Measure 1: Enhance ARS effectiveness through effective and automated services for acquisition, personal property, and administrative management.

FY 2013 Accomplishments:

- APD reviewed and manually archived over 400 Federal Business Opportunity (FBO) notices, as well as issued guidance to the Acquisition Workforce concerning the ability to auto-archive notices in the system to ensure the most accurate and up-to-date information is available to potential offerors.

- APD restructured the FBO office locations to be consistent with the Areas and BSCs, which simplified the system setup and provides redundancy for backup posting ability.

- APD initiated the review of the Integrated Acquisition System (IAS) Buyer Assignment rules for all REE requisitioner/receivers and budget approvers for errors and inconsistencies and coordinated the re-assignment of the affected individuals.

- APD prepared monthly Contractor Performance Assessment Reporting System (CPARS) Auto Register and Status reports for the BSCs and the Office of Procurement and Property Management.

- APD prepared quarterly FAC-COR reports for the BSCs to monitor the active and revoked certifications of Contracting Officers' Representatives.

By FY14 AFM will:

Implement the Invoice Processing Platform for REE, which will allow for the electronic processing and tracking of invoices, and provide a cost and time savings for the agencies.

Provide training and guidance to IPP Users on Invoice Processing procedures and best practices. Integrate ATS and FDMIS to eliminate redundancy, create efficiency and streamline tracking and data mining.

Provide ATS Training to the Acquisition Workforce and Administrative Officers on how to track award progress and contract closeouts.

Provide guidance to assist ARS' Acquisition Workforce to report past performance contract information in the Contractor Performance Assessment Reporting System (CPARS).

Provide guidance to IAS Users on the reports and information that are available in IAS Discoverer.

Implement the FAITAS Warrant Module to provide and track delegations of authority.

Provide guidance to Procurement Personnel for the auto-archival of FBO notices to ensure the most accurate and up-to-date information is available to potential offerors.

Provide guidance to Procurement Personnel to ensure that FPDS-NG reports are in a finalized status to accurately reflect procurement actions and funding obligations.

Investigate the e-filing and archiving of contract documentation in IAS.

By FY15 AFM will:

Provide training and guidance to IPP Users on Invoice Processing procedures and best practices.

Provide guidance to assist ARS' Acquisition Workforce to report past performance contract information in the Contractor Performance Assessment Reporting System (CPARS).

Provide ATS Training to the Acquisition Workforce and Administrative Officers on how to track award progress and contract closeouts.

Provide guidance to Procurement Personnel for the auto-archival of FBO notices to ensure the most accurate and up-to-date information is available to potential offerors.

Initiate processes for e-filing and archiving of contract documentation.

By FY 16 AFM will:

Provide training and guidance to IPP Users on Invoice Processing procedures and best practices.

Provide guidance to assist ARS' Acquisition Workforce to report past performance contract information in the Contractor Performance Assessment Reporting System (CPARS).

Provide ATS Training to the Acquisition Workforce and Administrative Officers on how to track award progress and contract closeouts.

Provide guidance to Procurement Personnel for the auto-archival of FBO notices to ensure the most accurate and up-to-date information is available to potential offerors.

Fully implement processes for e-filing and archiving of contract documentation.

Performance Measure 2: Enhance ARS effectiveness through effective and automated services for acquisition, personal property, and administrative management.

FY 2013 Accomplishments

- Continued to serve as an Agency subject matter expert to assist USDA's Office of Procurement and Property Management address CPAIS-Personal Property development issues. USDA has rescheduled implementation until FY2014.

- Monitored the monthly personal property inventories and suspense status and worked with BSCs and locations to ensure that the agency maintained a "Green" score for USDA's Metric for Property Suspense Clearing and Inventories, which measures the timeliness of clearing property suspense items and keeping property inventories current.

- Implemented GSA's fleet management system, FedFMS in anticipation of the new fleet card. ARS was the first USDA agency to implement the system for GOVs.

- Reviewed and monitored fleet card purchases, analyzed data, and updated data to the FedFMS system. This allowed for all fleet costs to reside in a single system and allowed BSC fleet managers to use FedFMS to monitor fleet costs and vehicle use.

- Monitored vehicle requisitions and ensured BSC fleet managers maintained vehicle allocation methodology (VAM) justifications for functional needs for vehicles that did not meet the minimum greenhouse gas score. Of the 44 replacement vehicles requested, 61 percent were alternative fueled vehicle, including hybrids and E-85 flex fuel vehicles.

- Manually collected E85 fuel use to ensure proper credit for alternative fuel use. Increased E85 fuel use by 17 percent in FY2013.

- Served on USDA's Technical Review Panel to review proposals for USDA's new fleet card

By FY 2014, AFM will:

Implement a new fleet card that provides level III data for all transactions. (Level III data includes cost per gallon, total no. of gallons, total cost, fuel type, and odometer)and a new fleet card system that includes a requirement for a unique Driver ID for each driver/card user; which is required for each fleet transaction.

Conduct training on the Fleet Card On-line system
Develop Quick Guide materials on the fleet card system.
Conduct User Acceptance Testing for USDA's new personal property system CPAIS-Personal Property

Implement USDA's new personal property system CPAIS-Personal Property based on USDA's confirmed implementation schedule.

Continue to serve as an Agency subject matter expert to assist USDA's Office of Procurement and Property Management address CPAIS-Personal Property issues post- implementation.

By FY 2015, AFM will:

Continue to develop CPAIS-PP quick guide training materials for Business Service Centers(BSC) and assist in BSC training.

Continue to serve as an Agency subject matter expert to assist USDA's Office of Procurement and Property Management address CPAIS-Personal Property issues post- implementation.

Continue to serve as an Agency subject matter expert to assist USDA's Office of Procurement and Property Management to further develop the fleet module of CPAIS-PP to ensure that it offers the same level of reporting requirements as FedFMS, allowing the agency to have all personal property asset data in one system.

Continue to conduct refresher training and materials on the Fleet Card On-line system.

By FY 2016, AFM will:

Continue to develop CPAIS-PP quick guide training materials for Business Service Centers(BSC) and assist in BSC training.

Continue to serve as an Agency subject matter expert to assist USDA's Office of Procurement and Property Management address CPAIS-Personal Property issues.

Continue to serve as an Agency subject matter expert to assist USDA's Office of Procurement and Property Management to further develop the fleet module of CPAIS-PP to ensure that it offers the same

level of reporting requirements as FedFMS, allowing the agency to have all personal property asset data in one system.

Continue to conduct refresher training and materials on the Fleet Card On-line system.

IMPROVE HUMAN CAPITAL MANAGEMENT

The AFM strategic plan contains objectives related to improved management of ARS human capital. The plan focuses on strategic workforce planning, leadership development, optimizing organizational structures to address current and future challenges, and improving performance management to maximize employee performance. The AFM strategic plan identifies human capital challenges and implements an accountability system to monitor and address these challenges. Such challenges include meeting the demand for cutting edge research talent, creating a workforce with a combination of skills not previously required, and fully supporting the Department's mission.

In managing its human capital and delivering its services to customers, ARS will continue to focus on ensuring civil rights and equal employment opportunity for everyone, regardless of race, color, national origin, gender, religion, age, sexual orientation, disability, political belief, marital or familial status, or any other factor. ARS is committed to continuous civil rights progress in the workplace, program delivery, and the efficient processing of complaints.

AFM plans to:

- Identify current and future skill gaps through an effective workforce planning process.
- Deliver human resource 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 strategies.
- Ensure that ARS fosters a workplace atmosphere conducive to achieving the Agency's mission.

AFM Goal 1: **Improved Human Capital Management**

Objective: Research, Education, and Economics Agencies have a highly qualified diverse workforce to fully accomplish the REE mission.

FY 2013 Accomplishments

•**Transitioning AFM into Business Service Centers.** In response to continuing budget challenges, ARS leadership developed and implemented a new structure to deliver administrative and financial management services more effectively and efficiently. Centered around three geographically dispersed Business Service Centers (BSC), the new structure places services closer to the research mission, takes advantage of lower facilities costs and reduced competition for talent in these areas, and incorporates hiring and retention flexibilities inherent to a mobile and virtual workforce.

• **Identified staffing gaps for REE Mission Critical Occupations (MCOs).** AFM participated in this USDA-level project. It involved gathering workforce data to identify critical staffing gaps for MCOs in the REE mission area. Based on the data, action plans were developed for five of these MCOs. REE agencies hire into all five of these USDA-identified MCOs. Portions of these plans will be implemented in FY14 and FY15 as appropriate for REE agency situations. These plans will be used to work with REE managers to

develop effective recruitment and marketing strategies. It is anticipated that this project will serve as a model to develop action plans for additional REE-specific MCOs as well as other types of REE positions.

• **Rebuilt capacity in human capital management skill set in Human Resources Division**. The HR Specialist (0201) occupation is one of USDA's MCOs. In FY12, HRD trained key HR staff in fundamental human capital concepts using both formal training and developmental assignments to rebuild this capacity. Developments of Human Capital Plans for FY 14 are underway for deliverable of March 2014.

• **Consistently met OPM's 80-day hiring goal for most REE hires**. HRD reports monthly to the Departmental Office of Human Resources Management OHRM. Recruitment action plans included strategies to meet this goal. In FY13, REE met OPM's 80 day hiring goal.

• **Partnered and collaborated with Departmental Staff on implementing a human capital planning tool and templates to facilitate a standardized and streamlined approach to human capital planning throughout USDA.** Provided feedback at critical junctures in the development of this tool. ARS-HRD is also using the tool to update its current human capital plan by the Departmental deadline of 3/31/14.

- **Conducted leadership human capital interviews to ensure strategic alignment of ARS's human capital plan.** During January/February 2014 timeframe, HRD distributed interview guides to ARS's executive and top management cadres, a total of 334 leaders in all. Respondents addressed key mission drivers, general workforce issues, Mission Critical Occupations, and suggested opportunities for the next 3 to 4 years. Results from these interviews are being incorporated into the updated ARS human capital plan.
- **Convened a REE human capital and workforce planning team to facilitate human capital planning activities.** The team is comprised of primary Points of Contact (POCs) in each of the REE agencies. We met several times throughout the last 9 months to share ideas, planning methods, and challenges. Tom Scott was also invited to present to this group to ensure all POCs understood Departmental requirements and could engage in collaborating to help make the Departmental tool the best possible.
- **Increased integration of FEVS and Cultural Transformation action planning into human capital planning strategies.** Even before the Department moved to achieve stronger of these mutually supporting areas, ARS looked for commonalities among these three initiatives to maximize resources and reinforce important leadership actions.

• **Increased efforts to recruit students, veterans and employees with disabilities in REE.** AFM HRD launched a multi-pronged approach to raise awareness and outreach in order to increase the numbers of new hires who are students, veterans and/or employees with disabilities. HRD accomplished the following:

• Created a new recruitment brochure to be used at career fairs and other recruitment venues targeted towards students, veterans, and people with disabilities and purchased new recruitment aids (display, table coverings, and brochure holders) to present a professional image at recruitment fairs;

• Developed educational materials for hiring managers and HR specialists focused on students, veterans and people with disabilities. The website will include information on the Schedule A Hiring Authority, to include a PowerPoint presentation for hiring managers on hiring people with disabilities, laws and Executive Orders, FAQ's and links to useful resources for people with disabilities and hiring managers.

• Conducted outreach through meetings and webinars to the ARS managers and employees to explain the various programs for veterans and persons with disabilities and responded to questions regarding specific hiring goals them for persons with disabilities and techniques to meet the goals.

• Attended several recruitment events nationwide targeted at one or more of these specific groups.

• These efforts resulted in making direct contact with potential candidates in one or more of these targeted groups and in laying the foundations for future targeted recruitment initiatives.

- Training HR specialists to close skill gaps and deficiencies in recruitment and use of hiring authorities.
- LA Training with Administrative Officers and HR Specialists on regulations of Letter of Authority Flexibilities.

Implemented various One USDA Line of Business as a means to provide more efficient and standardized services in the agencies, they include:

- EmPowHR – payroll and personnel processing system
- ERecruit – Staffing Acquisition System to replace USA Staffing System to provide an overall seamless recruitment and placement experience for applicants and hiring managers.

In response to OPM Demo audit findings: developed a comprehensive report and remediation plan; held Demo Functional Meeting for all BSC HR Specialists, team leaders and branch chiefs who service ARS; and worked closely with EBSC and WBSC to reconstruct cases with potential violations.

- Conducted internal self-audit of Delegated Examining Unit and submitted report to OHRM.
- Identified required HRS training for ARS transition from Demo and Alternative Merit Promotion to Delegated Examining and Merit Promotion; coordinated training with OPM and managed process to ensure all HRS, TLs and BCs received training.
- Developed implementation plan for E-Recruit to include communication, job aids, hiring manager guides, and training.
- Managed position title code project driven by One-USDA initiative and EmpowHR implementation.
- Developed REE Hiring Flexibilities Guide for managers and HR specialists.
- Completed and submitted the following reports to OHRM: FEORP, Position Management and Vacancy Control, Quarterly DE and Demo Workload, and Pathways.
- Held Merit Promotion Functional Meeting for BSC HR Branches and specialists to provide an overview of new Merit Promotion Departmental Regulation.

In FY 13, piloted 5% of the RPES Panels in a virtual environment with the primary goal being to minimize travel costs and assess if panels can be successfully conducted and maintain efficacy of the process in comparison to face to face.

Developed and conducted Individual Development Plan training for supervisors and employees.

On the Road Training Program The Employee and Leadership Development Staff changed its focus from conducting training locally, while making occasional trips to other locations on a as request basis, to providing training to the entire ARS community. The goal of this effort is to provide increased direct training support to all of ARS. This has resulted in a broader scope of diverse employees being trained and developed throughout the agency. Between 2010 and 2012 our efforts reaped the benefits of a

total of seven on the road training sessions being conducted. During 2013, schedules are set for training in SPA (TB4T @ College Station on 2/25); SAA (IDP & TB4T 3/3-3/4 @ Athens; QBQ, TB4T and TS4SMEs @ Gainesville); and PWA (CC & TB4T 4/22-4/25 @ Maricopa, AZ). We are currently in the planning stages of a summer trip to MWA (St Paul) and are on standby to provide CC training for NAA (Plum Island).

Training on AgLearn ELDS continues to partner with ARS SMEs to convert previously instructor-led trainings to web-based training. The focus of this effort is to provide training to a broad and diverse group of employees. The benefits of converting training over to a web-based format is an instant cost savings to the agency because we are able to train more with less. An example of this is the Research Panel Evaluation training that was converted over to a series of online training modules and webinars. Other trainings that have been converted and currently online are: Letter of Authority training for AOs, 2013 EEO policy statements for all employees, and Biosafety and Risk Assessment training for the scientific community. We continue to work with our customers to provide training on multiple platforms to meet their needs.

FEORP Data Partner with ODEO staff to ensure diverse numbers of employees are taking advantage of training and development opportunities throughout the agency. For FY13, employees participating in training and development opportunities are as follows: 52.44% of employees grades 1-4; 84.90% of employees grades 5-8; 93.78% of employees grades 9-12; 98.11% of employees grades 13-15; and 54.97% of SES employees.

ELDS Training In-House – NRLTP Leadership Seminar completed in December w/ assistance from the Gilburg Institute; Training schedule to start in June (delayed due to full HR training schedule); BSCs needs assessments completed; HRD needs assessment to be conducted soon; **DC Area** – completed (2) training sessions @ NIFA this FY with another 7 scheduled (Next is an Advanced MBTI Team Trainer scheduled for 2/26); working with ERS and NASS to ID training for them this year; **TB4T** – Teambuilding for Teams; IDP (Individual Development Plans); QBQ – Question Behind the Question; TS4SMEs – Training Skills for Subject Matter Experts; **VTC** – plan is to train staff in use of VTC equipment and adapting classroom training for delivery via VTC- no specific date set yet.

ELDS-Supported/Administered Training - Off-Location - OPM - Leadership for a Democratic Society (LDS) – Program announced 2/4; Maggie is already assisting one candidate (Lisa Fleming) through the process; Grad School (ELP – Assisting 3 active participants) (EPP – Assisting 1 active participant); **In-House** - Grad School – Coordinated the presentation of (7) HR-Related training sessions, (2) of which have already been completed and (5) scheduled between now and June (Job Analysis, Basic Staffing, Processing Personnel Actions and Project Management)

ELDS-Supplied Counseling - Completed personalized 1-on-1 IDP counseling sessions with 7 REE Agency employees
Communicating via Rosetta Stone – ARS has embraced the idea of being able to communicate with employees and customers by allowing employees to learn different languages.

As a result of the USDA Cultural Transformation initiative, FEVS 2012 survey results, annual program review, and Departmental changes to the performance management program, ARS worked on the continued strengthening of the performance management and employee recognition programs by focusing on two critical initiatives to further improve performance management and employee recognition. These initiatives included:

- Implementing the new Departmental Regulation on Performance Management, which integrated OPM GEAR principles, supervisory and employee program expectations, training requirements, and measures for accountability? ARS has been using this opportunity to further create a results-focused organization;
- Implementing our new reinvigorated awards portfolio which created a recognition program that is more meaningful and all-inclusive. More specifically, all positions with the agency are eligible to for one of the nine established specialty award programs.
- Creating a performance accountability database to assist the organization with tracking and monitoring program compliance, data gathering and analysis, and a mechanism for increasing the overall accountability among supervisors; and

In FY2013, AFM-HRD collaborated with the Department to review the new Department Regulation (DR) and conducted an analysis of how the new policy would impact REE.

AFM-HRD worked with supervisors and leadership to develop consistent expectations for teleworkers during weather or other emergencies. The primary goal being to ensure employees' safety during emergency situations. "Telework Readiness Tips" were developed and shared to assist employees and supervisors be better prepared for telework. These Telework Readiness Tips were ultimate incorporated into the new DR. AFM-HRD worked with leadership to encourage employees to practice teleworking. Practicing telework and setting clear telework expectations during emergency situations ensures for more complete continuity of operations. In addition, AFM-HRD hosted webinars and marketed the program to increase participation and understanding of telework as a strategic human resource tool.

In an effort to close gaps in telework data and encourage participation, AFM-HRD worked with the AFM Business Service Centers to standardize the issuance of telework eligibility notifications and maintenance of the telework database. This and other efforts decreased the number of employees with no telework agreement, increased the validity of the data reported to the Department each month brining REE closer to meeting the telework CT goals.

• **Continue phased implementation of ARS supervisory training program.** ARS is modifying the current supervisory training program to be delivered in VTC format as well as classroom. Additionally, the training curriculum for the agency has been established by gaining input from varying levels of leadership to ensure a comprehensive training program.

Personnel Security Staff re-validated all security clearances for ARS, ERS, NASS, and NIFA in compliance with the DNA/DM regulations
Fingerprints results are given within 48 hours on avg (90%).
Linc Pass adjudications completed within 60 days for new employees (90%).

Performance Measure 1.1: Fill critical positions and hire people with agency-desired skill sets into positions as they are approved to be filled.

By FY 2014, AFM will:

Identify current and future staffing gaps within each REE agency

Work with hiring managers to identify desired skill sets in critical positions
Develop an integrated marketing and recruitment strategy to attract diverse candidates with top skill sets from sources that provide maximum opportunity for all
Develop an evaluation plan, including appropriate metrics, to guide improvement in the hiring process.

By FY 2015, AFM will:

Identify current and future skills gaps within each REE agency
Develop metrics to guide improvement in the hiring process
Evaluate and refine marketing and recruitment strategy to attract diverse candidates with top skill sets from sources that provide maximum opportunity for all
Implement evaluation plan to guide improvement in the hiring process.

By FY 2016, AFM will:

Re-evaluate marketing and recruitment strategies to ensure they are producing desired candidates and agency results, and revise/refine as needed.
Continue to identify current and future staffing and skills gaps.
Adjust hiring process as indicated from evaluation and continue to monitor for effectiveness and potential improvements.

Performance Measure 1.2 Emphasize employees' continuous development.

Indicators:

By FY 2014, AFM will:

Develop career development templates for targeted critical occupations to assist employees to grow in the agency.
Develop and implement an employee continuous education requirement.
Retain and share corporate knowledge by defining/developing and implementing Knowledge Management strategies.

By FY 2015, AFM will:

Implement career development templates for targeted critical occupations and continue to develop additional templates to assist employees to grow in the agency.
Develop and implement tools for managers to use at local levels to facilitate meeting employees' continuous education requirements.
Continue to develop and implement effective corporate knowledge management strategies.

By FY 2016, AFM will:

Evaluate career development templates in use and refine as needed; continue to develop additional templates as needed based on proven models.

Evaluate and refine effectiveness and efficiency of process/tools to foster employees' continuous education requirements.
Evaluate and refine corporate knowledge management strategies.

Performance Measure 1.3 REE Agencies work toward achieving/retaining top ranking in USDA as "Best Places to Work" as reported in the Federal Human Capital Survey.

By FY2014, AFM will:

Monitor retention rates and develop additional metrics for REE Onboarding program/process to ensure effectiveness and efficiency of assimilation and support for new employees.
Continue implementation of the Performance Appraisal Assessment Tool (PAAT) in order to improve performance management and reward processes and actions.
Expand/implement maxiflex, telework, and other programs and flexibilities to assist employees in balancing work and personal responsibilities.
Evaluate and Analyze Federal Employee Viewpoint Survey to target key areas to be addressed. Establish action plan to close gaps to create a positive, results-oriented workforce.

By FY 2015, AFM will:

Evaluate and refine REE Onboarding program/process and metrics to ensure effective assimilation and support for new employees to increase retention.

Develop metrics and monitor the Performance Appraisal Assessment Tool (PAAT) in order to determine whether performance management and reward processes and actions have improved.
Expand/implement maxiflex, telework, and other programs and flexibilities to assist employees in balancing work and personal responsibilities.

By FY 2016, AFM will:

Evaluate and refine REE Onboarding program/process and metrics to ensure effective assimilation and support for new employees to increase retention.
Evaluate and refine the Performance Appraisal Assessment Tool (PAAT) as needed to ensure the tool is improving management and reward processes and actions.
Evaluate and refine workplace flexibility programs designed to assist employees in balancing work and personal responsibilities.

Performance Measure 1.4 Improve "Leading People" skills of all leaders, supervisors, and managers.

By FY 2014, AFM will:

Develop ARS Succession Plan and Ensure all REE Succession Plans developed
Fully implement a supervisory training program.

By FY 2015, AFM will:

Implement Succession Plan in ARS and Ensure client agencies plans implemented.
Complete implementation of and develop an evaluation plan for a supervisory training program.

By FY 2016, AFM will:

Evaluate REE Succession Plans for continued relevance and adjust as needed.
Evaluate supervisory training program and adjust/adapt as needed.

IMPROVE FINANCIAL MANAGEMENT

Objective: REE Agencies sustain a clean audit opinion and have access to quality financial information through financial systems that meet their management needs.

Accomplishment:

- USDA received an unqualified "clean" audit opinion for the FY 2013 consolidated statements.
- ARS has implemented the use of CATS to track the Agency 4% R&M requirement and ensure R&M charges are appropriate. We continue to work with the Locations and FD to improve the quality and ensure the accuracy of the data reported.
- The first phase of the ARMP system and process revisions identified by the Lean Six Sigma team were successfully implemented in 2014. The team continues to meet and has identified additional opportunities to be implemented in 2015.

Performance Measure 2.1 REE meets all monthly, quarterly, and annual appropriation level accounting and reporting requirements. Appropriated fund (obligation) and cash reports continue to evidence an accurate financial picture.

By FY 2014, AFM will:

Support the quarterly financial statements process, and actively respond to annual OIG audit of REE-wide financial statements and resolve relevant audit concerns.

By FY 2015, AFM will:

Support the quarterly financial statements process, and actively respond to annual OIG audit of REE-wide financial statements and resolve relevant audit concerns.

By FY 2016, AFM will:

Support the quarterly financial statements process, and actively respond to annual OIG audit of REE-wide financial statements and resolve relevant audit concerns.

Performance Measure 2.3 ARMPS and CATS are fully implemented on ARIS/ORACLE platform, meets needs of ARS users, and maximizes opportunities for financial data integration.

By FY 2014, AFM will:

Continue updating the ARMPS system to implement the data exchange opportunities that have been identified to ensure the system is up to date and utilizing current technology to increase efficiency. Continue to identify multiple data exchange opportunities between SAMS, ARMPS, CATS, ARIS and other non-financial ORACLE-based applications to reduce the need for duplicate data entry and increase operating efficiency.

By FY 2015, AFM will:

Continue updating the ARMPS system to implement the data exchange opportunities that have been identified to ensure the system is up to date and utilizing current technology to increase efficiency. Continue to identify multiple data exchange opportunities between SAMS, ARMPS, CATS, ARIS and other non-financial ORACLE-based applications to reduce the need for duplicate data entry and increase operating efficiency.

By FY 2016, AFM will:

Identify multiple data exchange opportunities between SAMS, ARMPS, CATS, ARIS and other non-financial ORACLE-based applications to reduce the need for duplicate data entry and increase operating efficiency.

Effectively managing the use of taxpayer dollars is a fundamental Federal responsibility. ARS intends to ensure that all funds spent are accounted for properly to taxpayers, Congress, and the Government Accountability Office (GAO). The AFM Financial Management Division (FMD) works to improve financial management in partnership with the USDA Office of the Chief Financial Officer (OCFO).

AFM-FMD plans to:

- Ensure that ARS meets all appropriation level accounting and reporting requirements, and ensure that all reports continue to indicate an accurate financial picture and that reporting difficulties are rapidly resolved.
- Continue to improve financial system business processes and financial reporting capabilities.
- Provide support to ARS travelers with professional customer-oriented travel and transportation staff and a Web-based travel system.
- Ensure financial management bulletins and undocumented business practices are incorporated into policies and procedures for the agency.

PROCESS IMPROVEMENT FOR EXTRAMURAL AGREEMENTS PROGRAM

USDA promotes the improvement and development of systems of accountability that encourage all employees to achieve high standards of performance and customer service. ARS recognizes the need for improved business process to achieve this high level of customer service and employee performance. The AFM Extramural Agreements Division further supports this initiative through the review and improvement of the extramural agreements process to provide a streamlined and consistent agreements process throughout the Agency.

ELIMINATE IMPROPER PAYMENTS

Based on recent audit estimates, Federal agencies make more than $45.1 billion in improper payments annually. This USDA initiative requires agencies to measure their improper payments annually, develop improvement targets and corrective action plans, and track the results annually to ensure that corrective actions are effective.

AFM will work with the Department plan to:

- Work with Department and Agency officials to reduce the number of improper payments made.
- Recover, where possible, overpayments made to individuals and organizations.

IMPROVE ASSET MANAGEMENT

It is the policy of USDA to promote the efficient and economical use of the Department's real property assets and to assure management accountability for implementing Federal real property management reforms. Based on this policy, ARS recognizes the importance of real property resources through increased management attention, the establishment of clear goals and objectives, improved policies and levels of accountability, and other appropriate actions. AFM supports the Department's real property asset management program and the following strategic objectives used for real property management improvement:

- Continuously update a capital investment strategy that incorporates both facility needs as well as program needs.

- Maximize facility utilization and co-locate Agency operations when possible.
- Use performance measures as part of the asset management decision process.
- Use public and commercial programs to provide management information to determine the appropriate levels of investment.
- Dispose of Underutilized assets.
- Use appropriate public and commercial benchmarks and best practices to improve asset management.
- Provide for safe, secure, and healthy workplaces.

AFM Goal 5: Improved Accountability and Program Stewardship of the ARS Extramural Agreements Program.

Objective: Extramural agreements are awarded and administered in an efficient and timely manner to ensure accomplishment of mission and program goals and objectives. All agreements are legally and fiscally sound and are in full compliance with established extramural policies and procedures.

Accomplishments:

- Implemented Phase 2 and 3 improvements as identified by the Business Process Review Team (BPRT) for Extramural Agreements. Modified ARIS/AIMS to incorporate new or revised business practices identified by the BPRT, which includes further streamlining of approval chain, and initiation of email notification for incoming and outgoing agreements.
- Implemented the Interagency Agreement (IA) Process, modified ARIS/AIMS to facilitate tracking of IAs, developed and delivered training on new process and data entry requirements.
- Updated P&P 700.0 Delegation of Authority for ADO's dated 1/24/13.
- Updated P&P 705.0, Memorandum of Understanding dated 3/29/13.

Performance Measure 5.1 Ensure effective use and administration of extramural agreements including fiscal and programmatic responsibility for ARS-PIs, Authorized Departmental Officers (ADOs) and Grant Management Specialists (GMS)

By FY 2014, AFM will:

Continue training programs on authorized uses of Extramural Agreements for ARS-PIs and deploy on AgLearn.

By FY 2015, AFM will:

Deploy AgLearn training programs on authorized uses of Extramural Agreements for ARS-PIs.
Develop Levels 1 and 2 ADO training program and deploy on AgLearn.

By FY 2016, AFM will:

Continue AgLearn training programs on authorized uses of Extramural Agreements for

ARS-PIs and Levels 1 and 2 ADOs.
Develop ARS specific training for GMS (Levels 3 and 4 ADOs) and deploy on AgLearn.

Performance Measure 5.3 Ensure ARS Extramural Agreements Regulations; Policies and Procedures (P&Ps) comply with applicable Government-wide standards as prescribed by OMB.

By FY 2014, AFM will:

Finalize updating Extramural Agreements P&Ps, and publish as necessary.
Publish revision to 7 CFR 550 to incorporate 2 CFR Part 200, Uniform Administration Requirements, Cost Principles & Audit Requirements for Federal Awards.

By FY 2015, AFM will:

Conduct comprehensive review of Extramural Agreements P&Ps, update and publish as necessary.
Codification of RSA General Provisions and clear through Departmental offices for Federal Register publication.

By FY 2016, AFM will:

Continue to conduct comprehensive reviews of Extramural Agreements P&Ps, update and publish as necessary.
Codification of RSA General Provisions and clear through Departmental offices for Federal Register publication.

SUPPORT FAITH-BASED AND COMMUNITY INITIATIVE

This initiative strives to support the essential work of faith-based and community organizations. AFM supports this initiative by ensuring the acquisition process allows these organizations to compete on equal footing for ARS contracts.

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By FY 2014, AFM will:

Publish a Small Business Regulatory Enforcement Fairness Act (SBREF) non-retaliation policy widely available to small entities.

Provide small businesses with regulatory compliance assistance in the form of generally-applicable, written compliance or similar written information.

Provide small business compliance assistance (e.g. training or counseling) other than generally-applicable, written guidance.

Provide public notice regarding small entities' rights under SBREFA, including the right to file a comment with the National Ombudsman.

Provide written notice of small entities' SBREFA rights when the agency issues a citation, notice of regulatory violation, charge of violation, or the like to a particular small business.

Develop and implement effective strategies for improving participation by small businesses, small disadvantaged businesses, 8(a) small businesses, women-owned small businesses, HUBZone small businesses, Service Disabled Veteran Owned Small Businesses, and persons with disabilities (AbilityOne) and for accomplishing all goals.

Create or enhance its outreach efforts to increase procurement with small businesses, small disadvantaged businesses, 8(a) small businesses, women-owned small businesses, HUBZone small businesses, Service Disabled Veteran Owned Small Businesses, and persons with disabilities (AbilityOne) and for accomplishing all goals.

By FY 2015, AFM will:

Provide small businesses with regulatory compliance assistance in the form of generally-applicable, written compliance or similar written information.

Provide small business compliance assistance (e.g. training or counseling) other than generally-applicable, written guidance.

Provide written notice of small entities' SBREFA rights when the agency issues a citation, notice of regulatory violation, charge of violation, or the like to a particular small business.

Continue implementation of effective strategies for improving participation by small businesses, small disadvantaged businesses, 8(a) small businesses, women-owned small businesses, HUBZone small businesses, Service Disabled Veteran Owned Small Businesses, and persons with disabilities (AbilityOne) and for accomplishing all goals.

Participate in outreach efforts to increase procurement with small businesses, small disadvantaged businesses, 8(a) small businesses, women-owned small businesses, HUBZone small businesses, Service Disabled Veteran Owned Small Businesses, and persons with disabilities (AbilityOne) and for accomplishing all goals.

By FY 2016, AFM will:

Provide small businesses with regulatory compliance assistance in the form of generally-applicable, written compliance or similar written information.

Provide small business compliance assistance (e.g. training or counseling) other than generally-applicable, written guidance.

Provide written notice of small entities' SBREFA rights when the agency issues a citation, notice of regulatory violation, charge of violation, or the like to a particular small business.

Continue implementation of effective strategies for improving participation by small businesses, small disadvantaged businesses, 8(a) small businesses, women-owned small businesses, HUBZone small businesses, Service Disabled Veteran Owned Small Businesses, and persons with disabilities (AbilityOne) and for accomplishing all goals.

Participate in outreach efforts to increase procurement with small businesses, small disadvantaged businesses, 8(a) small businesses, women-owned small businesses, HUBZone small businesses, Service Disabled Veteran Owned Small Businesses, and persons with disabilities (AbilityOne) and for accomplishing all goals.

IMPROVE ASSET MANAGEMENT

It is the policy of USDA to promote the efficient and economical use of the Department's real property assets and to assure management accountability for implementing Federal real property management reforms. Based on this policy, ARS recognizes the importance of real property resources through increased management attention, the establishment of clear goals and objectives, improved policies and levels of accountability, and other appropriate actions. AFM supports the Department's real property asset management program and the following strategic objectives used for real property management improvement:

- Develop a capital investment strategy that incorporates both facility needs as well as program needs.
- Maximize facility utilization and co-locate Agency operations when possible.
- Use performance measures as part of the asset management decision process.
- Provide management information to determine the appropriate levels of investment.
- Dispose of unneeded assets.
- Use appropriate public and commercial benchmarks and best practices to improve asset management.
- Provide for safe, secure, and healthy workplaces.

Indicator 1:

During 2013, AFM will improve stewardship (acquisition, operation, and disposal) of REE Real Property assets effectively supports and enhances the REE Mission Area.

FY 2013 Accomplishments*:*

- Updated the ARS Capital Investment Strategy condition index to prioritize ARS modernization and new construction needs based on facility condition and research program priority.
- Provided a standard Operation and Maintenance (O&M) Plan for Locations to use as a standard guide for implementation of a facility O&M Program at other ARS facilities to address general maintenance, preventive maintenance, and repair of facilities to minimize the life cycle cost of the facility.
- Utilized the facility plan developed by the Agency and Area Asset Management Review Boards to prioritize the allocation of R&M funds to meet mission requirements.
- FD continued funding and performing energy audits and re-/retro-commissioning of 25% of covered facilities annually to meet EISA requirements. Compliance status was entered into the DOE CTS tracking system and Energy Star Portfolio Manager
- FD continued to improve data quality for the annual GHG report
- FD revised and reissued Design Manual 242.1which includes the requirements of EPACT 2005, EISA, EO 13423 and EO 13514.
- FD updated policy and continued capturing operation and maintenance costs.
- FD continued to identify and facilitate ESPCS and UECS to identify, implement and finance energy and water improvements.
- Revised P&P 134.2 - Energy Water and Sustainability. It establishes roles and responsibilities commensurate with the new ARS structure and incorporates EPACT 2005, EISA, EO 13423 and EO 13514.
- Revised P&P 157, Major Facilities Construction. It establishes processes to execute major facilities construction and defines roles and responsibilities of key participants in the process.
- Revised P&P 157.2, Facility Construction Authorities. It establishes policy for construction authorizations, appropriation limitations, and policy for compliance to Congressional statutes.
- Continued developed of policies and procedures for the Federal Buildings Personnel Training Act, which will increase training for facility maintenance and safety personnel and insure federal facilities achieve the highest possible return on investment.
- Continued overall management of the Agency Modernization programs, including ARRA and B&F projects.
- FD completed installation of advanced electric meters and is networking them as required by EPACT 2005. FD is continuing to install advanced steam and natural gas meters. As required by EISA.
- FD issued policy, guidance and training on replacement of inefficient lighting as required by EISA.
- FD worked with OCIO to reissue policy on ElectronicsStewardship.
- Established a single point of contact in each Business Service Center (BSC) to coordinate the BSC asset management program.
- Completed 21 Security Site Assessments.
- Completed 23 ePAC Migrations.
- Established plans for 4 Security Site assessments for FY 2014.
- Established plans for 5 ePAC migrations for FY 2014.
- FD RPMB completed the transfer of 4 of the FY 2012 closure properties to the eligible

institutions and one transfer back to the land owner by September 30, 2013.

- FD transferred 2 of the FY 2012 closure properties to GSA for disposal in FY2013.
- Conducted twelve Environmental Site Assessment to ensure properties being transferred and received do not have environmental liabilities associated with them prior to the transfer.
- Ensure each location maintains environmental compliance and conserves natural resources by having an Environmental Management System that meets or exceeds the International Organization for Standardization (ISO) 14001 standard.
- Conducted 5 Environmental Assessments under the National Environmental Policy Act in conjunction with ARS property transfers.
- Secure a suite of over 125 AgLearn SkillSoft safety, health and environmental training courses for all ARS employees in which over 1000 courses were taken Agency-wide in FY2012.
- Prepared the Annual Occupational Safety and Health Report analyzing Agency trends and identifying several corrective actions.
- In accordance with the Hazard Communication Standard required by OSHA, ensured each location developed a chemical inventory for inclusion on Area SharePoint sites.
- Sponsor two monthly teleconferences to bring together, telephonically, the Agency's safety, health and environmental professionals. The purposes of the teleconferences are to disseminate information, solicit the exchange of ideas including lessons learned, enhance participation and involvement, and serve as a means for assessing the overall effectiveness of the Agency's program.
- Participated in the national Biosafety, Safety and Health Leadership Steering Committee sanctioned by the Administrator and responsible for coordinating and collaborating on mechanisms to strengthen relevant ARS Biosafety, Safety and Health Programs and to assist Agency leadership in fulfilling its responsibilities to provide oversight and support of program implementation and effectiveness.

ARS Office of the Chief Information Officer (OCIO) Management Initiatives

OVERVIEW OF MANAGEMENT INITIATIVES

ARS works through its Office of the Chief Information Officer (OCIO) to enable more effective and efficient research mission delivery through a strengthened information and technology management program. The premise of this program is based on the following vision statement:

"ARS information systems are mission driven and responsive to customer needs; they are reliable, secure, user friendly, relevant, innovative, well planned, and managed effectively."

Effective information systems flow from mission requirements. This relationship dictates a structured, comprehensive, and ongoing review of information systems and the technology needed to support ARS mission and internal and external customer needs. Because ARS is the government entity uniquely responsible for creating new knowledge and the data, information, and technology necessary for a sustainable and globally competitive American agriculture, the Agency's information technology program must provide a safe and reliable environment to support the creation, storage, and dissemination of this
knowledge.

The ARS OCIO works in consultation with the ARS Executive Information Technology (IT) Steering Committee to define the strategic direction of the Agency's information technology program in the ARS IT Strategic Plan, which defines ARS' IT strategic goals, objectives, and strategies. The plan identifies key information management issues and provides the framework for developing integrated information systems and technology through further definition and specification of architecture components and information elements. OCIO then works in coordination with the Agency's IT specialists to implement these IT strategies with broad Agency wide impact.

EXPAND ELECTRONIC GOVERNMENT

OCIO facilitates the Agency's implementation of broad Federally and USDA-mandated IT programs focused on expanding electronic government. OCIO will continue to work with the USDA Office of the Chief Information Officer (USDAOCIO) to achieve this goal. Specifically, OCIO will work with the USDA-OCIO on key areas for effective IT management, such as Enterprise Architecture, Federal Information Security Management Act (FISMA), and Capital Planning and Investment Control, as well as on network efficiency, reliability, and capacity to ensure support of E-Government projects.

Strategies and Means

- Ensure that the ARS mission drives its information systems and the deployment of information technology.
- Ensure that ARS information systems are reliable, secure, relevant, innovative, well planned, and managed effectively.
- Invest in appropriate human resources and infrastructure to ensure effective management of high quality information and state-of-the-art technology.
- Ensure information systems support research and technology transfer through development and dissemination of ARS advanced knowledge-based systems, decision tools, and databases.
- Ensure that researchers, educators, and the public have an awareness of and access to research accomplishments and agriculturally related information.

Appendix A:
Strategic Consultations & 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 National Program Leaders serve on many committees, taskforces and inter-agency working groups where they lend their expertise to solving agricultural problems on both a domestic and global scale.

ARS Inter-Agency Working Group Participation		
Group name	**Sponsoring Organization**	**Brief purpose**
Academy of Finland	USDA/Finland	Collaborate on food safety research; share food safety information
ADODR on Confidentiality Agreements	Food Companies	To discuss mutual interests related to functional foods
Agricultural Air Quality Task Force	Chief of NRCS, Office of the Secretary	FACA dealing with air quality, climate change and sometimes bioenergy research & policy
Agricultural Trilateral Working Group Pakistan, Afghanistan (NEW)	FSA	To promote food security for Pakistan and Afghanistan in partnership with USDA
Air Quality Research Subcommittee	CENR	Federal agency information sharing
Alternative Feeds for Aquaculture Initiative	USDA/NOAA	Spur progress in development of aquaculture feedstuffs not reliant on marine pelagic fisheries
American Bakers Association	ABA	To exchange information and assess industry research needs and priorities.
American College of Veterinary Preventative Medicine	AVMA	board certification association for veterinary preventive medicine- I'm a diplomat
American Leather Chemists Association	ALCA	To share information and assess priority needs of the hides and leather industries
American Meat Science Association	Meat and Livestock Industry and Universities	Coordinate public research in meat quality, and safety
American Society of Microbiology	ASM	share microbiologic information
American Veterinary Medical Association	AVMA	sharing of information on veterinary medicine
AMI Scientific Steering Committee	American Meat Institute (AMI)	Set research priorities and review grants
AMI, NCBA, AMI, Pork Board, UFFV,	Commodity	Exchange information on priorities
APHIS Plant Protection and Quarantine Board of Advisors	USDA, APHIS, PPQ	Coordination and Customer Needs for APHIS PPQ
APHIS Research Priorities Steering Committee	APHIS, ARS, NIFA	Interagency Coordination
APHIS Technical Advisory Group for Biological Control Agents for Weeds	APHIS	Provide Technical guidance to APHIS on risks associated with biological control agent releases
Aquatic Nuisance Species Task Force	Federal Interagency	Provide Technical Guidance to Federal Invasive Species Response (Aquatic Nuisance Species)
Armed Forces Pest Management Board	DoD	Consultant

ARS Inter-Agency Working Group Participation		
Group name	**Sponsoring Organization**	**Brief purpose**
ARS Liaison to FSIS Biosecurity Division	USDA	Coordinates biosecurity related research conducted for DHS or FSIS by ARS. Assist in conducting Carver-Shock analysis on biosecurity agents
ARS MOU with DMI, Inc.	DMI, Inc.	To cooperate in developing innovative new products to expand markets for U.S. dairy producers and processors
ARS MOU with the United Soybean Board	United Soybean Board	To improve coordination between the two organizations to better leverage resources applied to the research necessary to develop value-added non-food, non-feed, products using soybeans as a feedstock
ARS partnership with DMI, Inc., the National Dairy Council, and the Department of Defense, Combat Feeding	DMI, Inc.	Designed to leverage government, industry and university resources to greater overall effectiveness and efficiencies, increase collaboration, and help to achieve a more profitable dairy industry
Asian Tiger Mosquito Areawide IPM Project	ARS	Coordination and consultant
ASM Steering Committee for Research Colloquium	American Society of Microbiology (ASM)	To occur in 2011 on Meeting Global Water Needs (includes food safety)
Association of Public Health Veterinarians	AVMA	Communicate public health information among veterinarians working in state, local and federal govt
BEP Animal Health Initiatives	ARS, DoS	Scientific Diplomacy
Biobased Products and Bioenergy Coordination Council	REE Undersecretary	The Biobased Products and Bioenergy Coordination Council (BBCC) was established by the Secretary of Agriculture to provide a forum through which USDA agencies will coordinate, facilitate and promote research, development, transfer of technology, commercialization, and marketing of biobased products and Bioenergy using renewable domestic agricultural and forestry materials. This includes promoting information sharing, strategic planning and providing policy advice to the Secretary. (see www.ars.usda.gov/bbcc)
Biochem 20/20	Contractor	Biosecurity
Biodefense Backstopping	subPCC - DoD	Coordinate International collaborative efforts in developing countries
Bioenergy Crop Assistance Program (BCAP) Project Area Selection Criteria Working Group	Farm Service Agency	BioEnergy Science Team assisting FSA in developing science-based criteria for evaluation BCAP proposals
Biofuels Sustainability Criteria and Indicators Sub-committee	Biomass Research & Development Board	Develop criteria and indicators for sustainable biomass production
Biological Threat Reduction Program	DOD	Coordinate international collaborative efforts to enhance the development of a veterinary infrastructure and animal health research in developing countries
Biomass Conversion Interagency Working Group	Biomass R&D Initiative Board	coordinate Federal-wide efforts in support of converting ligno-cellulosics to fuels
Biomass R&D Board - Environmental Health & Safety	Congress/EPA/USDA	Identify EH&S hazards and benefits related to practices and technologies of components of the biofuels supply chain
Biosurety working group	NSABB	Advise federal government on developing personnel reliability standards
Biotechnology Coordinating Committee	Across USDA	Consistent communication regarding Biotech w/in USDA
Borlaug Global Rust Initiative	USDA, CG Centers, Gates Foundation, multiple wheat growing countries	Address Ug99 and other virulent wheat stem rusts

ARS Inter-Agency Working Group Participation		
Group name	**Sponsoring Organization**	**Brief purpose**
Cattle Fever Tick Eradication Program	APHIS	Coordination of research and operations
CBRN Countermeasures	Federal	Biosecurity Research
CEAP Steering Committee	NRCS	Coordinate CEAP activities
CEAP Working Group	NRCS	coordinate grazingland CEAP activities
Citrus Greening Coordinating Group	ARS, APHIS, Florida Citrus Mutual	To coordinate research to combat citrus greening disease in cooperation with APHIS, University collaborators, and IFAS.
Citrus Greening Research Planning Taskforce	ARS	Plan national research programs to develop and implement management strategies for citrus greening and canker.
Classified Life Sciences Research Interagency Working Group	ARS, HHS, DHS, NIH, CDC, USAF, OSTP, FPA, FSIS	To coordinate interagency activities related to classification of research.
Climate Change Carbon Cycle Interagency Working Group	US Climate Change Science Program	Info sharing, research coordination
Climate Change Ecosystems Interagency Working Group	US Climate Change Science Program	Info sharing, research coordination
Climate Change Land Use/Land Cover Interagency Working Group	US Climate Change Science Program	Info sharing, research coordination
Climate Change North American Carbon Project Steering Committee	US Climate Change Science Program	Research coordination
Climate Change Water Cycle Interagency Working Group	US Climate Change Science Program	Info sharing, research coordination
Codex Alimentarius	Codex- FDA coordinating US group	Intergovernmental Task Force on Antimicrobial Resistance
Colony Collapse Disorder Steering Committee	ARS	Coordination of research for Colony Collapse Disorder.
Combase	USDA/FSA-UK	Collaborate on food safety research: share food safety information
COMEXA (Comision Mexicano-Estados Unidos Para La Eradicacion del Gusano Barrenador de Ganados)	APHIS	Coordination
Committee on Environment & Natural Resources (CENR) Subcommittee on Water Availability & Quality (SWAQ)	OSTP (USGS has lead)	Coordinate water activities across all Federal agencies with water missions.
COPEG (Comision Panameno-Estados Unidos Para La Eradicacion del Gusano Barrenador de Ganados)	APHIS	Coordination
Core Group	Office of Pest Management Policy (USDA ARS) (participants include all USDA agencies involved in pesticide research or policy development)	Provide coordination of pesticide related issues across USDA
CRWG committee on Practices for Enhancing Personnel Reliability and the Culture of Responsibility in High Containment Labs	Interagency	Evaluate standards for personnel for high containment laboratories

ARS Inter-Agency Working Group Participation		
Group name	**Sponsoring Organization**	**Brief purpose**
Department of Defense Biological Threat Reduction Program (BTRP) Review	DoS, DoD, HHS, and USDA	Interagency Coordination
Deployed Warfighter Protection Program	DoD	Coordination of research and development
DHS AG/Food Sub IPT	Interagency	Coordination of research and development
DHS Chemical-Biological Capestone IPT	Interagency	Coordination of research and development
DHS S&T Chemical Countermeasures	USDA	The mission of the committee is to enhance and coordinate the nation's capability to anticipate, prevent, and protect, respond to and recover from chemical threat attacks through innovative research, development, and transition capabilities. Specific focus NSTC Task Force on Non-Traditional Chemical Agents: Research and Development Plan
DHS/NTA	USDA	The committee identifies and evaluates food and water capability, and countermeasure gaps for non-traditional agents (NTAs)
DHS-OMB-MAX	USDA	3 groups: Coordinating Homeland Security Science and Technology; Agriculture; and Rapid Detection Working Group
Diabetes Mellitus Interagency Coordinating Committee	NIH	Provide input on plans for research/treatment/education of diabetes
Dietary Guidance Working Group	USDA	Review federal nutrition publications for compliance with Dietary Guidelines for Americans
Drought Coordinating Council	USDA	Coordinate drought monitoring and decision making in USDA, advise Sec'y and agencies.
Dual Use Research working group	NSABB	Advise federal government on developing Dual use research guidelines
EFSA Scientific Colloquium on Assessing HealthBenefits of Controlling Campylobacter in the Food Chain ASM Research Colloquium on Global Food Safety	EFSA	Provide guidance on potential interventions in poultry for Campylobacter
EU-US Safe Food	EC	Share food safety information
FADT Subcommittee, Veterinary Countermeasures	ARS, DHS, APHIS, EPA, DoD	IWG
Fed Emergency Response Network	Federal	Coordinate Emergency responses to biosecurity: methods validation
Federal Experts Security Advisory Panel (FESAP)	Interagency	Security of Select Agent Policies
Federal Interagency Committee for Management of Noxious and Exotic Weeds (FICMNEW)	Federal Interagency	Provide Technical Guidance to Federal Invasive Species Response (Weeds)
Federal Interagency Committee on Invasive Terrestrial Animals and Pathogens (ITAP)	Federal Interagency (USDA and DOI Co-Chair)	Provide Technical Guidance to Federal Invasive Species Response (Invertebrates, Vertebrates, Plant and Animal Pathogens)
Federal-State Potato Research Program	ARS-National Potato Council	To conduct research on emerging pests of potato in a Federal-State partnership to address high priority areas
Feedstock Production Interagency Working Group, Genetic Improvement	Biomass Research & Development Board	Develop Interagency Strategic Plan for Bioenergy

ARS Inter-Agency Working Group Participation		
Group name	**Sponsoring Organization**	**Brief purpose**
Food Allergy Clinical Guidelines Coordinating Committee	NIAID	Oversee process of developing guidelines on food allergy
Food Defense R&D Interagency Committee	USDA	Coordination of Food Defense research and development between DHS, USDA, HHS, and any other pertinent agencies
Foreign Animal Disease Threat (FADT) Subcommittee, Basic Research Working Group	ARS, NSF, DHS, HHS	IWG
Foreign Animal Disease Threat Subcommittee	NSTC	Coordinate Foreign Animal Disease countermeasures and research
Forest Service	Forest Service	Interagency Coordination
FSU Animal Health Initiatives	ARS, DoS	Scientific Diplomacy
Garden Rose Council	Rose Nursery industry	To coordinate research efforts to address issues of high priority to the Garden Rose industry
Global Change Task Force	Office of Chief Economist	Information sharing among USDA agencies with climate change activities
Global Foot-and-Mouth Disease Research Alliance (GFRA)	ARS, APHIS, DHS	Global Foot-and-Mouth Disease Research Alliance to support FAO/OIE global control and eradication initiative
Global Health Initiative (GHI) Interagency Research Committee	ARS, NIH, CDC, NIFA, OSTP	1. To identify several high-impact research questions and potential "game changers" in global health; 2. To determine how the GHI Interagency Research Committee (IRC) can facilitate GHI plus partner country implementation of GHI's Principle #7, "Promote Research and Innovation;"3. To identify how individual agencies/initiatives can align current and planned global health research efforts to advance GHI principles and targets;
Global Research Alliance on Agricultural Greenhouse Gases		To bridge gaps in research on agricultural greenhouse gas emissions, and to coordinate such research on an international scale, ensuring that scientists share their findings with research communities and farmers in other countries as well as their own. Shafer is international Croplands coordinator
Global Water Cycle Interagency Work Group	Climate Change Science Program (CCSP)	Develop new, innovative science concepts to incorporate into the CCSP global water cycle science plan
Human Nutrition Coordinating Committee	USDA	Share information among USDA agencies whose mission includes nutrition-chaired by ARS
Human Studies Review Board	EPA	Expert consultation
ICT-Prague`	USDA/Czech Republic	Collaborate on food safety research; share food safety information
ILSI Carbohydrates Committee	International Life Sciences Institute	Focus on issues of importance to food industry
Implementation Team for Joint China National Energy Administration (NEA)-DOE-USDA MOU	Foreign Agricultural Service	Implement Joint NEA-DOE-USDA MOU for advanced biofuels production research.
Informal interagency group for responding to OIG study on USDA control of genetically-engineered crop holdings	Office of the Secretary, APHIS, ARS	Developed USDA-wide response to OIG study of how USDA managed holdings of genetically-engineered crops

ARS Inter-Agency Working Group Participation		
Group name	**Sponsoring Organization**	**Brief purpose**
Informal interagency group on OECD biosecurity and biobanks	State Department	Develops US government positions on OECD developed guidelines for biological resource center and related topics
Inter Agency Residue	Federal	Share food safety information
Interagency Cross-Cutting Group on Climate change and Human Health	USGCRP (OSTP)	Develop priorities, outreach, and strategies for adaptation to climate change
Interagency Feedstock Production Working Group	Bioenergy R&D Initiative Board	co-chair, Identify research needs and make recommendations
Interagency Grazinglands Working Group	USDA (ARS & NIFA)	Coordinate grazingland activities between USDA & DOI
Interagency Native Plant Conservation Alliance (PCA)	DOI	Promote & develop interagency and private partnerships
InterAgency Water & Drought Team	USDA	Coordinate REE activities among agencies
Interagency Water Group	State Department	Coordinate federal water agencies/international focus
Interagency Working Group on Climate Change and Public Health	EPA, NIH	Coordination
Interagency Working Group on Domestic Animal Genomics	OSTP	Review progress, needs & opportunities in animal genomics research
Interagency Working Group on Harmful Algal Blooms, Hypoxia, & Human Health	NOAA	Coordinate federal activities, re: harmful algal blooms, hypoxia and human health
Intergovernmental Risk Assessment Consortium	All Federal agencies- FDA runs it	Share information on risk assessment
Intergovernmental Select Agents and Toxins Technical Advisory Board	Interagency	Interagency Coordination
International Association for Food Production	IAFP	sharing information on food safety and science issues- yearly meeting and journal
International Bioengagement Program	subPCC- State Department	Coordinate international collaborative animal health research and biosafety activities
IR-4	USDA, NIFA, and ARS (participants include university researchers and crop industry reps,)	Generate data needed to develop research data to support new EPA tolerances and labeled product uses for minor crops (specialty crops)
IWG Molecular Vaccines	DoD, ARS, NIH, FDA	IWG
IWG on Prion Science	NIH, ARS, APHIS, EPA, NSF	IWG
JCR: Food Agriculture Sector, DHS Team	DHS	Biosecurity
Joint Subcommittee on Aquaculture	OSTP	Coordination of Aquaculture activities across federal agencies
Judicious Use of Antibiotics	USDA	Development of action and research goals
Methyl Bromide Alternatives Outreach Conference Program Committee	ARS, EPA, and industry	To plan and organize the annual International Methyl Alternatives and Emissions Control Research Outreach Conference
Methyl Bromide Quarantine taskforce (NEW)	State /EPA/USDA	To provide technical input to State/EPA policy makers on methyl bromide quarantine issues.
Methyl Bromide Technical Options Committee [MBTOC]	United Nations Environmental Programmes	Provide technical input to the signatories of the Montreal Protocol.
Microbe Project Inter- Agency Working Group	Federal	Genomics of organisms
MOST-SJTU	USDA/China	Collaborate food safety Res

ARS Inter-Agency Working Group Participation		
Group name	**Sponsoring Organization**	**Brief purpose**
MOU with GIPSA/FGIS	GIPSA/FGIS	To address the research priorities of GIPSA/FGIS in development measurement technologies for grain quality
National Barley Improvement Committee/American Malting Barley Association	Barley producers/industry	Barley stakeholder groups
National Berry Crop Initiative	Berry industry (ARS and NIFA participate)	To coordinate industry efforts to address issues of importance, including research, to the berry industry.
National Clean Plant Network	APHIS	Protects U.S. specialty crop agriculture and the environment from the spread, through asexual propagation, of targeted plant pathogens and pests that cause economic damage
National Coalition for Childhood Obesity Research	HHS	Collaboration among USDA, NIH, CDC and Robert Wood Johnson Foundation on prevention of childhood obesity
National Corn Growers Assoc./USDA Corn Germplasm Committee	Corn producers/industry	Corn stakeholder group
National Culture Collection Initiative	American Phytopathological Society	Develop a National System for Preservation and Distribution of Plant-associated Microbes
National Dairy Research Program	Dairy Management Inc., USDA (ARS and NIFA), HHS (National Institutes of Health) and DOD	Coordinate research on issues of importance to the dairy industry
National Dairy Research Program, Dairy Management	ARS/NIH/DoD	Partnership to advance research on nutrition and food processing issues of concern to the dairy industry.
National Environmental Protection Act Interagency Working Group	EPA	Info sharing, training
National Grape and Wine Initiative	National Grape and Wine Initiative (participants include representatives from table grape, raisin, wine, and juice sectors of the grape industry, ARS, NIFA, Extension, universities)	Identify industry needs that can be addressed through agricultural research, identify resources for the research, coordinate and conduct the research, transfer new knowledge and technologies from researchers to the industry
National Meeting Program Planning Committee for Plant Breeder Coordinating Committee	Several	Planning 2009 annual meeting at the Monona Terrace Convention Center in Madison, Wisconsin
National Oat Improvement Committee	Oat producers, industry	Oat stakeholder group
National Plant Breeding Coordinating Committee	NIFA	Support of plant breeding
National Plant Disease Recovery System	ARS and Land Grant University Institutions, DHS	As directed by HSPD-9, ARS is lead institution to develop a National Plant Disease Recovery system to respond to intentional and/or natural plant disease outbreaks.
National Plant Germplasm Coordinating Committee	ARS, NIFA, ESCOP	Communicates the value of the National Plant Germplasm System and strives to enhance its support
National Science and Technology Council	Chair – Ann Mills, Deputy Under Secretary for NR&E	Information exchange between Federal agencies on ecosystem services research, programs, and projects.
National Sclerotinia Intitiative	ARS with United Soybean Board, National Sunflower Association, National Canola Association, Peanut Council	To conduct research in partnership with Universities to address white mold related diseases and disorders.

ARS Inter-Agency Working Group Participation		
Group name	**Sponsoring Organization**	**Brief purpose**
National Sorghum Producers Assoc./USDA Sorghum Germplasm Committee	Sorghum producers, industry, researchers	Sorghum stakeholders
National Swine Improvement Federation	Swine Industry and Universities	Coordinate public swine genomics research and develop infrastructure to incorporate genomics information into the swine genetic evaluation system
National Vegetable Crops Initiative	NIFA	To develop a strategic plan for the continued growth and sustainability of vegetable crop production in the United States.
National Wheat Improvement Committee/National Association of Wheat Growers	Wheat industry, producers, researchers	ARS provides information on the funding needs of the wheat quality labs to the National Improvement Committee to be considered for recommendation to the National Association of Wheat Growers among their legislative priorities
NIDDK Advisory Council	NIDDK	Provide advice to NIDDK director -ARS is one of three ex officio agencies represented (DoD and VA are others)
NIFA	NIFA	Interagency Coordination
NIFA Grant Award External Steering Committee	Kansas State University	Provides scientific and stakeholder input
NIFA/ARS Biotech Risk Assessment Grants Program	ARS, NIFA	Biosafety research grant management and ARS/NIFA coordination
NIFA-FSRRN	USDA	Share food safety information
NIH Nutrition Coordinating Committee	HHS, NIH	Information sharing among NIH Institutes and other federal agencies conducting nutrition research.
NIH Trans-Agency Complementary and Alternative Medicine Coordinating Committee	NCCAM	Share information on complementary and alternative medicine research in federal government
Northwest Small Fruit Research Center	Northwest Center for Small Fruit Research	To coordinate high impact research which is responsive to the needs of the small fruit and nursery industries in the Northwest US
NSABB (National Science Advisory Board for Biosecurity)	Interagency	Coordination
NSABB Personnel Reliability Working Group	NIH	Review existing mechanisms and make recommendations for improvements
NSTC Subcommittee on Standards	Interagency	Develop standards for CBRN equipment
Nutrition Coordinating Committee	NIH	Share nutrition information among HHS agencies -ARS is USDA representative
OECD Scientific Collections Activity	OECD (International)	Develop Plan for Managing Collections of OECD Members
Office of Dietary Supplements Inter-agency work group	NIH	Information sharing among federal agencies conducting nutrition research and dietary supplements research
Office of Pesticide Programs	EPA	Development of research goals
Organic Working Group	USDA	Information exchange between USDA agencies on organic programs.
OSTP/IWG on Plant Genomes	OSTP	Coordination of plant genomics research among U.S. federal agencies
OSTP/IWG on Scientific Collections	OSTP	Develop a Plan for Maintaining Federal Scientific Collections
Overseas Biological Control Laboratories	ARS	Administration

ARS Inter-Agency Working Group Participation		
Group name	**Sponsoring Organization**	**Brief purpose**
Pest Information Platform for Education and Extension (PIPEE) Strategic Planning Committee	NIFA, RMA	To develop an integrated national system facilitated by information technology to provide centralized, useful tools with reliable information for IPM practitioners. Mapping of Soybean rust and soybean aphid
Pierce's Disease Task Force	Wine and Grape Industry	Coordinate ARS Pierce's Disease Research
Plant Breeder Coordinating Committee	Several	The PBCC serves as a forum for issues and opportunities of national and global importance to the public and private sectors of the U.S. national plant breeding effort.
POC for ARS Veterinary Workforce Planning Committee	Interagency (All govt agencies with Veterinarians)	Interagency Coordination
PROCINORTE	ARS	Scientific Diplomacy
Program Planning Committee for Soybean Rust Symposium	ARS	Planning 2009 Soybean Rust Symposium
Public Health Pesticide Committee	CDC	Coordination
RAC Biosafety Working Group	NIH	Provide support and recommendations to the NIH Recombinant DNA Advisory committee on biosafety issues
Rift Valley Fever Coordination	DoS and ARS	Workshop
Risk Assessment Consortium	Federal	Share food safety information
SARE – Sustainable Agriculture, Research & Extension, National Operations Committee	NIFA	Coordinate and communicate SARE activities among regions and other Federal agencies.
Science and Technology task force of JSA	JSA	Develop a strategic research and technology development plan for aquaculture across federal agencies
Science of Science Policy Interagency Task Group	OSTP, NSF	Address the need for better tools, methods, and data for improving our understanding of the efficacy and impact of science and technology policy decisions.
Scientific Committee for National Foundation for Infectious Diseases	NFID	Coordinate yearly scientific meetings in infectious disease
Scientific Forum on Invasive Species	APHIS, FS	Coordinate Research and Response to Invasive Species of Forest Areas
Screwworm Eradication Program	APHIS	Coordination of research and operations
Secretary's Bioenergy Decision Tool	Office of Energy Policy and New Uses, Office of the Chief Economist	Develop a place-based decision tool that provides information about USDA programs and resources that can be used by rural communities and investors to develop renewable energy projects.
Select Agent Tiering Committee	Interagency	Tier Select Agents
Small & Beginning Farm Coordinators	USDA	coordinate USDA activities to meet group's needs
South Atlantic Methyl Bromide Areawide project	ARS, EPA, and industry	To plan and prioritize research projects.
Steering Committee for the Food Safety Research and Response Network	USDA	Facilitate university based research food safety
Subcommittee on Sedimentation	USGS, Dept of Interior, Advisory Committee on Water Information, Water Information Coordination Program	Supports development of equipment, methodologies, and calibration for the collection, analysis, interpretation, and interchange of fluvial-sediment data and related technical information.

ARS Inter-Agency Working Group Participation		
Group name	**Sponsoring Organization**	**Brief purpose**
Sub-PCC on International Bioengagement	DoS, DoD, HHS, and USDA	Interagency Coordination
Sugarcane Research Planning Taskforce	ARS	Provides innovative solutions for sustainable sugarcane production.
Technical Representative to National Beef Cattle Evaluation Consortium	Beef Industry and Universities	Coordinate cattle genomics research and develop infrastructure to incorporate genomics information into the beef cattle genetic evaluation system
Technical Representative to National Pork Board Animal Science Committee	Swine Industry and Universities	Coordinate public swine research for traits relating to production efficiencies, pork quality and genomics
Tekes/Academy Finland	USDA/Finland	Collaborate food safety Res; share food safety information
Transfederal Biosafety Taskforce	USDA-HHS	Assess the current federal biosafety program, identifies gaps and solutions to improve the biosafety system
U.S. Wheat & Barley Scab Initiative	USDA, wheat/barley producers, millers, bakers	Reduce wheat mycotoxins and scab losses
Ug99 Wheat Stem Rust Action Team	ARS, APHIS, NIFA, OPMP	Coordinate Ug99 Wheat Stem Rust Response
UK-Food Standards	USDA/UK	Collaborate on food safety research; share food safety information
UK-International Food Research	USDA/UK	Collaborate on food safety research; share food safety information
US Animal Health Association	USAHA	Share information on animal health and related fields
US Group on Earth Observations (USGEO)	CENR	Fed agency info sharing & coordination; US rep to International GEO
US/EC Taskforce on Biotechnology	USDA, EU	Coordinates US and EC Biotechnology Research
USDA Barley Germplasm Committee	USDA	Barley researchers/industry
USDA BioEnergy Science Team (BEST)	REE, FS, AMS, OEPNU	Provide science support by ARS, ERS, NASS, NIFA, FS, AMS, and OEPNU to other agencies in the Department.
USDA Biotechnology Coordinating Group	USDA (USDA Coordinator, Michael Schectman)	Coordinate Plant and Animal Biotech Regulatory Policy and Research
USDA Corn Germplasm Committee	USDA	Corn researchers/industry
USDA Global Research Alliance Steering Committee	USDA	
USDA Invasive Species Coordinator Committee	USDA (USDA Coordinator Hilda Diaz-Soltero, Director)	Coordinate USDA Invasive Species Response
USDA Know Your Farmer Committee	USDA Dep. Sec.	Coordinate efforts to connect citizens with agriculture and nutrition
USDA Market-Based Environmental Stewardship Coordination Council	USDA OSEC	Provide agency-level advisory to the USDA Office of Ecosystem Services and Markets and the Secretary, who co-chairs the interdepartmental Environmental Services Board. Establish guidelines and science-based methods to measure the environmental benefits from conservation and land management activities in support of emerging environmental services markets.
USDA One Health Joint Working Group	ARS, APHIS, FAS, NIFA	Technical group to support One Health MAC
USDA Peoples' Garden	USDA	Promote citizens' involvement with agriculture through the Peoples' Garden
USDA Pollinators' Committee	ARS	Coordinating response to pollinators decline
USDA Remote Sensing Coordination Committee	Office of Chief Economist	Information sharing among USDA agencies

ARS Inter-Agency Working Group Participation		
Group name	**Sponsoring Organization**	**Brief purpose**
USDA Rice Germplasm Committee	USDA	Rice researchers/industry
USDA Risk Assessment Group	USDA	Share risk assessment info among USDA agencies
USDA Sorghum Germplasm Committee	USDA	Sorghum researchers/industry
USDA Sustainable Development Council	Chief Economist's Office	Coordinate USDA-wide sustainable activities
USDA Water Team	USDA	Coordinate USDA's water activities to meet Secretary's High Priority Performance Goals for Water Chair - Ann Mills, Deputy Under Secretary for NR&E
USDA Wheat Germplasm Committee	USDA	Wheat researchers/industry
USDA-ARS-FDA	USDA	Collaborate on food safety research; share food safety information
USDA-ARS-FSIS	USDA	Collaborate on food safety research; share food safety information
USDA-ARS-NIFA	USDA	Share food safety information
USDA-wide committee	Committee on Environmental & Natural Resources (NSTC)	Advises Executive Office on science and technology to support water availability
US-EC Biotechnology Task Force	OSTP	Foster US-EC science collaborations
USGEO Architecture & Data Mgmt Sub Group		Facilitate data sharing among agencies & others
USGEO Policy Sub Group	CENR	Develop US earth observations policy
USGEO Strategic Assessments Sub Group	CENR	Assess & prioritize US earth observation needs (air, land, sea)
Various committees/ task groups of Office of Environmental Markets	USDA	OEM has a unique role in the federal government's efforts to develop uniform standards and market infrastructure that will facilitate market-based approaches to agriculture, forest, and rangeland conservation.
West Coast Methyl Bromide Areawide project	ARS, EPA, and industry	To plan and prioritize research projects.
Working Group within the risk assessment consortium on nanotechnology	IRAC	Produce recommendations for federal agencies for research and policy