

# Introduction

## ARS Annual Performance Report for FY 2011 and Performance Plan for FY 2012 - 2014

The Agricultural Research Service (ARS) was established on November 2, 1953, pursuant to authority vested in the Secretary of Agriculture by 5 U.S.C. 301 and Reorganization Plan No. 2 of 1953, and other authorities.

ARS is the principal in-house research agency of the U.S. Department of Agriculture (USDA). Congress first authorized federally supported agricultural research in the Organic Act of 1862, which established what is now USDA. That statute directed the Commissioner of Agriculture "... To acquire and preserve in his Department all information he can obtain by means of books and correspondence, and by practical and scientific experiments..." The scope of USDA's agricultural research programs has been expanded and extended more than 60 times since the Department was created.

ARS research is authorized by the Department of Agriculture Organic Act of 1862 (7 U.S.C. 2201 note), Agricultural Research Act of 1935 (7 U.S.C. 427), Research and Marketing Act of 1946 (P.L. 79-733), as amended (7 U.S.C. 427, 1621 note), Food and Agriculture Act of 1977 (P.L. 95-113), as amended (7 U.S.C. 1281 note), Food Security Act of 1985 (P.L. 99-198) (7 U.S.C. 3101 note), Food, Agriculture, Conservation, and Trade Act of 1990 (P.L. 101-624) (7 U.S.C. 1421 note), Federal Agriculture Improvement and Reform Act of 1996 (P.L. 104-127), and Agricultural Research, Extension, and Education Reform Act of 1998 (P.L. 105-185). ARS derived most of its objectives from statutory language, specifically the "Purposes of Agricultural Research, Extension, and Education" set forth in Section 801 of FAIR.

The ARS mission is to conduct 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.

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.

**Verification, Validation and Program Evaluation:** ARS conducts a series of review processes designed to ensure the relevance and quality of its research work and to maintain the highest possible standards for its scientists. This process involves customer input to help keep the research focused on the needs of the American food and agricultural system. Each of the approximately 1,000 research projects, which are organized into 22 National Programs, undergoes a thorough independent external prospective peer review conducted by the Office of Scientific Quality Review (OSQR). All ARS employees, including the scientific workforce, are subject to annual performance reviews. Senior scientists undergo a rigorous peer review (Research Position Evaluation System-RPES) on a 3- to 5-year cycle. These processes ensure the continuing high quality output of the ARS research addressing the needs of American agriculture.

ARS also completes program evaluations pursuant to the **President's Management Agenda (PMA)**. The PMA is designed to strengthen the management of Federal programs and increase program accountability. ARS has conducted a **Program Assessment Rating Tool (PART)** analysis on all the research conducted under Strategic Plan Goals. The PART assessment seeks to measure four aspects of a program: program purpose and design, strategic planning, program management, and program results/accountability. ARS is conducting ongoing PART improvement plans for each goal as well. Results can be seen on the website [www.Results.gov](http://www.Results.gov).

Beginning in FY 2005, ARS' National Program Leaders (NPLs) and Area Directors annually review more than 1,000 research projects by applying the **Research and Development (R&D) Investment Criteria of relevancy, performance, and quality**. The information gained from this review helps the Agency identify low performing and/or low priority research. This information is used in shaping the annual budget; it is also be used to make future program management decisions. The R&D investment criteria are applied as follows:

- For **relevancy**, the NPLs assess whether ARS' research is consistent with the Agency's mission and relevant to the needs of American agriculture, as identified by the Administration and ARS' customers and stakeholders.
- For **performance**, the NPLs review the annual project reports submitted by each research unit. Beginning with FY 2004, these reports provided information on how well each research project did in achieving the milestones in its Project Plan.
- For **quality**, the Area Directors rely on data from the ARS OSQR reviews of each research project at the beginning of its 5-year program cycle. OSQR conducts rigorous reviews of ARS' research projects by independent external peer panels to ensure their quality. In addition, the Area Directors use information from the RPES reviews of individual scientists in making this assessment. RPES conducts rigorous peer reviews of ARS' scientists on a regular schedule (i.e., every three, four, or five years). The Area Directors also assess the capacity (i.e., facilities, human and fiscal resources, equipment, etc.) of each project to meet its research objectives, an important consideration for intramural programs.

The National Programs focus the work of the Agency on achieving the goals defined in the ARS Strategic Plan 2003-2007. The research priorities for each National Program are established with extensive input from customers, stakeholders, and partners, which is received, in part, at a series of National Program Workshops. A detailed Action Plan developed for each National Program is available on the ARS home page, [www.ars.usda.gov](http://www.ars.usda.gov); open "Research" and select the National Program of interest. The GPRA Annual Performance Plans, the GPRA Annual Performance Reports, and the National Program Annual Reports which serve to keep the work of the Agency focused on achieving the goals established in the ARS Strategic Plan are also available on this website. The aggregate effect of these processes is a strengthened research program and an accountability system that measures more effectively the progress made towards achieving established goals and outcomes.

**Key External Factors that Affect the Ability of ARS to Achieve its Goals and Objectives:** The future of American agriculture depends on its ability to respond to critical external factors. Effective planning within ARS will take these factors into consideration when establishing and executing the Agency's research programs.

**Globalization:** The globalization of all aspects of the food and fiber system is having a major impact on American agriculture. Profound changes are seen worldwide from competitive markets around the world, from diseases not limited to national boundaries, to population growth and evolving diets. These changes have led to a dramatically new trade environment, threats of exotic diseases and pests to domestic production, and international controversies over the use of biotechnology. To remain competitive, the food and agriculture sector needs to respond to these developments.

**Information Access and Communication:** The explosion of information technology, the worldwide use of the Internet, and the major advancements of cyberspace communications are changing the way private

industry, government, and individuals conduct daily business. Vast amounts of information are available in “real time,” more people from around the world will be able to retrieve the information, and advanced computer software will make the information more useful and meaningful. Advancements in communication technology offer benefits and opportunities for everyone involved in the American food and agriculture sector.

**Workforce:** A very important employment issue is the need to recruit and retain a highly skilled and technically well trained Federal workforce. The relatively low U.S. unemployment rate makes recruitment highly competitive. This competitive environment is expected to require more employer emphasis on recruitment, retention, student employment, upward mobility, and training/retraining programs. The public sector will need to recruit a diversity of people and to maintain a highly qualified and technically competent workforce. Expanding job opportunities for women and minorities in science and engineering will help to tap the Nation’s human potential.

**Technology:** Advances in technology--such as bioengineering, precision agriculture, remote sensing, and decision modeling--enable agricultural production to enhance nutrition, protect the environment, and continue to make the food supply safe. Biotechnology offers great promise for increasing production efficiency, improving food quality, and enhancing nutritional value. However, concerns about genetically modified organisms (GMOs) have had a marked impact on international exports of affected commodities, and prompted questions about the potential benefits and risks. Precision agriculture, remote sensing, and decision modeling will both increase production efficiency and mitigate adverse environmental impacts of agriculture. Public concern about food safety has led to new rapid detection technologies that, when fully implemented, will make the food supply safer.

**Changing Demographics:** Growing global populations, demographic changes, and economic growth will substantially increase the demand for agricultural products, thus creating new markets for U.S. products. At the same time, however, increased agricultural competitiveness from other countries will force U.S. agriculture to become more efficient. Because arable agricultural land is limited, the growing demands will increase pressure to maximize yields, protect marginal areas from unsustainable development, and minimize the harmful effects of agriculture on the environment and the natural resource base.

**Changing Structure of Agriculture:** The structure of the food and fiber system--from farm to market--changed dramatically in the last decades of the 20<sup>th</sup> century, and is likely to continue. Change can be seen all across the food and agriculture sectors. An increasing share of U.S. food and fiber is being produced on fewer, larger, and more specialized farms. Production and marketing are more vertically and horizontally integrated. Concentration is greater causing sharp declines in the number of buyers and sellers of a product. Consumer preferences, new technologies, and global markets bring about continuing changes that affect farmers, processors, marketers, and consumers.

**Congressional Support:** The ability of ARS to respond to the diverse needs of producers and consumers is determined by the level of Congressional support. As a consequence of inflation and higher operating costs associated with advances in research equipment and technology, the ARS scientific workforce, which reached a maximum of about 3,400 scientists in 1970, decreased by almost 40 percent during the ensuing 25 years. More recently, appropriations have allowed the Agency to expand its research program and hire additional scientists to bring the current number of scientists to almost 2,200.

**Drug-Free Workplace:** ARS will continue to use the applicable contract clauses and regulations to ensure compliance with drug-free workplace debarment and suspension requirements in all of its acquisition programs.

**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

## INTRODUCTION

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.

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# Strategic Goal 1:

## Enhance International Competitiveness of American Agriculture

Expanding global markets for agricultural products is critical for the long-term economic health and prosperity of our food and agricultural sector. U.S. farmers have a wealth of natural resources, cutting-edge technologies, and a supporting infrastructure that result in a production capacity beyond domestic needs. Expanding global markets will increase demand for agricultural products and contribute directly to economic stability and prosperity for America's farmers.

To expand overseas markets and facilitate trade, various USDA agencies assist in the negotiation of new U.S. trade agreements, the monitoring and enforcement of existing trade agreements, the administration of market development and export promotion programs, and the adoption of science-based regulatory systems and standards. In supporting these USDA activities, ARS plays a significant role, particularly under Objective 1.3: Improve the Sanitary and Phytosanitary System to Facilitate Agricultural Trade. However, ARS research in this capacity falls under Goals 1 and Goal 4. In working to protect crops from diseases, ARS also enhances the international competitiveness of American agriculture. Therefore, ARS has elected to report this category of research under Objective 4.2: Reduce the Number, Severity, and Distribution of Agricultural Pest and Disease Outbreaks. Relevant information is reprinted under both Objective 1.3 and Objective 4.2 for the reader's convenience.

### **OBJECTIVE 1.1: EXPAND AND MAINTAIN INTERNATIONAL EXPORT OPPORTUNITIES**

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Activities related to this objective are primarily carried out by other USDA agencies.

### **OBJECTIVE 1.2: SUPPORT INTERNATIONAL ECONOMIC DEVELOPMENT AND TRADE CAPACITY BUILDING**

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Activities related to this objective are primarily carried out by other USDA agencies.

### OBJECTIVE 1.3: IMPROVE THE SANITARY AND PHYTOSANITARY (SPS) SYSTEM TO FACILITATE AGRICULTURAL TRADE

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Sanitary and Phytosanitary (SPS) barriers put in place to protect humans, animals, and plants from foreign pests, diseases, and contaminants continue to increase due to the lack of regulatory capacity in various countries and/or the lack of sound science. These technical barriers impede agricultural trade around the world. Reduced trade flows due to SPS barriers limit U.S. exports and efforts of developing countries to participate in and benefit from global trade. In response to these problems, USDA uses its extensive expertise and works closely with other U.S. agencies to strengthen regulatory coordination, streamline procedures to enhance trade, and encourage the use of sound science in addressing SPS and biotechnology issues.

ARS provides the sound scientific basis that USDA can use to work aggressively with its private sector trading partners and international organizations to develop a stronger system of international guidelines. These new guidelines will foster the widespread adoption of science-based regulatory systems, helping to protect the life and health of humans, animals and plants within the United States as well as facilitating trade.

**Key Outcome:** An improved global SPS system for facilitating agricultural trade.

**The ARS research in support of Strategic Goal 1, Objective 1.3 is reported as Performance Measure 4.2.5 under Strategic Goal 4, Objective 4.2.**

## Strategic Goal 2:

### Enhance the Competitiveness and Sustainability of Rural and Farm Economies

American consumers benefit from agricultural products that minimize their food costs and maximize their consumption choices. However, many within the agricultural production sector are suffering from low commodity prices that have remained relatively unchanged for decades, while the costs of fuels and other purchased inputs have continued to rise. The Nation's rural economic vitality depends on the ability of producers to profitably produce agricultural products, including food, fiber, industrial products, and fuels, while at the same time enhancing the natural resource base upon which crop and livestock production depends. Future financial success will depend on increasing productivity and production and conversion efficiencies, accessing new markets for specialized products, developing biobased technologies that provide new opportunities for U.S. farmers, and utilizing tools and information to mitigate risks and rapidly make adjustments to changing market conditions. Because there is great diversity in the farm sector driven by varying available resources, climate, and individual preferences, an equally diverse range of solutions is needed. Also, the needs, concerns, and opportunities of large farms may differ from those of smaller or intermediate sized farms, regardless of location. Therefore, research will need to provide producers options in terms of what is best for them for their respective circumstances.

ARS conducts basic and applied research to develop new and more efficient technologies and systems for producing and processing agricultural products that can enhance the efficiency and profitability of producers as well as provide improved and new products for consumers. ARS researchers work to produce biofuels and other biobased products that expand markets for agricultural products, reduce national dependence on foreign sources, and enhance environmental sustainability. ARS also promotes livestock and crop productivity through genetic and genomic research, and the development of technologies that enhance the economic value of agricultural products.

#### **OBJECTIVE 2.1: EXPAND DOMESTIC MARKET OPPORTUNITIES**

Technological progress is creating new and expanded markets for agricultural products. New technologies will provide consumers with new and improved food, textiles, and fibers. Biobased technologies promise new opportunities for U.S. farmers to take advantage of energy and industrial markets. Currently, U.S. agriculture is the source of various products such as biopolymers, industrial chemicals and films, and clean burning bioethanol and biodiesel that are derived from plants and livestock byproducts rather than petroleum or other nonrenewable natural resources. New markets are also emerging for products and strategies to mitigate environmental concerns, such as the use of carbon sequestration to offset greenhouse gas emissions. ARS is in a position to bring biological and physical sciences together with engineering in a coordinated research program to expand a variety of market opportunities,

particularly for the sustainable commercial production of bioenergy, biofuels, and biobased products.

## Performance Measures

**Measure 2.1.1 Create new scientific knowledge and innovative technologies that represent scientific/technological advancements or breakthroughs applicable to bioenergy.**

### Baseline 2004

Four technological breakthroughs or scientific advancements that make significant contributions toward reducing the cost and increasing profitability, improving the efficiency, increasing the yield, and increasing the sustainability of producing or converting biobased feedstocks into biofuels.

### Target 2011

Cumulatively, 24 technological breakthroughs or scientific advancements that make significant contributions toward reducing the cost and increasing profitability, improving the efficiency, increasing the yield, and increasing the sustainability of producing or converting biobased feedstocks into biofuels.

### Indicator 1

***During FY 2011, ARS will develop new or improved, or more environmentally friendly processing technologies.***

FY 2011 Accomplishments:

**Designer yeast for cellulosic ethanol:** ARS scientists developed a new strain of industrial yeast that tolerates the toxic byproducts and efficiently ferments xylose to ethanol. Yeasts used for corn ethanol production are unsuitable for the production of cellulosic ethanol for two reasons: the yeasts are poisoned by the byproducts created when fermentable sugars are produced from cellulosic biomass; and the yeasts don't utilize xylose, which constitutes about one-third of the sugars in cellulosic biomass.

***Impact:*** New organisms have been developed to lower the costs of ethanol from lignocellulosic biomass. Several industrial partners plan to test the yeast, and ARS is applying for a patent.

**What happens to antibiotics used for ethanol production:** Antibiotics are used to control bacterial contamination at commercial fuel ethanol facilities, but the fate of these drugs was heretofore unknown. One concern is whether the antibiotics wind up in distillers grains, a biorefining coproduct used for livestock feed. ARS scientists, in collaboration with the National Corn-to-Ethanol Research Center, measured virginiamycin activity, a common antibiotic used by ethanol producers, in various process streams of an ethanol pilot plant, and found that biologically-active virginiamycin did wind up in the distillers grains.

**Impact:** This research provides data necessary for improving both distillers grains production and their use in animal feed.

**Corn gene enhances switchgrass biofuel production potential:** ARS scientists have increased starch production in switchgrass by up to 250 percent using a novel form of the corn gene *cg1* (*corngrass1*). Starch produced by *cg1* switchgrass was converted into simple sugars, such as glucose, without energy-intensive and expensive pretreatment of biomass. Moreover, *Cg1* switchgrass does not produce seeds or pollen, thus preventing gene flow to native switchgrass populations and protecting natural sources of genetic variation. The *cg1* switchgrass represents a new model for genetically enhanced feedstocks for the biofuel industry. This research is a collaboration between USDA and scientists at the DOE's Energy Biosciences Institute and the Joint BioEnergy Institute.

**Impact:** This technology could provide a new strategy for not only preventing gene flow to native switchgrass populations and protecting natural sources of genetic variation, but also enhance the amount of biofuel produced from switchgrass feedstocks and thus increase price competitiveness of biofuels, but also reduce pressures on existing land uses as the biofuels industry expands.

#### Indicator 2

**During FY 2011, ARS will develop new or improved methods to measure or predict quality.**

FY 2011 Accomplishments:

**Production environment affects switchgrass biomass quality and ethanol yield:** Theoretical ethanol yields were determined from biomass harvested from switchgrass production fields on 10 farms for a five-year period in Nebraska and South and North Dakota. Near Infrared Reflectance Spectroscopy (NIRS) calibrations developed by a team of ARS scientists were used to determine predict ethanol yields. Theoretical ethanol yield varied by year and between fields, with five-year means ranging from 91 to 103 gallons per ton of biomass. Total theoretical ethanol production ranged from 187 to 394 gallons per acre across fields planted to forage type switchgrass cultivars. Because of the liquid fuel differences, biorefineries will need to test switchgrass for biomass quality and consider the yearly variation that can occur in biomass production across a region when developing their business plans.

**Impact:** The development of the NIRS calibration equations and knowing that variable yields can be expected from harvested switchgrass feedstocks provides a way for science-based decision-making be used for the establishment of contracts for the emerging biofuels industry based on feedstock end use performance.

**Genetic diversity cooperative for Saccharum and perennial grasses:** ARS has begun a public-private cooperative for improving both sugarcane and energy cane that will provide important new sources of genetic diversity to help meet the demands of the emerging biomass industry in the southeastern U.S. and around the world. Based on the organizational model of the Germplasm Enhancement of Maize (GEM) Project, this cooperative will develop a pipeline of superior and genetically diverse sugarcane varieties and related energy grass feedstocks. Despite the high quality of current ARS sugarcane varieties, new genetic diversity is needed to overcome biotic and abiotic constraints to production. A pilot program has been initiated, involving ARS, university, and private partners for sugarcane and energy cane germplasm enhancement. The resulting hybrid clones from crosses will be released as public germplasm and shared among members. Additional opportunities are likely to exist beyond the initial Consortium efforts for further research agreements and commercialization.

**Impact:** The Saccharum cooperative provides a transparent way for pre-commercial improvement of public and private germplasm resources, while protecting privately held resources, and allowing new genetic combinations of improved traits for biofuel production to be made available for commercial purposes.

### Indicator 3

**During FY 2011, ARS will develop technologies leading to new or improved products from renewable resources and agricultural residues and wastes.**

FY 2011 Accomplishments:

#### **Protein-rich biomass produces more stable pyrolysis oils than lower protein content feedstocks:**

A major problem with pyrolysis oil is high oxygen content that leads to high acidity, chemical instability, and corrosion of pipes and tanks. ARS researchers showed that when protein-rich biomass (such as oilseed presscake) is pyrolyzed, more oxygen is released as water and fewer acids are produced while the overall pyrolysis oil yield remains unchanged. Consequently, the resulting pyrolysis oil is less acidic and has higher energy content, and so offers significant advantages over pyrolysis oil derived from purely lignocellulosic biomass.

**Impact:** This new approach provides new way to utilize residues left from the extraction of vegetable oils for biofuel production. The resulting use of residues will increase the conversion efficiency oil seed crops and increase their energy balance when utilized for biofuel production. The resulting pyrolysis oil is also more stable than from cellulosic feedstocks, and has overall greater energy content.

### Measure 2.1.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2011:

**During FY 2011, ARS reported on 5 technological breakthroughs or scientific advancements that made significant contributions toward reducing the cost and increasing profitability, improving the efficiency, increasing the yield, and increasing the sustainability of producing or converting biobased feedstocks into biofuels.**

<b>Describe the Technology</b>	<b>Describe the Transfer</b>	<b>Identify the Customer</b>	<b>Impact</b>
New industrial yeast that ferments xylose to ethanol, and tolerates toxic byproducts.	Material Transfer Agreements for the organism.	ICM Company, Michigan Biotechnical University	New organisms for lower cost ethanol from lignocellulosic biomass.
Data on antibiotic residues in distillers grains.	Oral presentation at 2012 Fuel Ethanol Workshop.	Ethanol industry, Distillers Grains industry, U.S. Food and Drug Administration.	Provides information necessary for improving distillers grains production and their use in animal feed.
New <i>Cg1</i> switchgrass germplasm.	Transfer of plant material.	DOE Energy Bioscience Institute and Joint Bioenergy Institute.	Provides a new strategy for enhancing biofuel conversion efficiency and natural containment of pollen.

## STRATEGIC GOAL 2

Near Infrared calibration equations for rapid switchgrass feedstock quality assessments.	Calibration equations provided to NIR consortium.		Provides a standard methodology for switchgrass feedstock quality assessment that can be used by all breeding programs and all commercial transactions of feedstocks for commercial cellulosic ethanol production.
Public-private cooperative for improving sugarcane and energy cane.	Plant materials.	Syngenta Corporation, two CRADA partners, multiple university plant breeding programs.	First-of-a-kind sugarcane genetic materials selected specifically for enhanced biomass performance.
Stable, Low acidity pyrolysis oil from high protein biomass	Two publications, two patent applications specific to oil seed presscakes	Arvens Tech (Peoria, IL); Ala Saket, olive oil business in Jordan.	Provides new way to utilize residues left over from the extraction of vegetable oils and other high protein biomass for biofuel production.

### **Measure 2.1.1 Outyear Performance Plan (the future performance indicators for this Measure)**

**During FY 2012, ARS will**

*develop improved biomass plants, sustainable biomass production systems, and efficient handling and storage technology for biomass feedstocks.*

*develop technologies and systems that improve the efficiency, economics, and sustainability of energy production from agricultural biomass.*

*develop technologies that enable increased commercial production of value-added co-products from biorefineries.*

**During FY 2013, ARS will**

*develop improved biomass plants, sustainable biomass production systems, and efficient handling and storage technology for biomass feedstocks.*

*develop technologies and systems that improve the efficiency, economics, and sustainability of energy production from agricultural biomass.*

*develop technologies that enable increased commercial production of value-added co-products from biorefineries.*

**During FY 2014, ARS will**

*develop improved biomass plants, sustainable biomass production systems, and efficient handling and storage technology for biomass feedstocks.*

*develop technologies and systems that improve the efficiency, economics, and sustainability of energy production from agricultural biomass.*

*develop technologies that enable increased commercial production of value-added co-products from biorefineries.*

**Measure 2.1.2 Develop cost effective, functional industrial and consumer products, including higher quality, healthy foods, that satisfy consumer demand in the United States and abroad.**

**Baseline 2004**

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 post-harvest spoilage decreasing return to producers. Healthy foods are often not convenient or readily accepted by significant numbers of consumers. In FY 2005, four new biobased products and food items with improved quality, nutritional or functional characteristics were developed by ARS and used by customers, both domestic and foreign.

**Target 2011**

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; and valuable co-products from agricultural residues and processing wastes.

**Indicator 1**

***During FY 2011, ARS will develop technologies leading to new or improved products from renewable agricultural resources, residues and wastes.***

**FY 2011 Accomplishments:**

Without proper storage facilities, ready-to-eat emergency-aid foods can lose sensory and nutritional quality in hot tropical climates. ARS scientists developed a new instant corn-soy blend with superior properties and a one year shelf life under minimal storage conditions. Twenty metric tons of this new emergency-aid food was shipped to Haiti in 2011 to feed over 3,000 malnourished children.

***Impact:*** This research helps provide emergency-aid food to third world countries and increases export markets for U.S. corn and soy producers.

Reduced water use has become a high priority in agriculture and food processing, especially in regions like the western U.S. where water availability is a growing concern. ARS scientists worked with a large fruit processing company and the California League of Food Processors to develop infrared dry peeling technology for peaches, pears and tomatoes. The novel peeling technology is patented and under commercial implementation. It is estimated that this novel technology will eliminate the use of more than 10 million gallons of water and the treatment of more than 10 thousand tons of caustic water material during each fruit processing season.

***Impact:*** This research helps fruit processing facilities reduce their water footprint thereby reducing costs and promoting good will in their communities.

Following the fall of the Iron Curtain, Central Asian countries have struggled economically, and many former Soviet biological weapon scientists in this region faced unemployment. With funding

from the State Department, ARS scientists, in collaboration with Tajikistan scientists, developed new native plant-based food and non-food products that will benefit the local economy in Tajikistan, making this country more self-reliant. This project also supported U.S. anti-terrorist objectives by redirecting 12 former biological weapon scientists into research with peaceful outcomes.

**Impact:** This research helps promote peace and self-reliance in Central Asia.

Although frying batters enhance the sensory quality of food, they also absorb large amounts of oil, which adds calories without nutrients and contributes to obesity. ARS scientists collaborating with an industrial partner developed gluten-free, rice-based frying batters that reduce oil uptake by as much as 50%. The technology has been commercialized by the industrial partner with projected economic impact of \$8 million and 100 new jobs by 2014.

**Impact:** This research enabled more nutritious and gluten-free foods.

Using environmentally-benign chemistries, ARS researchers extracted keratin from wool and converted it into a variety of creams and emollients for applications in personal care products. A commercial partner has utilized this technology to develop and commercialize “green” and “natural” hair conditioners.

**Impact:** This research enables the manufacture of high-value biobased products from wool.

ARS scientists developed a catalyst which efficiently converts the oil from Cuphea seeds (Cuphea is a common perennial plant) into a high-value specialty chemical. ARS filed for a U.S. patent on this technology and is working with an industrial partner to commercialize the cuphea-derived chemical as a natural fragrance. The chemical (2-undecanone) is also an effective mosquito repellent and may find applications in commercially-viable, natural and less toxic alternatives to DEET insecticide.

**Impact:** This research enables the manufacture of high-value biobased products from a perennial oilseed crop.

Only a small number of biodegradable, biobased plastics have been commercialized, and their relatively high cost limits their market potential. ARS researchers have developed technologies to produce biodegradable biopolymers for less than \$1/lb, a price-point which could access large plastics markets. ARS has filed for patent protection of these technologies, which utilize low-cost feedstocks – citric acid (the #1 chemical product produced via fermentation) and glycerol (a byproduct of biodiesel production).

**Impact:** This research enables the production of low-cost biobased plastics.

Fire retardant gels are applied to buildings and other structures threatened by large, intense fires nearby. Current fire retardant gel products are petroleum-based, are not biodegradable, and may produce toxic fumes upon burning. Using starch, water, and bentonite clay, ARS scientists developed a fire retardant gel that is biodegradable and less expensive than gels currently on the market. Whereas a ¼ inch thick gel must provide at least 10 minutes of protection, the new biobased gel is found to give nearly 30 minutes of protection. ARS is applying for a patent and a commercial partner is completing the development of a marketable product.

**Impact:** This research enabled a low-cost, environmentally-benign bio-based material to help contain large fires.

Pennycress (*Thlaspi arvense*) is an annual winter cover crop which produces oil well-suited for the production of renewable diesel and biodiesel. For instance, the biodiesel from Pennycress has a lower cloud point and is more oxidatively stable than soy-based biodiesel. And because pennycress can be double-cropped with soybeans, its cultivation does not compete with food production. ARS scientists selected an elite germplasm line exhibiting over 90% germination rates versus as low as 20% for varieties used previously. The new variety also yields up to 30% more seed with 6% higher oil content than current lines; so its oil yield per acre is about twice that of soybeans. ARS is currently working with companies to commercialize the production of this new pennycress variety for conversion into biobased jet fuel.

**Impact:** This research enabled a new oilseed crop for producing biofuels without impacting food production.

### Indicator 2

***During FY 2011, ARS will develop new or improved methods to measure or predict quality, or to sort by quality.***

#### FY 2011 Accomplishments:

Standard methods for assessing the quality of baking flours had been based on the use of partially-hydrogenated trans-fats in end products (baked goods). Since the baking industry is phasing-out the use of unhealthy trans-fats, ARS researchers developed a new method for testing end-products which do not contain trans-fats. This new method has already been adopted by flour testing labs and industrial bake labs to assess the performance of new wheat varieties and flour milling methods in cake baking.

**Impact:** This research helps the wheat industry better serve baking industry efforts to provide healthy foods.

ARS researchers developed a suite of methods for malting, mashing, and malting quality analyses at small-scales. Compared with current methodologies, these new methods are capable of 3x greater sample throughput without increased costs. These methods allow barley breeders and malt barley users to accelerate the selection of barley varieties that better satisfy U.S. brewer and consumer preferences.

**Impact:** This research will accelerate the development and use of improved barley varieties.

Current methods for determining peanut kernel moisture are labor-intensive and time-consuming. ARS researchers developed a portable, microwave-based moisture meter for determining in-pod peanut kernel moisture. The instrument has been field-tested successfully on a variety of peanut varieties in four states over three consecutive harvest seasons. A patent application has been filed, and a leading instrument manufacturer has expressed strong interest in licensing the technology.

**Impact:** This research enabled an easy, inexpensive and accurate method for measuring moisture in peanut kernels.

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### Measure 2.1.2 Summary of the Major Technologies Developed, Transferred, and Used in FY 2010:

*During FY 2011, ARS reported on 11 new technologies 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; and valuable co-products from agricultural residues and processing wastes that are in use.*

<b>Describe the Technology</b>	<b>Describe the Transfer</b>	<b>Identify the Customer</b>	<b>Impact</b>
Long shelf-life emergency-aid foods from corn and soy	Product is being produced commercially	Food processor which employs handicapped workers	Provides emergency-aid food to third world countries and increases export markets for U.S. corn & soy producers
New method which does not use trans-fats for assessing quality of baking flours	Method adopted by industry	Bakers, miller and wheat breeders	Helps wheat-products industries provide healthy foods
Microwave peeling process for fruits	Technology patented and under evaluation by commercial partners	Fruit and vegetable processors	Decreases water requirements
New food and non-food biobased products in Central Asia	Technology commercialized	Cattle feed and sugar syrup manufacturers in Tajikistan	Peaceful and more self-reliant countries in Central Asia
New quality assessment method for barley	Published results	Barley breeders and brewers	Accelerate the development and use of improved barley varieties
Low calorie, gluten-free frying batters	Method adopted by industry	Food processors	Enable more nutritious and gluten-free foods
Inexpensive method to measure moisture in peanuts	Commercial partner requested license	Ag instrument manufacturers	Easy-to-use, low-cost, accurate method to measure moisture in peanut kernels
"Green" technologies for creating personal health care products from wool	Technology commercialized	Personal health care products manufacturer	Value-added, green products from wool
Specialty chemical from cuphea seeds	Commercial partner requested license	Fragrance manufacturer	High value products from specialty vegetable oil
Biodegradable fire-retardant gel	Commercial partner requested license	Fire-retardant manufacturer	High value products from starch
Improved variety of pennycress	Variety being used by industry	Farmers and biodiesel manufacturer	Generate biodiesel without impacting food production

### Measure 2.1.2 Outyear Performance Plan (the future performance indicators for this Measure)

**During FY 2012, ARS will**

*develop technologies leading to new or improved products from renewable agricultural resources, residues and wastes*

*develop new or improved methods to measure or predict quality, or to sort by quality*

## STRATEGIC GOAL 2

**During FY 2013, ARS will**

*develop technologies leading to new or improved products from renewable agricultural resources, residues and wastes*

*develop new or improved methods to preserve, measure or predict quality, or to sort by quality*

**During FY 2014, ARS will**

*develop technologies leading to new or improved products from renewable agricultural resources, residues and wastes*

*develop new or improved methods to preserve, measure or predict quality, or to sort by quality*

## OBJECTIVE 2.2: INCREASE THE EFFICIENCY OF DOMESTIC AGRICULTURAL PRODUCTION AND MARKETING SYSTEMS

Fundamental to the long-term sustainability of agricultural production is the maintenance of an efficient, profitable, and economically competitive operation. Intense competition in global markets and pressure on U.S. farm policy to reduce price supports continue to emphasize the need for American agriculture to pursue and market higher value agricultural products. Furthermore, U.S. agricultural production and marketability is constantly influenced by factors such as unpredictable weather, disease and pest outbreaks, and changing consumer demands. Research must respond to consumer demands for healthy and safe products to ensure a sustainable and profitable agricultural production system that capitalizes on an abundant source of raw material for value-added food, fiber, and industrial products. The resulting technologies must effectively differentiate U.S. agricultural products from competing sources and provide customers with value-added processes that enhance product quality and value.

ARS research programs work to develop and transfer technology and information that make up the centerpieces of an efficient and economically sustainable agricultural sector. To improve the value and production efficiency of American crops and crop production, ARS takes responsibility for maintaining genetically diverse germplasm resource collections, which protects our genetic resource base and aids in plant and animal genetic research. In addition, ARS develops and disseminates science-based information to help U.S. agricultural producers manage unforeseen risks from climate, weather, pests, and disease outbreaks. Through these activities, ARS works to improve production efficiency and productivity to maintain profitability while enhancing the natural resource base upon which agriculture depends.

**Key Outcome:** Information and technology producers can use to compete more economically in the market place.

### Performance Measures

**Measure 2.2.1** Develop systems and technologies to reduce production costs and risks while enhancing natural resource quality.

#### Baseline 2006

Twelve new technologies and systems developed and used by customers to reduce the cost and increase profitability, improve the efficiency, or increase yield, and increase the sustainability of production.

#### Target 2011

Cumulatively, 29 technologies and systems developed and used by customers that utilize new configurations of practices and technologies to reduce the cost and increase profitability, improve the efficiency, or increase the yield, and increase the sustainability of production.

### Indicator 1

***During FY 2011, ARS will develop new production practices and decision support tools that increase profitability and improve environmental quality.***

#### FY 2011 Accomplishments:

Oilseed crops for biofuel in crop rotations. Sustainable biodiesel and jet fuel production will require widespread planting of oilseed crops. The several million acres of alternate-year summer fallowed wheat land in Montana is commonly identified for growing oilseed crops. ARS researchers at Sidney, MT in collaboration with South Dakota State University have conducted a long-term study using cool-season *Brassica juncea*, camelina and crambe oilseeds in two-year rotations with durum wheat. They discovered *Brassica juncea* had significantly superior seed and oil yield compared to the other oilseed crops, out-yielding both crambe and camelina by more than 100 and 360 lbs per acre respectively, and oil yield by 145% and 175%, respectively. Most importantly, durum wheat yields in rotations with the three oilseed crops were about 25%-35% lower than durum wheat in summer fallow rotations due to greater soil water use by the oilseed crops than if the alternate year fallow were used. This dispels the common notion that alternate year fallow land is available at no cost to food crop production. The study also showed insertion of the most productive oil seed crop into an every-other-year rotation would earn the farmer a greater overall return despite reduced durum wheat yields.

***Impact:*** This research demonstrates that *B. juncea*'s superior yield and oil producing qualities make it a promising candidate to meet future U.S. biofuel production needs by altering crop rotations in semi-arid areas of the Northern Great Plains.

Can cover crops be managed to self-seed? Perpetual self-seeding winter small grain cover crops may increase their adoption by reducing the risk of cover crop establishment and costs. An ARS scientist in Ames, IA used winter rye, wheat, and triticale to develop self-seeding cover crop systems for a soybean-corn rotation. The study revealed that plant establishment through self-seeding was more consistent using a wheat cover crop and mechanical seed dispersal before soybean harvest. The combination of these two factors consistently increased cover crops green ground cover, regardless of the initial cover crop seeding rate. In addition to lowering the cost and risk of establishing cover crops, cover crop function is extended beyond their normal termination dates – an added benefit to the new system.

***Impact:*** producers using organic crop production techniques could adopt these systems because of the potential for enhanced weed suppression without soil disturbance and the normal benefits of increased nutrient cycling and enhanced soil organic matter.

New roller/crimper design can lower no-till cotton production costs. Rollers/crimpers are used in no-till production systems to terminate cover crops before planting summer crops such as cotton. However, excessive vibration generated by earlier straight bar roller designs caused tractor operator discomfort and wear to the equipment, so adoption has been slow. Decreasing roller speed reduces vibration but increases the time needed to complete the operation. ARS researchers in Auburn, AL developed an operations strategy to reduce vibration while optimizing

the efficacy of rolling on cover crop termination. An original straight-bar design was compared to a smooth roller with crimping bar at 3.2 and 6.4 km/h speeds to determine the best system. Three weeks after rolling, both rollers had effectively terminated more than 95% of rye without the use of herbicides. The smooth roller with crimping bar transferred less vibration at both speeds to the tractor's frame than the straight bar roller, while maintaining comparable rye termination effects. Most importantly, no differences were found for seed cotton yield. Additional application of glyphosate herbicide with the rolling operation did not affect seed cotton yield, so using rollers only without herbicide is an effective to also reduce herbicide costs.

**Impact:** Mechanical termination of cover crops without disturbing the soil conserves soil resources and helps control weeds in the subsequent cash crop. Herbicide costs to the producer are significantly reduced. The new roller/crimper design is more acceptable to users due to decreased vibration during operation thus acceptance and adoption of this technique should increase.

**Measure 2.2.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2011:**

***During FY 2011, ARS reported on \_\_\_\_\_ new technologies and systems developed and used by customers that utilize new configurations of practices and technologies to reduce the cost and increase profitability, improve the efficiency or increase the yield, and increase the sustainability of production.***

<b>Describe the Technology</b>	<b>Describe the Transfer</b>	<b>Identify the Customer</b>	<b>Impact</b>
Pesticide Properties Database Technology (PPD): An online database of the chemical properties of common pesticides.	The database entries can be searched and downloaded from: <a href="http://www.ars.usda.gov/Services/docs.htm?docid=14199">http://www.ars.usda.gov/Services/docs.htm?docid=14199</a>	Anyone interested in the chemical properties of pesticides	ARS continues to receive notices from users who remark on the usefulness of the data.
Introducing new canola cultural practices in improving cultural practices and technologies	Four invited presentations to interested grower/stakeholder groups.	Growers, state, university, scientists, crop consultants, and agribusiness personnel	Sharing ideas, information, and research data to improve cultural practices
Decision support systems (DSS) to evaluate the potential economic benefit of purposely deficit irrigating crops and leasing the unused consumptive use. The DSS will use an optimization model to calculate the net return of different crop rotations under different irrigation amounts.	ARS is working with a commercial entity, Regensis Management Group, which will commercialize the DSS. The ARS version of the optimizer will be available on-line at the ARS software website.	Farmers, municipalities and industry (M&I), state water management officials, and ditch company personnel	Many Western states are experiencing growing competition for water between agriculture and M&I. This tool would make it possible for farmers to assess the potential to augment their incomes, continue farming, and avoid the complete sale of their water shares to M&I, a practice known as "buy and dry", by allowing them to

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<p>Updated an outreach tool called the Cover Crop Chart. Patterned after the periodic table of elements, the chart includes information on 46 crop species that may be planted individually or in cocktail mixtures. Information on growth cycle, relative water use, plant architecture, pollination characteristics, and nutrient cycling are included for most crop species. Updates to the chart included information on seeding depth and C:N ratio of aboveground biomass.</p>	<p>The chart is downloadable from the ARS Products and Services webpage in Portable Document Format (pdf).</p>	<p>The Cover Crop Chart is targeted at producers, consultants, educators and other groups with an interest in cover crops.</p>	<p>look at alternative crop rotations under reduced irrigation. Since release of v. 1.2, the chart has been downloaded over 1000 times by users in 18 countries.</p>
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**Measure 2.2.1 Outyear Performance Plan (the future performance indicators for this Measure)**

**During FY 2012, ARS will**

*develop new production practices and decision support tools that increase profitability and improve environmental quality.*

**During FY 2013, ARS will**

*develop new production practices and decision support tools that increase profitability and improve environmental quality.*

**During FY 2014, ARS will**

*develop new production practices and decision support tools that increase profitability and improve environmental quality.*

**Measure 2.2.2 Develop new technologies, tools, and information contributing to improved precision animal production systems to meet current and future food animal production needs of diversified consumers, while simultaneously minimizing the environmental footprint of production systems and enhancing animal well-being.**

<p><b>Baseline 2006</b></p>
<p>Ten 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.</p>
<p><b>Target 2011</b></p>

Cumulatively, 35 new technologies developed and used by ARS customers.

### Indicator 1

***During FY 2011, ARS will identify underlying genetic and physiologic mechanisms impacting reproductive efficiency, nutrient conversion, and growth in food animals.***

#### FY 2011 Accomplishments:

Farming of hybrid catfish (cross between channel catfish females and blue catfish males) has steadily grown in the United States, limited primarily by the availability of hybrid juveniles. Production of hybrid catfish juveniles requires the manual strip spawning of a huge quantity of high quality eggs. Pond trials showed that catfish oil incorporated as a dietary lipid supplement and fed to channel catfish females improved the fatty acid content of their eggs and their subsequent reproductive performance. At 5% catfish oil supplementation to the diet, a higher percent of catfish females reached maturity, and they produced more, higher quality eggs, all leading to superior hybrid catfish production.

***Impact:*** Improving reproductive performance and egg quality of the channel catfish females, reduces the costs of hybrid catfish juvenile production. The increased availability of hybrid catfish will drive increased hybrid catfish production.

Efficacy of salmon luteinizing hormone releasing hormone (LHRHa) to induce channel catfish spawning for hybrid embryo production. Exogenous hormone treatments are successfully used in channel x blue hybrid embryo production in catfish hatcheries but there is a need for an effective hormone that can be applied at reduced rates to lower production costs. It was demonstrated that low doses of salmon LHRHa were as efficacious as the currently used mammalian LHRHa to induce channel catfish ovulation.

***Impact:*** Several commercial hatcheries have tested this product and procedure and use of this novel compound has reduced the costs of hybrid catfish juvenile production.

Swimming speed and dissolved oxygen (DO) concentration affect Atlantic salmon performance. Exercise has been shown to enhance salmonid performance, but DO levels can be limiting. Hence, there is a need for research optimizing swimming speed and DO parameters. Scientists at The Conservation Fund's Freshwater Institute (TCFFI) determined that for Atlantic salmon; mean weight was significantly enhanced by both higher DO levels and swimming speeds, and exercise significantly reduced the prevalence of precocious males which have negative impacts on production.

***Impact:*** Increased performance and reduced precocity can be achieved through exercise and supplemental DO.

Five new lethal recessive defects that reduce dairy cow fertility. Lethal recessive defects that cause embryo loss are difficult to detect without genomic data even with very large sets of phenotypic and pedigree data because of too few observations per estimated mating interaction. Based on genomic testing, a method was developed to discover lethal defects by detecting the absence of haplotypes (a set of single nucleotide polymorphisms associated on a single chromosome) that had high population frequency but were never homozygous in the population.

Haplotype testing revealed 5 new, as well as 2 previously known defects, (3 in Holsteins, 1 in Jerseys, and 1 in Brown Swiss) consistent with the presence of a lethal recessive. The carrier genotypes exist in the three populations at levels from 2.7% to more than 20% indicating that there is opportunity to significantly improve conception rates and reproductive efficiency in dairy cattle, which is a very high industry priority.

**Impact:** Once animals have been genotyped, dairy farmers can now avoid mating carrier animals, thus increasing profitability by reducing those defects in the population. The results of this research are already being incorporated by the dairy industry to inform breeding programs and improve reproductive performance.

Potential major cause of reproductive failure in beef cattle. Feed and care for unproductive cows that fail to achieve pregnancy is a major cost in beef production. A test capable of identifying young cows with low likelihood to conceive and produce a live calf would have a substantial impact on the efficiency of beef production. During a study to identify genes producing variation in reproductive efficiency, ARS scientists discovered that as many as 30% of cows that had low success achieving pregnancy appeared to carry portions of the male-specific Y chromosome. Since only bulls are expected to have the Y chromosome, this research suggests transmission of Y chromosome to female offspring (via a chromosomal crossover event) may be a significant contributor to reproductive failures.

**Impact:** This discovery will now be used to develop a test that identifies beef heifers and cows which should not be used for breeding. A robust test for Y chromosome in beef cattle breeding herds that improves reproductive efficiency will lead to improved reproductive efficiency and lower production costs that will increase economic returns to producers and lower beef prices for consumers.

Increasing ewe prolificacy for sheep producers. A high priority and focus of the sheep industry is to increase the number of lambs weaned per ewe exposed for breeding. The use of Romanov crossbred ewes is increasing in the United States because the Romanov breed is the most prolific breed available. It was hypothesized that Romanov crossbred sheep may differ in reproductive performance when produced using Romanov rams or Romanov ewes because Romanov ewes produce much larger litters than ewes of other breeds. Therefore, the relative performance of Romanov crossbred ewes sired by Romanov rams compared to those born to Romanov ewes is an important industry issue. ARS scientists determined that Romanov crossbred ewes produced by either method were similar in their high levels of productivity – there was no significant maternal dam effect.

**Impact:** Producers can mate Romanov rams to ewes of locally-adapted breeds to lower the cost of producing Romanov crossbreds to realize improved fecundity and reproductive performance of the resulting Romanov crossbred ewe. This practical information will further increase use of Romanov superior genetics, resulting in greater productivity and profitability for sheep producers.

### Indicator 2

***During FY 2011, ARS will develop genomics infrastructure and tools to efficiently identify genes and their function for exploitation in genome-enabled improvement and precision management of food animal species***

FY 2011 Accomplishments:

Novel diagnostic assays differentiate virulent strains of the fish pathogen, *Yersinia ruckeri*. The fish disease 'enteric redmouth' caused by the pathogen *Yersinia ruckeri* was a devastating disease that has been controlled for years with an effective vaccine. However, recently newly identified strains of *Y. ruckeri*, called *Y.ruckeri* biotype 2 (BT2), pose an emerging threat to rainbow trout aquaculture and improved diagnostic assays are needed. Scientists have developed assays for the rapid and precise identification of the three specific strains of BT2 *Y. ruckeri* that are currently circulating in the US and Europe. The assays are easy to perform and interpret and depend on equipment already common to diagnostic laboratories.

**Impact:** These assays will be used to identify infected fish populations, and will facilitate the application of specific vaccines or other management practices aimed at controlling these newly emerging strains of bacteria in aquaculture.

Antiviral pathway identified in fish cells. Various fish cell lines have been developed to characterize viral recognition and response pathways in fish. ARS collaborators have individually expressed the major proteins of the viral hemorrhagic septicemia virus (VHSV) in fish cells to investigate infectivity and virulence of these proteins at a cellular level. Two VHSV proteins were found to inhibit antiviral responses in fish cells, decreasing production of the antiviral molecule, interferon. Furthermore the research indicated that interferon already present in the cell can block VHSV from multiplying. Collectively, this work suggests that the VHS virus adversely affects the cellular response to interferon which allows virus replication.

**Impact:** Knowledge of how particular VHSV proteins affect the viral recognition and response pathway in fish will enable development of a more targeted and effective vaccine for treatment of this pathogen in important aquaculture species.

A defective gene causes a novel stress syndrome in pigs. A defect within a gene, mutated in human muscular dystrophies, causes a novel stress syndrome in pigs. The stress syndrome can result in death of affected pigs after handling or transportation. ARS researchers at Clay Center, NE, using sophisticated genetic and physiological techniques, determined that a defective gene called dystrophin leads to elevated blood enzymes, heart arrhythmias and dramatically reduced levels of the protein in heart and skeletal muscles. The researchers' findings are consistent with observations of genetic mutations in humans with milder forms of muscular dystrophy associated with muscle weakness and heart failure.

**Impact:** This research will assist pork producers to eliminate this defect from their herds improving production efficiencies, pork quality, and the competitiveness and profitability of the pork industry. Pigs with this defect can also now be used as valuable biomedical models for human muscular dystrophy research.

Copy number variation in dairy cattle. Copy number variation (CNV) is a form of genetic variation in mammalian genomes due to varying numbers of specific alleles in an individual due to deletions or duplications of genetic material. Copy number variations (CNVs) are gains and losses of genomic sequence between two individuals of a species. While not yet well understood, CNV has been estimated to account for 100 to 1000 times more variation in a population than point mutations. CNVs also impact a higher percentage of genomic sequence and have potentially greater effects, including the changing of gene structure and dosage, altering gene regulation and exposing recessive alleles. Early work in humans through genome-wide association studies have associated CNVs with diseases such as intellectual disability, autism, schizophrenia, neuroblastoma, Crohn's disease, and severe early-onset obesity. Early research indicates that CNV variation may be associated with animal performance for many traits relating to health and production. In dairy cattle ARS scientists have identified 682 candidate copy number variations (CNV) regions, which represent ~4.60% of the genome. Many CNV regions (~56%) overlap with cattle genes (1,263), which are significantly enriched for immunity, lactation,

reproduction, and nutrition. ARS scientists also reported an initial analysis of CNV in cattle selected for resistance or susceptibility to intestinal nematodes and identified 20 CNV in total. Further analyses indicated that annotated cattle genes within these variable regions are particularly enriched for immune function.

**Impact:** These results provide a valuable foundation for future studies of gene variants underlying economically important health and production traits and will be critical to clearly understanding the relationships between the genome and the phenotype of food animals. This understanding will better enable the food animal industries to develop effective genetic selection programs for complex traits.

### Indicator 3

***During FY 2011, ARS will characterize food animal germplasm for traits of importance and continue to increase the inventory of germplasm stored within the National Animal Germplasm Program repository to preserve biodiversity***

#### FY 2011 Accomplishments:

Genetic variation associated with important diseases of beef cattle. Respiratory disease, foot rot, and pinkeye are important diseases of beef cattle that increase the cost of production and reduce animal well-being. New DNA technology makes it possible to identify genes in cattle associated with susceptibility or resistance to these diseases. ARS scientists used this technology to identify areas on six different chromosomes associated with the occurrence of these common and expensive diseases of cattle.

**Impact:** This discovery will allow development of specific DNA tests targeting susceptibility to these diseases and determine whether DNA-based selection can reduce the incidence of these diseases in beef cattle. Breeding for reduced susceptibility to common diseases would enhance animal well-being and production efficiencies, while reducing the need for antibiotic use in beef cattle and improving the profitability and competitiveness of the beef industry.

Genetic security increased. Globally, genetic diversity is contracting across livestock species. This problem was addressed by further developing a comprehensive ex-situ cryopreserved germplasm collection. The new germplasm acquisitions increased the level of genetic security for the livestock industry and research community. In addition the livestock sector has utilized 302 animals in the collection for research or for adding genetic diversity to live populations.

**Impact:** Systematically building and expanding the germplasm collection has increased the scope and value of the germplasm collection for food animal industry stakeholders. Increased utility of the germplasm collection has enabled the livestock industry and research community to access the collection's genetic resources as needed for scientific or production value.

Release of novel Kumamoto oyster breeding stock, Ariake Kumo. Existing U.S. Kumamoto oyster breeding stock had been hybridized with Pacific oysters and subjected to excessive inbreeding, producing undesirable characteristics and making larval culture difficult. In 2006, a genetically diverse sample of Kumamoto oysters was collected from the Ariake Sea in southern Japan and molecular markers were used to confirm their species identification. From 2007-2010, we raised an entire generation under strict quarantine conditions and conducted extensive disease testing on the imported parents and their first- and second-generation progeny to preclude the introduction of non-native pests and pathogens.

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**Impact:** This non-inbred and non-contaminated breeding stock is currently being used and evaluated by commercial producers and is likely to replace or revitalize current stocks and thus enhance the production of Kumamoto oysters.

Estimation of genetic parameters for growth and Enteric Septicemia of Catfish (ESC) resistance in channel catfish. Information on heritabilities and interactions among economically important traits is required for efficient improvement of these traits in channel catfish. ARS scientists at the Catfish Genetics Research Unit in Stoneville, Mississippi, evaluated channel catfish growth, fillet yield and resistance to ESC as part of an integrated breeding program. Heritability for growth and fillet yield were moderately high (0.35 and 0.38, respectively) while heritability for survival to ESC challenge was not different from zero. Breeding values were estimated and fish were selected for improved growth and fillet yield based on a selection index with equal weighting for growth and fillet yield.

**Impact:** The selected catfish form the foundation for a genetically improved population intended for release to the industry.

ARS trout lines incorporated into commercial lines. Plant-based fish feed reduces dependence on marine fishery resources. ARS researchers have selected lines of rainbow trout for several generations for improved feed conversion, protein retention, and growth rate at 6 months after first feeding when fed fish-meal free, barley containing diets. Working jointly with a commercial partner, these trout were incorporated into a commercial breeding program.

**Impact:** During the next production cycle these fish will account for at least 15% of commercially produced rainbow trout in the United States. Improved genetic trout lines from the ARS broodstock program are available to the trout industry and to trout researchers nationwide.

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### Indicator 4

***During FY 2011, ARS will characterize nutrient requirements of fish and shellfish, measure nutrient availability of feedstuffs to develop nutritional strategies for improving dietary efficiency, and to meet the need for sustainable sources of feedstuffs and the requirements of fish and shellfish with superior growth rates.***

### FY 2011 Accomplishments:

Regulators of feed efficiency in catfish. Factors that control feed efficiency are not well understood in catfish. Therefore ARS scientists conducted research to investigate the role mitochondrial respiratory chain enzyme activities on low and high Feed Efficient (FE) families of catfish. Mitochondrial complex enzyme activities showed that the activities of the liver mitochondrial complexes (I, II, III, IV) were all lower in the low FE family compared to the high FE family. Enzyme activities of the muscle and gene expression from the liver and muscle are currently being evaluated.

**Impact:** Understanding how the mitochondrial respiratory chain controls FE will help researchers develop strategies to improve FE in catfish.

Development of a standardized digestibility database for traditional and alternative feed ingredients. To develop new ingredients for fish feed diets, the availability of the nutrients in the ingredients, known as digestibility, need to be determined. This information must be generated empirically by testing the ingredients on fish, there are no laboratory methods with commercial processing to determine digestibility. ARS scientists compiled a first of its kind database containing digestibility coefficients for macro-nutrient, amino acids, and minerals for 80 ingredients with rainbow trout and 26 ingredients with hybrid bass.

**Impact:** This information has been requested by commercial aquafeed companies and ingredient suppliers both nationally and internationally, and will allow for more efficient feed utilization and ingredient substitution by the aquaculture industry.

Alternative feeding ingredients. Prices of soybean meal and corn, the two most commonly used traditional feed ingredients in channel catfish diets, have increased dramatically in recent years. Using less-expensive alternative feed ingredients to partially replace soybean meal and corn will reduce feed cost. Scientists at the National Warmwater Aquaculture Center, Stoneville, MS, investigated the use of corn gluten feed and cottonseed meal, two promising alternative feedstuffs, as replacements for soybean meal and corn in diets for pond-raised channel catfish. The study showed that a maximum of 50% of the soybean meal in channel catfish diets may be replaced (soybean meal was reduced from 51.4% to 25.7%) by a combination of corn gluten feed and cottonseed meal (up to 20% of each in the diet) without markedly affecting the physical quality of feed pellets, fish growth, processed yield, and body composition.

**Impact:** Results are being used by catfish feed mills to reduce feed costs while providing a nutritionally complete feed for commercial catfish farming.

**Measure 2.2.2 Summary of the Major Technologies Developed, Transferred, and Used in FY 2011:**

***During FY 2011, ARS reported on 8 technological breakthroughs or scientific advancements that made significant contributions toward developing new technologies, tools, and information contributing to improved precision animal production systems to meet current and future food animal production needs of diversified consumers, while simultaneously minimizing the environmental footprint of production systems and enhancing animal well-being.***

<b>Describe the Technology</b>	<b>Describe the Transfer</b>	<b>Identify the Customer</b>	<b>Impact</b>
Commercial genotyping test for beef heifer/cow fertility	ARS scientists developed a test for "Y" chromosome segments in beef heifer/cow genomes which reduces female fertility. This test will be relevant for all bovine.	Beef and dairy producers	Increased fertility will be realized for the beef and dairy industries through the identification and culling of females with reduced fertility.
Commercial genotyping test for 5 recessive lethal alleles in dairy cattle	ARS scientists identified a group of 5 recessive alleles in dairy cattle that reduce dairy cattle fertility.	Dairy producers	Increased fertility will be realized for the dairy industry through the identification and

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	These animals can now be identified through genotyping which will enable the industry to avoid potential lethal matings or cull the cows that carry the recessive alleles. This test may be relevant for all bovine.		management or culling of females that carry one or more of the recessive alleles.
Commercial genotyping test for novel stress syndrome in pigs.	ARS researchers at Clay Center, NE, using sophisticated genetic and physiological techniques, determined that a defective gene called dystrophin leads to elevated blood enzymes, heart arrhythmias and dramatically reduced levels of the protein in heart and skeletal muscles.	Swine producers	Pork producers can now eliminate this defect from their herds improving production efficiencies, pork quality, and the competitiveness and profitability of the pork industry. Pigs with this defect can also now be used as valuable biomedical models for human muscular dystrophy research.
Prediction model for feedlot cattle susceptibility to heat stress.	ARS scientists developed a model to predict individual animal susceptibility to heat stress including the effects of animal color, sex, species, temperament, hair thickness, previous exposure to heat, age, condition score, previous pneumonia or other related health issues, and current health status to predict susceptibility to heat stress.	Beef feedlot producers	Use of this prediction model for susceptible animals enables producers to provide appropriate care for each animal in the feedlot, improving welfare, maximizing animal performance, and increasing profitability by decreasing financial losses.
Novel diagnostic assays differentiate virulent strains of the fish pathogen, <i>Yersinia ruckeri</i> .	ARS Scientists developed these assays working with a commercial animal health company	Pharmaceutical company, fish farmers worldwide	These assays will be used to identify infected fish populations, and will facilitate the application of specific vaccines or other management practices aimed at controlling these newly emerging strains of bacteria in aquaculture
Vaccine developed to protect fish against columnaris disease.	ARS scientists developed and attenuated live vaccine in cooperative work with a commercial animal health company	Pharmaceutical company, fish producers worldwide	This vaccine has been commercially licensed to prevent columnaris disease to benefit fish farmers and the aquaculture industry.
Development of improved pond aerator.	Scientists have developed a new aerator called the power tube airlift aerator that concentrates high oxygen containing water in a small zone of water at lower costs than traditional aerator designs.	Fish farmers, especially intensive producers who need supplemental aeration.	Emergency aeration efficiency would exceed traditional paddlewheel aerators. The fewer moving parts and improved efficiency would reduce the costs associated with repair and maintenance, and lower power (electricity) consumption.
Determination of the compounds and microorganisms responsible for earthy-	Scientists has worked with producers of a variety of species including arctic charr, barramundi, rainbow	Fish farmers using recirculating systems	These management practices reduce off-flavor occurrence and thereby avoid economic losses due

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musty off-flavors in fish cultured in recirculating aquaculture systems	trout, and Atlantic salmon	to delaying harvests, such as additional feeding costs and losses of fish to disease and water quality problems.
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### **Measure 2.2.2 Outyear Performance Plan (the future performance indicators for this Measure)**

**During FY 2012, ARS will**

*identify underlying genetic and physiologic mechanisms for traits impacting efficiency of nutrient utilization, reproduction, adaptability, health and well-being in food animals.*

*develop genomics infrastructure and tools to efficiently identify genes and their function for exploitation in genome-enabled improvement and precision management of food animal species*

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

*characterize nutrient requirements of fish and shellfish, measure nutrient availability of feedstuffs to develop nutritional strategies for improving dietary efficiency, and to meet the need for sustainable sources of feedstuffs and the requirements of fish and shellfish with superior growth rates.*

**During FY 2013, ARS will**

*Identify underlying genetic and physiologic mechanisms for traits impacting efficiency of nutrient utilization, reproduction, adaptability, health and well-being in food animals.*

*Develop genomics infrastructure and tools to efficiently identify genes and their function for exploitation in genome-enabled improvement and precision management of food animal species*

*Characterize food animal germplasm for traits of importance and continue to increase the inventory of germplasm stored within the National Animal Germplasm Program repository to preserve biodiversity.*

*Characterize nutrient requirements of fish and shellfish, measure nutrient availability of feedstuffs to develop nutritional strategies for improving dietary efficiency, and to meet the need for sustainable sources of feedstuffs and the requirements of fish and shellfish with superior growth rates.*

*Discover improvements to production systems that will lead to lower costs of production.*

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## STRATEGIC GOAL 2

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**Measure 2.2.3      Expand, maintain, and protect our genetic resource base, increase our knowledge of genes, genomes, and biological processes, and provide economically and environmentally sound technologies that will improve the production efficiency, health, and value of the Nation's crops.**

Baseline 2006
Ten new technologies developed and used by ARS customers to increase production efficiency and enhance the economic value and quality of U.S. crop production while decreasing the environmental footprint of production systems.
Target 2011
Cumulatively, 35 new technologies developed and used by ARS customers.

### Indicator 1

***During FY 2011, ARS will develop crop production strategies to optimize crop genetic potential and mitigate losses due to biotic and abiotic stresses.***

FY 2011 Accomplishments:

New product developed that controls bee mites with acids from hops. Varroa mite is the most important pest of honey bee colonies and causes major colony losses due to parasitism and transmitting viruses, many of which are associated with colony collapse disorder. Beekeepers need new methods to control varroa mites because currently registered products are either inconsistent in their effectiveness, harmful to brood, contaminate wax combs, or no longer control varroa mites because the mite is resistant. Under a Cooperative Research and Development Agreement, ARS scientists in Tucson, Arizona, developed a product (commercialized as HopGuard™ by BetaTec Hop Products) that uses beta plant acids from hops to reduce varroa mite populations in colonies.

**Impact:** A Section-18 emergency registration was issued by EPA and HopGuard™ is now in commercial production and being used in honey bee colonies.

Research on bee feed demonstrates effects on bee health. Beekeepers feed high fructose corn syrup or sucrose to colonies as a carbohydrate source when flowering plants are not available; protein is fed when pollen is scarce. ARS scientists in Tucson, Arizona, demonstrated that colonies fed during the winter with sugar syrup made with sucrose had greater brood production in the spring compared with colonies fed high fructose corn syrup. A high rate of brood production in the spring is important for building strong colonies for the pollination of early season crops such as almonds. Similarly, ARS scientists in Baton Rouge, Louisiana, found that continual feeding of protein and sugar syrup and feeding protein enriched with pollen in mid-winter produces colonies that far exceed the sizes needed for almond pollination.

**Impact:** Adopting this strategy, beekeepers are finding that the supplemental feeding effect is enhanced if beekeepers use eight-frame equipment.

Clean citrus budwood. Citrus nurseries in central California maintain registered scion trees and budwood increase blocks in open fields, and they also grow citrus propagations in the field. All nursery trees must be free of *Citrus tristeza virus* and, because of the spread of the virus, nursery trees must be tested to insure they are virus-free. ARS researchers in Parlier, California, tested commercial monoclonal antibodies as cocktails for universal detection of California *Citrus tristeza virus* strains.

**Impact:** Two commercial nurseries are now using a *Citrus tristeza virus* immunoprint test kit assembled by the scientists to test all citrus for the virus, as is the University of California Lindcove Research and Extension Center in Exeter, California. Citrus tristeza virus-infected trees identified by the tissue-print method are removed immediately in this program, thus preventing additional dissemination of the pathogen.

Research demonstrates that stressing bees can make them more resistant to disease. The reasons behind bee declines has been a major concern for beekeepers and researchers, and many hypothesize that the declines are a result of increased susceptibility to disease due to increased stress. However, ARS researchers in Logan, Utah, found that when the alfalfa leafcutting bee was exposed to a temperature stress, either being excessively chilled or overheated, that chalkbrood infections actually declined; activity of the immune system increased, and this activity reduced the ability of the pathogen to infect the bee.

**Impact:** These results help to understand the relationship between stress and disease, assisting beekeepers in maintaining healthier hives.

**Indicator 2**

***During FY 2011, ARS develop new technologies to enhance the productivity of crop production by increasing the mechanization and automation options available to producers.***

FY 2011 Accomplishments:

Cover crop residue conserves soil moisture and enhances weed control and grape vine root growth. Cover crops have been shown to improve soil structure and weed control. It was unknown which cover crop practices are best suited for young vineyards in the Pacific Northwest. ARS scientists in Corvallis, Oregon, and collaborators at Oregon State University examined five different vineyard floor management schemes. One included the use of winter cover crop residue grown in alleyways as mulch within vine rows in a young vineyard. The use of the mulch in the vine row increased vine shoot and root growth, suppressed numerous weeds, reduced soil compaction, and maintained higher soils moisture over two growing seasons, as compared to a clean-cultivated control without mulch.

***Impact:*** The findings suggest that the use of cover crop residues as a mulch can improve vine establishment and conserve soil resources and soil quality when establishing new vineyards in the Pacific Northwest region.

New technique for measuring water availability in greenhouse and nursery potting mixes. ARS researchers in Wooster, Ohio, developed a new method to correlate moisture level and plant-available water in nursery and greenhouse potting mixes. Traditional methods for this process were developed for mineral soils. These methods were not precise for porous soils near saturation and thus not useful for greenhouse and nursery potting mixes composed of pine bark, peat moss, and other potting mix components.

***Impact:*** This new method allows for cost-effective measurement of soil moisture and plant-available water, and can be applied to irrigation models, allowing for more accurate crop irrigation. Also, this could result in more efficient irrigation with less water, nutrient, and pesticide runoff in greenhouse and nursery production.

Comprehensive application technology and strategy to reduce pesticide use. Pesticide applications are critical to ensure healthy, unblemished ornamental nursery plants. Conventional spray application practices recommend the modification of carrier volume for preparations of spray mixtures, but not the amount of active ingredients per unit area. ARS researchers in Wooster, Ohio, demonstrated that growers could use their existing spray equipment to reduce pesticide and water use by 50 percent by properly changing spray nozzles at no extra cost and still achieve effective pest and disease control. This equates to doubling the pesticide application efficiency while reducing pesticide costs, reducing health risk to applicators, and diminishing adverse impact to the environment.

***Impact:*** Benefits accrued with this approach included increased operational efficiency (the area sprayed is doubled thus the frequency and travel time required for the tank refilling times are reduced) and reduced costs for energy consumption and new equipment, as well as reduced risk of pesticide exposure of workers. By using the half-rate practice, growers reported savings of over \$200-\$500 per acre.

**Indicator 3**

***During FY 2011, ARS will maintain and enhance genetic and genomic databases and make information accessible via standard software from the Internet.***

#### FY 2011 Accomplishments:

The Legume Information System (LIS; <http://comparative-legumes.org>) is a long-term repository for legume genetic data and DNA sequence data, and tools to retrieve, analyze, compare, and visualize legume data that serves the legume research and breeding communities worldwide. Accomplishments in the last year include: (1) Introduction of home pages for 18 legume species, including in-house links to reference data sets warehoused at LIS and basic data about the species; (2) Gene family pages built around the soybean reference genome with the capacity for the addition of gene sequences from all 18 crops; (3) A gene sequence search and whole-chromosome alignment display tool; and (4) Mature genome browsers for three sequenced legume genomes (soybean, *Medicago truncatula*, and *Lotus japonicus*). This database provides online genetic and genomic support for researchers and breeders that work on alfalfa, common bean, garden pea, broad bean, peanut, pigeon pea, cowpea, chickpea, mung bean, and others.

**Impact:** The data enables researchers and breeders to leverage knowledge gained from established model legume species genome sequences, including the soybean. LIS hosted 10,000 unique visitors/users who viewed an average of 30 pages each in 2011. U.S. LIS users accounted for 37 percent of the visitors, while 63 percent were from outside the United States.

Major new genome mining tool released to corn researchers and breeders. Since the publication of the corn genome sequence in 2009, the need for new and better research tools for understanding how agronomic traits are determined by gene sequences and their variants has grown dramatically. ARS scientists in Ames, Iowa, and Cold Spring Harbor, New York, released MaizeCyc, an important new database utility that enables corn scientists and breeders to explore the intricate metabolic and chemical transport pathways encoded in the corn genome (chromosomes) that ultimately determine maize growth, yield, quality and nutritional value. MaizeCyc currently contains 8,894 enzymes, 2,109 enzymatic reactions, 390 metabolic pathways and 68 transport reactions that were assembled from information provided by key international authorities on plant protein functions (EntrezGene, UniProtKB-SwissProt and GenBank), classically identified maize trait genes, proteomics-based gene annotations, and individual contributions from corn researchers.

**Impact:** MaizeCyc is hosted by two ARS databases – MaizeGDB and Gramene. Together, these databases host several hundred thousand visitors each year from university, industry, and government corn and other crop researchers and breeders.

#### Indicator 4

***During FY 2011, ARS will describe in model plants and crop plants the structure, function, and regulation of agriculturally important genes that control plant composition and yield.***

#### FY 2011 Accomplishments:

Production of omega-5 gliadins, a wheat allergen, is reduced using genetic engineering. Food safety is taken for granted by many Americans. For some people, however, the consumption of wheat followed within a few hours by exercise can induce anaphylaxis due to the presence of the wheat proteins omega-5 gliadins. This food allergy is called wheat-dependent exercise-induced anaphylaxis. ARS scientists in Albany, California, used a biotech approach to silence the expression of genes encoding omega-5 gliadins in the commercial bread wheat variety 'Butte 86'. Analysis of proteins in grain from transgenic plants demonstrated that the omega-5 gliadins were either absent or substantially reduced relative to non-transformed controls.

**Impact:** The ability to genetically transform 'Butte 86' enabled flour composition to be changed in a targeted manner in a commercial U.S. wheat cultivar, and should accelerate future research on wheat flour quality and immunogenic potential.

Corn gene enhances switchgrass biofuel production potential. Major challenges continue to exist in increasing biofuel production from biomass feedstocks. ARS scientists in Albany, California, together with scientists at the Department of Energy, Energy Biosciences and Joint BioEnergy Institutes, have increased starch production in switchgrass leaves by up to 250 percent using a novel form of the corn gene cg1 (corngrass1). Starch produced by cg1 switchgrass was converted into simple sugars such as glucose and without energy-intensive and expensive pretreatment of biomass. Moreover, Cg1 switchgrass does not produce seeds or pollen, thus preventing the inadvertent movement of this gene by pollen to native switchgrass populations and protecting natural sources of genetic variation. This effort is a product of the USDA Plant Gene Expression Center and the Central-East Regional USDA Biomass Research Center.

**Impact:** Genetically engineered switchgrass represents a new model way to genetically improve feedstocks for the biofuel production industry.

#### Indicator 5

***During FY 2011, ARS will exploit genome sequence information to identify valuable genes in germplasm collections.***

#### FY 2011 Accomplishments:

Sorghum maturity locus gene cloned. Maturity1 (ma1) is the major gene that permits the transition from vegetative growth to flowering under long-day conditions in grain sorghum. ARS scientists in College Station, Texas, together with university and industry scientists, cloned the wild-type (tropical) ma1 gene, along with naturally occurring sequence variants that enable flowering under long-day conditions in temperate latitudes. These sequences are now applied to molecular and genetic screening of tropical sorghum germplasm for photoperiodic response, and for marker-assisted selection for this important trait in sorghum grain and biofuel research programs.

**Impact:** ARS breeders are utilizing ma1 as a marker for conventional breeding to adapt ARS tropical sorghum germplasm accessions to temperate latitudes and thus enhance its utility to sorghum breeders seeking desirable traits.

New disease resistant rice lines released. Rice sheath blight and rice blast are two of the most serious diseases of rice worldwide. ARS scientists at Stuttgart, Arkansas, and the University of Arkansas Agricultural Experimental Station, in cooperation with the International Center for Tropical Agriculture (CIAT), Colombia, and Louisiana State University, Baton Rouge, Louisiana, released four new rice lines with increased resistance to both sheath blight and blast. All four lines have excellent agronomic and grain quality characteristics, comparable to those of both parents. They are being used by rice breeding programs for stacking multiple ShB and blast resistance genes along with other desirable traits.

**Impact:** These four new rice lines enable U.S. rice breeders to more efficiently develop new varieties with enhanced resistance to sheath blight and blast disease to better protect U.S. rice production against these two major diseases.

Genetic assay developed for high oleic acid peanuts. High concentrations of oleic acid in seeds are beneficial attributes for peanut, a globally important food legume and oilseed. ARS researchers in Griffin, Georgia, developed a rapid DNA assay for alleles of genes governing the

high oleic acid trait in peanuts. This assay enables curators to identify particularly valuable samples, and breeders to test seed or leaf tissue rather than via destructive chemical analyses of ground seeds.

**Impact:** This rapid assay will help identify key genes linked to important agronomic traits, improve curatorial efficiency, and decrease the time and effort required to characterize peanut breeding material by eliminating undesirable types at the early seedling stage.

### Indicator 6

***During FY 2011, ARS will develop new genetic and genomic methods and tools to identify specific genes that affect end-product traits desired by consumers, such as oil and grain quality, disease resistance, and stress tolerance in agricultural crops.***

FY 2011 Accomplishments:

20,000 new deletion mutants released for analyzing soybean gene functions. Advances in the genetic and molecular understanding of soybean gene functions are critical for the continued improvement in soybean agronomic and quality traits through breeding. Mutant populations are indispensable sources of genetic variation for geneticists and breeders. ARS researchers in St. Paul, Minnesota, used fast neutron radiation to create over 20,000 new soybean gene knockout and gene disruption mutants that display variation in key soybean traits including seed protein and seed oil composition, maturity, morphology, pigmentation, roots, and nitrogen fixation.

**Impact:** This important new resource is accessible through the USDA SoyBase and Soybean Breeder's Toolbox database.

Corn germplasm lines with resistance to aflatoxin accumulation released. Two new corn germplasm lines (named Mp718 and Mp719) developed by ARS researchers in Mississippi State, Mississippi, were evaluated over 7 years of field testing and showed a 90 percent reduction in aflatoxin accumulation. These germplasm lines exhibit resistance to accumulation of both the toxin and the fungus that causes the disease, *Aspergillus flavus*. Because of this unique resistance to both the fungus and the toxin, corn hybrids with genetic resistance can be developed, and losses to aflatoxin contamination can be reduced by breeders selecting for either reduced aflatoxin accumulation or reduced fungal infection.

**Impact:** Commercial hybrids with genetic resistance can now be developed that reduce or even eliminate grain losses to aflatoxin contamination in corn.

Novel imaging and software platform for three-dimensional analysis of root architecture. Crop yields and hence global food security will be increasingly impacted by climate change and the reduced availability of water and nutrients. Improving plant root architecture to optimize water and nutrient uptake and thus minimize the negative impact of these factors on yield is achievable through conventional breeding. However, root system development and architecture are a challenge to measure and analyze in the field. ARS scientists in Ithaca, New York, together with Cornell University scientists, developed a high efficiency root growth imaging and analysis platform to phenotype growing root systems in three dimensions.

**Impact:** The high-throughput system, combined with an expanding array of germplasm resources, make it possible to explore the genetic components of root system architecture and physiology as they relate to both developmental processes and root traits associated with the acquisition of limiting resources (e.g. water and phosphorous).

New transgene containment technologies. Transgene escape, a potential environmental and regulatory concern for genetically modified crops, could be alleviated by removing transgenes from pollen, one obvious source for unwanted gene flow. ARS scientists in Albany, California, released four new types of molecular scissors, or recombinases, which can reduce the presence of transgene in pollen from 75 percent to less than 1 percent.

**Impact:** These systems provide the biotechnology seed industry with new tools for the genetic improvement of crop plants through biotechnology.

Potential sources of resistance and tolerance to Huanglongbing identified. Many citrus cultivars and breeding lines were characterized for potential resistance to Huanglongbing (HLB or citrus greening disease) in multiple experiments in the greenhouse and the field. Among materials tested *Poncirus trifoliata*, a popular rootstock, and some of its hybrids show some levels of tolerance to the disease and/or its insect vector.

**Impact:** *P. trifoliata* has already been utilized extensively in USDA breeding efforts, and some advanced hybrid selections with commercial potential may have useful resistance or tolerance to citrus greening or its vector.

Second source of resistance to reniform nematode identified for cotton. In 2009, U.S. cotton producers lost an estimated \$60 million in damage to the reniform nematode. ARS researchers in College Station, Texas, and their university colleagues and industry partners, mapped genes for resistance to reniform nematode onto chromosome 11 from the wild cotton species *Gossypium longicalyx*. A second source of nematode resistance in *Gossypium barbadense*, GB713, provides an excellent additional source of resistance to root knot nematode. Because this resistance source is from *G. barbadense*, a cultivated tetraploid cotton, it should be more readily transferrable to upland cotton (*G. hirsutum*). This research also identified markers for selecting root knot nematode resistance genes.

**Impact:** Advanced cotton lines carrying this marker are being evaluated in the field.

Grape powdery mildew genes. Although powdery mildew is economically the most important fungal pathogen of grapevines, the causal organism cannot be grown in pure culture, thereby limiting knowledge about its genetics. To identify and target weaknesses in powdery mildew biology, ARS researchers in Geneva, New York, sequenced and described all of the genes expressed by grape powdery mildew, as part of an international collaboration spanning powdery mildews of fruits, vegetables, grasses, and weeds. Researchers discovered powdery mildew genes required for reproduction, cold survival, and fungicide tolerance.

**Impact:** This improved knowledge of powdery mildew genetics provides new targets for disease management of a fungus that costs grape growers \$100 to 400 per acre per year.

Soybean genes that retard cyst nematode development. Soybean cyst nematodes attack the roots of soybean plants and cause approximately \$1 billion in damages each year to U.S. soybeans. In an effort to improve resistance to the soybean cyst nematode, ARS researchers in Beltsville, Maryland, discovered 30 soybean genes containing genes that effectively protected soybean plants from cyst nematode attack. However, variability for expression of those genes in plant roots was lacking. Researchers genetically engineered soybean plants to express greater numbers of these genes in their roots. Several genes delayed the development of 50 percent of the female cyst nematodes.

**Impact:** These genes potentially will be useful to soybean breeders wanting to broaden resistance to the cyst nematode.

**Indicator 7**

***During FY 2011, ARS will construct and maintain physical, genetic, and transcript maps to facilitate comparative analyses among plant genomes.***

## FY 2011 Accomplishments:

A saturated molecular genetic map for cotton. Genetic mapping of molecular markers to the 26 chromosomes of cotton is essential to the identification and location of genes on the chromosomes, and to understanding the genetic complexity of this important fiber and food crop. ARS scientists in College Station, Texas; New Orleans, Louisiana; Shafter, California; and Starkville, Mississippi, in collaboration with university and private company researchers, have finalized work on a saturated cotton genetic map having 2,072 loci. The work confirmed two major chromosomal exchanges and several DNA duplications among and within the cotton chromosomes. This map constitutes an important resource for cotton geneticists and breeders worldwide, who conduct studies on germplasm characterization, gene discovery, molecular breeding, and the eventual assembly of finished genome sequence for cottons.

***Impact:*** Effective utilization of the map will accelerate the development of new and improved cotton types that will enhance the productivity and profitability of cotton grown by farmers in all production regions of the world.

Plant Expression Database provides genetic clues for resistance to a deadly barley and wheat disease. Stem rust (Ug99), a devastating fungal disease of wheat and barley, is a serious threat to grain crop production globally because resistance is rare: In barley, there is only one known source of qualitative resistance to Ug99. The Plant Expression Database (PLEXdb; [www.plexdb.org](http://www.plexdb.org)) enabled researchers to simultaneously analyze gene activity in plants and their pathogens, which uncovered the structure, function, and regulation of the key genes for that resistance source. ARS scientists in Ames, Iowa, and their university collaborators applied PLEXdb to identify a new genetic 'hotspot,' a master switch for adult onset resistance that controls a major fraction of Ug99 defense response genes.

***Impact:*** Discovery of the new master switch for adult onset resistance to Ug99 potentially can accelerate breeding more durable and effective resistance to this insidious disease of small grains.

**Indicator 8**

***During FY 2011, ARS will identify, acquire, and expand plant germplasm collections to enhance their diversity.***

## FY 2011 Accomplishments:

Crop genetic diversity conserved and distributed to researchers. During fiscal year (FY) 2011, the 20 genebanks in the ARS National Plant Germplasm System (NPGS) added more than 5,000 separate samples of approximately 200 plant species to their collections, bringing to a total of 545,000 samples of more than 14,200 plant species conserved by NPGS genebanks. Scientific interest in this germplasm has increased tangibly during the last few years, with the average number of samples distributed per year (in FY 2011) totaling nearly 200,000, which is 70,000 more than the average a decade ago. These materials are keys for continued progress in crop genetics and breeding requisite for future food security.

**Impact:** Effective conservation of these materials safeguards them for crop breeding and research now and for the future.

Superior strategies developed for defining core subsets of germplasm collections. A core subset distills the total genetic diversity in a large germplasm collection into a suite of fewer accessions, providing a simplified snapshot of the collection's total diversity and complexity. Usually only a single core subset is developed, even for large collections, and it has been problematic to determine whether this single snapshot provides the accurate depiction needed to efficiently access genes of interest. ARS researchers in Fort Collins, Colorado, evaluated different strategies for defining core subsets of the collection of the wild beet species *Beta nana* as test case. Different statistical rules for defining the core subset highlighted different aspects of the genetic diversity in the collection. Rather than being limited to a single core subset, multiple such subsets can be defined flexibly to provide snapshots of genetic diversity customized to meet user needs.

**Impact:** The statistical tools and methods developed are now available to enhance curators' abilities to define custom subsets that facilitate more sharply targeted use of germplasm accessions.

Elucidation of key physiological genetic factors for the cryopreservation of vegetatively propagated plants. For many elite vegetatively propagated genebank accessions, cryopreservation of shoot tips or dormant buds is often the most secure and cost-effective means for long-term conservation. Cryopreservation protocols have traditionally been developed empirically, because the underlying physiological genetic process of regrowth following cryopreservation has been poorly understood. ARS researchers in Fort Collins, Colorado, discovered some of the first physiological genetic details of how plant shoot tips recover from cryopreservation treatments. Shoot tips dehydrated with cryoprotectants, exposed to liquid nitrogen, and allowed to recover expressed stress-related genes such as heat shock proteins, antioxidants, dehydrins and other physiological "housekeeping genes."

**Impact:** This research is a key breakthrough in understanding the genetic and biological bases of variation among genotypes in their response to cryopreservation treatments, as well as their response to therapeutic treatments for recovering germplasm from cryogenic storage.

New genetic tools for introducing and managing pecan genetic diversity. Knowledge of geographical patterns of genetic variability is vital for efficient and effective management of genetic resources in situ and ex situ in genebanks. ARS researchers in College Station, Texas, developed new DNA genetic markers for pecan (which also function with walnuts) that can reveal geographical patterns of genetic diversity and evidence of hybridization. To date, these new genetic tools have confirmed a lack of reproductive isolation for wind-pollinated pecans.

**Impact:** This research has contributed to the development of strategies for the safe introduction of new pecan species from Asia that might contribute genes for genetically improving the U. S. pecan crop, which has an annual farm gate value of hundreds of millions of dollars.

### Indicator 9

***During FY 2011, ARS will strengthen evaluation and breeding programs for specialty crops that have increasing economic importance.***

**FY 2011 Accomplishments:**

Developing peanuts with improved fatty acid composition and disease resistance. Fatty acid composition is an important characteristic for oil seed crops such as peanut. High oleic fatty acid composition is favored because it confers health benefits and improved oil stability. Using marker-assisted selection in an accelerated backcross breeding program, ARS researchers in Tifton, Georgia, completed the development of ‘Tifguard High O/L’ in less than 3 years.

**Impact:** Growers will benefit from the high yields of this new variety combined with excellent resistance to the peanut root-knot nematode and tomato spotted wilt virus. Other segments of the peanut industry and consumers will benefit from the high oleic trait, which results in a longer shelf life and healthier food quality.

The first varieties of the native Hawaiian ōhelo berry are released. The fruit of ōhelo berry, a native Hawaiian shrub related to blueberry, is gathered by local residents for jams, jellies, and pie fillings. Increasingly intensive harvesting of fruit from the wild has raised concerns of habitat disturbance and damage, increased vulnerability to invasive weeds, and reduced food supplies for the endangered native nēnē goose. ARS researchers from Hilo, Hawaii; Corvallis, Oregon; and their university collaborators selected two varieties of ōhelo berry – ‘Red Button’ and ‘Kīlauea’ – as dual purpose plants with edible berries and ornamental merit. These are the first varieties of this species to be bred, and they represent a key first step for long-term conservation and sustainable management of this species for ornamental and berry production.

**Impact:** The new varieties will provide an alternative to wild harvesting of this endemic species, and a new crop for small-scale, edible berry production in Hawaii.

**Measure 2.2.3 Summary of the Major Technologies Developed, Transferred, and Used in FY 2011:**

***During FY 2011, ARS reported on 8 new technologies developed and used to increase production efficiency and enhance the economic value and quality of U.S. crop production while decreasing the environmental footprint of production systems.***

<b>Describe the Technology</b>	<b>Describe the Transfer</b>	<b>Identify the Customer</b>	<b>Impact</b>
Two smart phone applications (Aerial Sprays and Vector Sprays) were developed and released through the Apple iTunes store in November 2011 with companion Android-based applications soon to follow.	The Aerial Sprays app is a mobile version of the ARS spray atomization models that aerial applicators have been accessing from the Web site for years. The Vector Sprays app allows users to select their sprayer, operating conditions, and spray solution, then it determines size of droplets they would be generating. The app allows users to adjust the operating conditions to generate the desired droplet size.	Aerial applicators, State and Federal regulators, extension personnel, public health officials in mosquito control districts, and researchers.	As of February 1, 2012, the apps have been downloaded by 852 users from 34 countries and the United States. These are the first smart phone apps released by ARS.

## STRATEGIC GOAL 2

<p>New line (VSH Resistant Bees) of honey bees resistant to varroa mite, the most important cause of bee mortality.</p>	<p>Scientists at ARS in Baton Rouge provided breeding stock through an MTA with a queen breeder.</p>	<p>Bee industry and university scientists.</p>	<p>This bee line has become so important to the bee industry that it was awarded a 2012 FLC Excellence in Tech Transfer Award.</p>
<p>Sequencing and description of varroa mite candidate gene targets were used to develop a new control strategy based on RNAi targets in the mite that do not occur in the host honey bee, and therefore are safe to target via incorporation in sugar water fed to the bees.</p>	<p>Scientists at ARS in Beltsville made sequence information available to an international team working to develop RNAi.</p>	<p>Scientists, and industry (e.g., a collaborator Beeologics, Inc.), developing RNAi technologies for mite control.</p>	<p>Worldwide initiation of RNAi-based control efforts for this parasite has now been initiated; with the first successful demonstration of RNAi activity in varroa in late 2010.</p>
<p>An environmentally-safe, organic plant-acid based varroa mite control strip for use in bee hives.</p>	<p>Scientists at ARS in Tucson worked with a CRADA with Haas Co. to develop the HopGuard™ product.</p>	<p>Bee industry, especially smaller beekeeping operations, including homeowners, and beekeepers that produce organic honey.</p>	<p>A Section-18 emergency registration was issued by EPA and HopGuard™ is now in commercial production and registered for use in 22 states, with enough product available to treat 600,000 hives in the United States this year (1/4 of all U.S. hives).</p>
<p>Improved dry and snap bean lines resistant to rust, bean common mosaic virus, and bean common mosaic necrosis potyviruses have been released.</p>	<p>Material transfer agreements were used to distribute seeds of improved dry and snap bean lines resistant to rust, bean common mosaic virus, and bean common mosaic necrosis potyviruses.</p>	<p>Plant breeders at various universities in the United States, China, and Sweden; Private seed company plant breeders.</p>	<p>Improved beans of various market classes with resistance to diseases are being developed</p>
<p>CottonDB, a cotton database maintained by ARS scientists providing detailed genomic, genetic, germplasm, and taxonomic information for cotton (<i>Gossypium</i> spp.). CottonDB serves as both an archival database and a dynamic resource for research activities.</p>	<p>In FY 2011, the CottonDB Web site had more than 279,000 visits and 8 million hits from users in more than 100 nations.</p>	<p>Domestic and international cotton research community.</p>	<p>Provides a source site for diverse databases in support of genomic and genetic investigations, and facilitates discoveries that positively impact cotton improvement efforts and benefit the U.S. cotton industry.</p>
<p>Red River Runner, a runner-type peanut cultivar, was released by ARS scientists and Texas AgriLife of Texas A&amp;M University.</p>	<p>Red River Runner has acceptable field resistance to Sclerotinia blight, and grade superior to other runner peanuts currently grown in Oklahoma.</p>	<p>This peanut cultivar is available to U.S. peanut growers.</p>	<p>Because of the grade superiority of RRR, peanut growers could potentially expect an extra \$70 per acre income, compared to other runner cultivars.</p>
<p>'US Early Pride', a very low-seeded, early-maturing citrus mandarin hybrid released.</p>	<p>This new variety combines early-season maturity, moderately sized fruit, with a deep strong orange–yellow color, and a rich sweet flavor that distinguishes itself by being very low-seeded and relatively easy to peel.</p>	<p>Citrus growers in Florida, California, and internationally.</p>	<p>20 acres have been ordered for planting in Florida, and trials will be established in California and Arizona soon. ARS also has an agreement with a South African cultivar development company, and the selection is being tested by them.</p>

**Measure 2.2.3 Outyear Performance Plan (the future performance indicators for this Measure)**

**During FY 2012, ARS will**

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

*develop new technologies to enhance the productivity of crop production by increasing the mechanization and automation options available to producers.*

*maintain and enhance genetic and genomic databases and make information accessible via standard software from the Internet.*

*describe in model plants and crop plants the structure, function, and regulation of agriculturally important genes that control plant composition and yield.*

*exploit genome sequence information to identify valuable genes in germplasm collections.*

*develop new genetic and genomic methods and tools to identify specific genes that affect end-product traits desired by consumers, such as oil and grain quality, disease resistance, and stress tolerance in agricultural crops.*

*construct and maintain physical, genetic, and transcript maps to facilitate comparative analyses among plant genomes.*

**During FY 2013, ARS will**

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

*develop new technologies to enhance the productivity of crop production by increasing the mechanization and automation options available to producers.*

*maintain and enhance genetic and genomic databases and make information accessible via standard software from the Internet.*

*describe in model plants and crop plants the structure, function, and regulation of agriculturally important genes that control plant composition and yield.*

*exploit genome sequence information to identify valuable genes in germplasm collections.*

*develop new genetic and genomic methods and tools to identify specific genes that affect end-product traits desired by consumers, such as oil and grain quality, disease resistance, and stress tolerance in agricultural crops.*

## STRATEGIC GOAL 2

*construct and maintain physical, genetic, and transcript maps to facilitate comparative analyses among plant genomes.*

*identify, acquire, and expand plant germplasm collections to enhance their diversity.*

*strengthen evaluation and breeding programs for specialty crops that have increasing economic importance.*

**During FY 2014, ARS will**

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

*develop new technologies to enhance the productivity of crop production by increasing the mechanization and automation options available to producers.*

*maintain and enhance genetic and genomic databases and make information accessible via standard software from the Internet.*

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*strengthen evaluation and breeding programs for specialty crops that have increasing economic importance.*

### **OBJECTIVE 2.3: PROVIDE RISK MANAGEMENT AND FINANCIAL TOOLS TO FARMERS AND RANCHERS**

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Activities related to this objective are primarily carried out by other USDA agencies.

## Strategic Goal 3:

### Support Increased Economic Opportunities and Improved Quality of Life in Rural America

Programs and activities related to this goal are primarily carried out by other USDA agencies. However, ARS has a large and very positive impact on rural America. For example, the National Agricultural Library operates the [Rural Information Center \(RIC\)](#). The Center assists local communities by providing information and referral services to local, tribal, state, and Federal government officials; community organizations; libraries; businesses; and citizens working to maintain the vitality of America's rural areas. The RIC Web site contains over 3,000 links to sources of current and reliable information on a wide variety of rural resources and funding sources, including RIC's Database: [Federal Funding Sources for Rural Area Databases](#).

The Rural Information Center information and referral services include:

- Responding to a broad array of information requests on topics such as successful strategies, models, and case studies of community development projects; small business attraction, retention, and expansion; housing programs and services; tourism promotion and development; recycling programs and community water quality; and technology transfer to rural areas.
- Developing customized information products in response to specific inquiries (e.g., assistance in economic revitalization issues; local government planning projects; funding sources; technical assistance programs; research studies, etc.)

In addition, in support of the White House Initiative on Tribal Colleges and Universities (TCU), ARS provides opportunities to American Indian communities through Memoranda of Understanding, specific cooperative agreements, and various programs and activities. ARS helps to strengthen the management and administrative infrastructure of TCU libraries; provides facilities and equipment to the libraries; sponsors internships, fellowships, lectures, career fairs, workshops, and other learning and training opportunities for TCU students and faculty; and provides student tuition assistance. These outreach efforts are intended to improve the quality of life in Native American communities by ensuring their access to USDA sponsored programs.

However, in planning research, ARS organizes its research program around the other four programmatic USDA/ARS Strategic Plan goals. In conducting research to ensure the quality and safety of food and other agricultural products, assess the nutritional needs of Americans, sustain a competitive agricultural economy, and enhance the natural resource base and the environment, ARS helps to provide economic opportunities for rural citizens, communities, and society as a whole.

## Strategic Goal 4:

### Enhance Protection and Safety of the Nation's Agriculture and Food Supply

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A secure and efficient agricultural production system is critical to providing the American consumer with a safe and healthy food supply. To maintain such a system, it is necessary to minimize production losses; maintain market viability; promote responsible environmental stewardship; and prevent, monitor, and control diseases that affect animals and humans. Diseases can negatively affect agricultural production systems by causing direct harm to livestock, threatening the health of agricultural workers and the public, and impacting trade.

ARS is an essential partner in ensuring the safety of the Nation's crop and animal products, producing the knowledge that the Nation needs to constantly improve and protect agricultural processes and products. As the agroecosystem evolves in response to changing conditions and human needs, ARS develops the knowledge to protect the Nation's agricultural supply from new threats presented by pathogens, parasites, environmental stresses, and arthropods. The Agency also participates in the development of new, practical technologies, and in the transfer of commercially viable concepts to industry. ARS research and technologies are used by many other Federal and private groups and action agencies, such as the Departments of Defense and Homeland Security, to protect the health of personnel, the integrity of property, and the environmental safety of logistic operations.

#### OBJECTIVE 4.1: PROVIDE THE SCIENTIFIC KNOWLEDGE TO REDUCE THE INCIDENCE OF FOODBORNE ILLNESSES IN THE U.S.

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For the Nation to have safe and affordable food, the food system must be protected at each step from production to consumption. The production and distribution system for food in the United States encompasses a diverse, extensive, and easily accessible system that is open to the introduction of pathogens (bacteria, viruses and parasites), bacterial toxins, fungal toxins (mycotoxins), and chemical contaminants through natural processes, global commerce, and intentional means. In response to these threats, crop and livestock production systems must be protected during production, processing, and preparation from pathogens, toxins, and chemicals that cause disease in humans.

To ensure the security of production systems, ARS conducts basic, applied, and developmental research resulting in new technologies, new and improved management practices, pest management strategies, sustainable production systems, and methods of controlling potential contaminants. These ARS activities are key to providing a safe, plentiful, diverse, and affordable supply of food, fiber, and other agricultural products.

**Key Outcome:** Reduction in foodborne illness associated with the consumption of meat, poultry and egg products.

## Performance Measure

### Measure 4.1.1 Develop new technologies that assist ARS customers in detecting, identifying, and controlling foodborne diseases that affect human health.

#### Baseline 2005

Thirteen new technologies developed and used by ARS customers to detect, identify, and control the most critically and economically important foodborne contaminants causing illness, death, or chronic disease that impact public health and industry, as determined by FSIS, APHIS, ERS, CDC, FDA, DHS, DoD, Risk Assessment Consortium, Codex Alimentarius Commission, and consumer and commodity organizations.

#### Target 2011

Cumulatively, 40 new technologies developed and used by ARS customers.

#### Indicator 1

***During FY 2011, ARS will utilize new detection and quantitative methodologies, including genomic technologies; and, through the study of epidemiology, ecology and host pathogen relationships, intervention strategies, and antibiotic resistance in food producing animals, develop practices, products, and information that will reduce preharvest pathogen and toxic residue contamination of animal-derived food products. Ensure that these technologies can be utilized by regulatory agencies and/or producers to help assure safe food products.***

#### FY 2011 Accomplishments:

Salmonella Typhimurium is a human foodborne pathogen and is one of the most prominent Salmonella serovars isolated from swine production farms. Unfortunately, Salmonella Typhimurium can undetectably reside in pigs without causing noticeable infection. These Salmonella-carrier pigs are a food safety problem for humans through contamination of penmates, the environment and slaughter plants that process pork for consumption. In searching for improved intervention strategies against Salmonella on the farm, ARS researchers in Ames, Iowa, have identified a gene (*poxA*) in Salmonella Typhimurium that, when mutated, dramatically reduces the ability of the bacterium to survive numerous stress conditions as well as antibiotic and chemical exposures. Furthermore, the gene mutation decreased the ability of Salmonella Typhimurium to colonize the pig. These mutants express outer membrane proteins that may make a vaccine more effective.

***Impact:*** This genetic system is critical for the ability of the Salmonella to cause disease and resist antibiotics. Thus it offers a novel target mechanism for intervention development against Salmonella. More importantly, this research has provided data for a patent/invention application, and may be used as a model for other species.

Investigations of dietary antibiotic effects on intestinal microbiomes are important for understanding how certain antibiotics enable animals to grow efficiently with less feed

consumption and how antibiotic alternatives should behave. Additionally, feeding subtherapeutic doses of antibiotics to farm animals will likely have collateral effects which should be considered by producers and commodity organizations in cost-benefit analyses of antibiotic use. ARS researchers at Ames, Iowa, in collaboration with scientists at Michigan State University examined effects of feeding certain antibiotics (ASP250) to swine, using a combination of phylotyping, metagenomics, quantitative PCR, and culture-based approaches. Swine fed ASP250 diets for two weeks demonstrated a shift of the gut flora (with higher *Escherichia coli* numbers in their feces); had elevated levels of bacterial genes for energy production and metabolism, and had higher levels of genes encoding resistance both for the ASP250 antibiotics and other antibiotics in feces.

**Impact:** The emerging science of metagenomics will help scientists understand the influence of antibiotic use in duration and dose on the microbial communities of the gut. These data will help guide other studies to evaluate duration and dose of various antibiotics in controlled or natural settings. Metagenomics and microbial ecology approaches could supplement broader and population-based studies, and will help industry in understanding how in-feed antibiotics actually increase feed efficiency and promote growth. This study provides data that will help USDA in the development and evaluation of alternatives for antibiotics in the treatment of animals and prevention of foodborne disease.

There is growing interest in feeding beef cattle in enclosed deep-bedded confinement barns for improved cattle performance and ease of manure management. However, there is no available information regarding the occurrence of pathogens in the manure/bedding material or in cattle that are housed in these barns. ARS scientists in Clay Center, Nebraska, demonstrated that both *E. coli* O157:H7 prevalence and generic *E. coli* concentrations can occur at high levels in the manure/bedding material of these facilities, and can vary with differences in ambient seasonal temperatures.

**Impact:** Understanding microbial survival in the manure/bedding material is important because this material can be a source of pathogens for contamination of additional cattle, or of water, food, and feed crops when the material is applied to cropland. Furthermore, this information is needed to develop recommendations and Good Agricultural Practices regarding the management of these facilities to reduce pathogens, thereby reducing the risk for contamination and human foodborne illness. There are two areas of impact: the reduction of *E. coli* levels at the pre-harvest level and consequently at the processing plant and the reduction of potential contamination of produce by applied manure to crops. This adds to the data needed by FDA in the application of their Good Agricultural Practices for fruits and vegetables.

Food-poisoning bacteria such as *Campylobacter* are significant causes of human disease; these pathogens can often be found as contaminants in poultry meat products. New non-antibiotic therapeutics are needed to reduce or prevent colonization of poultry by these harmful bacteria; which will largely translate into pathogen-free meat products reaching the consumer. ARS scientists at College Station, Texas, used modern molecular biological techniques (microarray analysis and real-time RT-PCR) to define gene expression changes in the avian spleen during an active *Campylobacter* infection.

**Impact:** This is the first study to define the complex mechanisms involved in innate immunity of poultry to *Campylobacter* infections, and in *Campylobacter* adaptation to the intracellular environment. It provides information on host-pathogen interactions, and defining the molecular mechanisms will facilitate development of new and more effective

intervention strategies for minimizing or even eliminating the occurrence of food-borne pathogens in commercial poultry. This also meets USDA's goal of finding alternatives to antibiotics in food animals. Enhancing host immunity may reduce the need for antimicrobials.

Perfluorooctanoic acid (PFOA) is a "nonstick" compound used in many industrial, commercial, and consumer products. Due to its extensive use, PFOA is widely found in humans, wildlife, and the environment. Cattle are exposed to PFOA while grazing in contaminated areas, but the extent to which PFOA accumulates in their meat is not known. ARS researchers at Fargo, North Dakota, together with scientists at the USDA Food Safety and Inspection Service, conducted a study to determine to what degree PFOA concentrates in the edible tissues of beef cattle and whether this may be a concern for human exposure. Beef cattle were fed a single dose of radiolabeled PFOA which could easily be tracked in the animals. The PFOA was quickly excreted in animal's urine and no detectable amounts were left in the animals after 8 days.

**Impact:** This study showed that PFOA was not likely to accumulate in beef and that consumption of beef should not be a significant source of exposure to PFOA.

#### Indicator 2

***During FY 2011, ARS will utilize new detection and quantitation methodologies, including genomic technologies, and through the study of crop/fungal/toxin relationships, production practices and expert systems, breeding targets for resistant crops, biocontrol technologies and chemical toxicity, develop practices, products, and information that will reduce preharvest fungal/toxin contamination of plant-derived food products. Ensure that these technologies can be utilized by regulatory agencies and/or producers to help assure safe food products.***

#### FY 2011 Accomplishments:

ARS identified a fungal metabolite that increases the toxicity of fungal toxins toward plants. Fusarium head blight is a devastating disease of cereal crops. The fungus causing the disease produces a trichothecene toxin, deoxynivalenol (DON), which is toxic to plants and helps the fungus spread in the plant tissue. DON is also toxic to humans and animals, and grain contaminated with DON is a significant food safety problem. ARS researchers in Peoria, Illinois, found that some Fusarium strains produce another metabolite, culmorin, that enhances the toxicity of DON to plants, and are using modern molecular and genetic techniques to determine if Fusarium strains that make both DON and culmorin are more virulent on cereal crops.

**Impact:** This research produced an improved understanding of the methods used by Fusarium to invade plant tissue and contaminate grain with toxins, and provides new targets for disease control and toxin reduction programs aimed at ensuring the quality and safety of the U.S. food supply.

Aflatoxins are cancer causing compounds produced by the fungus *Aspergillus flavus* when it invades crops. Strategies are being developed to prevent the fungal growth or its ability to make the toxin. Caffeic acid, an antioxidant, was found to reduce >95% of aflatoxin production by *Aspergillus flavus* without affecting fungal growth. Genetic studies suggest that antioxidants may trigger induction of the enzymes, alkyl hydroperoxide reductases, that protect the fungus from oxidizing agents that are produced when the fungus invades the crop. Consequently, aflatoxin synthesis is prevented through molecular regulation of toxin synthesis. ARS scientists at New Orleans, Louisiana, and Western Regional Research Center, Albany, California, have, therefore, discovered how to prevent aflatoxin production with safe, common natural chemicals. In addition,

studies have shown how these compounds work in the fungus so as to turn-off the aflatoxin biosynthetic machinery of the fungus. In short, the compounds trick the fungus into "thinking" that it does not need to produce aflatoxin, which are produced by the fungi to protect them from chemical attacks from plants.

**Impact:** This information will directly assist in devising methods of breeding crop plants to prevent aflatoxin contamination through providing insight as to how to control the genes that trigger biosynthesis of aflatoxins.

A series of chemical and mechanism-based bioassay studies were conducted in collaboration with United States Food and Drug Administration (USFDA), University of Nebraska and Texas Woman's University scientists. These studies demonstrated the effectiveness of extrusion cooking alone or with glucose supplementation to reduce the FB1 concentrations and related toxicity using an in vivo model. It was shown that extrusion alone and, more effectively, extrusion with glucose supplementation significantly reduced FB1 levels in and toxicity of the cooked product. Toxicity and elevated levels of biomarkers were correlated with FB1 concentrations in the cooked products indicating that degradation products, including "hidden" matrix-associated forms, did not significantly contribute to toxicity. Dose response data from these studies were used in the FB safety evaluation conducted by the 74th Joint Food and Agriculture Organization/World Health Organization Expert Committee on Food Additives (JECFA). The studies formed the basis for the Committee's conclusion that studies with *Fusarium verticillioides* culture material, when compared to studies conducted with pure FB1, indicate that the complex mixture of toxins produced by *F. verticillioides* either add to or potentiate the toxicity of FB1.

**Impact:** This work was used in the international FB safety assessment by JECFA to support the Committee's conclusion that studies conducted with highly purified FB1 may underestimate the risk associated with consumption of naturally contaminated corn and corn products. The results were also used by risk managers worldwide to support risk management decisions designed to minimize the health risks associated with fumonisin exposure.

Studies conducted in Guatemala by ARS scientists from Athens, Georgia, in collaboration with the Centro de Investigaciones en Nutricion y Salud in Guatemala (CIENSA), Creighton University and Duke University show for the first time that fumonisin exposure, based on the levels of urinary fumonisin B1, is significantly correlated with the level of sphingoid base 1-phosphates in blood spots and the increase in the sphinganine 1-phosphate to sphingosine 1-phosphate ratio. This finding is consistent with the hypothesis that high levels of fumonisin exposure in humans can lead to disruption of sphingolipid metabolism through inhibition of ceramide synthase. This is a significant finding because every animal disease known to be caused by fumonisin has been shown to be closely correlated with and preceded by evidence of disruption of sphingolipid metabolism.

**Impact:** This finding provides a research tool for assessing the threshold for disruption of sphingolipid metabolism in humans and for designing epidemiological studies to evaluate the potential of fumonisin exposure as a contributing factor to human disease.

Nivalenol (NIV) is a trichothecene related to deoxynivalenol (DON, vomitoxin), a mycotoxin commonly found in cereal commodities in the U.S. NIV has been reported to occur frequently in Asia and Europe, and a population of NIV-producing fungi was recently identified in the U.S. This is of immediate concern because NIV may be as toxic (or more toxic) than DON. For this reason rapid and sensitive methods for detecting NIV and DON are important. ARS scientists from Peoria, Illinois, collaborated with Kirin Holdings Company (Gunma, Japan), the National Agricultural Research Center (Kumamoto, Japan), the Kobe Institute of Health (Kobe, Japan),

and the National Institute of Health Sciences (Tokyo, Japan) in developing a novel antibody-based biosensor for the detection of NIV and DON in wheat.

**Impact:** Because the sensor can simultaneously detect both toxins it will find immediate utility in areas where these two toxins co-occur, assisting in the diversion of contaminated commodities from human food and animal feed supplies.

### Indicator 3

***During FY 2011, ARS will develop innovative methods and advanced technology systems that: rapidly and accurately detect, identify, and differentiate the most critical and economically important foodborne contaminants, such as bacterial, viral, and protozoan pathogens; drug and chemical residues; and pathophysiological and processing surface contamination. Ensure that the technologies are transferred to the Food Safety Inspection Service (FSIS) and the Food and Drug Administration (FDA); the Department of Homeland Security; and industry for implementation into Hazard Analysis Critical Control Point (HACCP) programs, and Good Manufacturing Practice (GMP) protocols for both large and small producers and processors.***

#### FY 2011 Accomplishments:

Currently, the USDA Food Safety Inspection Service (FSIS) uses a 7-plate microbial growth inhibition assay to screen for antimicrobial drug residues in beef samples from slaughter establishments throughout the U.S. Drawbacks include that it takes 24 hours to yield a result, the responses do not identify the drug (only the antibiotic class), and it is unable to detect many common drugs of regulatory interest. ARS researchers at Wyndmoor, Pennsylvania, developed, validated, and transferred to FSIS an improved screening method that also can identify individual drug residues in meat samples. The technology targets 60 of the most important drugs of regulatory concern and is able to screen at concentrations below current regulatory tolerance levels. A single analyst can perform preparation of 60 samples with the method in an 8-hour day for a series of sequential 10 minute analyses

**Impact:** The technology will be implemented by the USDA-FSIS National Residue Program to improve the monitoring and enforcement of veterinary drug residues, and thereby assure better animal husbandry practices, reduce environmental contamination, decrease microbial antibiotic resistance, and increase food safety.

Certain Shiga toxin-producing E. coli (STEC) serogroups, including E. coli O26, O45, O103, O111, O121, and O145 cause a similar illness in humans as E. coli O157:H7. Since these "top six" non-O157 STEC serogroups can be as dangerous as E. coli O157:H7, the USDA Food Safety and Inspection Service (FSIS) has very recently declared these STEC as adulterants in beef like E. coli O157:H7. At the request of the FSIS, ARS researchers at Wyndmoor, Pennsylvania, developed a method consisting of food enrichment, detection by the polymerase chain reaction targeting important genes involved in the disease process and serogroup-specific genes, and strain isolation protocols to detect and identify these non-O157 STEC pathogens in beef. Further, ARS developed, evaluated, and transferred a latex agglutination tests (LATs) for detection and confirmation of the STECs.

**Impact:** The detection, isolation and confirmation protocols will be employed by the FSIS and industry in March 2012, to monitor through regulations these important emerging pathogens in beef.

It is always desirable to use faster and better methods of analysis to monitor pesticide residues in foods. ARS researchers at Wyndmoor, Pennsylvania, validated both qualitatively and quantitatively the updated QuEChERS (quick, easy, cheap, effective, rugged, and safe) version coupled to low-pressure gas chromatography-tandem mass spectrometry for fast analysis of 150 pesticides in cantaloupe, broccoli, lemon, sweet potato, and catfish. The enhanced selectivity and sensitivity of this approach allowed the 150 pesticides to be separated in less than 7 minutes and to achieve less than 5ng/g limits of quantification for nearly all pesticides. Qualitatively, no false positives or false negatives were observed for 100 randomly spiked and blinded extracts at contamination levels greater than 10ng/g in the different matrices.

**Impact:** This is a new state-of-the-art method for pesticide residue analysis that will be evaluated in an AOAC International collaborative study for enhanced technology transfer of the method to regulatory monitoring laboratories around the world.

Virus contamination of shellfish has led to frequent outbreaks of hepatitis A and norovirus illnesses. Once contaminated, shellfish retain high levels of these viruses for extended periods. ARS researchers at Dover, Delaware, identified primitive blood cells of oysters, known as hemocytes, as the site of virus accumulation and persistence. Research developed simple and effective procedures to extract and test for viruses within the hemocytes. This technology is a dramatic improvement over traditional testing methods for viruses in shellfish which rely on tedious dissection and testing of intestinal tissues that contain only a portion of the viral contaminants.

**Impact:** The improved assay method will significantly enhance monitoring efforts and support regulatory agencies worldwide, such as the Food and Drug Administration, the Centers for Disease Control, UK-Food Standards Agency and industry goals to reduce shellfish-associated enteric virus illness.

To understand a potential avenue by which Salmonella (particularly multi-drug resistant Salmonella) evades beef carcass decontaminations steps, ARS researchers at Clay Center, Nebraska, completed a variety of studies on bovine lymph nodes. ARS collaborated with industry and academia to isolate Salmonella from peripheral lymph nodes of healthy cattle and demonstrate that Salmonella was protected from chemical and thermal antimicrobial interventions used in packing plants.

**Impact:** Researchers validated the microbiological analysis methods used to detect Salmonella in lymph nodes. These validation methods verified that the pathogens recovered originate from lymph nodes and not cross contamination. These data will help industry in modifying HACCP processing requirement for ground beef.

#### Indicator 4

***During FY 2011, ARS will determine the microbial ecology and transmission of human pathogens during animal, plant, and seafood (shellfish) processing, and identify the critical control points to reduce contamination. Develop innovative postharvest intervention strategies for improving the microbial and chemical safety of foods while reducing the impact on quality and consumer acceptance. Ensure that these technologies can be implemented into HACCP and GMP protocols and have efficacy for approval by FSIS and FDA.***

FY 2011 Accomplishments:

Non-O157 Shiga toxin-producing E. coli are a collection of E. coli strains that produce various

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lethal Shiga toxins. There are over 200 types of these E. coli strains and their ability to cause human foodborne illness ranges from harmless to those that can cause severe disease or death. Recently, these strains have become an increasing concern to the beef industry, regulatory officials, and the public. The USDA-Food Safety Inspection Service (FSIS) has now classified some serotypes as adulterants, and thus new laws will come into effect in 2012. ARS researchers at Clay Center, Nebraska, determined the prevalence and characterized non-O157 Shiga toxin-producing E. coli from over 4,000 commercial ground beef samples obtained from numerous manufacturers across the United States over a period of 24 months. Markers of the bacteria were present in approximately one quarter of ground beef samples. However, characterization of the specific bacterial strains obtained from the samples identified very few organisms that should be considered significant food safety threats.

**Impact:** This project provided the first large scale analysis of non-O157 in ground beef, and the results have been used by the beef industry and the FSIS to determine the best measures to take in regards to eliminating these pathogens from the beef supply.

Aerosols have been suspected as a means to transport food pathogens and contaminate fruits and vegetables grown in close proximity of concentrated animal feeding operations. However, studies investigating such transport are scarce, and science-based guidelines for the produce industry regarding the safe distance between produce fields and processing plants, and animal operations are lacking. ARS researchers in Albany, California, used gene sequencing methods to characterize bacterial communities in manure and air samples collected from dairies in the Central and Coastal valleys of California. Whereas known enteric pathogens were not detected in aerosol samples, bacterial species originating from cows at the dairy operation in the vicinity were identified. Thus, bacteria specific to each dairy may be used as tracers for detecting the source of pathogens that are transported to produce or fruit crops from feedlots or dairies.

**Impact:** These data transferred to the Food and Drug Administration and industry suggest a that a new strategy and Good Agricultural Practice document be developed for trace back epidemiological investigations by regulatory agencies and for quality testing by the produce industry.

Nanoparticles can be effective antimicrobial agents against foodborne pathogens. ARS researchers at Wyndmoor, Pennsylvania, investigated the antimicrobial activities of two nanoparticles (magnesium oxide and zinc oxide) against three major foodborne pathogens: *Escherichia coli* O157, *Salmonella* sp, and *Campylobacter jejuni*. The studies demonstrated that these nanoparticles dramatically killed those pathogens and, therefore, potentially can be added directly in foods or incorporated in packaging materials to improve microbiological safety. This research explores a new application of nano-technology and inorganic antimicrobial compounds in the food safety area, and provides useful information to the food and packaging industries.

**Impact:** The impact of nanoparticles on environment and human health is not clear at the moment since currently nanotechnology is being evaluated in the Food and Drug Administration Critical Path Initiative. Further toxicological studies are needed to determine the potential risks to humans which is a concern expressed by various international bodies.

The produce industry currently faces a major potential food safety problem, that chlorine levels needed to prevent pathogen survival in wash water are depleted during commercial operations. Working closely with the produce industry, ARS scientists from Beltsville, Maryland, evaluated a novel chlorine stabilizer in maintaining free chlorine efficacy on pathogen survival and cross-contamination during commercial wash operating conditions. In plant studies demonstrated that the patented compound (T128) significantly increases the efficacy of chlorine wash against bacterial cross contamination while maintaining the quality of leafy green vegetables under real world fresh-cut processing conditions.

**Impact:** This research is supported and conducted in collaboration with industry to optimize the application of T128 in the postharvest processing system. This work will provide a critical intervention strategy for FDA and industry inclusion in the Good Manufacturing Program for the processing of fresh cut produce.

Although the bacterium *E. coli* O157:H7 is currently most widely recognized, other *E. coli* types producing the same toxins have been implicated in cases of human diseases and are the subject

of pending new regulatory policy. ARS scientists in Clay Center, Nebraska, investigated whether antimicrobial compounds currently used by the meat industry to control *E. coli* O157:H7 are effective against these non-O157 Shiga toxin-producing groups (O26, O103, O111, and O145). They determined that six antimicrobial compounds were equally effective against *E. coli* O157:H7 and non-O157 on fresh beef

**Impact:** These results will assist the meat industry in developing effective antimicrobial intervention programs, and FSIS approving interventions against these newly recognized and regulated pathogens. As is, the data suggests that current intervention practices directed at O157:H7 are sufficient against all Shiga-toxin producing *E. coli*.

#### Indicator 5

***During FY 2011, ARS will undertake genomic and proteomic analyses of pathogens affecting food safety. 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 and food security.***

#### FY 2011 Accomplishments:

Salmonella Enteritidis is the world's leading cause of human salmonellosis. It is unique among 2500 Salmonella serotypes, because it is able to colonize and survive in the internal contents of eggs produced by otherwise healthy appearing hens. It does so with an efficiency and persistence that impacts epidemiology of human disease in a manner greater than all the other serotypes. Salmonella Enteritidis presented a puzzle to the research and producer community, because numerous studies indicated that strains varied greatly in their ability to contaminate eggs. However, genetic analysis repeatedly showed that the bacterium had very little genetic difference between strains in comparison to what is seen with other serotypes. ARS scientists at Athens, Georgia, compared three whole genomes by high-density tiling arrays that generated a mutational map and solved the puzzle of detecting genetic differences. Two of the strains were of the same phage type and were known to have no differences in gene content using DNA microarrays. Application of 3 techniques found that 250 Single Nucleotide Polymorphisms (SNPs) differentiated these two strains that varied in their ability to contaminate eggs.

**Impact:** This information supports efforts to protect the food supply by improving epidemiological investigations and by providing new gene targets for improving vaccines. Customers benefitting from this information are regulatory agencies such as the Food and Drug Administration, the Centers for Disease Control and the USDA-Food Safety and Inspection Service; in addition, producers of vaccines and field epidemiologists are benefitted.

In a primary study on the impact of biofilms, ARS scientists in Beltsville, Maryland, showed that pathogen and indicator microorganisms associated with biofilms on internal pipe walls could alter the microbial quality of irrigation water used to produce fresh produce. This study showed that it is imperative to monitor water quality at fields, rather than just at the intake.

**Impact:** This study strongly suggests that back-flushing the irrigation system or disinfecting irrigation pipelines have to be considered as viable management practices by producers, and included within produce related good agricultural practices (GAPs) to improve the safety of irrigated produce.

Lead levels in produce have recently come under serious consumer and medical scrutiny particularly as nutritious snack foods for children. Research conducted at Beltsville, Maryland, identified higher than normal levels of lead in carrots grown on old orchard soils where lead-arsenate insecticide had been used before 1950. Peeled carrots were shown to have higher carrot lead, showing that the contamination pathway was not due to soil adherence to the roots. Lead accumulates in the xylem portion of the root with very little lead in the rest of the storage root. Additional root crops (beet, turnip, and radish) were similarly tested and lead accumulation was observed but considerably lower than that found in carrot. This appears to result from the long xylem through the carrot compared to the wider diameter of the other root crops. Potato had very low lead when grown on the same soils, showing that phloem-fed tissues such as tubers, fruits, and grains accumulate very low levels of lead even on high lead soils.

**Impact:** The findings support the Food and Drug Administration's goal of understanding how carrots can be enriched in lead, and the industry's need to limit production of crops with high lead levels. The results are also critically important for the USDA-Agricultural Marketing Service which provides food through the School Lunch Program

A model that predicts lethality of Salmonella for given times and temperatures were requested by regulatory agencies. ARS researchers at Wyndmoor, Pennsylvania, conducted the research, and confirmed that the current pasteurization requirements for 10% salted liquid whole egg of minimum temperatures and times (i.e. 63.3 deg C for 3.5 min, or 62.2 deg C for 6.2 min) are sufficient to provide ca. 99.99-99.999% CFU/ml of destruction of Salmonella.

**Impact:** This model will assist the USDA, FSIS in issuing pasteurization performance standards and provide industry guidance for designing pasteurization processes that will ensure safe product.

Clostridium botulinum neurotoxins (BoNTs), responsible for botulism food poisoning, are rapidly absorbed in small amounts. Even though lethal they are concomitantly very difficult to detect. Scientists in Albany, California, developed monoclonal antibodies specific for BoNTs and tested them for their ability to provide protection against botulism exposure in a mouse model system. Following intravenous and oral exposures to lethal levels of toxin, the timing of antibody neutralization of the toxin was determined.

**Impact:** The results provided new information for defense, military and regulatory agencies on the toxicity of BoNTs, and revealed windows of opportunity for human therapeutic treatment with antibodies. A better understanding of the biology of toxins, the factors that affect their toxicity, and toxin neutralization are critical tools for advancing food safety and defense.

#### **Measure 4.1.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2011:**

***During FY 2011, ARS reported on 5 new technologies developed and used to detect, identify, and control the most critically and economically important foodborne contaminants causing illness, death, or chronic disease that impact public health and industry, as determined by FSIS, APHIS, ERS, CDC, FDA, DHS, DoD, FBI, CIA, Risk Assessment Consortium, Codex Alimentarius Commission, academia, and consumer and commodity organizations.***

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<b>Describe the Technology</b>	<b>Describe the Transfer</b>	<b>Identify the Customer</b>	<b>Impact</b>
Developed new methods for the detection of Shiga toxin producing E. coli	Validated new methods for the detection and characterization of Shiga-toxigenic E. coli	USDA-FSIS and meat industry	Technology will be implemented through regulation in March 2012 for mandatory testing
Developed a new screening method that targets 60 of the most important drug residues in meats	Validated a new, rapid, cost effective method that targets drug residues at concentrations below current regulatory tolerance levels	USDA-FSIS, FDA-Center for Veterinary Medicine, other international regulatory agencies	Technology will be implemented by the FSIS National Residue Program, and evaluated by international bodies (AOAC) for international regulatory use
Qualitatively and quantitatively updated the QuEChERS technology combined with GC-MS for the analysis of pesticide residues	Validated an updated version of QuEChERS, that is more rapid and sensitive and selective to detect and characterize 150 different pesticide residues in foods	USDA-FSIS, international regulatory agencies	Technology will be implemented by the FSIS National Residue Program, and evaluated by international bodies (AOAC) for international regulatory use
Determined that enclosed deep-bedded confinement barns can be a significant source of pathogen contamination of cattle	Bedding material in enclosed confinement barns are a source for the transmission of Shiga toxin producing E. coli, and a target for preharvest control measures to reduce these pathogens in cattle	Cattle producers, farmers, American Meat Institute, National Cattleman's Beef Association, USDA-Food Safety Inspection Service	Development of interventions and Good Agricultural Practices for reducing toxigenic E. coli strains from bedding and subsequent transmission to cattle, and ground beef derived from animal sources. Reduction of these toxin producing pathogens is a critical goal for industry and regulatory agencies, as a means to improving public health.
Develop a new biosensor for the detection of two critical mycotoxins, commonly found in cereal commodities	Develop a new biosensor for the detection of the trichothecenes Nivalenol and Deoxynivalenol, that are of worldwide concern for causing human disease after consumption of foods derived from cereal based products	FDA, cereal industry, USDA-Grain Inspection Service, international regulatory agencies such as UK-Food Standards Agency, EFSA-European Food Standards Agency, Food Regulatory agencies in Japan and China	Technology will find immediate national and international regulatory use for the monitoring of cereals and cereal based foods, which will assist in the diversion of contaminated commodities from human food and animal feed supplies

**Measure 4.1.1 Outyear Performance Plan (the future performance indicators for this Measure)**

During FY 2012, 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*

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*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.*

*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.*

*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.*

*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 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.*

*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.*

*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.*

## STRATEGIC GOAL 4

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### **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.*

*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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## **OBJECTIVE 4.2: REDUCE THE NUMBER, SEVERITY AND DISTRIBUTION OF AGRICULTURAL PEST AND DISEASE OUTBREAKS**

Safeguarding workers, property, domestic animals, and crop plants from pests and diseases is essential to American agriculture. Left without protection, agricultural production would decrease dramatically, threatening the Nation's prosperity and security. Because the United States is the world's largest exporter of agricultural goods, threats to U.S. agriculture are threats to our trading partners as well. Many pests and diseases are native to the United States; others have succeeded in becoming invasive pests, and yet others are likely to be introduced and established. Resources for preventing these problems are always going to be scarce in relation to the challenges, so the best knowledge available is necessary to focus the effort. An increasingly global agricultural economy and the threat of agroterrorism make the recognition and identification of potential new problems important and their prevention all the more challenging.

In the course of agricultural production, processing, and marketing, a wide array of pathogens and pests can threaten efficiency. The extent of damage depends on several factors. Influences such as globalization, international commerce, and the industrialization of agriculture can necessitate the increased movement of animals during production, lead to an increased presence of arthropod vectors, and increase the resistance of disease-carrying pathogens, ultimately increasing the severity of diseases and pests for crops, livestock, or even humans. Researchers' efforts to improve the efficacy of early detection and surveillance systems; increase the availability of vaccines, biotherapeutics, insecticides, and other protection systems; and develop effective quarantine measures can greatly decrease the severity of diseases and pests.

ARS plays a vital role in defending the Nation's agriculture from pathogens and pests, providing the knowledge necessary for agriculture to adapt to changing conditions. To shape its research efforts, the Agency regularly examines Homeland Security issues that might affect the quality of the Nation's food and fiber. ARS conducts research to find the best methods of protecting and treating agricultural commodities in storage facilities; reduce contamination from improper storage practices; and develop integrated systems for risk assessment, surveillance, treatment, and monitoring of pests and diseases. ARS maintains partnerships with Federal and State agencies and industry and professional organizations, whereby knowledge and discoveries are refined and applied to develop products and integrated systems to optimize protective efforts against pests and pathogens.

**Key Outcome:** The knowledge the Nation needs for a secure agricultural production system and healthy food supply.

### **Performance Measures**

**Measure 4.2.1 Provide scientific information to protect animals, humans, and property from the negative effects of pests, infectious diseases, and other disease-causing entities.**

**Baseline 2005**

Two research studies completed that had significant impact on the scientific community and will lead to new technologies for protection of humans, property, and livestock from harm due to pests or diseases.

**Target 2011**

Cumulatively, complete 10 research studies that have significant impact on the scientific community, leading to development of technologies for the integration of prevention and treatment strategies to manage top priority endemic and exotic threats to livestock, humans, and property.

**Indicator 1**

***During FY 2011, ARS will further investigate the biology and genomics of important animal pathogens (target two priority diseases) arthropods that transmit pathogens to humans and animals, and arthropods that damage property to better understand essential life cycle processes, interaction with commodities that require protection, and means of detection.***

**FY 2011 Accomplishments:**

Classical swine fever virus (CSFV) harbors three envelope glycoproteins (Erns, E1 and E2). Previous studies have demonstrated that removal of specific glycosylation sites within these proteins yielded attenuated and immunogenic CSFV mutants vaccine strains. ARS scientists in collaboration with scientists at the University of Connecticut analyzed the effects of removing the glycosylation sites of the Erns, E1, and E2 proteins on immunogenicity. Interestingly, Erns, E1, and E2 proteins lacking glycosylation failed to induce a detectable virus neutralizing antibody response and protection against CSFV. Similarly, no neutralizing antibody or protection was observed in pigs immunized with E1 glycoprotein. Analysis of Erns and E2 proteins with single site glycosylation mutations revealed that detectable antibody responses, but not protection against lethal CSFV challenge, is affected by removal of specific glycosylation sites. In addition, it was observed that single administration of purified Erns glycoprotein induced an effective protection against CSFV infection.

***Impact:*** This discovery has important implications for the manufacturing and future development of CSF vaccines, demonstrating that complete deglycosylation of E2 and Erns erase completely their immunogenicity in swine. Additionally, this is the first report indicating that Erns can be immunogenic and induce protection by itself.

Reducing the worldwide threat of invasive fire ants. The red and black fire ants were introduced into the United States during the early part of the 20th Century, eventually infesting 14 states in the Southeast and California. They have multiplied to dense populations wherever there is water, destroying pasturage and threatening livestock and humans with their biting and stings. Extensive genomic studies, including sequencing and annotation of the complete genome, have been helpful in a number of ways. First, the origin and subsequent movement of red fire ant populations were described, showing a pattern of introduction, adaptation, and subsequent onward movement of populations preadapted for invasive characteristics. Examination of the genome revealed hidden viral sequences, resulting in the discovery of the first viruses in any ant species. The third virus was found this year and is distinctive in being a DNA virus and very lethal

on the ant. The genomic sequence was also used to develop inhibitory RNA (RNAi) constructs that kill entire colonies based on disruption of one of two genes. A single feeding of these preparations was sufficient to destroy a colony in the laboratory. This is the first proof of concept for the utility of an RNAi insecticide, a concept developed by USDA ARS. Such insecticide would be highly specific for fire ants, leveraging the efforts of native species of ants to compete with the invasive fire ants.

**Impact:** Combined with established methods of biological control (insects and pathogens that kill fire ants), these new methods will contribute toward restoring ecological balance where fire ants currently reach an abundance not experienced in their native range. Such success in biological control would reduce the use of insecticides and improve productivity of pasture in the Southeast.

Saving money for operational screwworm control. The screwworm fly is a dramatically damaging pest of the Western Hemisphere that lays eggs that hatch into flesh eating maggots on mammals, including humans and livestock. It used to be distributed as far north as the Midwestern US, but was completely eradicated from North and Central America by systematic distribution of sterile male flies by USDA. These flies must be reared, irradiated, and distributed -- a process that currently costs the US government approximately \$10 million per year in order to establish a barrier of sterile flies between infested areas in South America and Panama. USDA ARS continues to improve the efficiency of the process by applying new technology. This year automated cryopreservation equipment was installed at the rearing plant, which eliminates the need to continuously rear a back-up colony and reference strains. Research identified chemicals that attract the flies to a site for egg-laying. Those chemicals will improve the rearing process by coordinating egg-laying by colony flies and also provide a better means of treating flies in small outbreaks. Scientists were able to genetically transform multiple lines of the flies, incorporating a marker protein and a cassette of DNA that induces the flies to produce only males.

**Impact:** These accomplishments will reduce costs and increase reliability of rearing. A strain of flies that produces only males will save significant money in rearing costs, as well as reducing the level of radiation required to sterilize released flies.

#### Indicator 2:

***During 2011, ARS will further investigate the epidemiology and ecology of important animal pathogens (target two priority diseases) arthropods that transmit pathogens to humans and animals, and arthropods that damage property to improve risk assessment, surveillance, prevention, and control by veterinarians and entomologists.***

#### FY 2011 Accomplishments:

The discovery of novel viruses in turkeys may help veterinarians unravel some of the mysteries of viral enteric diseases that affect poultry. Decades of research indicate that certain viruses may be the culprit for viral enteric diseases, but no single agent has been identified. ARS used a new powerful tool called "Metagenomics" to detect and sequence nucleic acid of all the RNA (ribonucleic acid) viruses present in the gut of turkeys affected by enteric syndromes. Metagenomics, a molecular technique, is the study of a collection of genetic material from a mixed community of organisms. The technology allows scientists to look at a complex environmental sample, sequence all the viral nucleic acid in the sample and analyze it as a single genome. Using this technology, ARS scientists extracted and analyzed nucleic acid from poultry intestine samples collected from five different turkey flocks affected by enteric diseases. The intestinal virus metagenome contained thousands of pieces of nucleic acid representing many

groups of known and previously unknown turkey viruses. As suspected, avian viruses such as astrovirus, reovirus and rotavirus—common in the gut of birds and implicated in some enteric diseases—were verified. The detection of numerous small, round RNA viruses, such as the members of the *Picornaviridae* family, long thought to be a major constituent in the turkey gut also was confirmed. However, ARS scientists found many previously unknown turkey viruses such as picobirnavirus, a small double-stranded RNA virus implicated in enteric disease in other agricultural animals. A calicivirus also was identified in poultry for the first time.

**Impact:** Discovering viruses that live in the gut places researchers a step closer to understanding viral communities in poultry, and will help scientists determine which viruses are associated with enteric diseases and which viruses are not.

Brucellosis is one of the most significant zoonotic diseases of livestock worldwide. *Brucella* species are an important cause of abortion in cattle, small ruminants and swine. An intensive eradication program for Brucellosis has been ongoing in the U.S. for more than 50 years. *Brucella* species tend to have a predilection for specific animal species (e.g. *B. abortus*-cattle, *B. suis*-pigs, *B. melitensis*-sheep and goats) but most can infect all mammals with varying degrees of virulence. Wildlife species serve as important reservoirs for *Brucella*; for example bison and elk in Yellowstone Park infect cattle and feral pigs infect both domestic pigs and cattle. The goal of this research project is to increase the understanding of the pathophysiology and host-pathogen interaction and from that knowledge develop improved diagnostic assays and vaccines to control and further eradication of the various *Brucella* species. ARS scientists have assessed the ability of current *B. abortus* vaccines to protect cattle against *B. suis*. In addition, the ability of cattle vaccines to protect wildlife against Brucellosis and reduce disease and thus their threat to our domestic animals is being assessed.

**Impact:** Developing control strategies for *Brucella* species in both our domestic animals as well as reducing the level of infection in the wild animal reservoirs will help ensure public health by preventing this food borne disease from infecting humans and assist in eradicating Brucellosis from the United States.

**Measure 4.2.1 Summary of the Major Scientific Discoveries, Technologies Developed, Transferred, and Used in FY 2011:**

***During FY 2011, ARS reported 99 new scientific discoveries, transferred and used by the scientific community, the private sector, and government agencies to develop control meansures to manage priority endemic and foreign animal disease threats.***

<b>Describe the Technology</b>	<b>Describe the Transfer</b>	<b>Identify the Customer</b>	<b>Impact</b>
Identification of determinants of virulence and immunogenicity in the Classical Swine Virus genome	This information was communicated to the pork industry and published in a peer-reviewed publications: Gavrilov B.K., Rogers K., Fernandez-Sainz I.J., Holinka L.G., Borca M.V., Risatti G.R. (2011). Effects of glycosylation on antigenicity and immunogenicity of classical swine fever virus	The Pork Industry	This discovery has important implications for the manufacturing and future development of CSF vaccines, demonstrating that complete deglycosylation of E2 and Erns erase completely their immunogenicity in swine.

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	envelope proteins. Virology 420: 135–145.		
ARS scientists used metagenomics tools to discover novel enteric viruses in turkeys	This information was communicated to the poultry industry and published in a peer-reviewed publication: Day J.M., Ballard L.L., Duke M.V., Scheffler B.E., Zsak L. (2010). Metagenomic analysis of the turkey gut RNA virus community. Virol J. 12;7:313	The U.S poultry industry	These studies provide new technologies to detect viruses are associated with enteric diseases of poultry.
Identifying strategies to control and eliminate Brucellosis in wild life reservoirs will improve public health and reduce food borne diseases	This information was communicated in 2 peer-reviewed publications: Olsen S.C. 2010. Brucellosis in the United States: Role and significance of wildlife reservoirs. Vaccine 28(S5):F73-F76. Olsen S.C., Hennager S.G. 2010. Immune responses and protection against experimental Brucella suis biovar 1 challenge in non-vaccinated of B. abortus strain RB51-vaccinated cattle. Clinical and Vaccine Immunology. 17(12):1891-1895.	The U.S. population and the Forest Service.	Wildlife remain the reservoir for Brucella in the U.S. Developing these control strategies will aid in eradicating Brucella from the U.S.
Complete genome of the fire ant	Publication	Developers of new methods for fire ant control	Decreases development time of new tools by years
Identification of two genetic targets for RNAi control of insects	Publication and invention disclosures	Farmers and the American people	Non-toxic, environmentally safe pest control with potential to avoid resistance

### Measure 4.2.1 Outyear Performance Plan (the future performance indicators for this Measure)

**During FY 2012, ARS will**

*further investigate the pathogenesis of important pathogens of livestock and poultry to understand mechanisms of disease.*

*further investigate the genomics of important farm animals, pathogens, and arthropods to understand host-pathogen interactions.*

*further investigate the epidemiology and ecology of important animal pathogens, arthropods that transmit pathogens to humans and animals, and arthropods that damage property to improve to improve risk assessment, surveillance, prevention, and control by veterinarians and entomologists.*

*discover scientific information that informs the selection of technologies for integrated pest management of arthropods that harm humans, animals, and structures.*

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*discover scientific information that informs the selection of technologies for integrated pest management of arthropods that harm humans, animals, and structures.*

**During FY 2014, ARS will**

*continue and further investigate the biology and genomics of important animal pathogens (target two priority diseases), arthropods that transmit pathogens to humans and animals, and arthropods that damage property to better understand essential life cycle processes, interaction with commodities that require protection, and means of detection.*

*continue to further investigate the epidemiology and ecology of important animal pathogens (target two priority diseases), arthropods that transmit pathogens to humans and animals, and arthropods that damage property to improve risk assessment, surveillance, prevention, and control by veterinarians and entomologists.*

*further investigate the pathogenesis of important pathogens of livestock and poultry to understand mechanisms of disease.*

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*further investigate the epidemiology and ecology of important animal pathogens, arthropods that transmit pathogens to humans and animals to improve to improve risk assessment, surveillance, prevention, and control by veterinarians and entomologists.*

*discover scientific information that informs the selection of technologies for integrated pest management of arthropods that harm humans and animals.*

**Measure 4.2.2 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.**

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### Baseline 2005

One technologies used by the commercial and government sectors relevant to the protection of humans, property, and domestic animals.

### Target 2011

Cumulatively, transfer five technologies to the commercial and government sectors.

### Indicator 1:

***During FY 2011, 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 2011 Accomplishments:

Understanding why mosquitoes bite. Mosquitoes transmit diseases to humans and animals, as well as harming animal well-being. Scientists have used molecular and cellular techniques to find that standard insect repellents interact with mosquito antennae in different ways. One repellent in particular, 2-undecanone, blocks reception of one of the major chemical attractants in the breath of cows. A special strain of mosquito was developed that lacks an antennal receptor involved in host-finding, providing a research tool for studying how to prevent bites.

***Impact:*** This work will lead to the creation of new, powerful repellents that will create opportunities for protection of livestock and reduce the need for insecticides.

Bed bug compounds. The resurgence of bed bugs has led to the need for a better understanding of bed bug behavior in the hope that this will contribute to the design of more efficient lures and traps. While certain bed bug-produced chemicals have been shown to be involved with the behaviors of attraction and aggregation, little information exists on the specific identity of these chemicals. Scientists have identified 17 individual chemicals that were collected from male and female bed bugs.

***Impact:*** The identification of these bed bug-produced compounds will be useful to other researchers and industry scientists trying to understand bed bug behavior and design better traps for bed bug monitoring and control.

None for NP 103.

### Indicator 2:

***During 2011, ARS will form new partnerships and continue old partnerships with industry, universities, and other government agencies in order to promote production and marketing of mathematical models, evidence-based procedures, computerized spatial analysis systems, and other tools that measure risk of animal pathogens, arthropods that pathogens and arthropods that destroy property.***

## FY 2011 Accomplishments:

None for NP 103.

None for NP 104

**Indicator 3:**

**During 2011, 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 of management of arthropods that damage property or that transmit pathogens to humans and animals.**

## FY 2011 Accomplishments:

Probiotics are live microorganisms that provide alternatives to antibiotics. They are also known to confer health benefits on the host by influencing the host immune system via increased antibody production, up-regulation of cell-mediated immunity, and augmenting innate defense mechanisms. ARS examined the role of *Bacillus subtilis*-based probiotics on macrophage functions such as nitric oxide production and phagocytosis, the two most important innate immune functions of macrophages. Macrophage, a key component of host innate immunity, participates in host defense by secreting cytokines and nitric oxide, which modulates inflammation and kill microbes. In controlled studies, ARS scientists demonstrated that certain strains of *Bacillus subtilis* increase macrophage function in broiler chickens.

**Impact:** These studies provide the scientific basis for the efficacy of certain strains of probiotics to enhance host protective immunity against enteric pathogens in broilers chickens.

It is widely recognized that the diversity of swine influenza virus (SIV) strains impedes the effective immunization of swine herds. This is of great concern as emerging variant swine influenza viruses could emerge into the human population. New variant viruses may also have significant negative economic impact on the swine industry. Therefore, the evaluation of modern vaccine technologies for SIV in the swine host is important for achieving greater control of emerging variant virus strains in swine populations and limiting the risk of transmission to humans. Live virus vaccines are considered to be more effective than inactivated or non-replicating virus vaccines as inducers of cellular immunity, but all licensed SIV vaccines in the United States are based on inactivated virus antigens. ARS scientists used molecular genetically engineered approaches to construct mutated H3N2 SIV genomes with attenuated replication properties. Truncation of a key viral protein (NS1) used by influenza virus to evade the host immune system resulted in a mutant virus with restricted replication in the swine respiratory tract, but strong immunogenic properties. Intranasal inoculation of pigs with this virus resulted in robust protection against homologous challenge, and significantly reduced viral replication and clinical signs upon challenge with a heterologous H1N1 SIV strain.

**Impact:** These studies demonstrated that a live genetically-engineered SIV vaccine can provide cross-protection against diverse strains of SIV viruses.

Swine influenza viruses pose a significant threat to public health as was seen in 2009 when the pandemic H1N1 influenza virus strain emerged from reassortment events among avian, swine, and human influenza viruses within pigs. As classic and pandemic H1N1 strains now circulate in swine, an effective vaccine may be the best strategy to protect the pork industry and public

health. Current inactivated-virus vaccines available for swine influenza protect only against viral strains closely related to the vaccine strain, and egg-based production of these vaccines is insufficient to respond to large outbreaks. DNA vaccines are a promising alternative since they can potentially induce broad-based protection with more efficient production methods. ARS working together with scientists at the NIH evaluated the potential of monovalent and trivalent DNA vaccine constructs to elicit immunological responses and protect pigs against viral shedding and lung disease after challenge with pandemic H1N1 or classic swine H1N1 influenza virus. Scientists also compared the efficiency of a needle-free vaccine delivery method to that of a conventional needle/syringe injection. The results of these studies demonstrated that DNA vaccination elicits robust serum antibody and cellular responses after three immunizations and confers significant protection against influenza virus challenge. Needle-free delivery elicited improved antibody responses with the same efficiency as conventional injection and may be considered for development as a practical alternative for vaccine administration.

**Impact:** These studies demonstrated that DNA vaccines can be engineered to protect against diverse influenza virus strains.

Johne's disease (paratuberculosis) is a chronic, progressive enteric disease of domestic and wild ruminants caused by *Mycobacterium avium* subspecies *paratuberculosis* (MAP). A large percentage of herds are infected and due to its impact on intrastate, interstate and international movement of cattle has been estimated to cost the cattle industry more than \$1 billion annually. Cattle are infected as calves, but do not show clinical disease until older, typically 2-5 years of age. During this asymptomatic subclinical period, diagnosis is difficult due to the impact of the organism on the immune system. Current vaccines reduce the severity of clinical disease, but do not prevent infection or disease. Improved diagnostics and vaccines are needed to address the problems associated with Johne's disease. ARS scientists generated antibodies to novel proteins of MAP that will be used in new diagnostic assays to detect MAP-infected cows using a serological test.

**Impact:** Development and use of these antibodies will assist in increased accuracy in diagnosing Johne's disease and help to control this devastating and economically important disease by enabling elimination of cattle in early stages of infection.

Defeating termites. The Formosan subterranean termite was introduced into the US in the 1940s and proceeded to spread throughout much of the Southeast from Texas to Georgia. It is a particularly destructive termite that can live in the ground or in nests it constructs within structures. USDA ARS has conducted research on new ways to control this termite and on how to form a strategy for community control. Although the termite continues to spread widely in the South, this program has conclusively demonstrated that an integrated pest management program against the termite can be very effective. The demonstration project saved the French Quarter of New Orleans from destruction by achieving 95% control of the termite, as measured by the disappearance of colonies from individual buildings and public spaces. The techniques used to achieve this level of control were based on a wide range of studies, including how termites develop to specialized forms, identification of individual colonies by their genetic signatures, invention of new kinds of monitoring and bait stations, detection equipment based on sound and infrared, and novel methods of treating living trees. In the course of this project, new classes of insecticide were developed, the complete genome of the termite was sequenced, and novel enzymatic pathways for energy production were discovered.

**Impact:** The efforts of the USDA ARS research program on termites can be credited with most of the development of modern termite control in the United States, protecting structures effectively without the negative environmental consequences of older treatment methods.

Saving military lives. One of the greatest challenges to the health of American Armed Forces personnel overseas is the threat of serious disease transmitted by insects. Our military relies on modern technology to protect hundreds of thousands of soldiers, sailors, airmen, and marines who are completely susceptible to malaria, dengue, leishmaniasis, and other serious illnesses. The Department of Defense invests \$3 million per year in USDA ARS to continue to invent and refine new solutions to this problem. Protection from sand flies that transmit leishmaniasis in the Middle East, Afghanistan, Pakistan, and East Africa was improved by showing that a new formulation of insecticide was more effective as a fog than older products. A method for treatment of camouflage netting provided protection from sand flies for over 18 months, even under harsh desert conditions. USDA ARS continued to provide standard tests of treated uniforms designed to protect military personnel from bites of mosquitoes, sand flies, ticks, and chiggers using techniques based on scientific evidence. Entirely new methods of repelling sand flies and mosquitoes from tents and uniforms were developed by combining two chemical components in nanoparticle matrices. Genomic analysis of sand flies resulted in the discovery of new targets for insecticidal action, as well as methods for biochemical detection of insecticide resistance.

**Impact:** These technologies will improve protection of American military personnel when they are deployed overseas so that fewer people will be able to accomplish the mission. The ability to operate safely in an environment where insect-transmitted diseases are a major source of illness and death gives our forces an advantage over its enemies.

Saving money for operational screwworm control. The screwworm fly is a dramatically damaging pest of the Western Hemisphere that lays eggs that hatch into flesh eating maggots on mammals, including humans and livestock. It used to be distributed as far north as the Midwestern US, but was completely eradicated from North and Central America by systematic distribution of sterile male flies by USDA. These flies must be reared, irradiated, and distributed -- a process that currently costs the US government approximately \$10 million per year in order to establish a barrier of sterile flies between infested areas in South America and Panama. USDA ARS continues to improve the efficiency of the process by applying new technology. This year automated cryopreservation equipment was installed at the rearing plant, which eliminates the need to continuously rear a back-up colony and reference strains. Research identified chemicals that attract the flies to a site for egg-laying. Those chemicals will improve the rearing process by coordinating egg-laying by colony flies and also provide a better means of treating flies in small outbreaks. Scientists were able to genetically transform multiple lines of the flies, incorporating a marker protein and a cassette of DNA that induces the flies to produce only males. These accomplishments will reduce costs and increase reliability of rearing.

**Impact:** A strain of flies that produces only males will save significant money in rearing costs, as well as reducing the level of radiation required to sterilize released flies.

Highly specific pest control (Hi-SPeC). Mosquitoes transmit diseases that can lead to disease and death of millions of people and animals worldwide. HiSPeC substances are highly specific for target pests, such as mosquitoes, and do not affect other insects. This novel approach is based on the technology that allows for the specific silencing of genes critical to survival of the target pest. This technology uses double stranded RNA (dsRNA) and the process of RNA interference (RNAi) to selectively silence gene products (proteins) that debilitate the mosquito and prevent it from transmitting several disease agents. Specific sequences of dsRNA are produced in bulk by an industrial partner. Because adult mosquitoes need sugar sources for survival, researchers have developed HiSPeC dsRNA constructs. These highly specific compounds that knock-out the targeted protein in the mosquito's body have been successfully delivered to adult mosquitoes using sugar baited traps. Traps baited with sugar and Hi-SPeC substances kill or debilitate mosquitoes and can complement current vector control strategies such as insecticide treated bednets (ITNs) and indoor residual spraying (IRS) programs to control

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important vectors of malaria and arboviruses to humans and animals. Without such a specific active ingredient, sugar baits for mosquitoes might cause an environmental problem by killing pollinators.

**Impact:** This new kind of tool for controlling insect populations will offer a series of environmentally safe, non-toxic alternatives to insecticides that kill all kinds of arthropods and present hazards to applicators and the public.

### Measure 4.2.2 Summary of Major Technologies Developed, Transferred, and Used in FY 2011:

***During FY 2011, ARS reported 7 new technologies developed, transferred, and used by the private sector and government agencies to protect animals, people, and property.***

<b>Describe the Technology</b>	<b>Describe the Transfer</b>	<b>Identify the Customer</b>	<b>Impact</b>
ARS scientists demonstrated that certain strains of <i>Bacillus subtilis</i> increase macrophage function in broiler chickens	This information was published in the scientific literature and communicated to the poultry industry: Lee, K.W., Lillehoj H.S., Li, G.X., Lee, S.H., Jang, S.I., Dong, X.J., Lillehoj, E.P., and Siragusa, G.R. 2010. Effect of <i>Bacillus</i> -Based Direct-Fed Microbials on <i>Eimeria maxima</i> Infection in Broiler Chickens. <i>Clin. Immunol. Micro. Infect. Dis.</i> 33:e105-10.	The poultry industry	Provides the scientific basis for the efficacy of certain strains of probiotics to enhance host protective immunity against enteric pathogens in broilers chickens.
ARS scientists demonstrated that a live genetically engineered swine influenza vaccine can provide cross-protection against diverse strains	This information was published in the scientific literature and communicated to U.S swine producers: Kappes M.A., Sandbulte M.R., Platt R., Wang C., Lager K.M., Henningson J.N., Lorusso A., Vincent A.L., Loving C.L., Roth J.A., Kehrl M.E. (2011). Vaccination with NS1-truncated H3N2 swine influenza virus primes T cells and confers cross-protection against an H1N1 heterosubtypic challenge in pigs. <i>Vaccine</i> . 2011 Nov 5. [Epub ahead of print]	The U.S. pork industry	ARS scientists demonstrated that vaccines can be rationally designed to provide broader protection against influenza virus strains
ARS engineered DNA vaccines effective against diverse strains of swine influenza virus	This information was communicated to swine producers and published in the scientific literature: Gorres J.P., Lager K.M., Kong W.P., Royals M., Todd J.P., Vincent A.L., Wei C.J., Loving C.L., Zanella E.L., Janke B., Kehrl M.E., Nabel G.J., Rao S.S. (2001). DNA Vaccination Elicits Protective Immune Responses against Pandemic and Classic Swine Influenza Viruses in Pigs. <i>Clinical and Vaccine Immunology</i> : 18, No. 11. 1987-1995.	The U.S. pork industry	These studies demonstrated that DNA vaccines can be engineered to protect against diverse influenza virus strains.
ARS identified and generated monoclonal antibodies to novel antigens of <i>Mycobacterium paratuberculosis</i> (Johne's Disease) that enable detect early infection of disease.	This information was communicated in peer-reviewed publications: Bannantine J.P., Paulson A.L., Chacon O., Fenton R.J. et al. 2011. Immunogenicity and reactivity of novel <i>Mycobacterium avium</i> subsp. <i>Paratuberculosis</i> PPE MAP1152 and conserved MAP1156 proteins	The dairy industry	Use of these monoclonal antibodies will enable diagnosis of Johne's infection early in cattle enabling farmers to control the disease on their farms.

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	with sera from experimentally and naturally infected animals. <i>Clinical and Vaccine Immunology</i> . 18(1):105-112. Scott M.C., Bannantine J.P., Kaneko Y., et al. 2010. Absorbed EVELISA: a diagnostic test with improved specificity for Johne's Disease in cattle. <i>Foodborne Pathogens and Disease</i> . 7(11):1291-1296.		
New fly trap	Efficacy data	Agriculture and public health	Effective barrier between people and flies
Smart phone app for more accurate spray application	Free access smart phone app	Insecticide applicators targeting biting insects	More effective control, less unintentional pollution
Long-lasting treatment of round bale habitats for stable fly	Publication and work with extension	Cattle producers	Provides a cheap, safe, and effective way to prevent round bale feeding sites from producing stable flies

**Measure 4.2.2 Outyear Performance Plan (the future performance indicators for this Measure)**

**During FY 2012, ARS will**

*continue to 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 new methods of management of arthropods that damage property or that transmit pathogens to humans and animals.*

*develop technologies and systems that achieve more effective integrated pest management of arthropods that harm humans, animals, and structures.*

**During FY 2013, ARS will**

*continue to 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 new methods of management of arthropods that damage property or that transmit pathogens to humans and animals.*

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*develop technologies and systems that achieve more effective integrated pest management of arthropods that harm humans, animals, and structures.*

**During FY 2014, ARS will**

*continue to 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.*

*continue to 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.*

**Measure 4.2.3 Develop control strategies based on fundamental and applied research to reduce losses caused by plant diseases, nematodes, arthropods, and weeds that are effective and affordable while maintaining environmental quality. Develop technically and economically feasible alternatives to preplant and postharvest use of methyl bromide.**

### Baseline 2006

Developed eight new, environmentally sound management practices that include crop resistance/tolerance through classical breeding and biotechnology, rapid and reliable diagnostics, pesticide development and use, and cultural and biological control. Biorationals have been studied and improvements explored that will provide additional protection for agriculturally important plants from pests and pathogens.

### Target 2011

Specific information and technology using methods cited above will be made available to producers and the research community to exclude, control, and/or better manage disease and pest outbreaks as they occur. Strategies and approaches will be made available to producers to identify and control and/or effectively manage over 10 new and emerging crop diseases and pests.

### Indicator 1:

***During 2011, ARS will develop methods to reduce emissions of harmful gases from crop production systems and post-harvest/quarantine treatments.***

FY 2011 Accomplishments:

Efficient fumigant emissions reduction strategies. Preplant soil fumigation is essential for economical production of many of our nation's fruit and nut crops, valued at over \$12 billion annually in the Central Valley of California alone. Although research is underway to reduce reliance on soil fumigation in the long term, health and air quality concerns and state and federal regulations are requiring immediate reductions in fumigant emissions. Field research and demonstration trials by ARS researchers in California determined that use of new plastic mulches (e.g., virtually impermeable and "totally" impermeable films, known as VIF and TIF, respectively) was the most effective strategy for reducing emissions by approximately 90 percent, compared to standard mulch.

**Impact:** The findings will help grower and regulatory stakeholders sustain economical crop production while reducing fumigant emissions.

Soil solarization demonstrated to be a viable nonchemical commercial alternative for cut-flower growers. Soil solarization is a nonchemical approach to managing soilborne pests using sun light, clear plastic, and high soil moisture to heat soil to lethal temperatures. ARS researchers in Fort Pierce, Florida, formulated a clear plastic film with ultraviolet light stabilizers, anti-fogging, and infra-red retentive compounds solid-tarp applications and evaluated on commercial cut-flower farms for 3 years. Soil solarization was shown to be effective in managing damage from soilborne pests up to 2 years when used behind effective soil fumigation programs. Solid-tarp solarization is recommended for use by commercial cut-flower growers to extend the interval between the annual soil fumigation to every other year.

**Impact:** Using soil solarization could reduce the amount of fumigant used by growers over a 2-year period by 50 percent.

#### **Indicator 2:**

***During 2011, ARS will continue to identify and characterize genes of insect 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 2011 Accomplishments:

Insect vector determined for 'crumbly fruit' of raspberry. Virus-induced 'crumbly fruit' in raspberry, which produces a quick decline of the crop, is the reason growers in the Pacific Northwest need to replant every 5-6 years. If the insect vector is not effectively managed, this disease complex costs growers from \$1,000 - \$3,000 per acre per year, even if clean planting stock is used. ARS researchers in Corvallis, Oregon, identified the viruses involved in this disease and their vectors. Although *Raspberry latent virus* was first thought to be transmitted by leafhoppers, researchers used specific vector transmission studies to discover that it was transmitted by aphids instead.

**Impact:** Providing information on the virus vector and its biology will be a benefit to growers by helping them know which insect vector to target for pesticide applications.

Sequencing the Russian wheat aphid genome and elucidating aphid salivary proteins to discover sources of pest resistance. The genomes of Russian wheat aphid biotypes 1 and 2 were sequenced by ARS scientists in the Wheat, Peanut, and Other Field Crops Research Unit in Stillwater, Oklahoma, and a draft assembly completed. Salivary proteins common or unique among biotypes of Russian wheat aphid and greenbug were identified. More than 30 salivary proteins of Russian wheat aphids were identified that will be valuable in developing RNAi gene

silencing technology to create new resistance genes to protect plants from Russian wheat aphids or other sucking insects.

**Impact:** This novel technique will be useful in developing transgenic wheat plants with new mechanisms of genetic resistance to the aphid pest.

Identified new soybean line with soybean cyst nematode resistance and develop genetic markers associated with the resistance. In the United States, nearly a billion dollars are lost in annual soybean production due to the parasitic soybean cyst nematode. Cultivars with genetically controlled resistance will reduce these losses. ARS researchers in Jackson, Tennessee, discovered a new source of resistance to the nematode in soybean, and identified three new genetic markers tagged to this nematode resistance.

**Impact:** These markers are being used for rapid selection of resistant lines in soybean breeding with increased accuracy. The marker-based selection methods from this research have delivered improved varieties to growers more rapidly, and provide them with more varieties that contain durable resistance to the newest races of the pathogen.

Cotton germplasm resistant to root-knot nematodes released. A cotton germplasm line, named GA 120R1B3, was jointly released by ARS, in collaboration with University of Georgia scientists in Tifton, Georgia. GA 120R1B3 is highly resistant to root-knot nematodes, suppressing nematode reproduction by 95 percent. GA 120R1B3 has good yield and excellent fiber quality in both the presence and absence of root-knot nematodes.

**Impact:** Public and commercial cotton breeding programs have begun to use GA 120R1B3 as a source of root-knot nematode resistance.

### Indicator 3:

***During 2011, ARS will continue to develop fundamental knowledge about insect biology and ecology that provides the foundation for strategies to exclude, detect, and mitigate pest infestations.***

FY 2011 Accomplishments:

Absolute configuration and synthesis of 7-epi-sesquithujene for biological control of emerald ash borer. Emerald ash borer, *Agrilus planipennis*, is an invasive Asian pest that threatens all native ash tree (*Fraxinus*) species. One promising candidate attractant for this pest, the plant volatile 7-epi-sesquithujene, stimulates odor reception of both male and female emerald ash borer. ARS researchers in Peoria, Illinois, determined the spatial arrangement of atoms of 7-epi-sesquithujene, which is necessary for its effective and economical synthesis. Another pheromone was discovered that attracts females of the emerald ash borer's natural enemy, a wasp named *Spathius agrili*.

**Impact:** Since the *Spathius agrili* wasp is being released as a control agent throughout the range of the emerald ash borer, the pheromone will be a useful tool for locating the wasp to be sure it is doing its job. The ability to attract both the emerald ash borer and its natural enemy will make biological control of the invasive insect more precise and effective.

Cigarette beetle egg stage is most tolerant to heat treatments. Methyl bromide was widely used in food-processing and storage facilities for the suppression of stored-product insect pests, but its use as a structural fumigant is being phased out. Heat treatments are a potential alternative, but

little information is available on their effectiveness against the cigarette beetle, a pest associated with food-processing facilities. ARS researchers in Manhattan, Kansas, in collaboration with Kansas State University, evaluated the susceptibility of all cigarette beetle developmental stages to elevated temperatures and determined that the egg stage was the most tolerant stage and that the time to kill 99 percent of eggs at 122°F was 190 minutes. Determining the most tolerant stage provides the target temperatures and exposure times need to provide control.

**Impact:** This study provides valuable information for managers and pest control professionals using heat treatments to control cigarette beetles in food-processing facilities.

A cold phytosanitary treatment for *Bactrocera invadens*. *Bactrocera invadens* is a new invasive fruit fly with a broad fruit-host range that threatens U.S. horticulture and trade. In order to prevent costly interruptions in international fruit trade, finding effective phytosanitary treatments for this pest is a high priority for federal and state plant protection organizations. Because the pest is not currently in the United States, research had to be done elsewhere. A colony of the pest was located at the International Atomic Energy Agency labs in Austria, and ARS scientists from Weslaco, Texas, made arrangements to conduct the research study there. As a result, a cold treatment against the pest was added to the APHIS, PPQ Treatment Manual (Schedule T-107k).

**Impact:** This will prevent interruption in trade and provide a solution to quarantines imposed by future infestations of the pest in the United States and elsewhere.

#### Indicator 4:

***During 2011, ARS will continue to develop fundamental knowledge about weed biology and ecology that provides the foundation for strategies to exclude, detect, and mitigate weed infestations.***

FY 2011 Accomplishments:

Guidelines for safe bioenergy crop production developed. Herbaceous perennial grasses grown for bioenergy purposes can provide huge amounts of biomass, but they also have the potential to become invasive if not managed carefully. ARS scientists in Urbana, Illinois, in collaboration with University of Illinois scientists, measured vital rates and dispersal characteristics of *Miscanthus* and used this information to develop guidelines for the design of bioenergy plantations to ensure against unwanted plant invasions. The guidelines included safe siting of production plantations, specifications for the width of buffer zones surrounding production fields, and eradication of plantings, among others.

**Impact:** These suggestions were used by the USDA Farm Services Agency in support of its Biomass Conversion Assistance Program *Miscanthus* (*Miscanthus X giganteus*) Establishment and Production projects.

Crop rotations to manage weeds in organic farming. Weeds are a major obstacle to successful crop production in organic farming. Producers may be able to reduce inputs for weed management by designing crop rotations that disrupt life cycles of weeds. Incorporating reduced tillage, diversifying crop rotations, and using winter crops in conventional farming operations have reduced herbicide use by 50 percent because weed density declines over time. ARS scientists in Brookings, South Dakota, devised a long-term crop rotation system comprised of perennial forages and annual crops that disrupt weed population growth and reduce weed densities.

**Impact:** This research provides a benchmark for designing crop rotations that benefit organic farmers and consumers by reducing herbicide inputs, fuel use, and production costs.

Benzoxazinoid compounds do not explain weed suppression by rye cover crops. Rye cover crops produce phytotoxic benzoxazinoid compounds which have been believed to contribute to the ability of this species to suppress weeds. ARS researchers in Beltsville, Maryland, showed that the most abundant benzoxazinoids found in soils associated with rye cover crops were at concentrations too low to be phytotoxic, and thus were unlikely to contribute to the observed levels of weed suppression provided by this cover crop. Consequently, within the soil environment, compounds other than rye benzoxazinoids are likely responsible for the weed suppression provided by rye cover crops.

**Impact:** This new knowledge is of value to researchers developing cover crop systems that have shown improved weed suppression abilities.

Preliminary success on finding biological control agents. ARS in Montpellier, France, and Thessaloniki, Greece, working with the ARS laboratory in Fort Detrick, Maryland, evaluated new pathogens with biocontrol activity against medusahead rye, white top (pepper grass), and Russian thistle. Some of these pathogens were highly effective and remain to be evaluated for safety against desirable species of plants.

**Impact:** If proven safe to use, these pathogens could be the solution to invasive weed problems that affect much of the western United States, with damage to the quality of forage and destruction of native plant assemblages.

#### **Indicator 5:**

***During 2011, ARS will continue to develop fundamental knowledge about plant disease biology and ecology that provides the foundation for strategies to exclude, detect, and mitigate disease outbreaks.***

FY 2011 Accomplishments:

Genome of the wheat stem rust pathogen was sequenced. Wheat stem rust, which is caused by the fungus *Puccinia graminis* f. sp. *tritici*, is a devastating disease for wheat that re-emerged as a global problem in east Africa after the new strain termed Ug99 was recognized in Uganda. Knowing the sequence of the pathogen's genome will allow researchers to develop new ways of controlling the pathogen. ARS researchers in St. Paul, Minnesota, collaborating with researchers at Broad Institute of Massachusetts Institute of Technology and Harvard University of Cambridge, Massachusetts, sequenced the wheat stem rust pathogen's genome and found that the genome is one of the largest and most complex of any fungus studied to date, containing more than 17,000 predicted proteins.

**Impact:** This represents the first complete genome sequencing of any rust fungus and provides important resources for the scientific community working on fungal plant pathogens and host resistance in cereal crops. In addition, this sequence data is being used to develop rapid diagnostic methods for detection of new mutant strains of the wheat stem rust fungus (such as Ug99).

Cloning of a gene responsible for susceptibility of wheat to fungal diseases. Fungal diseases of crops are an insidious threat to the production of food crops like wheat, a major food crop

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worldwide, because of the range of toxins they can produce. Wheat varieties that carry a gene called *Tsn1* or *Snn1* are particularly susceptible to fungal pathogens that cause economically limiting leaf diseases like tan spot and glume blotch. The *Tsn1* and *Snn1* genes control wheat's sensitivity to a toxin produced by these pathogens. ARS researchers in Fargo, North Dakota, isolated the genes from wheat and determined its DNA sequence. They were then able to resolve how these toxin-producing pathogens acquired the ability to subvert wheat's disease defense mechanisms. This work provides significant understanding of how these wheat pathogens interact with the crop to cause disease, and is expected to lead to novel methods for developing disease-resistant food crops that are critical to world food security.

**Impact:** This research has identified an important susceptibility gene present in wheat lines that, if removed or altered, has the potential to increase yield and economic returns to U.S. wheat growers.

Elimination of black raspberry necrosis virus from *Rubus* germplasm (brambles). Black raspberry necrosis virus is a quarantine pathogen. ARS scientists in Beltsville, Maryland, developed a protocol to eliminate black raspberry necrosis virus from infected black raspberry plants that combines the use of tissue culture growth, heat treatment, and harvest of plant shoot tips to produce virus-free plants. The protocol was tested on plants that grew for up to 18 months in a greenhouse and all of the plants were found to be virus-free.

**Impact:** This technique is being transferred to APHIS to help treat *Rubus* germplasm that was received as infected plants. This will in turn allow the germplasm to be conserved by genebanks and distributed to raspberry producers and breeders.

### Measure 4.2.3 Summary of the Major Technologies Developed, Transferred, and Used in FY 2011:

***During FY 2011, ARS reported 4 new environmentally sound management practices that include crop resistance/tolerance through breeding and biotechnology, rapid and reliable diagnostics, pesticide and cultural and biological control developed and used to protect agriculturally important plants from pests and pathogens.***

<b>Describe the Technology</b>	<b>Describe the Transfer</b>	<b>Identify the Customer</b>	<b>Impact</b>
To slow build-up of pink bollworm resistance to Bt cotton, growers had been required by EPA to set aside cotton not modified with the Bt toxin, but this is expensive to the growers. As an alternative, EPA granted permission to use sterile pink bollworms to reduce resistance development.	In a multi-agency project over a very large area, ARS scientists at Maricopa, AZ, and Parlier, CA, teamed with scientists from the University of Arizona to release sterile pink bollworm and successfully suppress resistance in Bt cotton.	This demonstration benefits the cotton industry, as well as regulators tasked with making decisions on permitting alternative means of resistance management.	This demonstration will not only save growers the expense of setting aside refuges that will be damaged by pink bollworms, but also presents a model for other agroecosystems that use engineered crops.
To reduce the amount of insecticide applied for codling moth control, lower amounts of insecticide were combined with microencapsulated sex pheromone as a mating confusant.	This approach was implemented in several growers' orchards and information was provided to the industry via the popular press, regional meetings, and scientific journals.	U.S. Apple; pome fruit (apple, pear) and walnut industries, generally.	This new technology has been adopted on 2,000 acres of apples in the Pacific Northwest.

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ARS scientists released a cotton germplasm line, GA 120R1B3 highly resistant to root-knot nematodes that suppresses nematode reproduction by 95 percent, and has yield and fiber qualities superior to other resistant germplasm and similar to many modern cultivars.	Deposited into the USDA National Plant Germplasm System, published in the Journal of Plant Registrations, and seed distributed to private and public cotton breeders.	Private company and university cotton breeders.	Nematode resistant cotton varieties with improved fiber quality, developed from this germplasm will produce cultivars with greatly improve cotton yield and fiber quality in nematode infested fields.
ARS scientists released two new soybean germplasm lines, with resistance to soybean cyst nematode populations, including the population that overcomes comprehensive resistance in cv. Hartwig.	New soybean germplasm JTN-5109 and JTN-5209 with broad resistance to nematode populations were publicly released. Transferred by seed distribution and written announcements in research journals.	Private seed companies and university cotton breeders.	Improved soybean varieties with broad resistance derived from JTN-5109 and JTN-5209 will be available to growers. The soybean growers will have reduced threat from nematodes and increased profits.

### **Measure 4.2.3 Outyear Performance Plan (the future performance indicators for this Measure)**

#### **During FY 2012, ARS will**

*develop methods to reduce emissions of harmful gases from crop production systems and postharvest/quarantine treatments.*

*will continue to identify and characterize genes of insect 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 insect biology and ecology that provides the foundation for strategies to exclude, detect, and mitigate pest infestations.*

*continue to develop fundamental knowledge about weed biology and ecology that provides the foundation for strategies to exclude, detect, and mitigate weed infestations.*

*continue to develop fundamental knowledge about plant disease biology and ecology that provides the foundation for strategies to exclude, detect, and mitigate disease outbreaks.*

#### **During FY 2013, ARS will**

*develop methods to reduce emissions of harmful gases from crop production systems and postharvest/quarantine treatments.*

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

*continue to develop fundamental knowledge about insect biology and ecology that provides the foundation for strategies to exclude, detect, and mitigate pest infestations.*

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*continue to develop fundamental knowledge about weed biology and ecology that provides the foundation for strategies to exclude, detect, and mitigate weed infestations.*

*continue to develop fundamental knowledge about plant disease biology and ecology that provides the foundation for strategies to exclude, detect, and mitigate disease outbreaks.*

**During FY 2014, ARS will**

*develop methods to reduce emissions of harmful gases from crop production systems and postharvest/quarantine treatments.*

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

*continue to develop fundamental knowledge about insect biology and ecology that provides the foundation for strategies to exclude, detect, and mitigate pest infestations.*

*continue to develop fundamental knowledge about weed biology and ecology that provides the foundation for strategies to exclude, detect, and mitigate weed infestations.*

*continue to develop fundamental knowledge about plant disease biology and ecology that provides the foundation for strategies to exclude, detect, and mitigate disease outbreaks.*

**Measure 4.2.4 Provide needed scientific information and technology that is environmentally acceptable to producers of agriculturally important plants in support of exclusion, early detection and eradication, control, and monitoring of invasive arthropods, weeds, nematodes, and pathogens; enhanced sustainability; and restoration of affected areas. Conduct biologically-based integrated and area-wide management of key invasive species.**

#### Baseline 2006

Developed and implemented strategies for management of key invasive pest species, such as the Asian longhorned beetle, leafy spurge, melaleuca, glassy-winged sharpshooter, whiteflies, and other species. Provided data in support of industry needs, APHIS and other action agencies. Conducted Areawide pest management programs for five insects and weeds. Increased systematic capabilities for fungal, bacterial and viral plant diseases and insect pests. Developed data for use in risk analyses of biological control agents, particularly with regard to modeling prediction of risk and protection of non-target species. NAL continued to operate [www.invasivespeciesinfo.gov](http://www.invasivespeciesinfo.gov).

#### Target 2011

Improve knowledge and understanding of the ecology, physiology, epidemiology, and molecular biology and genomics of endemic and emerging diseases and pests. Incorporate this knowledge into at least 10 management strategies to minimize chemical inputs and increase production. Expand systematics of arthropods, fungi, and other biological collections' infrastructure.

#### Indicator 1:

***During FY 2011, ARS will continue to develop and demonstrate technologies, including risk analysis, for excluding, detecting, and mitigating native and invasive insect pests, integrated pest management (IPM) and areawide approaches, and deliver IPM components and systems to ARS customers.***

FY 2011 Accomplishments:

Progress in controlling the invasive Argentine cactus moth in the United States and Mexico. Subsequent to its detection in south Florida in 1989, the Argentine cactus moth expanded its range 50-100 miles per year along the Atlantic Coast and west along the Gulf Coast to the barrier islands of Mississippi and bayous of Louisiana. Argentine cactus moth has become an imminent threat to many *Opuntia* cactus species valued as food, forages, and wildlife habitat, and are a major plant group contributing to ecosystem structure and biodiversity. ARS researchers in Tifton, Georgia, and Tallahassee, Florida, collaborating with APHIS, improved control tactics using field sanitation combined with sterile insect releases (SIT) along the leading edge of the invasion and at new outbreak locations. SAGARPA, Mexico, is implementing these tactics in the U.S.-Mexico bi-national campaign against this invasive pest.

***Impact:*** Following the successful eradication of this pest from islands off the coast of Quintana Roo, Mexico, these tactics have contributed to the further reduction of established populations of this pest on Mississippi and Alabama barrier islands, in

Louisiana bayous, and along the northwest Gulf coast of Florida, mitigating the further westward expansion of pest populations along the Gulf of Mexico.

New bait for monitoring and control of spotted wing drosophila, a pest of soft fruits. The spotted wing drosophila is a new invasive pest of soft fruits in the United States and is a serious threat to growers of berries and cherries in the Pacific Northwest. Unlike other drosophila flies which tend not to be pests because they only attack rotting fruits, this drosophila attacks healthy young fruits. Traps are used to detect its presence and determine the need for pest control measures. ARS scientists in Wapato, Washington, developed and demonstrated an improved bait formulation that is a combination of vinegar and wine as a trap lure.

**Impact:** This information improves the power of traps. The results also indicate that chemicals in addition to acetic acid and ethanol might be isolated and identified from vinegar and wine to make a synthetic chemical lure for a dry trap or bait station.

Novel banker plant system for biological control of silverleaf whitefly in horticultural crops. ARS researchers in Fort Pierce, Florida, in collaboration with those at the University of Florida developed a novel banker plant system for the management of the silverleaf whitefly, a pest and virus vector of vegetable and ornamental crops worldwide. Papaya was used as a non-crop banker plant preferred by the papaya whitefly, which acts as an alternative host for rearing and dispersal of a parasitoid wasp that also attacks the targeted silverleaf whitefly. By introducing papaya banker plants loaded with wasps into the greenhouse before any pest whiteflies are detected, the wasps act as sentries and attack any target whiteflies that might become established in tomato crops. This results in successful greenhouse tomato production without the use of pesticides.

**Impact:** This system has broad application for protection of horticultural crops and has also been used successfully in commercial herb, cucumber, eggplant, lettuce and poinsettia greenhouses in Florida.

Ovicidal and neonate activity of insecticides demonstrated for navel orangeworm. Almonds are the largest California nut crop (greater than 1.7 billion pounds produced) and the navel orangeworm caterpillar is the primary pest during production. Insecticide activity on the moth's eggs and young had not been established for newly registered insecticides in almonds. Two new classes of insecticides, anthranilic diamide and diacyl hydrazine, were shown by ARS researchers in Parlier, California, to be toxic to navel orangeworm eggs and newly hatched larvae (up to 97 percent kill), yet compatible with pheromone-based strategies that disrupt mating.

**Impact:** The use of the newly registered insecticides will replace broad spectrum insecticides. Identification of ovicidal activity will change spray timing (insecticides will go on earlier) and will improve control and minimize non-target effects.

#### Indicator 2:

***During 2011, ARS will continue to develop and demonstrate technologies, including risk analysis, for excluding, detecting, and mitigating native and invasive weed pests, including IPM and areawide approaches, and deliver IPM components and systems to ARS customers.***

#### FY 2011 Accomplishments:

Molecular genetic markers for medusahead. Medusahead (*Taeniantherum asperum*) is an invasive annual grass that threatens grazing and grasslands in the western United States.

Because it is closely related to wheat, ARS scientists in Reno, Nevada, have adapted existing simple sequence repeat markers that were developed for wheat breeding studies as new genetic markers to characterize different races of medusahead. Differences in DNA sequences generated from PCR using primers based on these markers were sufficient to differentiate populations of this weed.

**Impact:** This new knowledge is of value to scientists in identifying the best geographical regions to search for natural enemies to control this invasive medusahead.

Arundo armored scale released for biological control of Arundo donax, a waterway clogging invasive giant reed grass. The non-native, invasive giant reed grass *Arundo donax* has invaded at least 100,000 acres in the arid Lower Rio Grande Basin. It consumes water supplies and reduces access to the international border which is critical for national security. Biological control of this weed is critically needed, because other control methods are not economically or environmentally feasible. In 2011, ARS researchers in Weslaco, Texas, released over 3 million Arundo scale insects along the Rio Grande River, and establishment has been documented at all release sites.

**Impact:** This research and the resulting biological control program address the national research priority to protect scarce water resources for agriculture in the context of climate change, which is expected to increase drought length and severity in the Lower Rio Grande Basin. Information on the field biology of the scale is useful for researchers and land managers in other areas where Arundo is invasive.

Control of invasive Russian olive for habitat restoration. Russian olive is an invasive tree species in the west. The invasion decreases landscape productivity by reducing forage value and negatively impacting hunting and recreation. As part of a multi-government agency and regional land manager effort to restore habitat invaded by Russian olive, ARS researchers in Sidney and Miles City, Montana, in collaboration with USDA Natural Resources Conservation Service (NRCS) and the National Wild Turkey Federation, investigated best practices for Russian olive control. They determined that shearing the trees immediately followed by application of triclopyr formulated with basal bark oil was effective in preventing the destroyed trees from resprouting.

**Impact:** This cost effective methodology is now recommended by the NRCS and Dow Chemical for the control of Russian olive prior to restoration efforts.

### Indicator 3:

***During 2011, ARS will continue to develop and demonstrate technologies for excluding, detecting, and mitigating emerging and re-emerging plant disease pests, including IPM and areawide approaches, and deliver IPM components and systems to ARS customers.***

### FY 2011 Accomplishments:

Research improves in vivo rearing of nematodes on mealworm beetles, for pest control. The mealworm beetle, *Tenebrio molitor*, is used for mass production of nematodes that kill pest insects. Efficient rearing of the beetle is important for producers of the nematodes, both to be able to have a profitable business and to produce enough nematodes for the needs of customers. Six mealworm beetle diet formulations significantly improved immature survival, development time, food utilization efficiency, and reproductive potential. Two of these diet formulations increased the beetles' susceptibility to infection by two species of nematodes and resulted in higher nematode yields. In addition, the optimum system for beetle development was determined.

**Impact:** This work will make production of beneficial nematodes for pest control cheaper and more widely available.

Improved fire blight forecasting. Under conditions of proper sanitation that eliminate infection through inoculum on pruning shears, the fire blight pathogen will only infect apple and pear trees through the base of the flower. Due to the limited time (flowering) and the small area of the plant that needs protection, biocontrol of fire blight reduces the number of fire blight strikes by approximately 40 to 80 percent under commercial conditions. Improvements in disease forecasting can be coupled with the timing of biocontrol (or antibiotic) applications to further refine control. ARS scientists in Wenatchee, Washington, and collaborators discovered critical information on microbial growth and interactions on floral surfaces as related to flower age for the fire blight pathogen and its biocontrol agent.

**Impact:** This information was used to improve a model for fire blight risk assessment by more precisely relating hourly and daily high temperatures to the expected size of the pathogen population. The new version is called CougarBlight 2010 and is widely used by growers in the Pacific Northwest.

**Measure 4.2.4 Summary of the Major Technologies Developed, Transferred, and Used in FY 2011:**

***During FY 2011, ARS reported improved knowledge and understanding of ecology, physiology, epidemiology, and molecular biology and genomics of endemic and emerging diseases and pests; incorporated this knowledge into at least 4 management strategies that were developed and implemented to minimize chemical inputs and increase production.***

<b>Describe the Technology</b>	<b>Describe the Transfer</b>	<b>Identify the Customer</b>	<b>Impact</b>
Bait for detection and monitoring of spotted wing drosophila, a major new invasive pest that differs from other drosophila species in that it attacks not only rotting fruit, but also fresh fruit.	Demonstrated an improved bait formulation of vinegar and wine as a trap lure for spotted wing drosophila.	Cherry and berry industries, initially those in the Northwest but, as the insect spreads, throughout the United States.	This promises to be a low-cost means of monitoring the insect for determining the need to treat.
A new control measure for the control of Russian olive, an invasive tree species in the west.	A new formulation and a method of application of the herbicide triclopyr was developed in collaboration with a Federal land management agency, NRCS.	USDA Natural Resources Conservation Service (NRCS)	Customers and stakeholders of NRCS now have a more effective way of controlling a major invasive tree in the west.
Sensitive, specific antibody-based diagnostic reagents for early detection of soybean rust, caused by <i>Phakopsora pachyrhizi</i> , were developed by ARS researchers at Fort Detrick, Maryland. These new diagnostic reagents can identify and diagnose the disease in soybean leaves before	The diagnostic antibodies have been licensed to industry for production of kits for field detection of the pathogen.	Soybean growers, soybean breeders, and agricultural extension agents.	Early detection of soybean rust will allow soybean producers to reduce fungicide input costs leading to increased yield and profits.

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symptoms occur.			
ARS scientists from the South American Biological Control Laboratory, Buenos Aires, Argentina, and the Invasive Plant Research Laboratory, Fort Lauderdale, Florida, released a delphacid planthopper for biological control of water hyacinth.	Biocontrol agent was released at target sites and technology is available to those who have responsibility for control of the invasive weed.	General public in Florida, commercial interests associated with recreational lakes.	Restoration of natural habitats, enhancement of sport fishing on lakes.

**Measure 4.2.4 Outyear Performance Plan (the future performance indicators for this Measure)**

**During FY 2012, ARS will**

*continue to develop and demonstrate technologies, including risk analysis, for excluding, detecting, and mitigating native and invasive insect pests, integrated pest management (IPM) and areawide approaches, and deliver IPM components and systems to ARS customers.*

*continue to develop and demonstrate technologies, including risk analysis, for excluding, detecting, and mitigating native and invasive weed pests, including IPM and areawide approaches, and deliver IPM components and systems to ARS customers.*

*continue to develop and demonstrate technologies for excluding, detecting, and mitigating emerging and re-emerging plant disease pests, including IPM and areawide approaches, and deliver IPM components and systems to ARS customers.*

**During FY 2013, ARS will**

*continue to develop and demonstrate technologies, including risk analysis, for excluding, detecting, and mitigating native and invasive insect pests, integrated pest management (IPM) and areawide approaches, and deliver IPM components and systems to ARS customers.*

*continue to develop and demonstrate technologies, including risk analysis, for excluding, detecting, and mitigating native and invasive weed pests, including IPM and areawide approaches, and deliver IPM components and systems to ARS customers.*

*continue to develop and demonstrate technologies for excluding, detecting, and mitigating emerging and re-emerging plant disease pests, including IPM and areawide approaches, and deliver IPM components and systems to ARS customers.*

**During FY 2014, ARS will**

*continue to develop and demonstrate technologies, including risk analysis, for excluding, detecting, and mitigating native and invasive insect pests, integrated pest management (IPM) and areawide approaches, and deliver IPM components and systems to ARS customers.*

*continue to develop and demonstrate technologies, including risk analysis, for excluding, detecting, and mitigating native and invasive weed pests, including IPM and areawide approaches, and deliver IPM components and systems to ARS customers.*

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*continue to develop and demonstrate technologies for excluding, detecting, and mitigating emerging and re-emerging plant disease pests, including IPM and areawide approaches, and deliver IPM components and systems to ARS customers.*

**Measure 4.2.5 Provide environmentally sound fundamental and applied scientific information and technologies to action agencies, producers, exporters, and importers of commercially important plant and animal products in support of exclusion, early detection, and eradication of quarantine pests and pathogens that can impede foreign trade.**

#### Baseline 2006

Developed and implemented five strategies for exclusion, detection, and eradication of quarantine pests and pathogens. Provided data in support of needs of industry, APHIS, and other action agencies. New technologies developed and implemented by action agencies that have opened new export markets.

#### Target 2011

Improved knowledge and understanding of quarantine pest and pathogen biology and epidemiology, leading to 30 new technologies implemented by industry, APHIS, or other action agencies to mitigate risk of pests and pathogens resulting in expanded export markets while protecting the safety and security of American agriculture.

#### Indicator 1:

***During FY 2011, ARS will continue to develop diagnostic assays to detect and differentiate existing, new and/or emerging quarantine arthropod pests, weeds, nematodes, and pathogens.***

#### FY 2011 Accomplishments:

A new, naturally occurring hybrid virus of sweet potato is more severe than known viruses. In sweet potato field trials where germplasm is routinely screened for resistance to economically limiting viruses, a new member of the whitefly-transmitted Begomovirus group was detected that is more severe than common sweet potato viruses. Viruses in the Begomovirus group sometimes produce natural hybrids in the field, and this was shown to be a case of two begomoviruses, *Sweet potato leaf curl virus* and *Sweet potato leaf curl Georgia virus*. In collaboration with Alcorn State University, ARS scientists in Charleston, South Carolina, discovered that these viruses hybridized to form a new, more destructive virus for which resistance is not currently available. This new virus can result in a 20-80 percent yield reduction in current U.S. sweet potato cultivars. A broad spectrum diagnostic test was developed that will now detect all members of the sweet potato Begomovirus group that will be used in screening germplasm for new sources of disease resistance.

***Impact:*** This improves the efficiency of disease evaluation during the selection process for resistance to yield-limiting sweet potato viruses.

Rapid new diagnostic methods for identifying crop pathogens. Strains of the bacterium *Xylella fastidiosa* cause several economically important diseases including Pierce's disease of grape, citrus variegated chlorosis, and leaf scorch of almond and forest/landscape trees (oak, elm, mulberry, sycamore, and oleander). ARS researchers in Beltsville, Maryland, developed diagnostic molecular markers that will test for all strains simultaneously and distinguish among

the strains. Similarly, ARS scientists in Corvallis, Oregon, developed a high throughput method to detect multiple viruses simultaneously in small fruit and nursery crops (blueberry, blackberry, fig, raspberry, strawberry, sugaberry, rose). ARS scientists in Salinas, California, developed a method to identify and discriminate among all known criniviruses in single or mixed crinivirus infections in fruit and vegetable crops. Unknown criniviruses can be detected by this technique, and the method provides an easy, single reaction method for rapid identification of crinivirus infections.

**Impact:** Rapid and accurate detection of plant pathogens is the first step in limiting their spread and controlling the diseases problem. These methods are useful for clean plant programs that provide healthy plant materials for production and for regulatory agencies that protect U.S. agriculture from introduction of exotic plant pathogens.

Virus survey of cherry trees in the national genetic resources. It has been challenging to conduct surveys of virus that infect stone fruits due to the lack of precise detection methods that can process large numbers of samples. ARS scientists in Beltsville, Maryland, developed or adapted real-time PCR assays for detecting 12 viruses infecting stone fruits. The assays developed were used in virus surveys to evaluate samples collected from cherry trees in the ARS National Plant Germplasm System repositories in Davis, California; Geneva, New York; and on the National Mall of the National Park Service and at the U.S. National Arboretum, both in Washington, D.C. Several viruses and different combinations and infection rates were detected at the four locations. Two viruses were common among trees sampled in Geneva, at the Arboretum, and on the National Mall. Sequence analyses of the real-time PCR products of these two viruses indicated that there were differences in the genetic variation.

**Impact:** This survey helped to establish the virus infection status of cherry germplasm collections in the United States, and to validate protocols, which have been transferred to the APHIS quarantine program.

#### **Indicator 2:**

***During 2011, ARS will continue to expand interdisciplinary research to include means of excluding, managing and/or eradicating quarantine arthropod pests, weeds, nematodes and pathogens.***

FY 2011 Accomplishments:

Three new golden nematode-resistant potato varieties released. Effective control and management of golden nematode, *Globodera rostochiensis*, depends on the availability of golden nematode-resistant potato varieties. ARS researchers at Ithaca, New York, in collaboration with scientists at Cornell University, have recently released three new golden nematode-resistant potato varieties. The availability of resistant varieties is invaluable for helping to maintain a viable potato industry in the golden nematode-quarantine area of New York and ensuring the viability of that local U.S. potato industry.

**Impact:** These varieties will provide a source of resistance if golden nematode becomes widespread in New York or elsewhere in the United States.

Improved (cotton) boll weevil detection method enhances eradication program. Boll weevil eradication has been achieved in all of the U.S. Cotton Belt, except in southern and central Texas. Progress towards complete eradication of weevils from these areas depends upon better weevil detection with pheromone traps to ensure timely insecticide applications. With current pheromone trap techniques, substantial weevil infestations go undetected, even in those known

infested areas. ARS scientists in College Station, Texas discovered that a substantial proportion of lures contained an insufficient dose of pheromone, and that a single weevil can release significantly more pheromone than previously thought. This discovery led ARS researchers to recommend protocols of doubling the lure quantity and decreasing the lure replacement interval; these protocols were immediately adopted by the Texas Boll Weevil Eradication Foundation.

**Impact:** Adoption of these protocols has been instrumental in significantly advancing eradication progress in a chronically infested eradication zone. Improved protocols resulting from this research for chemical analysis and lure replacement has helped to protect the major advances achieved through the multi-billion dollar investment to eradicate boll weevils from the United States.

Impact of high temperature forced air heating of navel oranges on flavor quality. Heat is an effective quarantine treatment, but can sometimes cause off-flavor in oranges. ARS researchers in Parlier, California, in collaboration with researchers from the University of California, found that heat caused a significant loss in flavor, but that this change in flavor did not occur until the final 30 minutes of treatment. The off-flavor was associated with an increase in amount of flavor compounds with a fruity aroma.

**Impact:** This research demonstrated the timing and likely cause of heat-induced flavor loss in citrus, thus providing potential ways to help eliminate this problem and expand the use of this environmentally-friendly technique to control insect quarantine pests.

### Indicator 3:

***During 2011, ARS will apply essential taxonomy and systematics for organisms toward the correct identification and diagnosis and control of target arthropod pests, weeds, nematodes, and pathogens.***

FY 2011 Accomplishments:

Unlocking the regulation of the production of bacterially produced herbicides. One of the major challenges in the use of chemicals to control weeds is the limited number of modes-of-action of herbicides available. Many phytotoxins produced by bacteria, particularly *Pseudomonas syringae* strains, have modes-of-action unlike those of commercial herbicides. However, production levels of these natural herbicides are currently insufficient to warrant their commercialization. Using molecular genetics approaches, ARS researchers in Beltsville, Maryland, in collaboration with molecular biologists at the University of Nottingham, United Kingdom, showed that the overproduction of the regulatory protein RsmA, a natural protein produced by Psuedomonads, turns off phytotoxin production in three unrelated strains of *P. syringae*. This is the first demonstration of the role of RsmA in the production of phytotoxins in *P. syringae*.

**Impact:** These results suggest that overcoming the RsmA regulatory system will provide a way to improve phytotoxin production by this group of bacteria to commercially acceptable levels and/or improve the bioherbicidal activity of *P. syringae* strains that may be useful in the biological control of weeds.

Discovery of ten new species for biological control. During the field explorations for the target pests and their natural enemies in their native land, a number of organisms are usually found and collected for testing as potential candidates for biological control of the invasive target pests in the United States. Prior to the testing process, the accurate taxonomic identification of the natural enemies by classical procedures and/or by more sophisticated molecular methods is a key aspect for the success of the projects. During the extensive field explorations in FY 2011, ARS scientists

in Argentina discovered 10 species of insects that were new to science: one natural enemy of each waterhyacinth, Brazilian water weed, waterprimrose, cactus moth, and *Parkinsonia* weed; four of the cactus mealybug; and one ant species closely related to the target little fire ant. Some of these new species have been recently described and named by expert taxonomists with the close collaboration of ARS scientists. The descriptions of the remaining ones are in progress.

**Impact:** These accomplishments greatly increase the chances of success of the respective biological control programs in the United States, and contribute to the knowledge of the biological diversity in Argentina and globally.

#### **Indicator 4:**

***During 2011, ARS will expand new knowledge in epidemiology, host-parasite relationships and new means of developing host resistance toward exclusion, eradication, and management of quarantine arthropod pests, weeds, nematodes, and pathogens.***

FY 2011 Accomplishments:

Determined the relative susceptibility of 50 riparian plant species to infection by Sudden Oak Death. As the Sudden Oak Death pathogen, *Phytophthora ramorum*, is found in more and more eastern watersheds, it is necessary to determine what native plant species might be susceptible to root infection by the pathogen, and whether such species might become significant sources of inoculum. Using an assay to quantify inoculum from plants inoculated with *P. ramorum*, ARS researchers in Fort Detrick, Maryland, tested 50 species for susceptibility and inoculum production from roots and determined that most plants were not very susceptible to the pathogen or did not produce great amounts of inoculum from roots. Spore counts from tested plant species were compared to those obtained from a positive control, *Viburnum tinus*, and it was found that many species produce high numbers of *P. ramorum* spores from infected roots including dogwoods. When comparing healthy plants of *V. tinus* to plants with infected plants, root-to-root spread under flooded conditions was demonstrated.

**Impact:** This is the first documentation of root-to-root spread of this pathogen. This information is important for regulatory agencies in developing nursery scouting protocols and for the Forest Service in performing perimeter surveys of infested nurseries.

Epidemiology and management of zebra chip disease and its vector. Zebra chip disease of potato is causing millions of dollars in losses to the potato industry. The disease is caused by a new species of the bacterium *Liberibacter*. ARS scientists in Wapato, Washington, determined that the zebra chip disease is transmitted by the potato psyllid. ARS scientists also discovered that high temperatures during the potato growing season prevent development of the bacterium and resulting zebra chip. The scientists determined that zebra chip-infected potato seeds do not germinate, thus the disease could not spread through the distribution of potato seeds. In addition, advanced potato breeding lines that show some resistance to zebra chip were identified.

**Impact:** Information from this research improves our understanding of zebra chip epidemiology, benefits potato seed certification agencies, promotes national and international trade of potato seed, and facilitates development of effective and sustainable management strategies for this serious disease.

Genes combined to fight reniform nematode infection in cotton. It is difficult for pathogens to defeat plant genotypes with multiple sources of resistance. ARS scientists from Stoneville, Mississippi; College Station, Texas; and New Orleans, Louisiana, transferred unique sources of resistance to reniform nematode from two different wild relatives of cotton (*Gossypium* (G.)

*aridum* and *G. longicalyx*) to upland cotton (*G. hirsutum*). It was previously unknown if the two resistance genes were the same, and if they could be successfully combined into a single plant. To introgress the resistance into tetraploid *G. hirsutum*, which is incompatible with the resistant diploid cotton, the scientists transferred resistance genes from the two sources into *G. hirsutum* separately via hexaploid cotton as a bridging species. Molecular markers were used to confirm that the two resistance genes were located on different chromosomes, and could be successfully combined.

**Impact:** This discovery created a near-immune resistance source, and expands knowledge about these resistance genes and their utility in cotton improvement programs.

#### Indicator 5:

***During 2011, ARS will support interagency collaboration for tracking successful exclusion, eradication where possible, and management of quarantine arthropods, weeds, nematodes, and pathogens.***

FY 2011 Accomplishments:

Improved Federal interagency coordination of information exchange between scientists and regulators. The Federal Interagency Committee for Invasive Terrestrial Animals and Pathogens (ITAP) held a workshop to bring together the current state of science related to regulatory needs. The proceedings have been transferred to scientists and regulators, and a white paper is being written by ITAP that will help inform regulators on the state of science that underpins regulatory decisions, and serve as a guide to scientists on key science questions that must be answered to address the needs of regulatory agencies in making decisions.

**Impact:** This process is connecting regulators with scientists to better ensure that scientists produce the type of research needed for informed regulatory decisions on invasive arthropods, weeds, and plant pathogens, thereby better addressing exclusion and eradication needs of land management agencies.

Model for spread of citrus Huanglongbing (HLB). A model was developed to predict the spatial and temporal dynamics of Huanglongbing (HLB, also known as citrus greening) using Markov-chain Monte Carlo methods, and extensive data from infected areas of South Florida. Transmission rates and dispersal kernel were estimated for HLB. A working model was developed that focuses on the differential effects of host age on epidemiological parameters as well as variability across the plantation and that allows for uncertainty in the parameters as well as variability over time and through space. A Web-based version of the model developed for non-researcher users has been nearly finalized and is in validation testing. Model output suggests that controlling secondary infections by diseased tree removal and insecticide applications, plus controlling primary infection from new insect immigrations by areawide control strategies, can reduce disease increase to a manageable 2 to 5 percent increase per year, which appears to be economically sustainable.

**Impact:** This model assists growers and extension agents in management decisions for HLB.

Molecular markers and technology for rapid detection and differentiation of quarantine phytoplasmas in grapevine. Grapevine yellows is a destructive disease complex that affects a wide variety of grapevine cultivars in all major wine production countries. Known etiological agents of grapevine yellows diseases are phytoplasmas affiliated with at least four distinct genetic groups and five species. Several grapevine yellows phytoplasmas have been listed as quarantine

pests in the United States, European Union, China, and many other countries. Since disease symptoms induced by different grapevine yellows phytoplasmas are very similar, visual inspections at ports are not sufficient for diagnosis of various diseases. In the present study, ARS scientists in Beltsville, Maryland, identified a series of molecular markers that can effectively distinguish three quarantine phytoplasmas. Selected markers were used to devise a DNA fingerprinting-based procedure for simultaneous detection and differentiation of three major GY phytoplasmas in affected plants.

**Impact:** The findings and the new technology resulting from this study will help phytoplasma researchers, plant doctors, and quarantine personnel to identify and distinguish grapevine yellows phytoplasmas more efficiently.

Non-chemical control of the olive fruit fly. Olive fruit fly was found in olives along the eastern edge of the California Central Valley near orchards where olives are grown for canning. A parasitoid, *Psytalia humilis*, was imported from Guatemala and released in these locations and shown to successfully reproduce in olive fruit fly larvae. Pre-flight adults and crawling larvae of olive fruit fly were shown to travel long distances on the ground and could disperse in this manner throughout olive orchards. A corrugated yellow pan trap was evaluated as attract-and-kill method for olive fruit fly control.

**Impact:** Combined with other techniques, these non-chemical techniques will reduce the impact of olive fruit fly on production in California and allow maximum flexibility for addition of other targeted management techniques.

Low temperature oxygenated phosphine fumigation for controlling lettuce aphid. Postharvest pest control on perishable commodities such as lettuce is essential. Phosphine is a postharvest fumigant. An ARS researcher in Salinas, CA, found that oxygen significantly increases phosphine toxicity against lettuce aphid. Phosphine fumigation under 60 percent oxygen reduced treatment time from 3 days to 30 hours at low temperature. The shorter oxygenated phosphine fumigation was tested successfully in a pallet-scale trial with chilled head lettuce under an insulation cover for controlling lettuce aphid. The treatment did not adversely affect lettuce quality and achieved complete control of the insect, and provides an economical alternative to fixed, low temperature fumigation chambers for conducting low temperature phosphine fumigation.

**Impact:** This work makes it possible to export bagged lettuce free of quarantine pests.

**Measure 4.2.5 Summary of the Major Technologies Developed, Transferred, and Used in FY 2011:**

***During FY 2011, ARS reported improved knowledge and understanding of quarantine pest and pathogen biology and epidemiology, leading to 4 new technologies implemented by industry or other action agencies to mitigate risk of pests and pathogens resulting in expanded export markets while protecting the safety and security of American agriculture.***

<b>Describe the Technology</b>	<b>Describe the Transfer</b>	<b>Identify the Customer</b>	<b>Impact</b>
ARS scientists in Fargo, North Dakota, developed a practical machine for automated preparation of insect eggs for	The invention was distributed to APHIS facilities needing it and an industrial partner was found to manufacture the device.	Those who maintain insect colonies for research, biological control, and sterile insect control.	Customers will be able to maintain cryopreserved strains of insects, greatly reducing

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cryopreservation.

costs and risks associated with perpetual colonization

**Measure 4.2.5 Outyear Performance Plan (the future performance indicators for this Measure)**

A cold phytosanitary treatment for <i>Bactrocera invadens</i> , an invasive fruit fly, added to the APHIS, PPQ Treatment Manual (Schedule T-107k).	A colony of the pest was located at the International Atomic Energy Agency labs in Austria, and ARS scientists from Weslaco, Texas, made arrangements to conduct the research study there.	U.S. producers and exporters of fruit for export.	This will prevent interruption in trade and provide a solution to quarantines imposed by future infestations of the pest in the United States and elsewhere.
Commercial washing technique for cleaning citrus of the Asian citrus psyllid, which damages citrus and transmits Huanglongbing (HLB, or citrus greening).	The possibility of Asian citrus psyllid in loads of citrus arriving in Australia from California threatens the ability of California to export citrus into that market. ARS researchers in Parlier, California, demonstrated that Asian citrus psyllids are completely washed from fruit that are submerged, flooded, or sprayed at high temperatures using soak tanks and wash lines consistent with commercial practices in California. Nearly 99 percent of the insects remain trapped by the solution until they drown.	U.S. citrus growers and exporters.	This research showed that Asian citrus psyllids will very likely not be present in commercially packed fruit and will help maintain access of California citrus to Australia, a market valued at \$60 million annually.
Methods for identifying and distinguishing among potato cyst nematodes.	ARS scientists in Beltsville, Maryland, identified a cyst nematode new to science from a potato field and developed methods to distinguish this nematode from the cyst nematodes that are currently quarantined. Technology was transferred directly to regulatory agencies, as well as through scientific publications and through the nematode taxonomy website maintained by ARS at <a href="http://nt.ars-grin.gov/nematodes/search.cfm">http://nt.ars-grin.gov/nematodes/search.cfm</a>	State and Federal (APHIS) regulatory agencies	To protect domestic potato production by quarantining areas where certain nematodes are found. Being able to distinguish among potato cyst nematode types also keeps international markets open for U.S. producers.

**During FY 2012, ARS will**

*continue to develop diagnostic assays to detect and differentiate existing, new and/or emerging quarantine arthropod pests, weeds, nematodes, and pathogens.*

*continue to expand interdisciplinary research to include means of excluding, managing and/or eradicating quarantine arthropod pests, weeds, nematodes and pathogens.*

*apply essential taxonomy and systematics for organisms toward the correct identification and diagnosis and control of target arthropod pests, weeds, nematodes, and pathogens.*

*expand new knowledge in epidemiology, host-parasite relationships and new means of developing host resistance toward exclusion, eradication, and management of quarantine arthropod pests, weeds, nematodes, and pathogens.*

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*support interagency collaboration for tracking successful exclusion, eradication where possible, and management of quarantine arthropods, weeds, nematodes, and pathogens*

### **During FY 2013, ARS will**

*continue to develop diagnostic assays to detect and differentiate existing, new and/or emerging quarantine arthropod pests, weeds, nematodes, and pathogens.*

*continue to expand interdisciplinary research to support means of excluding, managing and/or eradicating quarantine arthropod pests, weeds, nematodes and pathogens.*

*apply essential taxonomy and systematics for organisms toward the correct identification, diagnosis, and control of target arthropod pests, weeds, nematodes, and pathogens.*

*expand new knowledge in epidemiology, host-parasite relationships and new means of developing host resistance toward exclusion, eradication, and management of quarantine arthropod pests, weeds, nematodes, and pathogens.*

*support interagency collaboration for tracking successful exclusion, eradication where possible, and management of quarantine arthropods, weeds, nematodes, and pathogens.*

### **During FY 2014, ARS will**

*continue to develop diagnostic assays to detect and differentiate existing, new and/or emerging quarantine arthropod pests, weeds, nematodes, and pathogens.*

*continue to expand interdisciplinary research to support means of excluding, managing and/or eradicating quarantine arthropod pests, weeds, nematodes and pathogens.*

*apply essential taxonomy and systematics for organisms toward the correct identification, diagnosis, and control of target arthropod pests, weeds, nematodes, and pathogens.*

*expand new knowledge in epidemiology, host-parasite relationships and new means of developing host resistance toward exclusion, eradication, and management of quarantine arthropod pests, weeds, nematodes, and pathogens.*

*support interagency collaboration for tracking successful exclusion, eradication where possible, and management of quarantine arthropods, weeds, nematodes, and pathogens.*

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# Strategic Goal 5:

## Improve the Nation's Nutrition and Health

Improving the Nation's health requires improving the quality of the American diet. The United States is experiencing an obesity epidemic resulting from multifaceted causes including sedentary lifestyles, selection of readily available high calorie foods, and increasing portion sizes. In addition, 4 of the top 10 causes of death in the United States—heart disease, cancer, stroke, and diabetes—are strongly associated with the quality of our diets—diets too high in calories, saturated fat, sodium, and added sugars, and too low in fiber rich foods such as fruits, vegetables, and whole grains. There is an increasing demand for foods that taste good, are convenient, economical, and yet offer nutrition and health benefits. Building a strong connection between agriculture and human health is an important step to providing a nutritionally enhanced food supply. Promoting healthier food choices and educating Americans to balance caloric intake with sufficient daily physical activity are vital steps to preventing obesity and decreasing risk for chronic diseases.

ARS conducts research to identify nutritive and health promoting components in foods, improve the understanding of human nutrient requirements at all stages of the life cycle, and better understand the relationships between diet and health. The Agency also determines the composition and bioavailability of beneficial components in foods, conducts the national “What We Eat in America” food consumption survey to track the nutritional quality of the American diet, and conducts research on dietary interventions and strategies for modifying diets, food choices, and physical activity behaviors. The outcomes of these combined research efforts provide a scientific knowledge base to evaluate the healthfulness of the American diet and food supply, and to establish sound dietary recommendations for Americans, such as the Dietary Reference Intakes and the USDA/HHS Dietary Guidelines. The information is widely used by policymakers, Government agencies, industry, and educators to promote better diets, reach children early, and enable people to make healthful food and lifestyle choices.

### **OBJECTIVE 5.1: ENSURE ACCESS TO NUTRITIOUS FOOD**

Activities related to this objective are primarily carried out by other USDA agencies.

### **OBJECTIVE 5.2: PROMOTE HEALTHIER EATING HABITS AND LIFESTYLES**

The prevalence of obesity in the United States has doubled during the past two decades, making it a critical public health problem. High quality research is required to address this multifaceted problem. Good health is dependent on adequate physical activity combined with consumption of foods with the right balance of nutrients to meet an individual's needs within caloric requirements.

Building databases of food composition is critical to developing healthy diets. Also important is improving the health promoting value of foods through selection, biotechnology, processing, and other practices. ARS research will monitor food consumption patterns of Americans across time, define ways to prevent obesity (particularly in minority populations who are particularly susceptible to this condition) improve health through dietary manipulation, and help establish optimal levels of nutrients/foods to maximize health.

## Performance Measures

**Measure 5.2.1 Monitor food consumption/intake patterns of Americans, including those of different ages, ethnicity, regions, and income levels, and measure nutrients and other beneficial components in the food supply. Provide the information in databases to enable ARS customers to evaluate the healthfulness of the American food supply and the nutrient content of the American diet.**

### Baseline 2005

Three food intake and nutrient content databases released by ARS and used by ARS customers to establish Federal dietary policy guidelines, food assistance and feeding programs, and food labeling to safeguard the health of the American people. Also, NAL continued to operate nutrition.gov.

### Target 2011

Cumulatively, 25 new databases developed and released to ARS customers.

### Indicator 1:

***During FY 2011, ARS will survey, release data on, and analyze national food consumption patterns of Americans.***

FY 2011 Accomplishments:

ARS-supported scientists from Boston, Massachusetts, compared laboratory measurements of calories for 269 fast food and sit-down chain restaurant food items collected at multiple locations across multiple states to the calories listed on menus and websites. On average, the analyzed calories were only 10 calories higher than stated, however 19% of the items tested were under-reported by more than 100 calories.

***Impact:*** This information will induce restaurants to more accurately state the caloric content of their food, which will in turn be of help to the consumer attempting to decrease caloric intake.

A series of data briefs, summarizing national by representative food intake from the What We Eat in America, NHANES dietary survey were made public, including snacking patterns of U.S. adults, beverage choices of adults, and drinking water intake.

**Impact:** Nationally representative summaries of these dietary habits provide a snapshot of current behaviors and how they compare with Dietary Guidelines for Americans, published by USDA and HHS.

**Indicator 2:**

**During 2011, ARS will develop new methods, conduct food composition analyses, and compile databases for known, emerging, and new classes of nutrients.**

FY 2011 Accomplishments:

ARS Scientists at Beltsville, Maryland, developed methods to generate fingerprints of plant chemical constituents and metabolites that identify plants with 100% accuracy.

**Impact:** This has application for regulatory agencies to identify the type of plants used in processed foods and dietary supplements in addition to helping maintain quality control and discovering adulteration or misbranding of products.

ARS published the USDA National Nutrient Databank for Standard Reference, Release 24.

**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. The database is freely available on the Web and for download to personal computers.

ARS compiled Release 3 of the Flavonoids Special Interest Database which includes values for five classes of flavonoids in 500 foods.

**Impact:** Substantial research in flavonoids, pigmented compounds in fruits and vegetables that have health effects but no known human dietary requirements, is being facilitated by having validated, standard measurements available for researchers.

**Measure 5.2.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2011:**

**During FY 2011, ARS reported 5 new databases developed and released to ARS customers to establish Federal dietary policy guidelines, food assistance and feeding programs, and food labeling to safeguard the health of the American people.**

<b>Describe the Technology</b>	<b>Describe the Transfer</b>	<b>Identify the Customer</b>	<b>Impact</b>
Independent analysis of calorie content of restaurant meals from 42 quick serve and sit-down restaurants	Scientific publication in medical journal	Researchers on diet, the food industry, and restaurant patrons	The average calorie content was close to nutrition information provided. But there was substantial understatement for some foods, particularly those with lower calories.
What We Eat in America (WWEIA) diet survey	Data Briefs – summaries of eating behaviors with comparison to federal	Researchers and clinical nutritionists	WWEIA is the only nationally representative diet survey. It is used by

	guidelines posted to ARS Web site		several federal agencies and hundreds of academic researchers studying the relation of foods or nutrients with health.
New method for identifying plants and dietary supplements using global fingerprinting	Publication in a scientific journal	Researchers and federal regulatory agencies	This method allows rapid identification of adulteration or misbranding of plant products.
National Nutrient Database for Standard Reference, Release 24	Publicly released on the ARS Web site with free use and ability to download	Other federal agencies, researchers, food industry, and consumers	Updated information on changes in composition of the American food supply allows knowledge of nutrient intake and tracking of changes in food products
Special Interest Database for Flavonoids, Release 3	Publicly released on the ARS Web site	Other federal agencies, researchers, food industry	Updated information spurs additional research and reformulation of foods to enhance health-promoting constituents

**Measure 5.2.1 Outyear Performance Plan (the future performance indicators for this Measure)**

**During FY 2012, 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.*

**During FY 2013, 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.*

**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.*

**Measure 5.2.2 Define the role of nutrients, foods, and dietary patterns in growth, maintenance of health, and prevention of obesity and other chronic diseases. Assess bioavailability and health benefits of food components. Conduct research that forms the basis for and evaluates nutrition standards and Federal dietary recommendations.**

**Baseline 2005**

Three Federal and Institute of Medicine reports used to establish Federal nutrition policy and regulations that employ ARS research results in formulating recommendations to safeguard the health of the American people.

**Target 2011**

Cumulatively, 23 new reports using ARS research to develop authoritative positions on nutrition and health issues.

**Indicator 1:**

***During FY 2011, ARS will identify dietary and lifestyle intervention strategies to prevent obesity and promote healthy food choices and eating behaviors.***

FY 2011 Accomplishments:

Research by ARS scientists at Beltsville, Maryland, found that about two ounces of whey protein but not soy protein or carbohydrate in the diets of overweight or obese volunteers for five months resulted in significant loss of weight, fat mass, and waist circumference.

***Impact:*** These research findings signify differences in the ability of different types of protein to affect metabolism and the potential to reduce the prevalence of obesity.

ARS scientists at Davis, California, discovered that person-to-person differences in weight loss were associated with levels of the stress hormone cortisol in saliva and executive function on a mental acuity test.

***Impact:*** These results indicate stress responses may be a significant determinant of weight status and, since many people react differentially to stress, indicates the need for focused weight loss strategies rather than a one-size-fits-all approach.

ARS-supported scientists at Houston, Texas, found that focusing on improved eating and exercise habits using behavioral modification strategies to individualize plans led to decreases in body mass index, subcutaneous fat, serum cholesterol and triglycerides in a group of overweight Mexican-American adolescents and these changes were maintained over 2 years.

***Impact:*** These findings indicate the benefit of intensive, daily intervention and point to future development of more cost-effective programs that can achieve the same benefits.

**Indicator 2:**

***During 2011, ARS will determine the functions, bioavailability, interactions, and requirements for known, emerging, and new classes of nutrients across the lifecycles.***

FY 2011 Accomplishments:

ARS supported researchers from Boston, Massachusetts, analyzed almost 1500 tissue samples obtained during colonoscopy and found that people with the highest levels of folate in colon tissue had a 76% reduction in risk for advanced adenomas and a 46% reduction in hyperplastic polyps or proximal adenomas.

**Impact:** Colon cancer is the number two cause of cancer deaths in the U.S. and inadequate dietary folate may increase risk of the disease. FDA has mandated folate fortification of wheat flour since 1998 but there has been concern that high levels might promote growth of colon cancer. This study reinforces the benefits of folate fortification.

ARS scientists from Houston, Texas have discovered a plant gene that governs the formation of calcium oxalate. When this gene is “turned off” very little oxalate is formed and calcium bioavailability is greatly enhanced.

**Impact:** Manipulation of this gene in plants of agricultural importance will result in plant foods with greatly increased calcium bioavailability.

ARS-supported scientists from Boston, Massachusetts, fed high beta-carotene maize labeled with stable isotopes to Zimbabweans who have low vitamin A status and showed that the beta carotene was efficiently converted to vitamin A.

**Impact:** Beta-carotene biofortified maize is an effective means of improving nutritional status. Breeding crops with more of this nutrient can help decrease the high prevalence of vitamin A deficiency in developing nations.

**Measure 5.2.2 Summary of the Major Technologies Developed, Transferred, and Used in FY 2011:**

***During FY 2011, ARS reported 4 new reports using ARS research to develop authoritative positions on nutrition and health issues are used to establish Federal nutrition policy and regulations that employ ARS research results in formulating recommendations to safeguard the health of the American people.***

<b>Describe the Technology</b>	<b>Describe the Transfer</b>	<b>Identify the Customer</b>	<b>Impact</b>
Dietary Guidelines for Americans, 2010	USDA/HHS policy document setting basis for federal dietary standards for 2010-2014	Federal agencies, food industry, clinicians, researchers, general public	Translates nutrient recommendations into practical food advice
Childhood and Adult Care Food Programs: Aligning Dietary Guidance for All	Authoritative report from the National Academies released on the web and via print.	USDA Food and Nutrition Service	Expert recommendations on how to have food in these programs conform to dietary guidelines
Examination of Front-of-Package Nutrition Rating Systems and Symbols: Phase I Report	Authoritative report from the National Academies released on the web and via print.	FDA	Set out food composition criteria for FDA to evaluate in considering new food labeling to better inform consumers on purchasing healthier options
Early Childhood Obesity Prevention Policies	Authoritative report from the National Academies released on the web and via print.	USDA/FNS, state and local governments that implement preschool feeding and physical activity programs	Expert recommendations that contribute to the White House Childhood Obesity Task Force goal and Let's Move program

**Measure 5.2.2 Outyear Performance Plan (the future performance indicators for this Measure)****During FY 2012, ARS will**

*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.*

**During FY 2013, ARS will**

*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.*

**During FY 2014, ARS will**

*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.*

**Measure 5.2.3 Publish research findings not encompassed under the other performance measures for this objective likely to significantly advance the knowledge of human nutrition, extensively influence other researchers in the same or related field, or yield important new directions for research.**

**Baseline 2003**

Six research studies published in peer reviewed biomedical literature with the potential to strongly influence the field of human nutrition or have demonstrated impact through high citation rates.

**Target 2011**

Cumulatively, 30 new scientific papers will be published that generate high impact among the research community.

**Indicator 1:**

***During FY 2011, ARS will publish new findings on metabolic processes that are affected by nutrient intake.***

FY 2011 Accomplishments:

The first systematic catalog of all identifiable metabolites in human blood serum was published by an international consortium including ARS scientists from Davis, California.

***Impact:*** This information was published in a scientific journal and made freely available on the Web at <http://www.serummetabolome.ca>. It enables researchers to link dietary and environmental changes with alterations in serum metabolites and prevention of chronic diseases, including heart disease, obesity and diabetes.

**Indicator 2:**

***During FY 2011, ARS will discover genetic or epigenetic factors that influence physiologic responses to diet or changes in gene expression in response to dietary intake.***

FY 2011 Accomplishments:

ARS-supported scientists in Houston, Texas, proved that epigenetic changes occur in humans by studying changes in genes of children born at different times of the year in rural Gambia where food availability differs markedly by season.

***Impact:*** Epigenetic changes, or inherited characteristics not due to changes in DNA but to the three-dimensional structure of genes, were previously shown in animals and plants. These results prove that epigenetic changes need to be considered in evaluating risk of many diseases and document the effects of early environment on establishment of heritable changes that are likely permanent.

ARS-supported scientists at Little Rock, Arkansas, found that obesity in mothers led to epigenetic changes in some genes, dysfunction of the mitochondria, organelles that control energy metabolism in the cell, and to impairment of burning fatty acids for fuel.

***Impact:*** These data help explain how and why maternal obesity can be passed on to offspring who are more likely to develop obesity, insulin resistance, and nonalcoholic fatty liver disease.

ARS-supported scientists from Boston, Massachusetts, have developed from the literature a database of such interactions relevant to nutrition, blood lipids, cardiovascular disease and diabetes. More than 2,000 studies of interactions gleaned from the literature presently are in the database.

***Impact:*** This database will greatly increase the capacity to develop new information related to diet/genetics interactions and will accelerate new discoveries in this area.

**Measure 5.2.3 Summary of the Major Technologies Developed, Transferred, and Used in FY 2011:**

***During FY 2011, ARS reported 4 new scientific papers published that generate high impact among the research community with the potential to strongly influence the field of human nutrition or have demonstrated impact through high citation rates.***

<b>Describe the Technology</b>	<b>Describe the Transfer</b>	<b>Identify the Customer</b>	<b>Impact</b>
Identification of all small metabolites in human blood plasma	Paper published in peer-reviewed scientific journal	Researchers	This is the first catalog of metabolites in human blood that will allow study of effects of diet on early phases of chronic diseases
Identification of epigenetic changes in human genes	Paper published in peer-reviewed scientific journal	Researchers	The first documentation of changes in human genes as a result of nutrition in the womb, which persist for at least 9 years, and appear to be permanent
Epigenetic changes in rats resulting from maternal obesity leads to impaired energy balance in offspring	Paper published in peer-reviewed scientific journal	Researchers	Discovery of the phenomenon partially explains why obese women have overweight children and suggests means for overcoming that
A database of over 2,000 studies that examine genetic interaction with nutrition	Paper published in peer-reviewed scientific journal	Researchers	Compilation of this database greatly expands the statistical ability to find differences in gene expression related to diet and health

**Measure 5.2.3 Outyear Performance Plan (the future performance indicators for this Measure)**

**During FY 2012, ARS will**

*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 2013, ARS will**

*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 2014, ARS will**

*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.*

**OBJECTIVE 5.3: IMPROVE NUTRITION ASSISTANCE PROGRAM MANAGEMENT AND CUSTOMER SERVICE**

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Activities related to this objective are primarily carried out by other USDA agencies.

## Strategic Goal 6:

### Protect and Enhance the Nation's Natural Resource Base and Environment

There is no substitute for fresh water, high quality soils, and clean air in productive agricultural ecosystems. Reliable supplies of food, fiber, feed, forages, and energy feedstock are essential for a productive agricultural sector and the maintenance of goods and services derived from the Nation's crop, pasture, and range lands. Agriculture relies on a healthy natural resource base whose sustainability depends on sound, science-based agricultural practices.

ARS research activities are designed to help ensure that the Nation's natural resources meet the long term needs of a vibrant society with its increasing population while enhancing the quality of life for producers, rural communities, and the Nation. To achieve these goals, ARS conducts multidisciplinary research to solve problems arising from the interaction between agriculture and the environment, and develops new practices and technologies to conserve the Nation's natural resource base and balance production efficiency with environmental quality. Since environmental quality is a global problem, ARS is expanding collaboration with international research institutions with the aim to produce technologies and practices that mitigate the adverse impacts of climate on agriculture and agriculture on the environment.

#### OBJECTIVE 6.1: ENHANCE WATERSHEDS' CAPACITIES TO DELIVER SAFE AND RELIABLE FRESH WATER

Water is fundamental to life and is a basic requirement for virtually all of our agricultural, industrial, urban, and recreational activities, as well as the sustained health of watersheds. ARS conducts fundamental and applied research on the processes that control water availability and quality for the health and economic growth of the American people. The Agency is working to develop and transfer to producers, action agencies, local communities, and resource advisors new knowledge, improved technologies, conservation practices, and decision support systems that will enable them to reuse degraded waters, improve water conservation, and increase water use efficiency in agriculture. This research will provide the tools to reduce the transport of agricultural pollutants and the associated degradation of terrestrial and aquatic ecosystems. The overall goal is to provide knowledge and tools to enhance water availability and quality, mitigate the adverse impact of droughts and floods on rural and urban communities, and improve the health of our Nation's watersheds.

#### Performance Measure

**Measure 6.1.1** Develop technology and practices to reduce the delivery of agricultural pollutants by water on farms and ranches and quantify the environmental benefit of conservation practices in watersheds.

**Baseline 2005**

Four agricultural practices and technologies developed and used by customers to enhance water quality and availability.

**Target 2011**

Cumulatively, 10 agricultural practices and technologies will have been developed and used by customers to enhance water quality and availability.

**Indicator 1:**

***During FY 2011, ARS will develop guidelines for irrigating in urban and agricultural settings with degraded waters.***

FY 2011 Accomplishments:

Because treated municipal waste water can contain low concentrations of antibiotics, its use as a source of irrigation water or to replenish groundwater supplies could increase the resistance of naturally occurring soil microorganisms to antibiotics. ARS scientists in Maricopa, Arizona, measured the antibiotic content and resistance of microorganisms in soil cores from a site in Gilbert, Arizona, that has been used to recharge groundwater with treated municipal wastewater for 20 years. They found that concentrations of lincomycin in non-treated soils were actually higher than in soils that had been irrigated with treated wastewaters, and that there was no increase in antibiotic resistance in the native gram positive soil microbial community in response to irrigation with treated wastewaters. These results indicate that using treated municipal wastewaters to recharge groundwater did not lead to the development of resistance to lincomycin among native soil microorganisms. The Town of Gilbert will provide this information to State regulators as evidence of the recharge facility's sustainability.

***Impact:*** Documents that treated municipal wastewaters can be used to recharge groundwaters in arid environments without affecting the resistance of native soil microorganisms to antibiotics. The result is an increase in the supply of available fresh water in these environments for agricultural and other uses.

Reduced fresh water supplies, and increase water demands, in the western United States have limited the amount of water available for irrigation, thereby impacting agricultural production. ARS scientists at Parlier, CA, identified plant species (e.g., poplar-tree clones; opuntia cactus) adapted to high saline drainage or groundwaters, that can be used for producing new bio-based products (e.g., biofuel; Se-enriched feed and fruit products) that have economic value for the grower. These findings improve our ability to sustain an agronomic-based system through drainage water reuse or the use of poor quality waters for irrigation, thereby reducing grower demand for high quality fresh waters in the western US, where supplies are limited.

***Impact:*** Alternative crop species are identified that provide economic value to growers while reducing agricultural demands on the limited supply of high quality fresh water in the western US.

In cooperation with researchers at the University of California, Riverside, ARS scientists at Riverside, CA, evaluated the yield and quality of 5 landscaping species (boxwood, escallonia, hawthorn, hibiscus, and juniper) grown under greenhouse conditions as container plants and irrigated with Cl-dominated waters at 6 salinity levels. Based on growth and aesthetic quality as observed in two separate experiments, species were ranked for their suitability for landscaping

purposes in salt-affected environments. The overall ranking was: hibiscus > juniper > escallonia > hawthorn > boxwood. This research provides nurserymen, home gardeners, and landscape professionals with criteria for selecting ornamental species suitable for use in salt-affected soils and regions.

**Impact:** Identifying ornamental crop species that can tolerate saline irrigation water, reduces the need for scarce freshwater supplies to be used to irrigate ornamental landscaping projects. Doing so conserves available fresh water supplies, particularly in arid regions.

#### Indicator 2:

***During FY 2011, ARS will develop guidelines for management practices that optimize soil, water, and economic benefits associated with drainage water management (DWM) systems in humid areas.***

FY 2011 Accomplishments:

Drainage waters from agricultural lands, especially those coming from subsurface tile drains, carry nutrients that can degrade the quality of downstream waters. Managing drainage system outlets during the non-growing season to reduce water and nutrient exports can both improve water quality and increase yields. In cooperation with Ohio State University, ARS scientists at Columbus, OH, found that over a three year period, corn yields increased in 66 percent of the fields where this management practice was applied. The prospect of increased yields is expected to encourage producers to adopt drainage water management (DWM) to reduce water and nutrient delivery to aquatic systems. NRCS is currently using this information to develop a strategy to promote the adoption of drainage water management by farmers in these priority watersheds.

**Impact:** Adopting DWM will help to improve downstream water quality in river basins and estuaries receiving drainage waters from agricultural lands (e.g., the Mississippi River Basin; in the Gulf of Mexico; Lake Erie), as well as in numerous municipal water supply reservoirs.

#### Indicator 3:

***During FY 2011, ARS will develop predictive equations, procedures, and databases that will allow improved estimation of concentrated flow erosion on agricultural fields and construction sites.***

FY 2011 Accomplishments:

Most erosion models were developed for croplands where hydrologic and erosion processes differ from those found on rangelands. Accurate prediction of soil loss on western rangelands requires an erosion model specifically designed for rangeland applications. To fill this need, ARS scientists at Tucson, AZ, developed the new Rangeland Hydrology and Erosion Model (RHEM). RHEM: 1) models erosion processes under both undisturbed and disturbed rangeland conditions; 2) adopts a new splash erosion and thin sheet-flow transport equation developed specifically from rangeland data; and 3) links model hydrologic and erosion parameters with rangeland plant communities by providing a new system of parameter estimation equations based on 204 plots in 49 rangeland sites distributed across 16 western U.S. states. RHEM estimates runoff, erosion, and sediment delivery rates and volumes at the hillslope spatial scale, and at the temporal scale of individual rainfall events. Subsequent experiments conducted to generate independent data for

model validation indicate the ability of RHEM to provide reasonable runoff and soil loss prediction capabilities for rangeland management and research needs, helping to sustain productive rangelands in the western U.S. in the face of changing land use and climatic fluctuations.

**Impact:** The development and use of this new model will improve the management of productive rangelands in the western U.S., enhancing their sustainability in the face of changing land use and climatic fluctuations.

Sediment is one of the primary pollutants of surface waters in the United States; stream bank erosion has been identified as a significant sediment source. To help manage stream bank erosion, ARS scientists at Oxford, MS, developed a new dynamic version of the Bank-Stability and Toe-Erosion Model (BSTEM), which is now available free of charge on the internet. BSTEM has been used throughout the United States, and in many places overseas, to analyze stream and gravitational forces, as well as the effects of above- and below-ground riparian vegetation biomass, on bank stability and bank-face erosion. The new dynamic version allows users to input years of daily river-stage data, allowing iterative simulation of the combined effects of hydraulic erosion and geotechnical stability. The new dynamic version incorporates a near-bank groundwater model that provides dynamic variations in pore-water pressure distributions and, therefore, bank strength, over the course of the simulation. The model serves as a tool for watershed managers to: 1) determine sediment loads from stream bank erosion; 2) determine potential sediment-load reductions using a range of mitigation strategies; and 3) design stable-bank configurations for stream restoration activities.

**Impact:** The new dynamic version of BSTEM provides a highly useful, web-accessible tool for watershed managers to help control erosion from stream banks. The already wide usage of this new model is helping to reduce a major source of eroded sediments in agricultural watersheds.

In cooperation with the Natural Resources Conservation Service (NRCS) and Kansas State University, ARS scientists at Stillwater, OK, developed a Common Computing Environment (CCE) certified version of the computer engineering application tool WinDAM B. Prior to CCE certification, the program was tested and evaluated using case histories and synthetic data sets. WINDAM B predicts the overtopping performance of earthen embankments, including allowable overtopping, breach erosion, and failure. This new computer tool will play an important role in helping to evaluate numerous existing structures, particularly those managed by NRCS that are reaching the end of their design lifespan. Use of the model will help determine hazard classification, develop emergency action plans, and reduce the costs of dam rehabilitation.

**Impact:** Through the use of this tool, particularly by NRCS, thousands of earthen dams and embankments that have reached the end of their designed lifespan can be accurately evaluated for threat of hazard, with emergency action plans developed when necessary. Overall, the use of this tool will improve human safety in the many watersheds where these dams and embankments exist, while reducing the cost to the taxpayer of dam rehabilitation.

#### **Measure 6.1.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2011:**

***During FY 2011, ARS reported 2 agricultural practices and technologies developed and used by customers to enhance water quality and availability.***

<b>Describe the Technology</b>	<b>Describe the Transfer</b>	<b>Identify the Customer</b>	<b>Impact</b>
A new Rangeland Hydrology and Erosion Model (RHEM).	Made available to users in the U.S. and throughout the world.	Rangeland managers (including BLM, FS, & NRCS) and conservationists charged with maintaining the productivity of western U.S. rangelands--providing reasonable runoff and soil loss prediction capabilities for rangeland management and research needs at the hillslope spatial scale and the temporal scale of individual rainfall events.	Enhanced sustainability of rangeland productivity in the face of changes in land use and climatic fluctuations.
A Common Computing Environment (CCE) certified version of the computer engineering application tool, WinDAM B.	Made available to users in the U.S. and throughout the world.	Primarily the Natural Resource Conservation Service charged with the management of thousands of earthen dams and embankments that have reached the end of their designed lifespan.	Thousands of earthen dams & embankments at the end of their designed lifespan can be accurately evaluated for threat of hazard, with emergency actions plan developed when necessary, improving human safety & reducing costs of dam rehabilitation.

### **Measure 6.1.1 Outyear Performance Plan (the future performance indicators for this Measure)**

**During FY 2012, ARS will**

*develop guidelines for improved or more efficient water use in agricultural systems, including developing criteria for water use efficiency, application of waste water, developing water use/reuse best management practices, and utilizing waste water to mitigate drought..*

*develop guidelines for management practices that optimize soil, water, and economic benefits associated with drainage water management (DWM) systems in humid areas.*

*develop predictive equations, procedures, and databases that will allow improved estimation of erosion on agricultural fields.*

**During FY 2013, 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 conservation practices to better protect water resources, improving the overall effectiveness of USDA conservation programs.*

*develop new or improved knowledge, tools, technologies, and guidelines to improve watershed management and ecosystem services in agricultural landscapes.*

**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 conservation practices to better protect water resources, improving the overall effectiveness of USDA conservation programs.*

*develop new or improved knowledge, tools, technologies, and guidelines to improve watershed management and ecosystem services in agricultural landscapes.*

## OBJECTIVE 6.2: IMPROVE SOIL AND AIR QUALITY TO ENHANCE CROP PRODUCTION AND ENVIRONMENTAL QUALITY

High quality soil and air resources are essential for enhanced crop production and environmental stewardship. Productive soils enable efficient cycling of nutrients, help sequester atmospheric carbon, contribute to improved water and air quality, and foster other ecosystem services such as wildlife habitat. However, soils are vulnerable to degradation and damage through natural processes and human activities.

Air quality and atmospheric gas composition also have an impact on, and are in turn impacted by, agricultural production. Research is needed to control gaseous and particulate matter emissions from agricultural operations to protect air quality and mitigate impacts on climate.

ARS provides agricultural producers and land managers with strategies and technologies to enhance soil and air quality, and provides Federal and State agencies with science-based information to establish policy and regulatory decisions. For example, ARS research develops remedies for soil conditions limiting crop production and adversely affecting environmental quality. The Agency also works toward further developing safe and productive applications of animal manure and selected industrial and municipal byproducts as a low cost means of enhancing soil properties and improving crop production. Additionally, ARS is developing new measurement and prediction tools to determine the effects of agricultural land management practices on soil quality. In addressing its research objectives, ARS works to balance the stewardship of air and soil resources with the attainment of profitable and sustainable agricultural yields.

### Performance Measure

**Measure 6.2.1 Develop practices and technologies to enhance soil resources and reduce emissions of particulate matter and gases from crop production lands, agricultural processing operations, and animal production systems.**

#### Baseline 2005

Six agricultural practices and technologies to enhance soil and air natural resources developed and used by customers and partners.

#### Target 2011

Cumulatively, 18 agricultural practices and technologies to enhance soil and air natural resources will be developed and used by customers and partners.

#### Indicator 1:

***During FY 2011, ARS will assess the potential risks and benefits to agricultural systems that may arise from global change, and develop agricultural management practices and***

***decision support strategies that enable producers to take advantage of beneficial effects and mitigate adverse impacts.***

FY 2011 Accomplishments:

Effects of warmer air temperatures on crop growth, development, physiology and yield. To determine how increasing air temperatures may affect future crop yields, ARS scientists from the U.S. Arid-Land Agricultural Research Center, Maricopa, AZ and the University of Arizona used infrared heaters and varied planting dates to expose wheat crops to an unusually wide range of temperatures. The effects of higher air temperature on wheat yield varied due to interacting effects of planting date, risk of frost, and the response of crop photosynthesis, water use and duration of wheat crops. For two planting dates, warming protected the developing wheat grain heads from frost damage and led to good yields, while lower ambient air temperature plots produced no grain. The results indicate that increasing air temperatures using current management and/or cultivars will likely decrease wheat yields in irrigated systems of Arizona and California. However, if warming is sufficient to reduce the risk of frost, growers might plant wheat earlier, thus extending the wheat growing season and either stabilizing or increasing wheat yields.

***Impact:*** These results suggest that new varieties and cultivation practices are needed to maintain or increase wheat yields with increasing air temperatures. The results also indicate that planting dates and growing season lengths may be adjusted for increasing temperatures if the number of frost-free days increases, thus reducing the risk of crop losses.

Corn water use efficiency increases under elevated CO<sub>2</sub>. Water availability for agriculture is expected to decline as atmospheric CO<sub>2</sub> increases in the future. Thus, it is important to understand how plants grown under elevated CO<sub>2</sub> will respond to water stress. ARS scientists in the Crop Systems and Global Change Laboratory, Beltsville, MD, investigated the relationship between plant growth and water use for a corn crop in soil bins housed in sun-lit growth chambers under two CO<sub>2</sub> concentrations. Soil water contents observed under elevated CO<sub>2</sub> were higher than those grown under ambient CO<sub>2</sub> concentrations even though less irrigation water was applied. The corn grown under elevated CO<sub>2</sub> used up to 20% less water than corn grown under ambient CO<sub>2</sub> levels.

***Impact:*** As atmospheric CO<sub>2</sub> increases, less water is needed for corn production, thus providing a focus for breeding new crop varieties for adaptation to dryer growing conditions. By determining the genetic basis for this characteristic, other corn varieties can be bred for increased water use efficiency, thus enabling production where water is a limiting factor for crop production.

Carbon dioxide eliminates desiccation in warmed semi-arid rangelands. Climate change is expected to bring warmer, desiccating conditions to many world rangelands. However, many analyses have not considered the direct effect of rising CO<sub>2</sub>, which ARS scientists hypothesized would positively improve plant water use efficiency, thereby off-setting the negative effects of warming-induced desiccation. ARS scientists in Cheyenne, WY, Fort Collins, CO, and Maricopa, AZ, plus collaborators from the University of Wyoming created and experiment with higher CO<sub>2</sub> and slightly warmer temperature conditions expected to occur during the second half of this century. They discovered that combined elevated CO<sub>2</sub> and warmer temperatures favored growth of warm-season, perennial grasses, and that the additional CO<sub>2</sub> completely reversed the desiccating effects of the warmer temperature in a typical native semi-arid prairie environment.

***Impact:*** These results are helping climate change scientists make better predictions about how rising CO<sub>2</sub> will affect the responses of rangelands to climate change, and are

being used to develop climate change adaptive management strategies for ranchers and public land managers.

**Indicator 2:**

***During FY 2011, ARS will identify the processes that control the rate at which agricultural systems release and absorb greenhouse gases, and develop agricultural management practices that contribute to reductions in the Nation's net greenhouse gas emissions.***

FY 2011 Accomplishments:

Improve nitrogen management released online. Nitrogen losses from agricultural systems impact soil, water, and air quality. There is a need for new tools that can help us assess reactive nitrogen losses from agricultural systems. New USDA-ARS tools such as the Nitrogen Trading Tool, Nitrogen Index 4.3, and NLEAP-GIS 4.2 were calibrated and validated, and were released in December 2010 via a new ARS webpage (<http://www.ars.usda.gov/npa/spnr/nitrogentools>). These tools have been downloaded hundreds of times and are being used by international agencies, universities, and national and international peers to assess the effects of management practices on nitrogen losses in order to reduce these losses to the environment.

***Impact:*** The NLEAP software provides producers and land managers with a tool that enables simulation of the emissions consequences of management decisions, thus helping reduce losses of reactive nitrogen to the environment.

**Indicator 3:**

***During FY 2011, ARS will develop practices which remediate degraded soils.***

FY 2011 Accomplishments:

Conservation-based biomass feedstock harvest recommendations. Crop residues are a potential renewable bioenergy feedstock that can produce power, heat and transportation fuels. Crop residues refer to the non-food portion of a crop that remains after grain harvest that protects soil from erosion and builds soil organic matter. Guidelines or recommendations are needed when deciding where, if, and how much residue needs to remain on the land and how much may be harvested. ARS Researchers at Morris, Minnesota, developed recommendations for conservation-based biomass feedstock harvest, which were used to write university and Natural Resources Conservation Service (NRCS) factsheets, and were presented at workshops and field days. These guidelines provide decision tools to producers, consultants, extension and NRCS, and industry for determining where, if, and how much crop residue can be harvested.

***Impact:*** These recommendations help safeguard soil productivity by guiding how much residue needs to be left on the soil when residue is harvested, to maintain soil productivity, thus ensuring that soils can indefinitely supply food, feed, fiber and fuel.

**Indicator 4:**

***During FY 2011, ARS will develop methods to reduce emissions of harmful gases from crop and animal production systems.***

FY 2011 Accomplishments:

Seasonal and annual ammonia emissions from southern High Plains beef cattle feedyards. Ammonia gas escaping from beef cattle feedyards is a loss of valuable fertilizer nitrogen and can negatively impact sensitive ecosystems and degrade air quality. The quantity of ammonia emitted from feedyards and the factors controlling losses are not understood. ARS researchers from the Conservation and Production Research Laboratory in Bushland, TX in collaboration with researchers at West Texas A&M University and Texas AgriLife Research measured ammonia emissions from two feedyards over a two-year period to identify the sources and fate of ammonia gas losses. The major factors affecting emissions were ambient temperature and dietary crude protein concentration in feeds, with over 52% to 59% of fed nitrogen lost as ammonia at the two feedyards over the two years of the study. These results are the most extensive measures available of ammonia emission from feedlots.

**Impact:** These results provide an important database that can be used by scientists to validate and verify process models of emissions, provide the cattle industry accurate science-based information to meet regulatory requirements, and give regulators more comprehensive real-world data to build ammonia emissions inventories.

#### **Indicator 5:**

***During FY 2011, ARS will develop practices and approaches which mitigate the detrimental effects of tropospheric ozone on agricultural crops.***

FY 2011 Accomplishments:

Climate change factors such as rising atmospheric carbon dioxide (CO<sub>2</sub>) and ozone can exert significant impacts on crop growth, but how the soil microbes in agricultural systems respond to these factors remains largely unexplored. Using a long-term field study conducted in a no-till wheat-soybean rotation system with open-top chambers, ARS researchers in Raleigh, NC showed that elevated CO<sub>2</sub> stimulated plant biomass production and ozone lowered plant biomass production, but only elevated CO<sub>2</sub> significantly affected soil microbial biomass, respiration and community composition. Enhanced microbial biomass and activity from elevated CO<sub>2</sub> coincided with increased soil nitrogen availability likely due to stimulation of soybean nitrogen-fixation under elevated CO<sub>2</sub>. These results highlight the need to consider the interactive effects of carbon and nitrogen availability on microbial activity when projecting soil carbon balance under future CO<sub>2</sub> scenarios. The addition of nitrogen to agricultural systems through fertilizers or legume crops may stimulate microbial decomposition processes and limit carbon sequestration potential. The results also suggest that projected ozone concentrations under future climate scenarios may reduce plant productivity, while having less impact on soil microbial processes.

**Impact:** These findings enhance our ability to predict and manage soil carbon sequestration under changing climate conditions.

#### **Indicator 6:**

***During FY 2011, ARS will develop management practices and decision tools to improve soil quality and protect the environment.***

FY 2011 Accomplishments:

User-friendly model developed to predict annual phosphorus loss in runoff. Non-point source pollution of fresh waters by agricultural phosphorus (P) can limit water use for drinking, recreation, and industry. An ARS researcher at Madison, WI developed and validated a user-friendly spreadsheet model (Annual P Loss Estimator -APLE) to predict long-term changes in soil

P and P loss in runoff for a wide variety of agricultural conditions. APLE is especially designed to assess the impact of manure management, including grazing or mechanical application, surface application or incorporation, rate and timing of manure application, and manure P content as a function of animal diet.

**Impact:** Parts of the model have been incorporated into the WI P Index, and the model is being used to help evaluate and improve predictions by other P Indexes, which are used by producers and their consultants across the US to comply with the USDA NRCS 590 nutrient management standards.

#### Indicator 7:

***During FY 2011, ARS will document the effectiveness of management practices and control technologies to reduce the emission of harmful gases from crop and animal production systems.***

FY 2011 Accomplishments:

Systems and methods for reducing ammonia emissions from liquid effluents and for recovering ammonia. ARS researchers at Florence, SC invented new methods to remove and recover ammonia from liquid effluents such as animal and municipal wastewater. The invention produces a concentrated non-volatile ammonium salt.

**Impact:** The potential benefits are reduced ammonia emissions from liquid manure, cleaner air inside the barns with benefits to animal health, and recovery of ammonia as a concentrated liquid nitrogen reusable as a plant fertilizer.

#### Indicator 8:

***During FY 2011, ARS will demonstrate the effectiveness of management practices and control technologies that will reduce nutrient losses, reduce emissions, and control pathogens from animal production operations.***

FY 2011 Accomplishments:

Mathematical model for pathogen transport and retention developed. Existing mathematical models to simulate the movement of pathogens through agricultural soils and groundwater do not provide reliable predictions, even under relatively simple, well defined conditions. Researchers at the USDA-ARS U.S. Salinity Laboratory and the University of California at Riverside have developed a mathematical model for pathogen transport and retention in soils that can be used to protect aquifers. The approach considers pathogen transport in the bulk water and adjacent to the soil surface, and pathogen retention on the solid surface. The model provides a clear explanation for many poorly understood observations of pathogen transport and retention in soils.

**Impact:** This research will help identify areas where additional research is needed for predicting the fate of pathogens in soils and aquifers.

New application technology reduces poultry litter nutrient losses in runoff. Use of poultry litter as a soil amendment often results in excessive nutrients losses in runoff water. ARS scientists at the USDA-ARS National Soil Dynamics Laboratory (NSDL) recently developed equipment that places poultry litter in a band when applied to soil. Use of this implement can potentially reduce the impact that nitrogen and phosphorus nutrient losses from poultry litter has on water quality.

**Impact:** Subsurface banding poultry litter reduced the impact of N and P loss in surface water runoff to levels observed in the non-fertilized pasture.

**Indicator 9:**

***During FY 2011, ARS will deliver a Nitrogen Index (N Index) relative risk assessment tool that provides field guidance for potential movement of nitrogen via runoff, leachate, or gas emission from various landscapes and cropping systems.***

FY 2011 Accomplishments:

Improve nitrogen management released online. Nitrogen losses from agricultural systems impact soil, water, and air quality. There is a need for new tools that can help us assess reactive nitrogen losses from agricultural systems. New USDA-ARS tools such as the Nitrogen Trading Tool, Nitrogen Index 4.3, and NLEAP-GIS 4.2 were calibrated and validated, and were released in December 2010 via a new ARS webpage (<http://www.ars.usda.gov/npa/spnr/nitrogentools>). These tools have been downloaded hundreds of times and are being used by international agencies, universities, and national and international peers to assess the effects of management practices on nitrogen losses in order to reduce these losses to the environment.

**Impact:** The NLEAP software provides producers and land managers with a tool that enables simulation of the consequences of nitrogen management decisions, thus helping reduce losses of reactive nitrogen to the environment.

**Indicator 10:**

***During FY 2011, ARS will develop instrumentation and models to measure and predict emission and dispersion of particulate matter and gases from animal production operations.***

FY 2011 Accomplishments:

Determining the effect of animal diet on air emissions from feedlot surfaces. Air emissions from animal feeding operations affect the environment and pose potential nuisance concerns to downwind neighbors. Based on laboratory studies, there is evidence that animal diet impacts the types and amounts of air emissions from manure. ARS researchers at Clay Center, NE, developed a method for evaluating the spatial distribution of air emissions at the field-scale, and determined that diet had an effect on the spatial distribution, types and quantities of odorants produced by manure.

**Impact:** Having the ability to predict the locations of elevated air emissions will allow producers to use cost-effective precision management techniques to minimize air emissions from feedlot surfaces.

**Measure 6.2.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2011:**

***During FY 2011, ARS reported 2 agricultural practices and technologies to enhance soil and air natural resources will be developed and used by customers and partners. ARS also reported 2 new technologies or strategies provided to manure and byproduct producers and users to improve profitability while meeting environmental objectives.***

<b>Describe the Technology</b>	<b>Describe the Transfer</b>	<b>Identify the Customer</b>	<b>Impact</b>
High performance nitrifying sludge (HPNS) bacterial composition: Compositions of bacteria which are effective for the nitrification of wastewater, particularly at low temperature.	Transfer Agreement (MTA): One liter sample of HPNS bacterial composition produced using ARS technology covered by US Patent App 2011/0000851 A1 was provided to a company for start-up of a full-scale field nitrifying reactor providing manure treatment to 5,200 pigs.	Livestock producers, scientists, industrialists	This technology is effective to treat wastewater contaminated with animal fecal waste and/or ammonia which is particularly difficult in winter months. The high performance nitrifying sludge contains bacteria which are highly effective for wastewater nitrification at very low temperatures (5 degrees) where other nitrifying sludges typically perform poorly
Method for Reducing Ammonia Emissions from Livestock Wastewater and for Recovering the Ammonia.	Currently seeking to grant commercial license of this invention (U.S. Patent Application Serial No. 13/164,363 – Filed June 20, 2011).	Livestock producers, scientists, industrialists.	The potential benefits are reduced ammonia emissions from liquid manure, cleaner air inside the barns with benefits to animal health, and recovery of ammonia as concentrated liquid nitrogen that can be re-used as plant fertilizer
Simulation tool for assessing and reducing reactive nitrogen losses from agricultural systems	Nitrogen Trading Tool, Nitrogen Index 4.3, and NLEAP-GIS 4.2	Farmers, crop consultants, NRCS field offices, extension agents	Increased efficiency of N fertilizers leading to increased profit from reduced inputs, lessened environmental impact from reduced excess losses to air and water
Recommendations for conservation-based biomass feedstock harvest	Used to write university and Natural Resources Conservation Service (NRCS) factsheets	Farmers, crop consultants, NRCS field offices, extension agents, agrochemical businesses	Safeguards soil productivity by defining how much residue is needed to maintain soil productivity, thus ensuring that soils can indefinitely supply food, feed, fiber and fuel.

**Measure 6.2.1 Outyear Performance Plan (the future performance indicators for this Measure)**

**During FY 2012, ARS will**

*assess the potential risks and benefits to agricultural systems that may arise from global change, and develop agricultural management practices and decision support strategies that enable producers to take advantage of beneficial effects and mitigate adverse impacts.*

*identify the processes that control the rate at which agricultural systems release and absorb greenhouse gases, and develop agricultural management practices that contribute to reductions in the Nation's net greenhouse gas emissions.*

*develop practices which remediate degraded soil, improve soil quality and protect the environment.*

*develop methods to reduce emissions of harmful gases and particulate matter from crop and animal production and processing systems.*

*develop a nitrogen relative risk assessment tool that provides field guidance for potential movement of nitrogen via runoff, leachate, or gas emission from various landscapes and cropping systems.*

*develop instrumentation and models to measure and predict emission and dispersion of particulate matter and gases from agricultural operations.*

**During FY 2013, ARS will**

*identify the processes that control the rate at which agricultural systems release and absorb greenhouse gases, and develop agricultural management practices that contribute to reductions in the Nation's net greenhouse gas emissions.*

*assess the risks and benefits to agricultural systems that may arise from global change, and develop agricultural management practices and decision support strategies that enable producers to take advantage of beneficial effects and mitigate adverse impacts.*

*document the characteristics of, develop simulation models for, and develop methods to reduce emissions of gases and particulate matter from crop and animal production and processing systems.*

*develop practices which remediate degraded soil, improve soil quality and protect the environment.*

*Develop management practices, control technologies, and decision tools to reduce or eliminate atmospheric emissions, loss of nutrients, and offsite transport of pathogens and pharmaceutically active compounds from animal production operations.*

*Develop guidelines for safe and effective agricultural uses of manure and selected municipal and industrial byproducts to lower production costs, improve soil properties, and reduce use of energy and petroleum-based products.*

**During FY 2014, ARS will**

*identify the factors controlling the rate at which agricultural systems release and absorb greenhouse gases, and develop agricultural management practices that contribute to reductions of the Nation's net greenhouse gas emissions.*

*assess the risks and benefits to agricultural systems that may arise from global change, and develop agricultural management practices and decision support strategies that enable producers to take advantage of beneficial effects and mitigate adverse impacts.*

*document the characteristics of, develop simulation models for, and develop methods to reduce emissions of gases and particulate matter from crop and animal production and processing systems.*

*develop practices which remediate degraded soil, improve soil quality and protect the environment.*

*Develop management practices, control technologies, and decision tools to reduce or eliminate atmospheric emissions, loss of nutrients, and offsite transport of pathogens and pharmaceutically active compounds from animal production operations.*

*Develop guidelines for safe and effective agricultural uses of manure and selected municipal and industrial byproducts to lower production costs, improve soil properties, and reduce use of energy and petroleum-based products.*

### **OBJECTIVE 6.3: CONSERVE AND USE PASTURE AND RANGE LANDS EFFICIENTLY**

Healthy, vigorous plant communities on diverse lands protect soil quality, prevent soil erosion, and provide sustainable forage and cover for livestock and wildlife. They also provide fiber and a diverse habitat for wildlife, improve water quality and sequester atmospheric carbon dioxide. The four serious threats that pose an increasing risk to the values, goods, and services provided by public and private pasture and range lands are wildfire, invasive species, loss of open space, and reduced profitability.

ARS works with public and private land stewards to maintain/enhance watersheds and landscapes and their environmental services. The Agency produces the scientific knowledge needed to actively manage pasture and range lands and maintain the health, diversity, and resilience of these ecosystems.

**Key Outcomes:** Pasture and range land management systems that enhance economic viability and environmental services.

#### **Performance Measure**

**Measure 6.3.1. Improved management practices and technologies for managing pasture and rangelands to improve economic profitability and enhance environmental values.**

##### **Baseline 2005**

Fifteen new technologies or strategies provided to pasture, forage, and range land managers to conserve and restore natural resources while supporting profitable production.

##### **Target 2011**

**Baseline 2005**

Cumulatively, 39 new technologies or strategies will be provided to pasture, forage and range land managers to conserve and restore natural resources while supporting profitable production.

**Indicator 1:**

***During FY 2011, ARS will provide increased understanding of genetic resources, genomics, and molecular processes of grasses, legumes, and other herbaceous plants that affect establishment, persistence, production and use so that improved germplasm and cultivars can be released for pasture, harvested forages, turf, biofuels, rangeland restoration, and conservation.***

FY 2011 Accomplishments:

New gene inserted in alfalfa could save dairy costs \$100 million annually. More efficient food production will be required to meet increasing demands by a growing population. Reducing protein nitrogen losses in dairy operations is one strategy to improve production efficiency. ARS researchers in Madison, WI identified a novel enzyme in red clover responsible for phaselic acid production and transferred the gene that encodes this enzyme to alfalfa. Plants with higher levels of phaselic acid may also be more resistant to UV and ozone stress, as well as stresses from insect pests and plant pathogens.

**Impact:** If red clover phaselic acid protection can be reconstituted in alfalfa, it is estimated that improved protein and nitrogen utilization would save farmers more than \$100 million annually by reducing the need for purchased supplemental feed proteins. Improved efficiency could also substantially reduce nitrogen waste from cattle on dairies that would end up in surface and ground waters.

First alfalfa gene index assembled to accelerate commercial variety improvement. ARS scientists at St. Paul, MN, conducted an in-depth analysis of the genes active during cell wall development and assembled the first alfalfa gene index that identifies a majority of alfalfa genes. Two major components of alfalfa stems are cellulose, a sugar molecule that is easily converted to ethanol, and lignin, a cross-linking molecule that interferes with conversion of cellulose to ethanol. Several genes associated with the regulation of lignin and cellulose biosynthesis were identified that along with the new gene index can provide ways for plant breeders to increase cellulose and decreasing lignin expressed in cell walls to increase the value of alfalfa as a bioenergy crop.

**Impact:** Rapid identification of useful genes and their function can be used to accelerate genetic improvement for specific traits of commercial interest and increase the total value of products produced from alfalfa. Lignin in cells walls is a major impediment to digestion of alfalfa by livestock and conversion of cellulosic biomass to liquid fuels, so improvements in digestion increase animal performance and reduce feedstock processing costs.

Two new native legume germplasm developed for western rangeland restoration. To combat weed invasion, effective rangeland restoration programs restore a diversity of plant species. Currently, there is a lack of commercially available native legume species. Of particular interest is Western prairie clover, a perennial legume found naturally in North America that provides its own nitrogen through biological fixation. ARS researchers at Logan, UT, released 'Spectrum' and

'Majestic' western prairie clover germplasm to the commercial seed trade. Spectrum was selected to represent plant materials from the central and eastern Columbia Plateau, central and eastern Blue Mountains, Northern Basin and Range, and Snake River Plain regions. Majestic was selected to represent plant materials from the western Columbia Plateau and Western Blue Mountains regions.

**Impact:** Range restoration with these clover germplasm releases will enhance biodiversity, provide forage for wildlife and livestock, and enhance habitat for native pollinators. Native legumes are also needed to help improve native pollinator diversity on previously degraded rangelands.

#### Indicator 2:

***During FY 2011, ARS will provide forage and pasture management technologies and strategies that reduce inputs while improving livestock performance and sustaining the environment.***

FY 2011 Accomplishments:

Improving grazingland classifications using remote sensing to restore pasture health in the Northeastern U.S. Accurate estimates are needed for the amount of land that is used for grazing, and remote sensing technologies could greatly help track changes. ARS scientists at University Park PA, developed and released software to automate corrections for atmospheric and landscape topography variation that are necessary before *Landsat* and other satellite imagery can be applied to pastures in the northeastern United States. *National Land Cover Data* estimates were compared with the more accurate but non-spatial NASS *National Agricultural Census* data to determine whether county-level areas were correctly identified in the twelve Northeastern states. Total agricultural areas were similar for the two data sources, but the *National Land Cover Data* poorly distinguished between row crops and pasture or hayland.

**Impact:** This research provides a needed improved method for accurately classifying grazing and forage areas in diverse mixed land use in northeastern U.S. landscapes. Urban encroachment, loss of farmland, and intensive management all contribute water quality degradation, so accurate identification of pasturelands is needed to find ways to mitigate sources of pollution.

Inexpensive grazing solution to reduce overgrazing on western rangelands. Livestock often concentrate grazing in one part of a range, while avoiding other regions. Keeping livestock dispersed from heavily grazed regions is a challenge for grazing management. ARS at Boise, Idaho and US Forest Service researchers evaluated several factors that drive livestock aggregation patterns in partially forested range in eastern Oregon. It was found that the point where cattle initially entered a pasture was the primary driver of subsequent grazing distributions. Results indicate that by instituting simple, inexpensive changes in where livestock enter pastures, managers could prevent overgrazing and increase profitability.

**Impact:** Altering pasture entry into large pastures and allotments can be considerably less expensive and more easily implemented than herding, water development, fencing, and movement of supplement locations.

#### Indicator 3:

***During FY 2011, ARS will provide rangeland management technologies and strategies that reduce inputs while improving livestock performance and sustaining the environment,***

***including reducing the risks of wildfires, invasive weeds, and other threats, by stabilizing, restoring, and monitoring degraded rangeland in an affordable and sustainable manner.***

FY 2011 Accomplishments:

New erosion prediction tool targets conservation saving money and soil. Soil erosion from agricultural lands and deposits of sediment into rivers and lakes is a persistent environmental challenge that costs the United States over \$6 billion dollars every year. In collaboration with ARS scientists in Boise, Idaho, and Tucson, Arizona, scientists at the Great Basin Rangelands Research Unit in Reno, NV, developed a new soil prediction tool for rangelands that helps land managers to predict long-term soil loss after individual storms. This new tool provides a way for land managers to predict where erosion will occur, and provides a way to assess the possible effectiveness of different conservation practices before soil degradation occurs.

***Impact:*** This tool has been adopted by the Natural Resources Conservation Service and is being used to evaluate existing conservation programs and how they can be enhanced and improved deliver of conservation in a more cost-effective manner by targeting areas of concern.

**Measure 6.3.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2011:**

***During FY 2011, ARS reported 6 new technologies or strategies provided to managers of pasture, forage and range lands to improve conservation, restore natural resources, and increase profitability.***

<b>Describe the Technology</b>	<b>Describe the Transfer</b>	<b>Identify the Customer</b>	<b>Impact</b>
New gene inserted in alfalfa		U.S. Dairy Industry	Potential annual savings, \$100-million
Alfalfa gene index assembled	Validated information in public genetic database	Noble Foundation and Consortium for Alfalfa Improvement (ARS, Noble, Forage Genetics and Pioneer)	10-fold increase in the number of known alfalfa gene sequences - In animal production a 1% increase in cell wall digestibility leads to a 3.2% increase in daily live-weight gain in beef cattle. A 5% increase in digestibility increases dairy net return by 2%
Two new native legume germplasm	Release of <i>Spectrum</i> and <i>Majestic</i> Western Prairie Clover	BLM, USFS, and private producers	Seed industry is now increasing foundation seed for sale. Potential impact is considered to be dramatic since these are the only such germplasm developed for the arid western US rehabilitation
Remote sensing classification method	Software and scientifically-based tools including Classification presented to NRCS	USDA NRCS and NASS, and USGS	Accurate classification of eastern pasture lands so more effective management plans can be developed – Potential annual pasture profit of \$95 million

## ARS Strategic Goal 6

Inexpensive grazing solution	Grazing management guidelines and improved best practices	US Forest Service and land managers	New management information that can significantly reduce the impact of grazing livestock on the land resource base – reduced need for using purchased inputs to distribute livestock
New erosion prediction tool	Technology presentation to NRCS managers for implementation	USDA NRCS	Accurate estimation of erosion so more effective management plans can be developed and implemented – greater impact from invested conservation program payments

### **Measure 6.3.1 Outyear Performance Plan (the future performance indicators for this Measure)**

#### **During FY 2012, ARS will**

*provide increased understanding of genetic resources, genomics, and molecular processes of grasses, legumes, and other herbaceous plants that affect establishment, persistence, production and use so that improved germplasm and cultivars can be released for pasture, harvested forages, turf, biofuels, rangeland restoration, and conservation.*

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

*provide rangeland management technologies and strategies that reduce inputs while improving livestock performance and sustaining the environment, including reducing the risks of wildfires, invasive weeds, and other threats, by stabilizing, restoring, and monitoring degraded rangeland in an affordable and sustainable manner.*

#### **During FY 2013, ARS will**

*provide increased understanding of genetic resources, genomics, and molecular processes of grasses, legumes, and other herbaceous plants that affect establishment, persistence, production and use so that improved germplasm and cultivars can be released for pasture, harvested forages, turf, biofuels, rangeland restoration, and conservation.*

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

*provide rangeland management technologies and strategies that reduce inputs while improving livestock performance and sustaining the environment, including reducing the risks of wildfires, invasive weeds, and other threats, by stabilizing, restoring, and monitoring degraded rangeland in an affordable and sustainable manner.*

#### **During FY 2014, ARS will**

*provide increased understanding of genetic resources, genomics, and molecular processes of grasses, legumes, and other herbaceous plants that affect establishment, persistence, production and use so that improved germplasm and cultivars can be released for pasture, harvested forages, turf, biofuels, rangeland restoration, and conservation.*

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

*provide rangeland management technologies and strategies that reduce inputs while improving livestock performance and sustaining the environment, including reducing the risks of wildfires, invasive weeds, and other threats, by stabilizing, restoring, and monitoring degraded rangeland in an affordable and sustainable manner.*

# ARS Management Initiatives

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 INITIATIVE 1: ENSURING THE QUALITY, RELEVANCE, AND PERFORMANCE OF ARS RESEARCH (COVERS ALL RESEARCH OBJECTIVES)

The Office of Management and Budget (OMB) has established Governmentwide 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 Measure

**MI 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 2004

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.

#### Target 2011

100% of ARS' projects will be conducting highly relevant research.

**MI 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.**

**Baseline 2005**

Using an average based on cumulative scores for the past five years, 76.1% of projects received scores of No, Minor, Moderate revision needed upon initial review and, overall, 97% received such scores by the completion of the review.

**Target 2011**

Using a cumulative five-year average, 80% of the projects reviewed will receive initial scores of No, Minor, or Moderate revision needed and 98% receive such scores by completion of review.

**Baseline 2005**

RPES conducted 392 scientific peer reviews of ARS scientists: 181 (46.2%) were upgraded, 203 (51.8%) remained in grade or were referred to the Super Grade Panel, 3 (0.8%) could not be graded because of insufficient information, and 5 (1.3%) had a grade/category problem.

**Target 2011**

RPES will conduct 400 scientific peer reviews of ARS scientists.

**MI 1.3 Performance: ARS will monitor the percentage of annual research project milestones met.**

**Baseline 2004**

85.3% of ARS project milestones were fully or substantially met.

**Target 2011**

89% of ARS' project milestones will be fully or substantially met.

**Baseline 2004**

NPS completed three National Program Reviews.

**Target 2011**

NPS will complete National Program Reviews for all Programs in the first 5-year cycle and will begin reviews for the programs currently in the second 5-year cycle.

**FY 2010 Accomplishments are reported under the USDA Performance Accountability Report and OMB PART requirements.**

**MANAGEMENT INITIATIVE 2: 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 the [Animal Welfare Information Center](#) (AWIC), the [Rural Information Center](#) (RIC), the [Food Safety Research Information Office](#), and the [Agriculture Network Information Center](#) (AgNIC). The library 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. Recently, the library, with partners in the land-grant university and agricultural information service communities, has initiated development of the National Digital Library for Agriculture (NDLA).

**Performance Measures**

**MI 2.1 The services and collections of the National Agricultural Library continue to meet the needs of its customers.**

**Baseline 2005**

The National Agricultural Library total annual volume of customer service transactions exceeded 82 million.

**Target 2011**

The National Agricultural Library total annual volume of customer service transactions exceeds 145 million.

**Indicator 1:**

***During FY 2011, NAL will continue to expand and improve services based on customer usage and satisfaction data.***

FY 2011 Accomplishments:

The National Agricultural Library (NAL) is the largest and most accessible agricultural research library in the world. It provides service directly to the staff of USDA and to the public, primarily via the NAL Web site, <http://www.nal.usda.gov>. NAL was created with the U.S. Department of Agriculture (USDA) in 1862 and was named in 1962 a national library by Congress (7USC§3125a), as "the primary agricultural information resource of the United States." NAL is the premier library for collecting, managing, and disseminating agricultural knowledge. The Library is the repository of our Nation's agricultural heritage, the provider of world-class information, and the wellspring for generating new fundamental knowledge and advancing scientific discovery. It is a priceless national resource that, through its services, programs, information products, and Web-based tools and technologies, serves anyone who needs agricultural information. The Library's vision is "advancing access to global information for agriculture."

Progress Towards Becoming "Digital NAL" For decades, NAL has delivered some services and content digitally. The goal of "Digital NAL" is 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." A number of projects to re-engineer NAL operations and improve NAL's digital services commenced in FY2011. The Library's primary database and digital repository of USDA publications were restructured and made accessible to internet search engines with a resulting increase in usage. The Library's information technology infrastructure is being reinforced and brought up to date. The NAL collection development policy was revised. The DigiTop and DigiCALS services for USDA personnel was combined and re-engineered with improved capabilities. Growth of the AGRICOLA index has been identified as a critical task to further a Digital NAL. An automated indexing application was identified and the implementation procedure begun. The indexers will become editors performing quality control and are tuning the indexing application with the goal of increasing annual production to more than 250,000 articles in the next two years.

***Impact:*** Services were expanded and improved and new initiatives were begun to support further expansion and improvement.

Delivering Information and Research Services.

NAL provides free access to agricultural information, primarily through its core Web site, [www.nal.usda.gov](http://www.nal.usda.gov). NAL's FY2011 total volume of direct customer transactions exceeded 95 million transactions. Services delivered digitally continued to grow while services based entirely on physical materials continued to decline. Examples of accomplishments and progress include:

- DigiTop usage stayed strong while document delivery services decreased. USDA staff executed 1,303,403 full text downloads from NAL's DigiTop (Digital Desktop for USDA) service level with usage in FY2009. In contrast document delivery requests received by NAL decreased by 35 percent to 19,124 items as more material became available online. 100% of document delivery requests were received electronically and 83% delivered electronically. Reference transactions decreased 27.8% to 11,151 as more information is available on our web site.

- Integration of DigiTop and Current Awareness Literature Service. Mark Logic software system was procured to integrate the Current Awareness Literature Service and DigiTop services beginning January 2011. Cost savings and a more robust search and discovery platform for USDA staff are among the expected outcomes
- NAL's AFSIC received project funds to support organic livestock producers and researchers. The Alternative Farming Systems Information Center received \$114,000 from USDA's National Institute of Food and Agriculture and Agricultural Marketing Service to select, digitize, and make publicly available important USDA publications on organic livestock production.
- NAL completed the digital conversion of items from the USDA Pomological Watercolor Collection funded by a grant of \$206,600 from The Ceres Trust. Over 7,500 original watercolor paintings are now available on the NAI web site at <http://usdawatercolors.nal.usda.gov/>.
- NAL's AFSIC/RIC received \$1.5 million grant from the American Farm Bureau Federation and with additional funding from NIFA is operating the Beginning Farmer and Rancher Development Program (BFRDP) Curriculum and Training Clearinghouse (CTC). The CTC is actively collecting information on beginning farmer and rancher education, training, outreach and mentoring materials and activities, and making this information available at the online [library](#). [Start2Farm.gov](http://Start2Farm.gov). This website went live in August 2011 as an online accessible "one-stop" source of information for beginning farmers and ranchers, and is organized into four main topic areas: educational programs, financing, service providers, and networking; additionally a "New to Farming" tutorial, events calendar, BFRDP & USDA program information are featured. The site has had over 75,000 page views since launch. Start2Farm.gov will access materials developed by projects funded through the BFRDP program by displaying project related materials uploaded by grantees.
- NAL receives renewed funding to digitize Fruit and Vegetable Market News Reports collection. Funding received from USDA/AMS since 2006 has supported digitization of over 2,200-450 titles (~87,700 pages) of AMS Reports which provide detailed marketing information for fruit and vegetable commodities at domestic wholesale markets and production areas, since 1916.
- NAL's Food and Nutrition Information Center/Nutrition.gov specialists provided advice and digital content including:
  - **Chefs Move to Schools Project.** The Child Nutrition Team managed the Chefs Move to Schools project and database that as of September 30<sup>th</sup> had 3,259 chefs and 3,193 schools enrolled in the program.
  - **SNAP-Ed Connection Launch of EARS Interactive Training Module.** The Supplemental Nutrition Assistance Program (SNAP)-Ed Connection team launched an interactive training module for SNAP educators and providers called "An Introduction to EARS". This self-paced online learning module provides an in depth overview of the Education and Administrative Reporting System (EARS), which aims to provide uniform data and information about SNAP nutrition education activities across all states.
  - **Interactive DRI for Healthcare Professionals.** This tool calculates an individual's daily nutrient recommendations based on the Dietary Reference Intakes (DRIs) and is located at <http://fnic.nal.usda.gov/interactiveDRI> and usage increased 36% over FY2010.
  - **Nutrition.gov: Website Statistics.** Pageviews increased 18%, from 1,690,029 in FY2010 to 1,995,922 in FY2011 (+ 305,893)
  - Partnership with **Food Distribution Program on Indian Reservations Partnership (FDPIR).** **FNIC developed an** online "Sharing Gallery" for FDPIR staff to share nutrition education materials, images, or other resources of interest to federal staff and others interested in nutrition education for Native Americans was released in FY11.

**Impact:** Services were expanded and improved.

Developing Decision Support Tools for Science-Based Sustainability Practices.

Concern for the environment has increased consumers' interest in how agricultural products are grown and made. As a result, researchers and the food industry are working to better assess the environmental impacts of processes and activities that span an agricultural product's life cycle, from the acquisition of raw materials to the product's eventual disposal. Currently, however, few information resources devoted to this life cycle inventory exist, particularly for products originating in North America. NAL has begun an initiative to build a database of data sets gauging the material and energy inputs of production processes, along with the outputs released to the environment during production, use and disposal. This life cycle assessment database can then be expanded to include data from other industries, so that one can evaluate the potential environmental impacts of products throughout their life cycle and the processes in place to produce them. Such data can then inform decisions about changing processes or the materials that go into them to reduce the burden on the environment. NAL has

**Impact:** Services were expanded and improved.

Digital repository

During FY 2011, NAL renamed the digital repository to "NAL Digital Collections" (NALDC), <http://naldc.nal.usda.gov/>. NAL added approximately 3,000 items to its digital repository. By the end of FY2011, NAL's digital repository included ~46,000 items. The Library launched the new NAL Digital Collections in September 2011. The goal of this effort is unify the existing three platforms into a single platform with a simplified search interface and a streamlined process for adding items and descriptions. Along with the NALDC, NAL launched the USDA Watercolors Collection, <http://usdawatercolors.nal.usda.gov/>, a collection of over 4,500 pomology images.

**Impact:** Services were expanded and improved.

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>). AgNIC provides access to high-quality agricultural information selected by its 63 AgNIC partners, including land-grant universities, NAL, and other institutions around the world. The AgNIC search now provides access to over 5 million sources. AgNIC incorporates 2/3 of the AGRICOLA database and 1.5 million PubMed records which include links to local libraries owning the items, in case people would like to borrow them locally. AgNIC harvests over 30 relevant full-text digital repositories from institutions worldwide, in multiple languages. The AgNIC partners identified over 150 additional digital repositories to harvest. AgNIC utilizes Open Source technologies which are all freely available. AgNIC partners engaged in four new Specific Cooperative Agreements to digitize unique content held at partner institutions.

- **Vivo:** NAL is working with ARS, other REE Agencies, and Forest Service to establish a semantic web application that enables the discovery of research and scholarship across the USDA science agencies. The application will allow better discovery for networking, collaboration and research. VIVO will also allow citizens to better discover USDA research. This application is called "VIVO" and is an Open Source, or free application jointly developed by Cornell University and the University of Florida. NAL hosts VIVO for USDA and provides leadership for implementation.

- *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. 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 improved.

**Measure MI 2.1 Outyear Performance Plan (the future performance indicators for this Measure)**

**During FY 2012, NAL will** continue to expand and improve services based on customer usage and satisfaction data.

**During FY 2013, NAL will** continue to expand and improve services based on customer usage and satisfaction data.

**During FY 2014, NAL will** continue to expand and improve services based on customer usage and satisfaction data.

**MI 2.2 The National Agricultural Library and partners implement the National Digital Library for Agriculture.**

**Baseline 2005**

The NAL and partners began formal discussions about developing the National Digital Library for Agriculture (NDLA).

**Target 2011**

The NDLA comprises more than 100 partner institutions that preserve and provide access to quality digital information, including millions of pages of digital content; is recognized widely, used extensively, and valued by the agricultural community; and is the U.S. agriculture component of the global digital science and technology knowledge base.

**Indicator 1:**

***During FY 2011, NAL will not work on this objective.***

FY 2011 Accomplishments:

NAL ceased work on the NDLA at the end of FY2009 due to lack of funding.

**Impact:** No impact

**Measure 2.2 Outyear Performance Plan (the future performance indicators for this Measure)**

**During FY 2012, NAL will not continue work on the NDLA.**

**During FY 2013, NAL will not continue work on the NDLA.**

**During FY 2014, NAL will not continue work on the NDLA.**

**MANAGEMENT INITIATIVE 3: 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.**

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**Performance Measure**

**MI 3.1 Take proactive steps to increase representation of minorities, women, and employees with targeted disabilities in the workforce; improve retention; increase career development opportunities; and increase diversity in award recognition programs.**

**Baseline 2005**

The FY 2005 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 the barriers.

**Target 2011**

Reduce/eliminate barriers identified in the MD-715, Annual EEO Program Report.

**Actionable Strategies/Activities for Management Initiative 3**

- **Expand outreach activities in K-12 schools (long-term goal), universities/colleges, and minority serving institutions and organizations to educate students and faculty about scientific research and diversify the workforce.**

**FY 2011 Accomplishments:**

The Agricultural Research Service (ARS) continued to conduct outreach activities in K-12 schools and colleges and universities including the 1862, 1890, and 1994 Land Grant Institutions and minority serving institutions such as Hispanic-Serving Institutions (HSIs), Historically Black Colleges and Universities (HBCUs), and Tribal Colleges and Universities (TCUs). Additionally, the Agency continued to conduct outreach activities with minority serving organizations [i.e., Society for Advancement of Chicanos/Latinos and Native Americans in Science (SACNAS); Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS), Thurgood Marshall College Fund, Conference on Asian Pacific American Leadership (CAPAL)], the Workforce Recruitment Program (WRP), and the USDA/1890 National Scholars Program.

ARS also partnered with several student-based organizations in an effort to educate potential applicants about ARS career opportunities; decrease the negative image of agriculture; and increase the number of PhDs received in science, technology, engineering, and mathematics (STEM) disciplines. Furthermore, outreach and recruitment initiatives helped develop and strengthen partnerships with institutions of higher education and minority serving organizations. These initiatives are coordinated with the ARS Office of Outreach, Diversity, and Equal Opportunity (ODEO), including the Area ODEO Program Managers and the Area EEO/Diversity Committees and Special Emphasis Program Managers. ARS staff participated in several of the planned events, including, but not limited to, resume critiques.

**Professional/Science-Based Organizations:** Exhibits were set up and hosted at several scientific professional society events for the purpose of showcasing ARS careers and employment opportunities as well as to serve as a major advocate to specific communities and/or organizations, providing educational materials, enhancing not only ARS but also USDA at these events while improving the overall image of USDA with increased positive exposure in order to improve understanding of access to employment opportunities and understandings of ARS scientific mission:

- American Chemical Society Meeting and Expo (Administrator and Information Staff)
- American Indian Science and Engineering Society (AISES) Annual Conference
- American Society of Agricultural and Biological Engineers
- Annual Biomedical Research Conference for Minority Students (ABRCMS)
- Association of Research Directors
- Federal Asian Pacific American Council (FAPAC)
- Latinos for Hire, Los Angeles, California
- Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS) Conference
- National FFA Organization (formerly known as Future Farmers of America until 1988)
- Society for the Advancement of Chicanos and Native Americans in Science (SACNAS)
- Youth Motivational Task Force/University of Arkansas at Pine Bluff

**Other events: ARS staff participated in the following events for the purpose of promoting careers in agriculture and science:**

- American Society of Agricultural and Biological Engineer National Irrigation Symposium
- Annual Meeting of the National Institute of Food and Agriculture
- Annual Student Researcher Day (MWA)
- Beltsville Area Research Center Poster Day
- Charles Herbert Flowers High School Research Symposium
- Delaware Valley Science Fair (NPA)
- Department of Defense Base Closure and Realignment Career Fair (NAL)
- Environmental Wellness Festival (Mandan, North Dakota)
- Historically Black Colleges and Universities 2011 Technical Assistance Conference at the Alabama A&M University (MSA)
- Kansas-Assisted Equality Coalition (NPA)
- Lincoln Spring Career Fair (MWA)

- Maricopa Agricultural Center's Annual Farm Day (PWA)
- Marketplace for Kids (Fargo, North Dakota)
- Morton County Ag Day (Mandan, North Dakota)
- Northern Star Council Boy Scouts of America (MWA)
- Peoria, Illinois 4<sup>th</sup> Annual Student Researcher Day
- Prince Georges County Schools Science and Career Fairs
- Prince Georges District of the National Capitol Area Council, Boy Scouts of America (BA)
- Rau Elementary School Science Fair (Sidney, Montana)
- Seattle Expanding Your Horizons Career Conference (PWA)
- Sidney, Montana Middle School Science Fair
- Women in Chemistry (Wyndmoor, PA)
- Women in Natural Sciences (Wyndmoor, Pennsylvania)
- Women in Science Careers Panel (NPA)
- Woodland Job Corps Center Mentoring Program
- USDA Cooperators Conference, St. Louis, Missouri
- USDA's Earth Day (including Area events)
- USDA's Friends and Neighbors Day
- USDA's (DC) and ARS's (Beltsville) Take Your Daughter and Son to Work Day (Areas also sponsored events)
- Vansville Elementary School Science Fair

**Colleges/Universities and K-12 Events: ARS staff participated in career fairs and career day events hosted by the following K-12 schools, colleges, and universities for the purpose of promoting careers in agriculture and science:**

- **Alabama A&M University**
- **Alcorn State University**
- **Bismarck State College**
- **Central State University**
- **Central Washington University**
- **City College of San Francisco**
- **Colorado State University**
- **Cornell College**
- **Cornell University**
- **Delaware State University**
- **Delgado University**
- **Dickinson State University**
- **Dillard University**
- **Florida A&M University**
- **Fond du Lac Tribal and Community College**
- **Fort Valley State University**
- **Grambling State University**
- **Iowa State University**
- **Jamestown College**
- **Kansas State University**
- **Kentucky State University**
- **Langston University**

- Laramie County Community College
- Leech Lake Tribal College
- Lincoln University
- Maryville State University
- Michigan State University
- Montana State University
- New Mexico University
- Nebraska Christian College
- North Carolina A&T State University
- North Dakota State University
- Northeastern Illinois University
- Purdue University
- Rutgers University
- Sisseton Wahpeton Community College
- Sitting Bull College
- South Carolina State University
- South Dakota State University
- Southern University and A&M College
- St. Edwards University
- Tennessee State University
- Texas A&M University
- Truman College
- Tuskegee University
- United Tribes Technical College
- University of Alaska - Fairbanks
- University of Arkansas – Pine Bluff
- University of Arizona
- University of California – Davis and Riverside
- University of Maine
- University of Mary
- University of Maryland
- University of Minnesota
- University of Missouri
- University of Nebraska-Lincoln
- University of New York
- University of North Dakota
- University of Utah
- University of Wisconsin
- University of Wyoming
- Utah State University
- Valley City State University
- West Virginia State University
- Whittier College
- Williston (North Dakota) State College

- **Wright College**
- **Xavier University**
- **Yakima Valley Community College**

#### **Agency Partnerships:**

##### **Adopt a Scientist Pilot Program**

The pilot program was initiated in February 2011 partnering ODEO, Beltsville Area (BA), and the Charles Herbert Flowers High School. Salaries for the students will be supported by ODEO (\$13,740) to support three high school summer hires (one Hispanic male and two African American females). The purpose of the program is to expose local high school students to what it takes to become a scientist and the wide variety of careers and lifestyles that are available with a scientific career.

##### **Educational/People's Garden initiative**

All Areas continue to support Secretary Vilsack's USDA Educational/People's Garden initiative.

##### **Beltsville Elementary School**

The ARS BA employees continue to volunteer at science fairs, and the Academic Mind Core Endeavor, an annual event that takes place at the Beltsville Elementary School in Maryland. The event consists in providing students 100 questions and answers in the areas of science, math, art, health, literature, music, and social studies. The employees assist in testing the students in their ability to provide as many correct answers as possible.

##### **Bridge Internship and Job Preparation Program (BIJP)**

The PWA WRRC continues the BIJP between WRRC and City College of San Francisco. The program entails a 180-hour laboratory internship for working adults studying at City College of San Francisco. The students who are looking for a career change have basic biotech skills. The intern's salary is fully funded through a City College of San Francisco grant. Currently, two WRRC research units are participating in the program with a total of two students. The diversity of BIJP is evident in the enrollment: one Asian male and one Asian female. Many of the supervisors who are participating in the BIJP also participated in the formerly named SFWorks Program.

##### **Conference on Asian Pacific American Leadership (CAPAL)**

ARS continues the partnership (since 2008) with CAPAL to provide young Asian Pacific American leaders an opportunity to gain exposure to career opportunities with the Federal government in general, and ARS in particular. ARS is committed to provide \$10,000 annually until 2013. In 2011, ARS hosted two CAPAL interns in the DC Metropolitan Area (senior at the University of California, Berkeley majoring in political economy and Chinese interning with HRD and graduate student interning with the Food components and Health Laboratory of the Beltsville Agricultural Research Center.

##### **Confederated Tribes of Colville Reservation**

The ARS Root Disease and Biological Control Research Unit, PWA, Pullman, Washington, continues to lead a STEM outreach and engagement program (initiated in 2005) involving ARS, Washington State University (WSU), Bellevue College, Natural Resources and Conservation Service, and members of the Confederated Tribes of the Colville Reservation. The goal of the program, *Pumping-Up the Math & Science Pipeline: Grade School to College* is to enhance the flow of students from underserved and rural communities into STEM professions. The program targets students on the Colville Reservation and in rural regions of North Central Washington State. This targeted population is plagued with chronic poverty, low high school graduation rates, and high youth suicide rates. The Pipeline Program has six components: (1) science and math education in reservation and rural schools (2) on-reservation summer science camps; (3) high school summer research interns at ARS laboratories; (4) mentoring undergraduates students (5) connecting students to employment opportunities in STEM professions; and (6) development of a biofuels program on the Colville Reservation. The Pipeline Program enhances

students' interest in science and math through monthly visits to Nespelem School and Paschal Sherman Indian School on the Colville Reservation by scientists who present science and math modules. Subsequently, student interest is cultivated during the Skwant Life Science Summer Camps held at the Paschal Sherman Indian School. High school students are then offered paid summer research internships at ARS laboratories, with WSU providing on-campus housing for the interns. Pipeline Program volunteers also mentors undergraduates from underrepresented and underserved groups to help them succeed at WSU in STEM majors. The Pipeline Program is underpinned by the commitment of world-class scientists and engineers to not only mentor, train and employ young future scientists, but also, to teach in the communities of the students. The Pipeline Program is a portable platform that can be used for science and math outreach and education to other groups of Americans, who are traditionally underrepresented in STEM professions. The mission of the program is extending the benefits of science and math to all Americans. Native American students participating in the Pipeline program in junior high school and high school in 2005 are now enrolling at WSU. The key to success is engaging students in grade school and keep them in STEM programs throughout high school. As a result, they see the benefits of a college education and a STEM profession. Thirty eight underserved students have participated in the ARS Summer Research Internship Program. Twelve students have been hired on the Student Temporary Experience Program as Bioscience Aids in ARS Research Units at Pullman, Washington. In addition, over 2,000 students have been exposed to USDA-ARS research programs as part of the activities sponsor by the Pipeline Program. Enrollment of Native American students at WSU has increased four times in part to Pipeline activities.

#### **Fortis College, Landover, Maryland**

At no cost to the Agency, the Fortis College Biotechnician Program prepares students for entry level, research, manufacturing, and quality control positions in academic and industrial biotechnology facilities. Students begin their academic path by entering into Standard Laboratory Operating Procedures in which they learn how to efficiently function in a laboratory setting; practicing safe laboratory techniques and applying scientific methodologies. Students then progress to perform advanced molecular studies including protein production techniques, DNA studies, and biomanufacturing procedures using the most up-to-date equipment including spectrophotometers, thermocyclers, biological safety cabinets, and gel electrophoresis boxes. The BA hosted three students (African American female, African American male, and Hispanic female).

#### **Society for the Advancement of Chicanos and Native Americans in Science (SACNAS)**

ARS representatives hosted an exhibit to showcase the many career opportunities available within ARS and USDA. SACNAS provides unparalleled conference activities for students, postdocs, educators, administrators, and researchers in all disciplines of science, mathematics, and engineering. A Northern Plains Area (NPA) scientist continues to mentor at SACNAS.

#### **Thurgood Marshall**

For the past several years, ARS has sponsored and participated in the Thurgood Marshall College Fund (TMCF) Leadership Institute and Career Fair. ARS' sponsorship is \$10,000 annually. The TMCF Leadership Institute is the only organization in the United States that represents all of the Nation's public HBCUs. In addition to the career fair, ARS typically conducts workshops during the event. This year, staff served as a panelist targeting potential employees on the skills necessary to become and succeed as a federal government employee.

#### **1890 National Scholars Program**

ARS continued to support eight scholars by providing them with paid internships, professional development training, use of laptops, tuition, fees, and books. During 2011, two scholars were converted as a nutritionist and an accountant. The other scholars are enrolled at Tuskegee University, Langston University, South Carolina State University, Southern A&M University, Alabama A&M University, and Florida Agricultural and Mechanical University with majors in accounting, agricultural business, animal science, civil engineering, and dietetics. They are employed with ARS during the summer and will be converted to full time employees upon their graduation. ODEO participated in the planning and execution

of the orientation and leadership development conference for the new scholars of the 1890 National Scholars Program held in Annapolis, Maryland during the summer 2011. In addition to serving on the planning committee for the orientation, ODEO staff also presented a workshop on Etiquette Basics, and conducted professional development sessions for the students in preparation for interaction with senior management during the Orientation.

### **Hispanic-Serving Institutions (HSIs)**

- The Eastern New Mexico University received an USDA Hispanic-Serving Institutions (HSIs) grant to enhance students' experience in conducting animal science research under the supervision of a Research Leader of the Livestock Behavior Research Unit.

USDA provided a grant to the Northeastern Illinois University (a HSI member) to increase the number of STEM students pursuing graduate study in environmental and agricultural sciences. An NEIU student is being hosted and mentored through a 10-week undergraduate research experience summer program on the University of Illinois' campus by an Ecologist in Global Change and Photosynthesis Research at Urbana, Illinois.

- ARS' Southern Plains Area (SPA) and the USDA Hispanic-Serving Institutions National Program (HSINP) continued collaborating with the College of Science's Center for Mathematics and Science Education at Texas A&M University in College Station, Texas.

The program is designed to reach out to communities and K-12 schools with hands-on, inquiry-based activities that link them with USDA-ARS scientists, laboratory sites and current agricultural science research. It is being expanded under the auspices of the USDA HSI National Program to a national model with a K-12 focus on insect life cycles using the USDA-ARS research on the corn earworm (*Helicoverpa zea*) as a model at each laboratory site, plus a secondary focus on one area of local research e.g. Honey Bee (*Apis mellifera*) research at the USDA-ARS laboratory in Tucson, Arizona.

As a follow-up to a teacher workshop held at USDA-ARS Knippling-Bushland U.S. Livestock Insects Research Laboratory in Kerrville, Texas, the Future Scientists Program Project Director (Director) taught twelve classes within two days at the B.T. Wilson 6<sup>th</sup> Grade Center. In addition, scientists from the SPA research unit provided the Director stable and house fly samples and vials of ticks, and a "4-Poster" tick medicating device into classrooms to enrich the presentations and showcase to students some of the work being conducted at their local USDA-ARS laboratory. Attendees included 245 students (52 percent White, 43 percent Hispanic, 3 percent African American, and 2 percent Asian). Also, in 2011, the Director visited the University of Houston-Downtown, Houston, Texas to meet with a graduate of the USDA HSINP Ambassador Program, an Associate Professor in the Department of Urban Education University, to discuss a possible collaboration on a grant that would facilitate the Future Scientist Program Project Director presenting the Future Scientists Program in two schools to teachers as part of their professional development. The teachers are already serving as mentors to Education Majors during their "Teaching Practice." The teachers would spend one afternoon at the ARS SPA Children's Nutrition Research Center (CNRC) in Houston, Texas. Similarly, the Future Scientist Project Director would present the program to the Education Majors as part of their coursework, and they would visit the CNRC as well. Corn earworms would be used with elementary students in the two schools during the year. During the 1<sup>st</sup> or 2<sup>nd</sup> quarter of FY 2012, the University of Houston-Downtown in collaboration with a research scientist at the CNRC will submit the grant proposal to the Houston Foundation.

### **Wallace-Carver Internship Program (WCIP)**

The ARS hosted ten students from the WCIP [BA – three; Midwest Area (MWA) – five; North Atlantic Area (NAA) – one; and PWA – one). The WCIP is an elite internship program for students involved in cutting-edge agriculture, science and research. The interns participate in a one-week orientation in Washington, DC (housing and travel expenses paid by ODEO); in symposium discussions with global leaders in science, industry and policy; and have the opportunity to work in the most current

agriculture research, gaining unparalleled professional experience. The students are assigned to a 4-6 week project that they are required to report on at the end of the program. Salaries are paid by the receiving Areas (approximately \$32,000 for the ten students).

- **Review and assess the utilization of the student programs [Student Temporary Employment Program (STEP), Student Career Experience Program (SCEP), and postdoctoral research associate programs]. Encourage managers to convert students who have previously participated in the program from the STEP to the SCEP.**

#### **FY 2011 Accomplishments:**

ARS continued to review the student programs and encourage managers to convert students participating in STEPs to SCEPs. These programs provide access to a large pool of talented individuals with fresh ideas as well as ARS' focus to provide access to improve diversity in the workforce.

Post-docs: ARS currently has 308 Post-docs (38 percent are White males; 35 percent are White females; 11 percent are Asian males; 7 percent are Asian females; 2 percent are African American females; 2 percent are Hispanic males; 1 percent are African American males; 1 percent are Multi-race females; 1 percent are Multi-race males; .32 percent are American Indian females; .32 percent are American Indian males; and .32 percent are Hispanic females).

SCEPs: ARS currently has 64 students in active status. Forty-five percent (29) are minorities (22 percent are African American females; 8 percent are African American males; 4.6 percent are Hispanic females; 4.6 percent are Hispanic males; 1.5 percent are American Indian females; 1.5 percent are Asian females; 1.5 percent are Multi-race females; and 1.5 percent are Multi-race males); 29.6 percent are White males; and 25 percent are White females. Note: Minorities increased 12 percent since 2010. The ODEO Outreach and Recruitment Branch and the Area ODEO Program Managers continue to track the participants in the ARS SCEP and Post-Doc Program, as a recruitment initiative. Due to the high quantity of students participating in the STEP, ARS has no means to track STEPs. Student programs can serve as a viable recruitment tool to address the aforementioned issues, but only if student employment leads to permanent employment.

ARS has no students in the Workforce Recruitment Program (WRP) which targets students and recent graduates with disabilities and the use of open continuous vacancy announcements which specifically solicit candidates with non-disqualifying disabilities. However, the focus will continue to seek students from WRP in hopes that a few of the candidates will be available for permanent employment after completing their school commitments.

- **Ensure that all employees complete mandatory USDA and recommended training.**

#### **FY 2011 Accomplishments:**

The USDA Office of the Assistant Secretary for Civil Rights (OASCR) required No Fear Refresher training [98 percent completed the training (the remaining two percent are most likely employees who have separated from ARS – further investigation is being conducted)]. New employees are required to take the Comprehensive No Fear Training. ARS provided mandatory training for managers and supervisors whom

spend at least 25 percent of their time supervising. The training was conducted by the Brookings Institute in 25 2-day sessions from November 2010 through August 2011. The objective of the training was to educate the supervisors and managers on their roles and responsibilities in the performance and accountability of employees. The training was well received and in some instances managers took immediate action to begin addressing employee performance issues. Other ARS training included:

- Educational videos and Agency sponsored courses through AgLearn:
  - Introduction to Conflict Coaching – 8 employees from Headquarters
  - How to Deal with Workplace Bullying – 214 employees from the 9 Areas including Headquarters.
- Lunch discussions conducted by the Department, which employees ARS-wide participated.
- The ARS Disability Program Manager conducted Reasonable Accommodation training at the following: New Employee Orientation sessions; Administrative and Financial Management workshops, including an all employee meeting about Employee Relations; New Research Leader sessions; ARS Employee Development Staff; North Atlantic Area EEO Committee meeting and an all employee meeting; National Agricultural Statistics Service all employee meeting; Economic Research Service all employee meeting; and National Agricultural Library all employee meeting.
- The Office of ODEO coordinated with the OASCR to conduct civil rights impact analysis training for senior management and other supervisors and managers responsible for making organizational decisions. There were a total of 50 participants (12 face to face and 38 via video conferencing).
- Employees were encouraged to be part of the Special Emphasis Program (SEP) observances approved by the Office of Personnel Management to enhance their understanding and knowledge of each other's cultural differences and similarities and to learn about the uniqueness and talents that each employee brings to the workplace. The Area ODEO Program Managers and/or SEP Managers were involved in the planning of nearly all of the Departmental SEP observances as well as sponsoring Area observances.

**Result:** Training enabled employees to expand their knowledge on all aspects of diversity which supports the Administrator's Diversity/Equal Employment Opportunity Policy Statement to create and maintain a competitive and diverse workforce.

While in 2011 the Federal Government experienced an increase in discrimination complaints, ARS remarkably decreased its employees' complaints by 56 percent during that same year.

#### ■ **Introduce Multigenerational Training and sponsor a Multigenerational Diversity Day.**

##### **FY 2011 Accomplishments:**

**Multigenerational trainings are offered upon request by managers.**

#### ■ **Determine if there is a need to create and maintain a formal pilot mentoring program to develop ARS' human capital to its fullest extent.**

##### **FY 2011 Accomplishments:**

The Human Resources Division (HRD) offers a mentoring program for new HRD employees and several Area Offices have developed formal mentoring programs for scientists, new employees, etc. Informal mentoring of ARS students is occurring both in the Areas and Headquarter officers. Examples are:

- The BA continues to provide supportive funds (\$43,000 for 21 interns) for the Summer College Intern Program (SCIP) for college students currently attending college. The purpose of the SCIP is to assist research units in providing meaningful research experiences to promising college students considering a career in science or the agricultural industry.
- The MWA continues the “New Secretary Mentoring Program.” In the past, new secretaries in the Area attended on-site administrative training to expand their office and administrative skills. However, in 2011 the meeting was held via webinar to maximize resources during this time of budget constrains.
- The NAA continues the “New Scientists (SYs) Mentoring Program.” The new SYs are on probation for three years. The Research Leader of the newly hired SYs establishes a committee of three SYs within the same unit familiar with the specific research. The purpose of the committee is to guide the new hires through the process so at the end of the probationary period, there is no question about whether the new hire will be retained or not as an ARS employee.
- The NPA continues to develop their newly hired Category 1 and 4 scientists in the “Newly Appointed Scientist Professional Development Program (NASPDP).” The goal of this program is to assist the new scientists in establishing performance standards to ensure fairness and equity in evaluating professional scientific development.

The NASPDP provides a 3-year-period of development to enhance a newly appointed scientist’s transition into an ARS scientific position and to carefully monitor and evaluate their progress. This program covers all newly appointed Category 1 and 4 scientists, thereafter referred to as new scientists (including RLs) within the NPA. It includes all individuals hired under either merit or demonstration program authority and irrespective of their probationary status.

The program includes two components: professional development and mentoring. The professional development component includes a panel review of the scientist’s accomplishments, while the mentoring component offers the participants an opportunity to learn about ARS organizational and research culture from an experienced ARS scientist. Each new scientist (called a protégé) is assigned a mentor, who is an ARS scientist at or above GS-14. Except in rare circumstances, protégés and mentors are matched by disciplinary and research backgrounds and interests, and mentors are usually from a different location from the protégé. Checking-in topics are sent to all mentors and protégés on a regular basis, and the program is evaluated annually. At the end of FY 2011, there were 25 protégés participating in the NASPDP with their respective mentors.

Since the inception of the program, 40 protégés have successfully completed the program. Of the 86 new scientists hired into NPA since 2004, 83 percent are currently NPA employees. Of the ten resignations of former protégés, two took other professional positions (one in the State where he was recruited from and the other took a position with industry); three left as a result of a location closure (Laramie); one is deceased; two cited spousal employment issues; and two took positions in academia.

- **Maintain and increase involvement in knowledge management and mentoring activities to strengthen our workforce.**

#### **FY 2011 Accomplishments:**

The Agency Administrator continued to stress to the Administrator's Council the importance of encouraging employees to participate in career development and mentoring programs.

The following strategies have been implemented to improve our efforts in succession planning and management:

1. Utilized Leadership Development Training Programs to prepare employees to advance their career toward positions of greater responsibility, i.e., the Aspiring Leader Program for administrative assistants GS 5-7; New Leader Program for administrative assistants, technician, and support scientists GS 7-11; Executive Leadership Program for mid-level employees GS 11-13; and Executive Potential Program for employees at GS 13-15. These programs are promoted and announced agency-wide in the REE mission area.
2. Provided career development training as needed to assist employees on how to establish action plans towards career planning and career paths.
3. Provided New RL Training to help RLs in the transition and management of their administrative role, functions and responsibilities.
4. Sent annual reminders to managers and supervisors for Individual Development Plans (IDP) to be established or updated. HRD created and implemented an IDP PowerPoint training to provide employees with valuable information on how to prepare a sound IDP. This training is also part of the new ARS' Supervisory Training Program and the new hire's checklist.

- **Create, implement, and maintain a secure and confidential electronic exit interview process to determine why employees choose to leave ARS. Develop a plan to overcome any obstacles in the workforce.**

**FY 2011 Accomplishments:**

As part of the Management Directive 715 (MD-715), a plan was developed to reinstate the exit interview process implementing an Exit Interview Form to collect information on why employees are leaving ARS. The Human Resources Division (HRD) developed a survey, and comments were compiled from the REE mission areas. HRD and ODEO will collaborate on the most effective method to collect the data and utilize the survey results with a tentative implementation date of 2013.

- **Encourage employees to utilize the ARS programs such as career development, mentoring, and Special Emphasis Programs, and to serve on EEO/Diversity Advisory Committees.**

**FY 2011 Accomplishments:**

The Agency Administrator and Deputy Administrator, AFM, continued to stress to the Administrator's Council the importance of encouraging employees to utilize career development and mentoring programs.

Aspiring Leaders Program (3 sessions – 3 participants)

- 1 African American male (33 percent)
- 1 African American female (33 percent)
- 1 Asian female (33 percent)

New Leader Program (4 sessions – 7 participants)

- 3 White males (42.8 percent)
- 2 Hispanic females (28.5 percent)
- 1 African American female (14.2 percent)
- 1 White female (14.2 percent)

Executive Leadership Program (2 sessions – 2 participants)

- 1 Asian female (50 percent)
- 1 White female (50 percent)

Executive Potential Program (1 session – 11 participants)

- 6 Asian males (54.5 percent)
- 3 White males (27.2 percent)
- 1 African American male (9 percent)
- 1 Hispanic male (9 percent)

Management Development Center Courses  
(16 participants)

- 5 African American females (31.5 percent)
- 5 White females (31.5 percent)
- 4 White males (25 percent)
- 1 Asian female (6.25 percent)
- 1 Asian male (6.25 percent)

Federal Executive Institute Training (6 participants)	3 White males (50 percent) 2 African American males (33.3 percent) 1 Asian male (16.6 percent)
New Research Leader Training Program (10 participants)	9 White males (90 percent) 1 Asian male (10 percent)
Senior Executive Service Forums (4 participants)	3 White females (75 percent) 1 African American male (25 percent)
Human Resources Management for Supervisors and Managers (64 participants)	31 White males (48.4 percent) 12 Asian males (18.7 percent) 11 White females (17.1 percent) 6 Asian females (9.3 percent) 3 African American males (4.6 percent) 1 Hispanic male (1.5 percent)
Introduction to Supervision (22 participants)	7 White males (31.8 percent) 6 Asian males (27.2 percent) 4 White females (18.1 percent) 3 Asian females (13.6 percent) 2 African American males (9 percent)

Special Emphasis Programs (SEPs) and EEO-Diversity Advisory Committees:

Following the DR 4230-002, Special Emphasis Programs, through Memorandum of Understandings, ARS identified collateral duty (20 percent) National SEP Managers (SEPM) serving on USDA advisory councils for Asian American and Pacific Islanders, African Americans, Persons with Disabilities, Hispanics, Gay, Lesbian, Bisexual and Transgendered, Native Americans, Women, and Veterans. Additionally, each of the 9 Areas have SEPMs in place (the PWA has SEPMs in each location). The SEPMs serve as advisors to management and other employees. ARS is instrumental in the planning of the USDA observances for SEP and encourages the attendance of ARS employees. ODEO prepares and distributes statistical information for each SEP that data is available (excludes Gay, Lesbian, Bisexual, and Transgendered) and through the Area ODEO Program Managers, the information is distributed to all employees. The SEPMs receive the workforce analysis from the MD-715 and assists in the defining of conditions that could be potential barriers to a diverse workforce. Each SEPM has received training from the Graduate School or USDA. During FY 2011, the National Agricultural Library established a SEP committee to identify and communicate developmental training courses of personal and professional interest, communicating local and free organization memberships that are affiliated with SEP, assuring groups that are represented below the Civilian Labor Force (CLF) are appropriately recognized, and recommending specific actions to management that could reduce the possibility of discriminatory practices.

Result:

*Progress towards achieving a more diversified workforce*

The ARS Administrator fully supports the Secretary's initiative on summer interns by employing more than 1,000 interns in 2010. ARS utilized the Department's request for summer student hiring statistics to remind managers of the requirement to remain cognizant of diversity in their summer student hiring efforts. Between 2010 and 2011, ARS has increased the overall representation of minorities in student appointment by almost 4 percent. ARS will continue to analyze the diversity rates of student hires to develop additional outreach programs and hiring manager guidance.

Early in the fiscal year, the HRD provided hiring managers with the OPM Shared List of People with Disabilities. When the list became available to hiring managers and supervisors through the Max Federal

Community in March, we encouraged managers and supervisors to access and review the lists on their own. Finally, in August 2011, as part of implementing the USDA 90-day hiring reform initiatives, ARS mandated the review of the OPM Shared List of People with Disabilities for all hiring managers planning to recruit to fill positions. All managers must certify that they have reviewed the OPM Shared List of People with Disabilities before HRD staff will move forward with competitive recruitment procedures.

- **Promote consistency in new employee, Research Leader, and scientist orientation programs throughout ARS regarding all components of the EEO Program.**

**FY 2011 Accomplishments:**

The ODEO coordinated with the HRD training activities to ensure consistency in the New Employee, New Research Leader, and Scientist Orientation programs regarding all components of the EEO Program. The following items were included in the various trainings: ODEO Vision/Mission Statement, current FY USDA-ARS-Area (if applicable) EEO/CR Policy Statements; ARS Sexual Harassment Policy Statement; Anti-Harassment Policy Statement; Reasonable Accommodation Brochure; EEO Complaint Process; DR-4300-010, Civil Rights Accountability Policy and Procedures; and EEO Mediation/Alternative Dispute Resolution information. The ODEO Deputy Director and/or a representative, and the ODEO Area Program Managers participated in each of the New Employee, New Research Leader, and New Scientist Orientation programs.

- **Identify barriers to parity among minorities and women in Agency award recognition programs; increase award recognition parity among minorities and women.**

**FY 2011 Accomplishments:**

Based on the data collected and analyzed by HRD, the findings reflected that an average of 11 percent of performance was granted among the three different types of job categories for the Areas. The comparative analysis of the award data for each job category demonstrated an equal (plus/minus ½ percent) distribution among all Areas. HRD will continue to monitor the award recognition for these three categories for any trends. HRD is still working towards establishing an electronic performance management (ePM) system. HRD also continues promoting an organizational culture that recognizes employees for their contributions and accomplishments toward meeting the agency's mission.

- **Ensure that civil rights personnel are more visible to all employees, i.e., Area Civil Rights Managers, EEO/Diversity Committees, Civil Rights Staff participating in the CARE (Consolidated Assistance, Review, and Evaluation) Program and the Human Capital Management Assessments.**

**FY 2011 Accomplishments:**

ARS is ensuring visibility of civil rights to all employees by the Administrator issuing the Diversity/Equal Employment Opportunity Policy Statement annually aligning with the Secretary's Civil Rights Policy Statement. During FY 2011, the Anti-Harassment Policy Statement was revised, which includes sexual

harassment, in addition to the Sexual Harassment Policy Statement. ARS also ensures visibility of civil rights by having location representatives on the EEO-Diversity Committees and SEPs. ODEO continued to encourage the Area ODEO Program Managers to keep in constant contact with the Location offices to assist with outreach, diversity, and equal opportunity efforts. As a result of the Consolidated Assistance Review and Evaluations (CARE), the locations that have been reviewed report that the majority of the employees are aware of ODEO personnel, including Area ODEO Program Managers, and location contacts relating to ODEO issues. Due to budgetary restrictions ARS has not been able to implement a full-scale independent survey of its customers and employees. However, we have begun exploring ways to increase the amount of surveys that we conduct, including the use of our “Your Two Cents” (Y2C) cultural transformation initiative. Y2C was designed by the Research, Education, and Economics Mission Area leaders to solicit ideas and input about work and organization from all ARS employees. In addition, we have reviewed and continue to monitor the Agency’s performance in the Federal Employee Viewpoint Surveys (FEVS). In these surveys ARS has performed well with respect to employee perception of the Agency’s support for diversity. Nearly two thirds of all employees responded positively about ARS’ support for diversity in all of the related FEVS questions. For the past two years, a greater percentage of ARS employees responded positively on the FEVS questions related to an organization’s support for diversity than employees in either the USDA-Overall or the Government-wide.

ARS actively utilizes the performance management system to ensure that customers and employees are treated in accordance with anti-discrimination laws and regulations. Equal Employment Opportunity and Civil Rights performance expectations must be included in critical elements of employee plans and serve as a stand-alone element on supervisory plans. Based on summary performance rating data we know that at around 36.2 percent of rated ARS employee received an “exceeds” rating on their element with civil rights performance expectations; 63.7 percent received either a “meets” or an “exceeds” rating; and well under one percent failed (4 employees; or 0.06 percent).

Of the four employees who failed their civil rights related performance elements all were referred to Employee Relations for corrective action (e.g., Performance Improvement Plan). Since the rating, one has successfully completed the Performance Improvement Plan and the rating of record has been updated and another has separated from the agency.

#### **MANAGEMENT INITIATIVE 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**

**MI 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 2005**

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 NPS. The Outreach Coordinators are responsible for actively seeking ways to reduce/eliminate internal barriers that prevent target populations from accessing ARS research products.

**Target 2011**

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.

**MI 4.2 Identify significant Outreach activities and report them annually to the USDA Office of Outreach.**

**Baseline 2005**

ARS identified 20 significant Outreach activities and reported them to the Departmental Office of Outreach as requested.

**Target 2011**

ARS will cumulatively report 100 significant Outreach Activities to the USDA Office of Outreach and through the GPRA Annual Performance Report.

**Actionable Strategies/Activities for Management Initiative 4**

- 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.

### **FY 2011 Accomplishments:**

Implemented a Capital Investment Strategy to efficiently and effectively manage real property through good stewardship of ARS' real property assets.

Planned and implemented a Voluntary Early Retirement Authority (VERA) and Voluntary Separation Incentive Program (VSIP) for both ARS and NASS. The NASS VERA & VSIP was successful in reorganizing state offices into regional offices as well as standing up a National Operations Center in St. Louis, MO. The ARS VERA & VSIP was instrumental in providing separation incentives to impacted employees whose projects were eliminated in FY-11. As a result of FY-11 budget reductions, in addition to conducting VERA and VSIP for impacted employees, successfully provided directed reassignments to over 80 permanent employees. In addition, planned the successful 1<sup>st</sup> QTR FY-12 VERA & VSIP implementation for all four REE agencies.

In coordination with the Office of Diversity and Equal Opportunity, hired 14 Student Career Enhancement Program (SCEP) students and 886 Student Temporary Employment Program (STEP) students in FY-11.

Coordinated the REE Agencies' implementation of the USDA Telework program which resulted in over 78% rate for eligibility.

Successfully implemented the OPM 80 day hiring model and the USDA Position Management directive that has resulted in an average time to hire of less than 80 days in the last quarter of the fiscal year.

Successfully participated in both the OPM/USDA HR audit and the USDA Office of Civil Rights audit of HR hiring and discipline practices.

Broadened the ARS USA Staffing implementation for the recruitment and referral of all positions by adding Scientist and Wage Grade positions. HRD also implemented USA Staffing for NIFA, ERS and NASS thus providing a single, standardized tool for all REE recruitment and staffing.

Fully digitized all REE position descriptions in order to provide easier accessibility and edit capabilities for HR specialists and hiring managers.

Actively participated in support of USDA's "ONE USDA" HR Enterprise System planning and development.

Fully implemented the Non Employee Identity System (NEIS) to support the REE agencies' ability to validate secured access for all non-Federal employees.

Provided effective system administration for GovTrip users.

Provided support and management data to Agency managers in order to reduce travel costs by 20%.

USDA (including REE) received an unqualified (clean) audit opinion on USDA's FY 2011 financial statements.

Provided guidance and assistance in the use of U.S. Bank's electronic reconciliation system (Access Online) for REE employees.

Represented REE on the USDA Department-wide A-123 Project Team to address issues that relate to the USDA Purchase Card Program. The Project Team was assembled to identify the appropriate manual and automated processes and controls to remediate or substantially reduce the related risk and severity of existing material weakness and significant deficiencies. Also, the Team focused on process improvement and implementation of necessary updates to documentation, training, and Department-wide guidance to ensure knowledge transfer and process sustainability.

Provided web-based training to REE Coordinators on U.S. Bank's reconciliation system and management and oversight responsibilities for the purchase card program.

Provided guidance and training on improving the accuracy of the data reported in the Federal Procurement Data System – Next Generation (FPDS-NG). Conducted verification and validation to review overall accuracy of data in FPDS-NG.

Conducted Integrated Acquisition System (IAS) requisitioner/receiver and budget approver training to augment the guidance and pamphlets provided by the Department.

Served as the Agency subject matter expert to help OPPM and OCFO clarify the business processes, requirements, and objectives needed for CPAIS for acquisition receipt, disposition, inventory management, vehicle operations and maintenance, asset history, and FMMI interfaces. (Anticipated implementation is FY2012).

Worked with OPPM and OCFO to identify and resolve issues with the interface between Property Management Information System (PMIS/PROP) and FMMI, assisted in developing requirements for capturing vehicle requisitions through Interagency Payments and Collection (IPAC) for the FMMI to PROP interface, and identified issues involving separate bank card transactions combining into a single transaction. These issues affected the agency suspense and inventory process.

Served as the Agency fleet manager subject matter expert for the Fleet Business Line with USDA's Charge Card Service Center. Worked to identify and resolve issues relating to the fleet card and fleet system, redesigned fleet reports to obtain enhanced fleet data, increase of level III data, identified issues related to improper coding of alternative fuels, and identify system issues with information feeding into VISA/US Bank.

Prepared "Flex Reporting Quick Guide" to assist fleet managers in generating fleet card inventory and transaction reports using US Bank's new reporting module.

Established new vehicle replacement guidance that addressed methods to right-size fleets, reduce greenhouse gas emissions, and justify continued vehicle need prior to vehicle replacements. Monitored vehicle requisition system and ensured fleet managers maintained justifications for functional needs for vehicles that did not meet the minimum greenhouse gas score. Of the 75 new vehicles acquired, 53% were alternative fueled vehicle, including hybrids.

Issued Bulletin 10-706, *E-Green File Implementation in ARIS/AIMS*. After initial implementation to the ADOs, use was expanded to include view only rights to all ARIS/AIMS users. The implementation of the E-Green module in ARIS/AIMS provided an electronic portal for maintaining agreements thereby, reducing paper consumption and providing for the capability of cross-servicing within the Agency.

Bulletin 10-707, *Implementation of Office of Management and Budget Grant and Cooperative Agreement Requirements: Data Universal Number System/Central Contractor Registration (DUNS/CCR) Registration and Sub-Award Requirements*. This Bulletin allowed ARS to implement the requirements of the Office of Management and Budget regulations in order to promote transparency and accountability government wide. In addition, developed written procedures on how to register and use fsrc.gov, (the sub award reporting website) and developed a FAQ sheet on how to obtain a DUNS number and register in the CCR.

Continued oversight of Agency-wide closeout of all inactive and expired extramural agreements in the Health and Human Services Payment Management System (HHS/PMS). The result is a reduction in ARS' "green book" costs, which fund these charges.

Successfully updated and released the mandatory 2011 maintenance training for all ARS Authorized Departmental Officers Designated Representatives (ADODR). The training material provided ADODRs with knowledge of responsibilities required to effectively monitor and closeout extramural agreements.

Presented two sessions of Level 1 ADO Training in January 2011. Approximately 70 AOs and all ADOs attended the training. This training allows AOs to become ADOs on Research Support Agreements thereby extending the delegation of authority to the Locations and improving accountability on agreements.

Successfully implemented policy and procedures necessary to comply with Government-wide Debarred and Suspension regulations for non-procurement transactions by modifying ARIS/AIMS to include a direct link to the Excluded Parties Listing System (EPLS). EPLS provides federal agencies with information on organizations or individuals either barred or suspended from doing business with the Federal government.

Successfully implemented policies and procedures for receiving funds from Foreign/International cooperators (non-Federal partners) by electronic funds transfer (EFT). The incoming EFT process ensures timely receipt, tracking, and access to funds provided to ARS scientists via Trust Fund or Reimbursable Agreements.

Implemented the enterprise licensed, 128-bit encrypted and cloud-hosted Facilities Management System web portal with performance management dashboards. This analysis and comparative benchmarking environment allows ARS managers to access and analyze real-time operational cost data that will help them reduce laboratory operating and energy costs, and make better decisions regarding deployment of limited facilities capital investment and repair funds.

Developed preliminary enterprise network architecture for IP-addressable meters and metering databases on network-connected servers. The cloud-hosted time-series historian database is Agency and Region/Area agnostic.

Implemented and began functional testing of web-based ARS FMS Integrated Workplace Management System (IWMS) as an underlying application within the secure portal with single sign-on functionality.

### **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.

**Performance Measure 1.1** Hire people with agency-desired skill sets.

*Indicators:*

*By FY 2012, AFM will:*

*Identify current and future skills gaps within each REE agency  
Actively recruit to ensure maximum opportunity for all  
Develop a sound marketing strategy to attract top candidates  
Develop metrics to guide improvement in the hiring process*

*By FY 2013, AFM will:*

*Identify current and future skills gaps within each REE agency  
Actively recruit to ensure maximum opportunity for all  
Develop a sound marketing strategy to attract top candidates  
Develop metrics to guide improvement in the hiring process*

*By FY 2014, AFM will:*

*Identify current and future skills gaps within each REE agency  
Actively recruit to ensure maximum opportunity for all  
Develop a sound marketing strategy to attract top candidates  
Develop metrics to guide improvement in the hiring process*

**Performance Measure 1.2** Emphasize employee continuous improvement.

*Indicators:*

*By FY 2012, AFM will:*

*Develop a career development template 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.*

*By FY 2013, AFM will:*

*Develop a career development template 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.*

*By FY 2014, AFM will:*

*Develop a career development template 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.*

**Performance Measure 1.3** REE Agencies retain/achieve top ranking in USDA as “Best Places to Work” as reported in the Federal Human Capital Survey.

*Indicators:*

*By FY 2012, AFM will:*

*Develop a program/process to assimilate and support new employees to increase retention. Implement the USDA On-Boarding program.  
Implement the Performance Appraisal Assessment Tool (PAAT) in order to improve performance management and reward processes and actions.  
Expand/implement maxiflex, telework, Career Patterns and other programs and flexibilities to assist employees in balancing work and personal responsibilities.*

*By FY 2013, AFM will:*

*Develop a program/process to assimilate and support new employees to increase retention. Develop action strategies to improve the employee response to OPM's Employee Viewpoint Surveys.  
Implement the Performance Appraisal Assessment Tool (PAAT) in order to improve performance management and reward processes and actions.  
Expand/implement maxiflex, telework, Career Patterns and other programs and flexibilities to assist employees in balancing work and personal responsibilities.*

*By FY 2014, AFM will:*

*Develop a program/process to assimilate and support new employees to increase retention. Develop action strategies to improve the employee response to OPM's Employee Viewpoint Surveys.  
Implement the Performance Appraisal Assessment Tool (PAAT) in order to improve performance management and reward processes and actions.  
Expand/implement maxiflex, telework, Career Patterns and other programs and flexibilities to assist employees in balancing work and personal responsibilities.*

**Performance Measure 1.4** Improve “Leading People” skills of all leaders, supervisors, and managers.

*Indicators:*

*By FY 2012, AFM will:*

*Implement the Supervisory Management Program. Continue to support OPM and USDA's leadership programs such as SES CDP, Aspiring Leader Program and the New Research Leader Development Program.*

*By FY 2013, AFM will:*

*Implement the Supervisory Management Program. Continue to support OPM and USDA's leadership programs such as SES CDP, Aspiring Leader Program and the New Research Leader Development Program.*

*By FY 2014, AFM will:*

*Continue to support OPM and USDA's leadership programs such as SES CDP, Aspiring Leader Program and the New Research Leader Development Program.*

## **AFM Goal 2: Improved 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.

**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. Reporting difficulties are rapidly resolved.

*Indicators:*

*By FY 2012, AFM will:*

*Actively respond to annual OIG audit of REE-wide financial statements and resolve audit concerns within established due dates.*

*By FY 2013, AFM will:*

*Actively respond to annual OIG audit of REE-wide financial statements and resolve audit concerns within established due dates.*

*By FY 2014, AFM will:*

*Actively respond to annual OIG audit of REE-wide financial statements and resolve audit concerns within established due dates.*

**Performance Measure 2.2** All REE travelers are supported by a professional, customer oriented Travel and Transportation staff and Web-based systems are operational.

*Indicators:*

*By FY 2012, AFM will:*

*Implement GovTrip throughout REE ensuring it's operational and documented for end-users.  
Conduct GovTrip post-implementation review and effect process changes as necessary.*

*By FY 2013, AFM will:*

*Implement GovTrip throughout REE ensuring it's operational and documented for end-users.  
Conduct GovTrip post-implementation review and effect process changes as necessary.*

*By FY 2014, AFM will:*

*Implement new eTravel system under the GSA ETS2 contract as required.*

**Performance Measure 2.3** CATS is fully implemented on ARIS/ORACLE platform, meets needs of ARS users, and maximizes opportunities for financial data integration.

*Indicators:*

*By FY 2012, 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.*

*By FY 2013, 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.*

*By FY 2014, 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.*

### **AFM Goal 3: Improved Real and Personal Property Management**

**Objective:** Agencies receive effective and automated services for acquisition and personal property management.

**Performance Measure 3.1** Acquisition & Property Division, Facilities Division, Area, Locations, and REE agencies partner to effectively implement and administer E-commerce initiatives and custom electronic information exchange.

*Indicators:*

*By FY 2012, AFM will:*

*Reevaluate the use of the purchase card in ARS (Field); review and determine appropriate number and users of purchase cards.  
Implement USDA CPAIS for personal property in REE.*

*By FY 2013, AFM will:*

*Continue evaluating the use of the purchase card in ARS (Field); review and determine appropriate number and users of purchase cards. Continued implementation of USDA CPAIS for personal property in REE.*

*By FY 2014, AFM will:*

*Continue evaluating the use of the purchase card in ARS (Field); review and determine appropriate number and users of purchase cards. Continued implementation of USDA CPAIS for personal property in REE.*

**Performance Measure 3.2** REE Agencies realize cost savings and receive best value through leveraging their energy buying power.

*Indicators:*

*By FY 2012, AFM will:*

*Coordinate between APD and FD to develop and implement a comprehensive energy buying plan.*

*By FY 2013, AFM will:*

*Continue and expand coordination between ARS locations, APD and FD to develop and implement a comprehensive energy buying plan.*

*By FY 2014, AFM will:*

*Analyze and make adjustments to the Agency's energy buying plan to sustain and expand the program.*

**Performance Measure 3.3** REE agencies realize cost savings and receive best value through effective fleet management.

*Indicators:*

*By FY 2012, AFM will:*

*Review vehicle procurements for minimum size needed for mission.  
Maximize use of alternative fuels and alternative fuel vehicles.  
Monitor fleet fuel use for methods for overall fuel savings.*

*By FY 2013, AFM will:*

*Review vehicle procurements for minimum size needed for mission.  
Maximize use of alternative fuels and alternative fuel vehicles.  
Monitor fleet fuel use for methods for overall fuel savings.*

*By FY 2014, AFM will:*

*Review vehicle procurements for minimum size needed for mission.  
Monitor vehicle use and allocation methodologies to determine optimal fleet inventory.  
Maximize use of alternative fuels and alternative fuel vehicles. Monitor fleet fuel use for methods for overall fuel savings.*

**Performance Measure 3.4** Develop metrics for REE acquisitions.

*Indicators:*

*By FY 2012, AFM will:*

*Provide guidance and training to improve the accuracy of the data reported in the Federal Procurement Data System – Next Generation (FPDS-NG). .*

*Provide guidance and assist the acquisition workforce to report past performance contract information in the Contractor Performance Assessment Reporting System (CPARS).*

*By FY 2013, AFM will:*

*Provide guidance and training to improve the accuracy of the data reported in the Federal Procurement Data System – Next Generation (FPDS-NG). .*

*Provide guidance and assist the acquisition workforce to report past performance contract information in the Contractor Performance Assessment Reporting System (CPARS).*

*By FY 2014, AFM will:*

*Provide guidance and training to improve the accuracy of the data reported in the Federal Procurement Data System – Next Generation (FPDS-NG). .*

*Provide guidance and assist the acquisition workforce to report past performance contract information in the Contractor Performance Assessment Reporting System (CPARS).*

**Performance Measure 3.5** Ensure Acquisition Workforce meets Federal Certification Programs where mandated.

*Indicators:*

*By FY 2012, AFM will:*

*Provide guidance on Federal Acquisition Certifications to the Acquisition Workforce to ensure certified and maintain certification. Recommend training to ensure Acquisition workforce meets the current standards.*

*By FY 2013, AFM will:*

*Provide guidance on Federal Acquisition Certifications to the Acquisition Workforce to ensure certified and maintain certification. Recommend training to ensure Acquisition workforce meets the current standards.*

*By FY 2014, AFM will:*

*Provide guidance on Federal Acquisition Certifications to the Acquisition Workforce to ensure certified and maintain certification. Recommend training to ensure Acquisition workforce meets the current standards.*

**AFM Goal 4: Improved Accountability and Program Stewardship of the ARS Asset Management Program.**

**Objective:** Stewardship (acquisition, operation, and disposal) of REE Real Property assets effectively supports and enhances the REE Mission Area.

**Performance Measure 4.1** Enhance the protection and well being of the work force and REE assets.

*Indicators:*

*By FY 2012, AFM will:*

*Identify and protect ARS infrastructure and real property assets.  
Work with Office of Homeland Security to establish protocols for validating high priority physical security needs.  
Analyze trends regarding employee safety and wellbeing with the goal of reducing worker injuries and OMSP exposures to workplace hazards, and implement corrective action.*

*By FY 2013, AFM will:*

*Perform Continuous assessment of ARS infrastructure and real property assets.*

*Work with Office of Homeland Security to reassess protocols for validating high priority physical security needs.*

*Analyze trends regarding employee safety and wellbeing with the goal of reducing worker injuries and OMSP exposures to workplace hazards, and implement corrective action.*

*By FY 2014, AFM will:*

*Perform continuous assessment of ARS infrastructure and real property assets.*

*Work with Office of Homeland Security to reassess protocols for validating high priority physical security needs.*

*Continue education and safety awareness programs and analysis of trends regarding employee safety and wellbeing with the goal of reducing worker injuries and OMSP exposures to workplace hazards, and implement corrective action.*

**Performance Measure 4.2** Maintain a robust Real Property Asset Management program.

*Indicators:*

*By FY 2012, AFM will:*

*Develop and implement a facility Operation and Maintenance Program to address general maintenance, preventive maintenance, and repair of facilities to minimize the life cycle cost of the facility*

*Exercise proper stewardship of environment, natural, and energy and water resources as defined by EO 13423 – Strengthening Federal Environmental, Energy & Transportation Management.*

*Utilize the facility plan developed by the Agency and Area Asset Management Review Boards in determining the allocation of R&M funds to meet mission requirements.*

*Establish a single point of contact in each Area to coordinate the Area's asset management program.*

*By FY 2013, AFM will:*

*Expand implementation a facility Operation and Maintenance Program to address general maintenance, preventive maintenance, and repair of facilities to minimize the life cycle cost of the facility and ensure facility managers are trained in accordance with the Federal Buildings Personnel Training Act.*

*Exercise proper stewardship of environment, natural, and energy and water resources as defined by EO 13423 – Strengthening Federal Environmental, Energy & Transportation Management.*

*Utilize the Capital Projects Repair Plan developed by the Agency and Area Asset Management Review Boards in determining the allocation of R&M funds to meet mission requirements.*

*Build on the initial Capital Investment Strategy to prioritize investment of Agency resources for recapitalization at high priority facilities.*

*Work with Business Service Centers and Areas to enhance the Agency's real property asset management program.*

*By FY 2014, AFM will:*

*Expand implementation of a facility Operation and Maintenance Program to address general maintenance, preventive maintenance, and repair of facilities to minimize the life cycle cost of the facility.*

*Continue training of facility managers to operate and maintain real property assets in the*

*most efficient manner*

*Exercise proper stewardship of environment, natural, and energy and water resources as defined by EO 13423 – Strengthening Federal Environmental, Energy & Transportation Management.*

*Utilize the Capital Projects Repair Plan developed by the Agency and Area Asset Management Review Boards in determining the allocation of R&M funds to meet mission requirements.*

*Build on the initial Capital Investment Strategy to prioritize investment of Agency resources for recapitalization at high priority facilities*

*Evaluate opportunities to expand, automate, and standardize the Agency's real property asset management program*

**Performance Measure 4.3** Implement Energy Policy Act (EPACT) 2005 and the Energy Independence and Security Act of 2007

*Indicators:*

*By FY 2012, AFM will:*

*Establish roles and responsibilities of AFM/Areas/Locations/State Offices in implementing EPACT 2005 and the Energy Independence and Security Act of 2007 goals.*

*Maximize the use of no cost/low cost energy management programs.*

*Evaluate how to allocate energy reduction/renewable energy initiatives across ARS in a manner that maximizes progress in meeting Agency EPACT 2005 and the Energy Independence and Security Act of 2007 goals.*

*By FY 2013, AFM will:*

*AFM/Areas/Locations/State Offices continue to work as an effective team in implementing EPACT 2005 and the Energy Independence and Security Act of 2007 goals.*

*Maximize the use of no cost/low cost energy management programs.*

*Evaluate how to allocate energy reduction/renewable energy initiatives across ARS in a manner that maximizes progress in meeting Agency EPACT 2005 and the Energy Independence and Security Act of 2007 goals.*

*By FY 2014, AFM will:*

*AFM/Areas/Locations/State Offices continue to work as an effective team in implementing EPACT 2005 and the Energy Independence and Security Act of 2007 goals.*

*Maximize the use of no cost/low cost energy management programs.*

*Evaluate how to allocate energy reduction/renewable energy initiatives across ARS in a manner that maximizes progress in meeting Agency EPACT 2005 and the Energy Independence and Security Act of 2007 goals.*

**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.

**Performance Measure 5.1** Ensure effective use and administration of extramural agreements including fiscal and programmatic responsibility for ADODRs.

*Indicators:*

*By FY 2012, AFM will:*

*Continue training programs on authorized uses of Extramural Agreements.  
Develop automated notification of reporting due dates.  
Continue developing awareness of fiscal accountability, and ensure legitimate commitment and sufficiency of funds.  
Consolidate interim and annual reporting requirements (AD-421 process).*

*By FY 2013, AFM will:*

*Continue training programs on authorized uses of Extramural Agreements.  
Develop automated notification of reporting due dates.  
Continue developing awareness of fiscal accountability, and ensure legitimate commitment and sufficiency of funds.  
Consolidate interim and annual reporting requirements (AD-421 process).*

*By FY 2014, AFM will:*

*Continue training programs on authorized uses of Extramural Agreements.  
Develop automated notification of reporting due dates and agreement expiration dates.  
Continue developing awareness of fiscal accountability, and ensure legitimate commitment and sufficiency of funds.*

**Performance Measure 5.2** Ensure fiscal and financial systems are fully integrated into the agreement process.

*Indicators:*

*By FY 2012, AFM will:*

*Develop efficient billing and accounting processes.  
Develop process to close agreements in a timely manner.  
Review other agencies' business processes for automated agreement account reconciliation and closeout. Consider implementing best business practices.*

*By FY 2013, AFM will:*

*Develop efficient billing and accounting processes.  
Develop process to close agreements in a timely manner.  
Review other agencies' business processes for automated agreement account reconciliation and closeout. Consider implementing best business practices.*

*By FY 2014, AFM will:*

*Continue oversight of process to close agreements in a timely manner.  
Implement best business practices for post award administration and closeout of extramural agreements as identified by the ARS Business Process Review team.*

**Performance Measure 5.3** Agreement business processes are measured for effectiveness and efficiency.

*Indicators:**By FY 2012, AFM will:*

*Develop metrics to evaluate agreement process  
Measure timeliness of account reconciliation to ensure timely closeouts.*

*By FY 2013, AFM will:*

*Develop metrics to evaluate agreement process  
Measure timeliness of account reconciliation to ensure timely closeouts.*

*By FY 2014, AFM will:*

*Implement best business practices for pre award; post award administration; and closeout processes for extramural agreements as identified by the ARS Business Process Review team.*

**AFM Goal 6: Improved Electronic Access to AFM Information and Business Applications.**

**Objective:** AFM applications fully meet REE needs for administrative and financial management information and guidance in support of improved productivity, service, and reduced costs.

**Performance Measure 6.1** Ensure employees have access to personal and professional resources.

*Indicators:**By FY 2012, AFM will:*

*Develop a network-based Management Information System, i.e. Customer Service "Portal", that facilitates the implementation and effectiveness of a virtual service center organizational structure, providing a full suite of integrated administrative services including HR, Acquisition / Contracting, IT, Facilities mgmt & operations, Research Agreements, and Financial management & accounting. This tool will facilitate the following organizational improvements:*

- Standardizes and automates management methods for tracking and assigning work, and for reporting real-time performance and customer satisfaction in support of diverse customer-base located across the country.*
- Reduces costs associated with officing, hiring, and relocating staff into traditional bricks & mortar facilities.*
- Creates virtual office environment where distributed service delivery teams can share electronic documents / files and communicate with each other real-time.*
- Allows distributed support services personnel to stay physically close to where the work of the agency gets done.*

*By FY 2013, AFM will:*

*Develop a network-based Management Information System, i.e. Customer Service "Portal", that facilitates the implementation and effectiveness of a virtual service center organizational structure, providing a full suite of integrated administrative services including HR, Acquisition / Contracting, IT, Facilities mgmt & operations, Research Agreements, and Financial management & accounting. This tool will facilitate the following organizational improvements:*

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- *Creates virtual office environment where distributed service delivery teams can share electronic documents / files and communicate with each other real-time.*
- *Allows distributed support services personnel to stay physically close to where the work of the agency gets done.*

*By FY 2014, AFM will:*

*Develop a network-based Management Information System, i.e. Customer Service "Portal", that facilitates the implementation and effectiveness of a virtual service center organizational structure, providing a full suite of integrated administrative services including HR, Acquisition / Contracting, IT, Facilities mgmt & operations, Research Agreements, and Financial management & accounting. This tool will facilitate the following organizational improvements:*

- *Standardizes and automates management methods for tracking and assigning work, and for reporting real-time performance and customer satisfaction in support of diverse customer-base located across the country.*
- *Reduces costs associated with officing, hiring, and relocating staff into traditional bricks & mortar facilities.*
- *Creates virtual office environment where distributed service delivery teams can share electronic documents / files and communicate with each other real-time.*
- *Allows distributed support services personnel to stay physically close to where the work of the agency gets done.*

**Performance Measure 6.2** Ensure that new or modified administrative processes or information systems effect measurable, qualitative improvements.

*Indicators:*

*By FY 2012, AFM will:*

*Continue to test and develop innovative and low cost methods for improving quality and accessibility of operational data in order to reduce energy use and operational costs at ARS laboratory facilities across the country, including the following specific goals:*

- *Pilot test optical character recognition data extraction technologies for faxed Utilities bills, and direct uploading of Electronic Data Interchange (EDI) invoices into the ARS FMS utilities management software.*
- *Deploy encrypted tablet computers and smart phones at test sites for mobile data collection and mobile work order management, empowering facilities maintenance personnel. Integrate mobile app that allows work to be performed when out of cellular or (approved) Wi-Fi range.*
- *Pilot test a flat file transfer of captured and calculated data to both EPA Energy Star Portfolio Manager and GSA Carbon Footprint. Both external databases are linked to fulfilling congressionally mandated data-call requirements which are traditionally handled by manually assembled spreadsheets. Similarly, pilot test*

*flat file upload to CPAIS computed metrics that are now congressionally mandated and otherwise unavailable in CPAIS.*

*By FY 2013, AFM will:*

*Continue to test and develop innovative and low cost methods for improving quality and accessibility of operational data in order to reduce energy use and operational costs at ARS laboratory facilities across the country, including the following specific goals:*

- Pilot test optical character recognition data extraction technologies for faxed Utilities bills, and direct uploading of Electronic Data Interchange (EDI) invoices into the ARS FMS utilities management software.*
- Deploy encrypted tablet computers and smart phones at test sites for mobile data collection and mobile work order management, empowering facilities maintenance personnel. Integrate mobile app that allows work to be performed when out of cellular or (approved) Wi-Fi range.*
- Pilot test a flat file transfer of captured and calculated data to both EPA Energy Star Portfolio Manager and GSA Carbon Footprint. Both external databases are linked to fulfilling congressionally mandated data-call requirements which are traditionally handled by manually assembled spreadsheets. Similarly, pilot test flat file upload to CPAIS computed metrics that are now congressionally mandated and otherwise unavailable in CPAIS.*

*By FY 2014, AFM will:*

*Continue to test and develop innovative and low cost methods for improving quality and accessibility of operational data in order to reduce energy use and operational costs at ARS laboratory facilities across the country, including the following specific goals:*

- Pilot test optical character recognition data extraction technologies for faxed Utilities bills, and direct uploading of Electronic Data Interchange (EDI) invoices into the ARS FMS utilities management software.*
- Deploy encrypted tablet computers and smart phones at test sites for mobile data collection and mobile work order management, empowering facilities maintenance personnel. Integrate mobile app that allows work to be performed when out of cellular or (approved) Wi-Fi range.*
- Pilot test a flat file transfer of captured and calculated data to both EPA Energy Star Portfolio Manager and GSA Carbon Footprint. Both external databases are linked to fulfilling congressionally mandated data-call requirements which are traditionally handled by manually assembled spreadsheets. Similarly, pilot test flat file upload to CPAIS computed metrics that are now congressionally mandated and otherwise unavailable in CPAIS.*

# ARS Office of the Chief Information Officer (OCIO) Management Initiatives

## OVERVIEW OF MANAGEMENT INITIATIVES

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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 Agencywide impact.

## EXPAND ELECTRONIC GOVERNMENT

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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 (USDA-OCIO) 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.

### **Actionable Strategies/Activities for OCIO Management Initiatives**

- 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.