Introduction

ARS Annual Performance Report for FY 2009 and Performance Plan for FY 2010 - 2012

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.

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 **relevance**, 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; 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 20th 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

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

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

Objective 1.2: Support International Economic Development and Trade Capacity Building

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

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 2009, ARS will develop new or improved, or more environmentally friendly processing technologies.

FY 2009 Accomplishments*:*

1. ARS scientists developed a strain of switchgrass that, when grown in Nebraska, produced a potential ethanol yield of 355 gallons per acre – 20 gallons per acre greater than that of the previous best cultivar.

   Impact: This is the first publicized example of a switchgrass strain specifically bred for improved conversion to ethanol.

2. The plant cell wall is a complex composite of polysaccharide polymers, phenolic compounds and proteins; and the genes controlling cell wall composition are poorly understood. In collaboration with U.S. Department of Energy (DOE), ARS scientists sequenced the entire genome of the grass *Brachypodium*; and a complete draft of the genome was released through the website www.brachypodium.org. In addition, ARS researchers developed over 200 inbred *Brachypodium* varieties which are freely available to researchers, and have created over 4,000 T-DNA lines which will soon be released to the public. Using near infrared spectroscopy (NIR), ARS scientists have identified 27 mutants of *Brachypodium* with altered cell wall composition.

***Impact*:** This work will enable research to improve cell wall properties for biofuel production.

3. Photo-period response genes must be incorporated into tropical sorghum lines so that they will flower and produce seed in temperate locations, such as the U.S., where the day-length is longer during the growing season. ARS researchers developed molecular markers and new genomic methods to efficiently breed varieties having these photoperiod-response genes. In addition, ARS scientists developed a quick and low-cost fluorescent screening assay to identify drought-tolerant sorghum germplasm. The fluorescent method is as effective as conventional selection techniques which required multi-year field trials at multiple locations.

Impact: These new sorghum breeding tools will accelerate the development of new sorghum varieties with superior traits for bioenergy feedstock production.

Indicator 2

During FY 2009, ARS will develop new or improved methods to measure or predict quality.

FY 2009 Accomplishments*:*

1. It has been suggested that land under Conservation Reserve Program (CRP) contracts can be used productively for growing perennial grasses as energy crops. ARS scientists showed that Old World bluestem grown on CRP land in central Oklahoma produced an average of only 1.7 DryTons/acre and that a native mix produced 0.9 DT/acre. Maximum yields were obtained at the October harvest for both Old World bluestem (1.86 DT/acre) and the native mixed species (1.0 DT/acre). Although soil characteristics were not altered by three years of annual harvest, biomass production consistently declined at all sites over the three harvest years.

***Impact*:** This study shows that some CRP land may not be attractive for biomass feedstock production.

2. Conventional wet chemistry analyses of biomass composition and tests for biomass conversion to ethanol are time-consuming and expensive. ARS scientists developed Near-infrared Reflectance Spectrometry (NIRS) calibrations for predicting biomass ethanol yield (per ton) for switchgrass. The NIRS measurements provide data on cell wall composition, cell wall sugars, soluble sugars, lignin, released and fermented glucose from cell wall cellulose, released cell wall pentoses, and other biomass quality attributes. The calibrations enable rapid and accurate estimation of theoretical ethanol yield from hexose sugars, theoretical ethanol yield from pentose sugars, total ethanol yield per ton, total ethanol yield per acre, total theoretical ethanol yield per ton, and total theoretical ethanol yield per acre.

Impact: These calibrations will enable more efficient feedstock breeding, genetics, and management research, and will enable biorefining instrumentation/methods to determine ethanol yield from a particular biomass feedstock.

3. Efficient and accurate methods to estimate the amount of switchgrass biomass feedstock within a production area will help decision makers, and biorefiners in particular, plan their

operations. ARS scientists evaluated the effectiveness of various indirect methods for on-field estimation of switchgrass yields in a multi-year study. Visual obstruction was the best method for estimating yield on switchgrass fields with low to variable stand densities, while elongated leaf height measurements should be used on switchgrass fields with high, uniform stand densities. Twenty to 30 elongated leaf height measurements in a field could predict switchgrass biomass yield within 10% with 95% confidence.

Impact: These procedures can be used by biorefiners to estimate feedstock supply in a production area, and also by the USDA National Agricultural Statistics Service (NASS) to estimate national bioenergy supplies from switchgrass.

4. Combining annual and perennial crop species in rotational cropping systems – termed "living mulch" cropping systems – could enable the production of both food and bioenergy on the same land and thereby minimize the displacement of food crops by cellulosic energy crop production. Concurrent management of food/feed crops such as corn or soybeans with perennial crops (forages) requires that the forages be suppressed during row-crop production. ARS scientists investigated combinations of reed canarygrass or orchardgrass with leguminous forages such as alfalfa, kura clover, and birdsfoot trefoil in a corn-soybean-forage rotation. The cover crops were managed by harvesting four times during the forage year and by suppressing with a 10 inch glyphosate band over the row during the corn and soybean years. They found that a combination of alfalfa, kura clover, and reed canarygrass resulted in the highest forage yields and lowest weed densities. They also found that seeding an unadapted alfalfa in the spring of the forage year supplemented yield and suppressed weeds in the former crop row. Use of the cover crops also allows producers to remove more corn stover (for bioenergy) and still maintain long-term productivity of the soil.

Impact: This study showed that producers can produce both food and bioenergy crops on the same land, diversify their cropping systems, obtain high yields of forages for livestock or bioenergy, eliminate the lower yields usually encountered in the first (establishment) year for perennials, and improve ecosystem function of corn production systems.

Indicator 3

During FY 2009, ARS will develop technologies leading to new or improved products from renewable resources and agricultural residues and wastes.

FY 2009 Accomplishments*:*

1. Pretreatment of cellulosic biomass is necessary in order to obtain reasonable yields of ethanol, but it requires expensive equipment and so is a major cost component in cellulosic ethanol production. In addition, the narrow window for crop harvesting requires long-term storage of biomass feedstocks, which can lead to significant losses from spoilage. ARS scientists developed simple, yet novel methods to combine these two steps --storage and pretreatment -- on-farm. They found that biomass can be stored with sulfuric acid or lime for one to six months in sealed plastic bags typically used for silage production. On-farm pretreatment/storage resulted in ethanol yields comparable to those obtained when pretreatment methods were done at a biorefinery, while avoiding spoilage

losses, reducing overall costs, and providing farmers with opportunities to capture more return from their biomass crop.

***Impact*:** This work will help to enable on-farm preprocessing of biomass feedstocks and thereby provide farmers with opportunities to capture more returns from biomass feedstock production.

2. Peanut oil could be an excellent feedstock for biodiesel production, but no data currently exist about which cultivars might be best suited for this market. ARS scientists evaluated the economic and agronomic performance (under both low and high input management strategies) and biodiesel engine performance of over 40 different cultivars.

***Impact*:** The research identified five peanut cultivars which exhibit superior production performance and oil characteristics and will help to enable on-farm biodiesel production.

Measure 2.1.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2008:

During FY 2009, ARS reported on 4 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.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
A new strain of switchgrass that increases ethanol yield per acre by 7%	Germplasm offered to seed producers	Perennial grass seed producers	Helps enable cellulosic biorefineries
Enzyme technology to reduce the energy required to dry distillers grains by 15%	Technology available for licensing	Corn ethanol producers	Increases profitability and reduces financial risks for corn ethanol producers and increases the energy efficiency of corn ethanol production
Enzyme technology that enables corn ethanol producers to produce corn oil as a co-product	Technology available for licensing	Corn ethanol producers	Increases profitability and reduces financial risks for corn ethanol producers
Use of distillers grains as fish food in aquaculture	Technology available for licensing	Corn ethanol producers	Increases profitability and reduces financial risks for corn ethanol producers

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

During FY 2010, ARS will

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

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

develop renewable energy technology and systems to meet on-farm and remote rural needs and to enhance the rural economy.

During FY 2011, ARS will

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

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

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.

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 2009, ARS will develop technologies leading to new or improved products from renewable agricultural resources, residues and wastes.

FY 2009 Accomplishments*:*

1. A low-cost, cotton-rich nonwoven pad was developed by scientists at New Orleans, LA, using commercially available fire-retardant (FR) chemicals and fibers. The pad passed the California-legislated standard flammability tests for mattresses. An Agreement of Confidentiality with a U.S. firm has been signed to explore its application.

   ***Impact*:** Adoption of this technology will expand utilization of cotton in products which currently use synthetic fabrics.

2. Using extrusion technology, novel, lentil-based snacks rich in gluten-free dietary fiber and protein were developed by researchers at Albany, CA, in collaboration with the Departments of Food Science and Human Nutrition, and Biological Systems Engineering at Washington State University and in support of growers represented by the U.S. Dry Pea and Lentil Council. The value-added, lentil-based snacks had a high acceptance rating by a sensory panel. The products and technology developed under this accomplishment will be submitted as part of an invention entitled "Extruded Legumes."

   ***Impact*:** In the U.S., 1 in 133 consumers is considered to be allergic to gluten (Celiac disease). According to the USDA, the gluten-free market is currently valued at approximately $700 million and is expected to increase to $1.7 billion by the year 2010.The commercialization of value-added lentil-based, gluten-free products will benefit a large number of consumers allergic to gluten, and will increase demand for this commodity.

3. Antimicrobial packaging materials were developed from citrus processing residues by scientists at Wyndmoor, PA. Pectin/polylactic acid films possess the mechanical properties similar to those of petroleum-derived thermoplastics, plus they can absorb antimicrobial agents and control their release, serving as an active barrier for the inhibition of growth of all classes of bacterial pathogens.

   ***Impact*:** Biobased products can utilize abundant crop processing residues and reduce our dependence on foreign petroleum. In comparison with other methods, the present patented method is simpler, more efficient and environmentally friendly (no organic solvents), and can be easily scaled up.

4. Researchers at Albany, California, with support from a USDA, CSREES-funded NRI grant, are developing novel natural antimicrobial-containing films from apples and

tomatoes. Incorporation of natural essential oils from oregano, thyme, cinnamon, all spice, clove and lemon grass into apple- and tomato-based films and coatings were found to be active against E. coli 0157:H7, Salmonella enterica and Listeria monocytogenes. Films have been applied to hams and chicken, and their effectiveness has been verified on these foods. In addition, tests are underway to test the effectiveness of films against E. coli 0157:H7 in spinach. Concurrent sensory evaluations of films on foods are being performed to confirm sensory acceptability of these novel films. Continuous production methods have been developed to support future commercialization of the technology.

***Impact*:** Americans are increasingly concerned over the safety of their foods. This technology will enhance food safety while utilizing natural agriculturally-based ingredients.

5. Researchers at Albany, California, developed a fertilizer encapsulation matrix which, in lieu of petroleum-derived chemicals, contain entrapped functional microbes that fix nitrogen, and releases nutrients, growth promoters and insecticides into the soil for extended periods of time. The biobased fertilizer reduces the number of fertilizer applications that are required, saving labor, energy and the environment.

***Impact*:** Fertilizer costs have risen dramatically, a problem that has affected food production costs and, ultimately, food prices. Such biobased fertilizer could benefit farmers in the U.S. and in developing countries that have more limited resources.

Indicator 2

During FY 2009, ARS will develop new or improved methods to measure or predict quality, or to sort by quality.

FY 2009 Accomplishments*:*

1. Engineers at Manhattan, KS, modified a simple laboratory roller mill system to measure and analyze the electrical conductance of wheat as it was crushed. This facilitated detection of wheat kernels with live insects hidden inside of them. Furthermore, the apparatus is low cost (~$1500 for parts) and can inspect a one kg sample in less than one minute. A CRADA was formed with Total Manufacturing Company to produce and market commercial versions of the roller mill and the first salable version is complete.

***Impact*:** Grain kernels infested by insects may show no indication on their exterior, but often contain hidden larvae. Although grain is always inspected for insect infestations upon shipping and receiving, many infested samples go undetected. Many methods for detecting infested wheat have been developed but none has seen widespread use due to expense or inadequate accuracy, or both. The technology is currently being adopted by General Mills, Inc. More widespread adoption of this technology is expected in the next few years.

2. Scientists in New Orleans, LA, developed and fabricated a large sample pressure system for measuring cotton samples for use on multiple types of bench-top color spectrophotometers. The optimal pressure for measurement was established. Protocols for measuring large samples were established and implemented. Two additional systems

were fabricated and installed for use at Agricultural Marketing Service (AMS) and Cotton Incorporated.

***Impact*:** Need exists for an improved, pressurized fiber sampling system that can precisely measure cotton fiber samples. The new fiber sampling system yielded significant improvements in color measurement consistency and variability over the present manual sampling systems for large fiber samples.

3. Scientists at Wooster, OH, in cooperation with researchers at Pullman, WA, led the method development and coordinated the approval tests for the American Association of Cereal Chemistry revision of the sugar-snap cookie method, the most widely used bake test for soft wheat quality.

   ***Impact*:** The revised test is more uniform and reliable than the previous method for a wider range of soft wheat types in the U.S., Europe, Latin America and China. This will improve the progress in selecting wheat for the U.S. It also will allow researchers to better assess germplasm from other countries for its breeding value to improve U.S. wheat.

4. A method developed by scientists at Madison, WI, uses microplate fluorometers commonly available in research laboratories and simple, inexpensive reagents to measure beta-glucans in grains.

   ***Impact*:** Due to the recent cardiac health claim extended to both barley and oats relating to their content of beta-glucans, there is a need for simple and efficient test methods using standard laboratory instrumentation to quantify this phytonutrient in grains. The new method makes the analysis much more widely available than was previously the case using traditional flow-injection-analysis methodology. The publication describing the grain and malt beta-glucan analysis method has been highlighted by the American Association of Cereal Chemists in a listing of highly-downloaded articles from the journal Cereal Chemistry.

5. ARS researchers at Albany, CA, determined that mandarin oranges contain significant levels of dietary synephrine. Synephrine is a bioactive molecule that has shown some promise as an aid to weight management and also possess decongestant properties. The researchers also determined intragrove and intergrove variability and the effect of storage on synephrine concentrations. Results from this study were distributed through a peer-reviewed article and were picked up by the popular press.

   ***Impact*:** Mandarin orange growers have been looking for ways to increase consumer utilization of their product by identifying value-added biomolecules present in mandarin oranges. Growers indicated that these outputs were instrumental in generating increased consumer demand and ultimately contributed to the growers selling out their crop for the 2008-2009 season.

Measure 2.1.2 Summary of the Major Technologies Developed, Transferred, and Used in FY 2008:

During FY 2009, ARS reported on 4 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.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
ARS scientists at Peoria, IL, developed a novel technology for converting soybean oil into a highly effective, biobased sunscreen active ingredient. This technology relies on covalently incorporating ferulic acid, a natural phenolic compound, into vegetable oils. The fatty acid part of the product imparts the water-resistance required of effective sunscreens, while the feruloyl group provides UV protection and strong antioxidant properties. Combining ferulic acid with soybean oil (collectively referred to as SoyScreen™) produces a strong UV-A and UV-B absorbing material.	This invention was licensed by iSoy Technologies and scaled up for commercial adoption.	iSoy Technologies	iSoy has successfully marketed SoyScreen™ as a broad UV protection/antioxidant active ingredient, which is now formulated into Peter Thomas Roth's Wrinkle Preventer. Elizabeth Arden introduced a product line containing SoyScreen™ in Asian markets in 2008 (Prevage with Soy Ferulate) and are in development of a similar product for Western markets. Additional sunscreen products are expected to be on the market in 2010.
Researchers in Albany, CA, reduced the cost of binders used in charcoal formulations by using agriculture-based binders.	ARS worked with the Clorox Corporation under a CRADA to develop and transfer the technology.	Clorox Corporation	The agriculture-based binders are not only more cost effective but they also work better than binders used in commercial formulations. Pilot studies are now in progress to evaluate the formulations during scale-up processes. This new use will expand utilization of the agriculturally-based binder.
ARS researchers at Albany, CA, developed 100% fruit and vegetable "wraps" or "Papers" that can be used to package or present other healthy foods such as fish, oatmeal, cottage cheese, egg, polenta, bread, beans, nuts, etc which are shelf stable, tasty and economical.	The technology has been licensed to a start-up company.	Origami Foods	Origami Foods recently opened a factory in an economically-depressed area. Origami's sales are quickly expanding and the American public will soon be able to obtain this product at selected stores and various restaurants. This technology will offer consumers another opportunity to consumer fruits and vegetables and expand markets for these commodities.
ARS researchers at New	In 2008, CrispTek, LCC	CrispTek, LCC of	Fried foods coated with the product

Orleans, LA, developed and patented a rice-based low oil-uptake batter technology for deep fried foods.	of Columbia, MD acquired the exclusive license right to the ARS patent and rolled out its first product, ChoiceBatter, in June 2009, and it is currently available through their website at www.ChoiceBatter.com.	Columbia, MD	are low in fat, gluten-free and Kosher-pareve. The development meets the need of healthier foods and thus will have an impact on the health and well being of US consumers. A follow-up CRADA between ARS and CrispTek is underway to study the effects of solvents on the textural and sensory properties of the batters.

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

During FY 2010, 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

During FY 2011, 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

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

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 2009, ARS will develop new production practices and decision support tools that increase profitability and improve environmental quality.

FY 2009 Accomplishments*:*

1. Potato yield in the Northeast has remained stagnant for over 50 years, despite increased inputs of pesticides, nutrients, and water. Additionally, numerous soil-borne diseases are a persistent problem in potato production. ARS research showed that when soil quality was improved, potato plants developed more leaf area with greater and longer lasting photosynthetic potential. Several rotation crops with the potential to reduce soil-borne diseases when managed as full season, green manure, or fall cover crops were evaluated.

   Impact: Canola and rapeseed rotations reduced certain soil-borne diseases by 30-80% based on a combination of factors that included incidence, severity, and percentage of damage. As a result improved plant growth and decreased disease, yields were increased by as much as 50 percent. This new technology provides growers with specific rotation guidance that makes them more competitive in the global economy.

2. Peanut oil could be an excellent feedstock for biodiesel production, but no data currently exist about which cultivars might be best suited for this market. Also, production systems for market-quality peanuts are not well-suited for a biodiesel production because of the high input costs. ARS scientists evaluated the economic and agronomic performance (under both low and high input management strategies) and biodiesel engine performance of over 40 different cultivars.

   Impact: Five peanut cultivars exhibited both superior production performance and oil characteristics, and would help to enable on-farm biodiesel production. It was demonstrated that the use of conservation tillage in peanut/cotton rotation systems, while having no adverse impacts on crop yield or quality, resulted in lower production costs, lower emissions, and water savings of 20% versus conventional tillage.

3. Weeds are the primary limitation and expense to organic onion production. ARS scientists found that mustard (*Sinapis alba*) seed meal, applied at 1 to 2 tons/acre after the 2 leaf stage of onion growth, controlled annual weeds without significant injury to onions. Mustard seed containing high levels of sinalbin suppressed weeds much better than seed meal derived from seed lines bred for low glucosinolate levels.

Impact: Mustard seed meal is useful to producers of organic crops for weed suppression. Implementation of this means of weed control could result in reducing the high costs of hand weeding, saving as much as $800 to $6,000 per acre.

Measure 2.2.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2009:

During FY 2009, ARS reported on 4 new technologies and systems developed and used by customers that utilize new configurations of practices and technologies to dreduce the cost and increase profitability, improve the efficiency or increase the yield, and increase the sustainability of production.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
ARS developed a mechanistic simulation model for soybean growth and development.	The GLYCIM model with a graphical user interface (GUICS) to manage files is available on the ARS website.	Soybean growers and scientists.	Using GLYCIM to schedule irrigation, growers in the Mississippi Delta have demonstrated a 25% increase in water use efficiency.
On-farm bioenergy using a scalable, integrated system for the economic, gasification of non-densified biomass.	Invention disclosure submitted.	Rural communities, cereal grain and grass seed producers.	Provides value-added, alternative use for straw that was previously burned.
GPS-controlled 3-point hitch for precision implement operation.	Invention disclosure.	Producers, consultants, extension.	Tool provides precise grade control of attached implements resulting in more efficient water management and drainage.
ARS developed a two-dimensional computer model that interfaces with plant models and simulates water, heat, and solute movement in soils.	The 2DSOIL model is available on the ARS website.	Government and industry Scientists and engineers in the U.S., Europe and Israel.	Model is used to estimate groundwater and solutes dynamics in soils.

Measure 2.2.1 Outyear Performance Plan (the future performance indicators for this Measure)

During FY 2010, ARS will

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

During FY 2011, ARS will

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

During FY 2012, 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.

Baseline 2006
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.
Target 2011
Cumulatively, 35 new technologies developed and used by ARS customers.

Indicator 1

During FY 2009, ARS will identify underlying genetic and physiologic mechanisms impacting reproductive efficiency, nutrient conversion, and growth in food animals.

FY 2009 Accomplishments*:*

1. Poultry nutrition research progressed in FY 2009 towards a better understanding of the mechanisms that regulate feed intake and nutrient utilization during different phases of the production cycle. Ethanol production may increase the relative cost of corn normally used for broiler production but also produces distillers dried grains with soluble (DDGS) which are utilized by the livestock industries. It was thought that formulating diets with DDGS would result in lower energy feeds that may be inappropriate for broilers selected based on growth attained with much higher energy diets. However, this ARS work clearly demonstrated that the modern broiler can thrive on diets containing quantities of DDGS.

   Impact*:* This research has direct impact on the broiler industry and will enable the increased utilization of DDGS in broiler rations lowering the cost of production for the industry.

2. Streptococcus aureus is a notorious pathogen causing chronic bovine mastitis in dairy cattle. The unique ability of S. aureus to hide in mammary cells provides a high level of protection to the pathogen from both the host immune defenses and conventional antibiotics, preventing elimination. This usually results in the culling of between 8% and 15% of the US dairy herd annually due to chronic infection. To combat this significant economic threat to the dairy industry, ARS scientists have developed a fusion of 2 proteins capable of carrying a lysostaphin enzyme across the plasma membrane of mammary epithelial cells and kill intracellular S. aureus. This technology is not limited to just mammary epithelial cells and may have novel antimicrobial application in many other areas. Now in field trials.

Impact: This work will potentially produce tremendous saving for the dairy industry by increasing the productivity and health of dairy cattle and by decreasing reliance of the industry on conventional antimicrobials.

3. Research by ARS scientists demonstrated that yearling heifers with fewer uterine antral follicle counts have decreased heifer pregnancy rates. Antral follicles are small follicles that can be seen and counted with ultrasound. Each primordial follicle contains an immature egg that can potentially develop in the future. Identifying heifers with greater antral follicle counts offers a strategy to increase fertility and pregnancy rates of yearling heifers. Additional research by ARS scientists has demonstrated that the size of the ovulatory follicle is related to the probability that a cow will successfully become pregnant and have a calf. Breeding herd reproductive rates are one of the key factors determining the success and profitability of a commercial beef enterprise. At breeding, the ovulatory follicle has a diameter range from 12 to 30 mm. Fertility was demonstrated to be greatest for cows with ovulatory follicles ranging from 14 to 18 mm in diameter. Cows with follicles greater than 21 mm, did not conceive.

   Impact: Screening cows for ovulatory follicle size prior to breeding is a potential tool to allow producers to evaluate the fertility of individual cows. Decisions then can be made to cull non-fertile cows significantly improving reproductive efficiency and profitability.

4. Catfish fry are produced in hatcheries where eggs are hatched and fry are grown for 4 to 10 days. Fry are then transferred from the hatchery to nursery ponds for further growth. Hatchery water conditions are stable, and at optimum conditions for fish whereas environmental conditions may vary greatly in the nursery pond. Research has shown that catfish fry have high tolerance for sudden decreases in water pH, but low tolerance for increasing water pH. Both channel catfish and hybrid blue x channel catfish are sensitive to abrupt pH increases.

   Impact: Farmers have been advised to monitor pH before transferring fry and fingerlings, and not move fish into higher pH environments. This simple practice is being adopted having significant impacts on fry survival in catfish farming.

Indicator 2

During FY 2009, ARS will develop technologies leading to improved marketability of animal products.

FY 2009 Accomplishments:

1. Previously, ARS scientists had developed a noninvasive method to predict tenderness of the ribeye muscle of U.S. Select and U.S. Choice beef carcasses based on visible and near infrared spectroscopy. Current research was expanded to demonstrate that this technology could also be used on the top sirloin and could logically be expanded to additional cuts. This technology should benefit both consumers and all sectors of the beef industry by identifying cuts of beef that are consistently tender and by providing the beef industry tools to improve overall beef tenderness and consistency. Additional research determined that injection marination could improve the tenderness of tip side steaks. The tip center steak had previously been identified as an economical menu alternative for foodservice outlets. However, tip center steaks have unacceptable

tenderness characteristics. Additional work demonstrated that previously identified genetic tenderness markers could partially mitigate the toughening effects of aggressive growth promotant strategies used by cattle producers.

Impact: Restaurants can now feature tip side steaks as an alternative selection with acceptable tenderness levels improving customer satisfaction. This work provides quantitative evidence of the value of genetic tenderness markers in commercial production systems.

2. Valuable salmon oils can be extracted from fish processing wastes, but they must be stabilized immediately to prevent oxidative damage to long-chain polyunsaturated fatty acids. Smoke-processing was evaluated by ARS scientists at Fairbanks, Alaska, in cooperation with the University of Alaska scientists as a technology to reduce oxidation of salmon oil. Salmon heads exposed to hot smoking produced oils with decreased oxidation and superior antioxidant potential, including higher levels of anti-oxidant tocopherols, than their non-smoked counterparts.

   Impact: Smoking fish processing by-products will improve the value and marketability of the valuable fish oils. Extending the timeframe for oil isolation and stabilizing the oils without addition of costly antioxidants may reduce the cost of these high value oils.

3. Because of popular concern over the use of fish meal in diets for fish reared in culture, many seafood suppliers prefer fish reared on diets with low or no fish meal in the feed. As dietary fish meal is reduced in the diet of carnivorous fish such as rainbow trout, several critical nutrients become limiting. ARS scientists in Aberdeen, Idaho, have shown that rainbow trout fed plant based, fish meal free diets, required supplementation with potassium chloride, sodium chloride and magnesium oxide, to improve feed efficiency and fish health. These minerals are abundant in fish meal, but limiting in plant based proteins meals.

   Impact: Supplementation of these minerals is now done in all fish meal free trout feeds, for both research and commercial production of ARS formulations. Fish reared on fish meal free diets have broad appeal.

Indicator 3

During FY 2009, ARS will identify genes and their function leading to DNA tests for use in food animal genetic improvement programs.

FY 2009 Accomplishments:

1. Osteopetrosis is a rare inherited disorder that makes bones increase in both size (mass) and fragility and is an emerging genetic disease in the Red Angus breed resulting in stillborn calves. Research was conducted to map the osteopetrosis disease locus using the SNP50 genotypes from Angus DNA samples. This research was then used to develop a commercial diagnostic test for osteopetrosis in collaboration with the USDA – Beltsville Area Research Center, USDA – Meat Animal Research Center, University of Illinois, University of Nebraska, and the Red Angus Association of America.

   Impact: This research led to identification of the mutation and a commercial DNA test was produced that identifies carriers of the defect in the Red Angus breed.

2. Bovine respiratory disease (BRD) is the most economically damaging single disease of cattle currently afflicting U.S. beef herds. A candidate gene that is known to be a regulator of immune response in cattle was studied and a large group of DNA markers were identified relating to BRD. A total of 24 genetic markers were significantly associated with BRD.

   ***Impact**:* These new markers and will now be evaluated for improved genetic resistance to BRD in cattle to decrease the impact of BRD on beef cattle production efficiency.

3. ARS research improved the genomic analysis of meat tenderness in beef cattle. Previous studies had determined that genetic variation in the calpastatin gene (CAST) makes a substantial contribution to variation in beef tenderness. Commercially available genetic markers in the gene have been successfully used for nearly ten years, but the marker system has limited utility in some breeds and populations. A thorough analysis of the CAST gene using new genomic technologies developed in part by ARS scientists identified 41 additional markers which were used to develop an improved test with wider applicability.

   ***Impact**:* These improved tests present the opportunity to make more rapid progress in genetic selection for increased meat tenderness in beef cattle.

4. Some families of catfish are more resistant than others to enteric septicemia of catfish (ESC). Resistant families repeatedly demonstrate <30% mortality following experimental challenge, while susceptible families demonstrate >70% mortality. Analysis of gene expression showed that the tumor necrosis factor (TNF) gene is differentially expressed in the two family types, showing a significantly higher peak in expression in spleen tissue at 48 hours post-challenge and at 72 hours post-challenge in liver tissue from resistant families. Expression of the TNF gene and its correlation with resistance to E. ictaluri and other pathogens will be fully explored.

   Impact: TNF is a candidate gene to use in screening for genetic improvement in resistance to ESC and possibly other diseases.

5. Toll-like receptors (TLRs) are a family of immune response proteins found in humans and other vertebrates. We identified, mapped and thoroughly described nine TLR genes and surrounding markers in rainbow trout. These TLR genes are candidate targets for marker assisted selective breeding for improved disease resistance in rainbow trout and other salmonids.

   Impact: As the association between disease and these TLR genes is evaluated, the TLR genes and markers could be important for marker assisted selective breeding.

Indicator 4

During FY 2009, ARS will develop genomics infrastructure and tools that will enhance efficiency and speed of gene identification, and utilization of DNA data in genetic improvement programs of food animals.

FY 2009 Accomplishments*:*

1. Previously developed genomic predictions were transitioned from a research project to a production system, and the United States became the first country to replace official traditional genetic evaluations with genomic evaluations based on direct examination of DNA in January 2009. Numerous changes were made to the USDA genetic evaluation program to enable efficient management of genomic information, incorporate it in official USDA evaluations, and distribute those evaluations to stakeholders. Artificial-insemination and breed organizations now can use an online query to designate animals to be genotyped, determine if the animal has already been nominated, and check the reason a genotype was rejected. Four commercial laboratories provide genotypes that are stored in the USDA national dairy database, and the most recent international evaluations are combined with genomic and traditional data into a single evaluation that includes all available information. The programs and edited genotypes were also used to compute Canadian national evaluations in August 2009; USDA and Canadian researchers cooperated in developing international evaluation methods to combine genomic information from all countries. This research led to the development of a web site (http://aipl.arsusda.gov/) to catalog and manage the genetic evaluations for 20 million dairy cattle and goats for yield (milk, fat, protein, and component percentages) and fitness (mastitis resistance, longevity, conformation, and reproduction) traits and economic indexes as well as supporting documentation. This website is utilized by dairy industries worldwide, including producers, breed registry societies, artificial-insemination organizations, milk-recording associations, and dairy records processing centers, as well industry and university researchers.

   Impact: The availability of genetic evaluations and supporting documentation on the web site allows earlier access to estimates of genetic merit, which significantly increases genetic progress for economically important traits that contribute to production efficiency.

2. The results of ARS development of the commercial genotyping tool (BovineSNP50, Illumina) continue to have a major impact on livestock research. The dairy artificial insemination industry capitalized on substantial gains in accuracies of predicted genetic value early in an animal's life and predictions of genetic merit enhanced by genome-wide SNP genotypic data from the BovineSNP50 have been implemented into the genetic evaluations of the Holstein, Jersey and Brown Swiss breeds. As a result, increased genetic gain will be an immediate impact of this technology as superior animals are more readily identified and more intense selection pressure applied to produce the next generations of dairy animals. Applications of commercial genotyping technologies developed by ARS scientists were used in numerous related applications including rumen metagenoic and soybean SNP discovery. These technologies were also used internationally in collaborative projects in Kenya to evaluate nematode resistance in sheep and in Pakistan to sequence indigenous dairy breeds and water buffalo. ARS scientists cooperated with the University of Maryland in research to identify a more precise marker order and complete coverage of the bovine genome, critical for cattle genome research.

   Impact: This research will further improve accuracies of genome enhanced predictions of genetic merit and identification of causal genetic variation underlying phenotypic differences in traits of economic importance. Increased genetic progress improves production efficiencies for dairy producers decreasing relative production costs.

3. The application and implementation of molecular technologies requires a large suite of polymorphic genetic markers to enhance capabilities for genetic analyses in rainbow

trout. Single Nucleotide Polymorphisms (SNPs) are highly abundant markers which are evenly distributed throughout the trout chromosomes. Scientists in Leetown, West Virginia employed a high throughput strategy to discover SNPs in rainbow trout. Over twenty thousand putative SNPs were identified and 384 were tested resulting in a 48% validation rate. Of those new markers, 167 were placed on the rainbow trout genetic map.

Impact: Based on the validation results, approximately 10,000 putative SNPs from the original data set will be useful for implementing molecular genetic technologies into rainbow trout selective breeding for improved production efficiency and sustainability.

Indicator 5

During FY 2009, ARS will continue to characterize germplasm of food animals for traits of importance.

FY 2009 Accomplishments*:*

1. Crossbred progeny representing the seven most widely used breeds in the beef industry underwent extensive performance recording for feed intake, carcass and tenderness traits in steers, and reproductive traits in females. Analyses of individual marker associations were conducted and compared with analyses of similar populations in Canada and Australia for growth, feed efficiency, and carcass traits. Crossbred cows born in 1999 and 2000 have been individually fed to determine maintenance requirements and continue to be evaluated for longevity (productive herd life), reproductive and maternal traits. Additional traits being evaluated include vaccination response, treatment and diagnostic records, lung lesions at slaughter, and blood counts on entering the feedlot to support research on genomics of disease resistance. A bovine genomic assay including 58,000 markers was used on 2,600 crossbred cattle that had been weighed at birth, at weaning, and at one year of age. Hundreds of strong associations between markers and growth were estimated with a high degree of confidence. Thousands of weaker associations between markers and growth were also identified.

   Impact*:* These results are a critical step in developing additional tools that can be widely used by the cattle industry to improve growth and birth weights.

2. ARS scientists contributed 115,572 novel genetic markers which were combined with other publicly available markers to produce a high density porcine genomic assay for use in genome selection programs and research for the swine industry. ARS scientists also contributed DNA samples for preliminary assessment of the assay (SNP chip). This technology has now been adopted worldwide for use in genomic research and breeding programs in the swine industry. Similar research identified 18 genes and various other regions for associations with female reproductive performance. This research validated several known genes involved in signaling or synthesis of reproductive hormones additional results indicate that genes affecting energy metabolism are also significant, especially for rebreeding performance traits. In related work, predictive DNA markers for pork quality near the calpastatin gene were evaluated for pork tenderness. Five markers were identified that were consistently associated with shear force tenderness across four different populations of industry-relevant pigs.

Impact: These SNPs are highly predictive of pork tenderness in industry populations and will enable the swine industry to improve product tenderness increasing consumer demand for pork products.

3. Commercial salmon producers in the U.S. use fish stocks that are not many generations removed from wild, unselected stocks, and must be certified stocks of North American salmon. Scientists at the National Cold Water Marine Aquaculture Center in Franklin, Maine evaluated the growth of salmon from their breeding program in commercial sea cages in collaboration with industry. A salmon line was selected for increased growth and eggs from this improved line were provided to commercial producers.

   Impact: Utilization of improved fish will increase the profitability and sustainability of coldwater marine aquaculture in the U.S. and provide a quality seafood product to U.S. consumers.

4. There is increasing demand by farmers for the hybrid catfish (female channel x male blue catfish), though strategies to maximize production are still being developed. Scientists at the HKD Stuttgart National Aquaculture Research Center compared production characteristics of hybrid catfish to channel catfish; both groups of fish shared a common maternal strain. Hybrids had higher yields and this study demonstrated that the greater yield of the hybrid catfish was attributable to higher feed consumption. Higher consumption and increased yield suggests no loss in growth efficiency and thus improved performance.

   Impact: Identifying a superior performing fish is an important factor in ensuring sustainable catfish production in the US.

Indicator 6

During FY 2009, ARS will develop improved cryopreservation technology for storage of animal germplasm and continue to increase the stocks of germplasm stored withint eh National Animal Germplasm Program repository.

FY 2009 Accomplishments:

1. The security of US animal genetic resources improved significantly as the total collection increased beyond 540,000 samples, an 18% increase from the previous year. Preliminary research projects were initiated to ensure the long term viability of the germplasm collection. Beef semen has been cryopreserved since the 1950's but the viability of samples in long storage has not been scientifically evaluated. Preliminary results indicate that storage time has not affected fertility. Additional research was conducted to improving the efficiency of mating procedures with cryopreserved germplasm involving a non-surgical procedure for artificially inseminating sheep. The procedure has been shown effective with fresh ram semen (55% fertility) however cryopreserved semen is significantly lower and therefore requires additional exploration for methods or technologies to overcome this limitation. In addition, 1,194 samples from 263 animals left the repository for animal generation, germplasm evaluation, or DNA studies.

   Impact: This program is important for the identification and preservation of genetic variation in the livestock industry for valuable traits and to protect critically important germplasm worldwide.

Measure 2.2.2 Summary of the Major Technologies Developed, Transferred, and Used in FY 2009:

During FY 2009, ARS reported on ____ 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.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
A line of Atlantic salmon from the 2004 year class selected for increased growth or weight was spawned as a select line in 2008. Fish were genotyped for North American origin using a panel of seven microsatellite loci developed by the US Fish and Wildlife Service. Salmon were also health certified for disease status.	Eggs (approximately 500,000 unfertilized and eyed eggs) from these Atlantic salmon were transferred from the USDA ARS National Cold Water Marine Aquaculture Center salmon breeding program to the Maine Aquaculture Association.	Salmon Farmers affiliated with the Maine Aquaculture Association.	Utilization of improved germplasm will increase the profitability and sustainability of coldwater marine aquaculture in the U.S. and provide a quality seafood product to U.S. consumers.
An incubator for catfish egg masses was developed with a radically new design, dependent on periodically lifting the developing embryos out of the water.	A commercial-scale unit was fabricated and tested at a commercial hatchery during the 2008 spawning season, resulting in a technical note on this new incubator design. While standard troughs are loaded with not more than 18 pounds of eggs and require at least 2 ½ gallons per minute (GPM) of water flow, the new design incubated up to four times that amount on as little as 2 GPM water flow. Work continued at a second hatchery in Mississippi during the 2009 spawning season. Sixteen troughs using the new design were constructed and used (in modules of four troughs operated with one motor), hatching over 30 million eggs.	Catfish fingerling producers.	This incubator is still in the preliminary stages of design and use, nevertheless it appears that it will save both considerable space and water compared to existing equipment.
Genetic evaluations for 20 million dairy cattle and goats for yield (milk, fat,	Genetic evaluations available at http://aipl.arsusda.gov/	Dairy industries worldwide, including producers, breed	Availability of genetic evaluations and supporting documentation on the web site allows

	protein, and component percentages) and fitness (mastitis resistance, longevity, conformation, and reproduction) traits and economic indexes as well as supporting documentation.		registry societies, artificial-insemination organizations, milk-recording associations, and dairy records processing centers, as well industry and university researchers.	earlier access to estimates of genetic merit, which increases genetic progress for economically important traits that contribute to production efficiency.
	Independent validation of commercial DNA tests for the beef industry. These tests address economically valuable beef cattle production traits, but require independent validation for adoption by the beef industry.	Released to public through National Beef Cattle Evaluation Consortium website.	Beef cattle seedstock producers, breed associations, extension specialists and DNA testing companies.	Potential customers have better information to decide whether to use DNA testing products and which products to use. DNA testing companies have independent data to market products. Some potential products have been withheld from the market based on performance in independent validation. Results in more effective selection for beef quality traits. This year the process has been improved to allow estimation of the proportion of genetic variance in the economically important traits explained by the DNA tests.
	Differential gene expression (transcriptome) profiling determined by whole genome microarray analysis for liver, breast muscle, brain and duodenum tissues collected from broiler chickens at hatch and one week after hatching.	Raw data for the expression of 32,773 unique transcripts and variants encompassing all known genes in the chicken genome have been deposited with the National Center for Biotechnology Information (NCBI) Gene Expression Omnibus (GEO) under the accession number GSE15413.	Scientists throughout the world will use this information to study mechanisms involved in the regulation of nutrient utilization in broiler chickens.	Results obtained from the analysis of this data by different groups worldwide will contribute new insight toward improving nutrition and management practices in commercial broiler chicken production.

Measure 2.2.2 Outyear Performance Plan (the future performance indicators for this Measure)

During 2010, 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 2011, 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 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.

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 2009, ARS will develop crop production systems and technologies that harness genetic potential, optimize crop productivity and quality, mitigate losses due to weeds, nematodes, pathogens, and arthropod pests, and utilize appropriate automation to provide a secure food, fiber, feed, and flower supply that is competitive in the global marketplace.

FY 2009 Accomplishments*:*

1. *More precise genetic engineering to improve the quality of plants.* Improvement of multiple traits through genetic engineering often requires the co-introduction of multiple genes controlled by different promoters. However, multiple gene promoters can cause unexpected problems with transgene expression. ARS scientists at Kearneysville, West Virginia, found gene "insulator" sequences that prevent the interactions of the multiple gene promoters.

   ***Impact*:** The gene "insulator" sequences will be instrumental for transgenic research especially for co-expressing or precisely engineering multiple genes or traits.

2. *Improved spray drift reduction technologies.* With increasing environmental awareness and associated concerns with potential off-target movement of applied crop protection products, aerial applicators will soon be facing pesticide label-enforced buffer zones. These buffer zones potentially reduce the treatable area of crop production fields by requiring field-edge strips that remain untreated in an effort to increase the downwind distance from the application swath to the field edge. New technologies are needed that will reduce spray drift from aerial and ground application as compared to conventional application systems. In cooperation with the U.S. EPA Office of Pesticide Programs, ARS scientists in College Station, Texas, provided definitive assessments of protocols that can be used to test potential drift reduction technologies (DRTs). The work also involved both low- and high-speed wind tunnel testing protocols for ground and aerial DRTs, including assessments of various spray nozzles and the droplet sizes produced.

***Impact*:** This accomplishment is critical in providing the aerial application industry with scientifically sound information, protocols, and new technology to assure ongoing compliance with evolving regulatory requirements.

3. *Kaolin clay-based product controls weeds in bramble production*. Weed management is an important component of small fruit cropping systems. If left unchecked, weeds will compete with blackberry transplants for soil resources and adversely affect plant productivity. ARS scientists, in Kearneysville, West Virginia, determined that incorporation of hydrophobic kaolin into cultivated soil after planting suppressed weed growth for 3 years without affecting blackberry productivity. A patent was filed to protect this technology.

   ***Impact*:** This kaolin clay and soil combination increases the arsenal of products for managing weeds in horticultural crops.

4. *Elimination of Rhizoctonia from azalea stems used for propagation.* The pathogen that causes web blight on azalea, *binucleate Rhizoctonia*, is carried on healthy appearing stems used to propagate next year's crop. The pathogen annually damages about 30 percent of the azalea cultivars commonly grown. ARS scientists in Poplarville, Mississippi, in cooperation with Mississippi State University scientists, developed methods that will eliminate *Rhizoctonia* species from azalea stems collected for propagation. Submerging stems in 122°C water for 21 minutes eliminated the pathogen from the stem with only minor damage that would not hinder rooting success. This research is one component of an integrated control approach and a critical first step in minimizing the spread of this pathogen in the azalea crop.

   ***Impact*:** The control strategy will reduce crop damage, minimize fungicide usage, while improving crop yield potential.

Indicator 2

During FY 2009, ARS will maintain and enhance genetic and genomic databases and make information accessible via standard software from the Internet.

FY 2009 Accomplishments*:*

1. *New Web-based tools accelerate the genetic improvement of soybean.* The soybean genome contains 46,000 predicted genes, and associating specific genes with high-value traits is an important challenge. ARS scientists at Ames, Iowa, released a greatly improved version of SoyBase and the Soybean Breeder's Toolbox (SBT), a powerful suite of Web-based applications, that enable breeders and researchers to more fully exploit knowledge of the soybean genome structure to accelerate crop improvement. SoyBase and the Soybean Breeder's Toolbox is an integrated repository for information on soybean genetic maps, physical maps, genetic markers, gene sequences, disease and stress resistance, and trait ontology.

   ***Impact*:** SoyBase, together with the soybean genome sequence, is expected to dramatically speed progress in breeding and identifying the genetic and molecular basis for many important soybean traits.

2. *Valuable new genetic analysis software developed.* Until now, there have been no methods to automatically combine genome sequence data with information about the actual location of the sequences within the genome. Such methods would substantially accelerate the rate of discovering genes vital for corn genetic improvement. ARS researchers in Ames, Iowa, invented a new software program, named "Locus Lookup Tool", that enables geneticists and breeders to more rapidly locate regions of the corn genome that most likely include genes controlling specific valuable traits.

   ***Impact*:** This tool will enable researchers to exploit more extensively the intrinsic value of the recently completed genome sequences for key corn varieties.

Indicator 3

During FY 2009, 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 2009 Accomplishments*:*

1. *ARS scientists and colleagues complete the sequence of the corn genome.* ARS researchers at Ithaca, New York, along with collaborators at Washington University, Iowa State University, the University of Arizona, and the Cold Spring Harbor Laboratory in Cold Spring Harbor, New York, compiled the comprehensive sequence of the corn genome with support of the National Science Foundation, Department of Energy, and USDA National Institute of Food and Agriculture. The researchers also used advanced DNA sequencing data to assemble a haplotype genetic map of the corn genome that detail portions of the genome shared by 27 diverse inbred lines of corn. The map is designed to make it easier to link genes and genetic patterns to significant traits.

   ***Impact*:** The corn genome sequence and new genetic map will significantly accelerate breeding of corn and other crops to meet the challenge of increasing productivity and the challenges of climate change.

2. *Sorghum lignin synthesis gene with bioenergy applications.* Development of new cellulosic biofuels from sorghum and switch grass is restricted by technical barriers in breaking down the lignin in plant cell walls. To overcome that barrier, ARS researchers at Lincoln, Nebraska, have characterized a key gene that controls lignin structure and content. They characterized a low lignin (brown rib) sorghum mutant and sequenced the *bmr-6* gene that causes the mutation. A single amino acid change causes the mutation, which reduces the level of a lignin synthesis enzyme, resulting in reduced lignin content. The mutant sorghum lines have higher ethanol yields and higher ethanol conversion efficiency than do wild type sorghum lines.

   ***Impact*:** Characterization of this lignin gene mutation strengthens strategies needed to develop bioenergy feedstocks from sorghum and other grass crops.

3. *Genes involved in plant defense mechanisms identified in sugarbeet roots.* The sugarbeet root maggot is one of the most devastating insect pests of sugarbeet and is found in two-thirds of all U.S. sugarbeet fields, accounting for 10 to 100 percent reduction in sugar yield. To improve disease resistance, a better understanding of the molecular mechanisms controlling plant defense responses is needed. ARS scientists in

Beltsville, Maryland, identified nearly 500 root genes whose expression is modulated by insect feeding. One gene in particular (BvSTI) was found to have the potential to destroy insect digestive enzymes. Expression of the engineered BvSTI gene in sugar beet roots and model plants provided increased resistance to several major insect pests that feed on vegetable and crop plants, including sugarbeet.

> ***Impact*:** Researchers will be able to use this information to identify plant resistance mechanisms that will lead to new methods for development of improved elite germplasm lines with enhanced disease and pest resistance.

4. *Circadian clock governs adaptation to environmental change and high-value traits.* The circadian clock serves to synchronize the internal biology of an organism with its environment, and thus plays an important role in plant adaptation to environmental change. ARS scientists at West Lafayette, Indiana, and Albany, California, showed that 2 percent of the soybean seed genes assayed, and 12 percent of the corn genes assayed, including those involved in photosynthesis, starch utilization, hormone synthesis, and plant growth, are governed by the clock.

> ***Impact*:** These processes in turn impact key agronomic traits like seed yield, seed quality, flowering, biomass, and stress tolerance. ARS scientists tested individual corn and soybean genes and confirmed that they impact clock functions, thereby establishing a foundation for the exploration of clock genes for improving seed yield, seed quality, and the adaptability of these crops.

Indicator 4

During FY 2009, ARS will improve plant genetic transformation systems to expand their utility and improve exploitation of genome sequence information to identify valuable genes in germplasm collections.

FY 2009 Accomplishments*:*

1. *New rice blast resistance genes identified.* Rice blast disease is a serious threat to rice production in the United States and worldwide due to constant development of more virulent races of the pathogen. ARS scientists at Stuttgart, Arkansas, analyzed a total of 1,800 rice accessions in the U.S. rice germplasm collection for the presence of blast resistance genes using DNA markers and disease evaluation. Diverse accessions contained the Pi-ta resistance gene. Others appear to possess new genes for blast resistance.

> ***Impact*:** These accessions will be important to breeding programs for blast resistance.

2. *Drought-stress genes in corn and resistance to aflatoxin contamination.* Throughout the world, aflatoxin contamination is one of the most serious food safety issues. Chronic problems with pre-harvest aflatoxin contamination occur in the southern United States, and drought stress is a major factor contributing to the condition. Recent studies have demonstrated that higher concentrations of defense or stress-related proteins were produced in corn kernels of resistant genotypes, suggesting that pre-harvest field condition related to drought stress influenced gene expression for pre-harvest aflatoxin contamination. ARS scientists in Tifton, Georgia, applying proteomic comparisons

between resistant and susceptible corn kernel proteins, have identified stress-related proteins, along with antifungal proteins associated with corn kernel resistance.

> ***Impact*:** Gene expression analyses of developing corn kernels and the proteomic studies that suggest defense-related genes are up- or down-regulated by abiotic stresses, and this is correlated with post-harvest aflatoxin contamination.

3. *New genes identified to protect wheat from the Ug99 wheat stem rust threat.* More than 80 percent of the world's wheat varieties are vulnerable to the virulent new wheat stem rust strain, Ug99, which has appeared in Eastern Africa. New sources of Ug99 resistance are urgently needed. In 2009, ARS researchers identified new sources of Ug99 genetic resistance in wild and weed relatives of wheat, and have made initial progress in incorporating those genes into bread wheat. ARS researchers in Manhattan, Kansas, mapped and transferred a Ug99 resistance gene from the wild wheat *Triticum timopheevii*. ARS researchers in Fargo, North Dakota, identified resistance genes from goatgrass and perennial wheatgrass species and are now advancing genetic resources to facilitate the use of these new resistance genes. ARS researchers in Raleigh, North Carolina, identified 30 breeding lines with Ug99 resistance and are assessing those lines for agronomic traits in partnership with the International Wheat and Maize Agricultural Research Center (CIMMYT) in Mexico for distribution globally.

> ***Impact*:** These new sources of genetic resistance to Ug99 are keys for breeding wheat with more durable resistance to Ug99 to protect the global grain supply.

Indicator 5

During FY 2009, 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, nutrient composition, disease resistance, and stress tolerance in agricultural crops.

FY 2009 Accomplishments*:*

1. *Early flowering genes identified that accelerate fruit tree breeding.* Fruit tree breeding is a slow and expensive process because of the long delay between planting a seedling and its first flowering. Years of breeding and testing can be saved if that time is shortened. ARS scientists at Kearneysville, West Virginia, have identified and incorporated into breeding stock a gene that promotes early flowering and fruiting, shortening the juvenile stage in plum from 4 years to less than 1 year. Once breeding results are achieved, the genetically engineered early flowering trait can be removed before varietal release, resulting in a tree that can be categorized as non-genetically engineered.

> ***Impact*:** Early flowering and fruiting will enable the rapid development of new and improved varieties of plum and other fruits, as well as forest and woody ornamental species.

2. *Molecular marker developed for seedlessness and disease resistance in grape.* New cultivars of seedless table grapes require embryo rescue by tissue culture and several years of growth to evaluate seedlessness. A new molecular marker developed by ARS scientists at Geneva, New York, predicts seedlessness, enabling breeders to select

seedless types soon after embryo rescue, and discard seeded grapevines without investing resources in their maintenance and evaluation. In addition, a marker for a broad spectrum powdery mildew resistance was discovered in the same breeding material.

***Impact*:** Beyond the scientific progress toward isolating and characterizing these genes, the molecular markers will accelerate the selection of seedless grapes with disease resistance, which will enable growers of these future cultivars to drastically reduce pesticide applications. Varieties with the broad spectrum powdery mildew resistance would save growers from $100 to $400 per acre annually in pesticide costs and reduce direct and indirect effects of pesticide application.

Indicator 6

During FY 2009, ARS will construct and maintain physical, genetic, and transcript maps to facilitate comparative analyses among plant genomes.

FY 2009 Accomplishments*:*

1. *Apple rootstock map completed.* Genetic maps are an important tool for locating genomic regions that affect apple rootstock traits. ARS scientists at Geneva, New York, completed a genetic map of apple rootstocks that encompasses all 17 linkage groups (chromosomes) of the apple genome and identified the location of 16 genes expressed in roots only and 13 disease resistance homologues, some of which co-locate to known disease resistance regions.

   ***Impact*:** This accomplishment has enabled the discovery of markers linked to important apple rootstock traits which will enable marker-assisted breeding.

2. *Genetic mapping of day-length sensitivity in grape.* Grapevines grown throughout the eastern United States are poorly adapted to low-temperatures and frequently are damaged by severe winters and fluctuating temperature during the spring and fall. There is tremendous variation among cultivated and wild grapes for tolerance to low-temperature stress, including some types that are capable of initiating dormancy in response to shortening day-length in early fall. To understand the genetic control of day-length sensitivity, ARS scientists at Geneva, New York, identified in the grape genome the locations of genes controlling photo-periodic induction of dormancy. One region of the genome accounted for over 40 percent of the variation observed for photo-periodic induction of dormancy.

   ***Impact*:** The mapping of this trait is the first step in developing an assay that will improve the selection efficiency for this trait and generating improved cultivars of grape for cold climates.

3. *Inheritance of sunflower downy mildew resistance.* Downy mildew, a serious disease of sunflower, often strikes early in the growing season, especially under cool, damp environments. Sunflower line HA-R5 confers resistance to nine races of the pathogen

that causes the disease and is a promising source of downy mildew resistance for commercial sunflower hybrids. It is difficult to transfer the resistance genes without knowing the genetic control or inheritance. ARS scientists at Fargo, North Dakota, determined the inheritance of the downy mildew resistance gene in HA-R5 and genetically mapped it to a genomic location near two DNA SSR markers.

> ***Impact*:** These DNA markers closely linked to the resistance gene will enable marker-assisted selection for developing downy mildew resistant lines.

Indicator 7

During FY 2009, ARS will identify, acquire, and expand plant germplasm collections so as to enhance their diversity.

FY 2009 Accomplishments*:*

1. *An invaluable collection of black raspberry (Rubus occidentalis) germplasm.* Previous research conducted by ARS scientists in Corvallis, Oregon, had identified lack of variability as a critical roadblock to developing new improved black raspberry cultivars. Black raspberry necrosis virus (BRNV) was identified by as a critical problem challenging the long term viability of the black raspberry industry. ARS scientists solicited wild black raspberry seed from friends, colleagues, native plant societies, and other enthusiasts by mail, and then collected black raspberry from along the southern and western edge of its range in eastern North America. Between these two collections, more than 150 populations from many states and several provinces are represented in a common garden in Corvallis.

   > ***Impact*:** This collection of germplasm has the potential to give researchers new sources of variability, and perhaps resistance to BRNV or its aphid vector, that will aid in the development of critically needed cultivars for the commercial industry.

2. *More than 530,000 samples of crop genetic diversity conserved and distributed to researchers.* During FY 2009, the 20-plus genebanks in the USDA-ARS National Plant Germplasm System (NPGS) added more than 20,000 new samples for a total of more than 530,000 distinct types of more than 13,200 plant species that are now being conserved by NPGS genebanks. Scientific interest, especially for germplasm of specialty crops, has increased tangibly during the last few years, with the average number of samples distributed per year by the NPGS now totaling about 140,000 – 40,000 more than the average a decade ago.

   > ***Impact*:** These materials are keys for continued progress in crop genetics and breeding, which is requisite for future food security.

Indicator 8

During FY 2009, ARS will strengthen evaluation and breeding programs for specialty crops that have increasing economic importance.

FY 2009 Accomplishments*:*

1. *New, more effective approaches for conserving genetic resources of wild relatives of apples.* Conserving genetic resources of tree crops in field plantings is expensive and subjects the invaluable genetic materials to the constant threats of diseases, pests, and environmental extremes. ARS researchers at Fort Collins, Colorado, and Geneva, New York, applied statistical genetic models to identify a "core subset" of about 100 trees that captures most of the genetic diversity contained in a total of more than 1,000 wild apple trees. Similarly, for another species of wild apple, a core subset of about 30 trees encompassed most of the genetic diversity in 700 trees.

   ***Impact*:** These results will enable apple curators to reduce the number of wild apple trees required for field plantings without significantly diminishing the total amount of genetic diversity conserved. They will also enable apple breeders to more rapidly identify new sources of genetic variability for horticultural traits key to apple genetic improvement.

2. *Unique new high-yielding soybean line released.* The U. S. soybean crop might be vulnerable to unforeseen diseases, pests, and environmental extremes because its genetic base is relatively narrow. ARS researchers in Urbana, Illinois, released a new soybean line with nearly 40 percent of its genetic ancestry differing substantially from currently widely-grown varieties.

   ***Impact*:** In addition to providing unique genes to diversify the U. S. crop and reduce such vulnerability, this line is also high yielding, and could be incorporated readily into soybean breeding programs for the southern United States without decreasing the yield potential of current breeding stock.

Measure 2.2.3 Summary of the Major Technologies Developed, Transferred, and Used in FY 2009:

During FY 2009, 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.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Two new exceptional peach varieties – 'Flavrburst' and 'SummerFest'. ARS scientists at Kearneysville, West Viginia, and Byron, Georgia, released two new peach varieties that address increased costs for orchard operations (pruning, thinning, and harvesting) while maintaining excellent quality. 'SummerFest' provides growers an upright growth habit, high quality peach shown to be more productive, easier to manage, and helps to reduce the costs of production. 'Flavrburst' peach was developed with an exceptional sweet and only mildly acidic flavor, providing a highly desirable flavored peach for the consumer.	Budwood was provided to the licensee.	Commercial fruit growers and homeowners.	'SummerFest' provides growers with a new peach tree growth type that is more productive and more easily managed than standard peach trees. 'Flavrburst' provides growers with a very high quality peach for marketing. Both new peach varieties provide consumers with a very high quality, flavorful peach and are healthful additions to the diet.

A portable scanning system, DepositScan, was developed by ARS scientists at Wooster, OH, to quickly evaluate deposition quality of pesticide spray applications. The system consists of DepositScan software, a laptop computer, and a standard handheld business card scanner. Inaccurate application of pesticides on target areas can cause serious spray drift and off-target loss problems, resulting in excessive pesticide use, food safety concerns, environmental contamination, and hazards to workers.	The software for DepositScan is available to the public without charge, and can be downloaded from the Web site http://ars.usda.gov/mwa/wooster/atru/depositscan.	Farmers, extension educators, agricultural chemical manufacturers, and researchers.	DepositScan has considerable potential to minimize off-target pesticide loss including spray drift and impact pesticide spray application efficiency and efficacy.
Development of 1,536 SNP DNA markers for gene/quantitative trait locus (QTL) discovery for the purpose of defining genes associated with disease and insect resistance, seed quality traits, and resistance to abiotic stress.	The markers have been made available without charge through the Internet. Also, the DNA sequence data describing the markers were submitted to the National Center for Biotechnology Information (NCBI) Nucleotide database. Direct transfers also were made to private companies.	Researchers in ARS and universities, and private seed companies involved in molecular plant improvement.	The analyses of segregating populations have produced genotype data that is being used to define the genome positions of genetic factors controlling resistance to soybean rust, resistance to soybean cyst nematode, the level of oleic and linolenic acid in soybean oil, seed protein concentration, and resistance to iron deficiency chlorosis.
Development of great northern common bean cultivar 'Coyne' with enhanced disease resistance to common bacterial blight and bean rust.	Release to the public, and registration in Journal of Crop Registration.	Public and private common bean breeders.	Increased yield stability of common bean, especially in Nebraska, North Dakota, and Michigan where the diseases are devastating.
Molecular information about genes controlling resistance to soybean rust in soybean genotypes PI 587886 and PI 587880A.	Publication in Theoretical and Applied Genetics.	Soybean geneticist/plant breeders in the public and private sectors.	Knowledge of the genes controlling resistance in these genotypes is actively being used to incorporate resistance into productive soybean cultivars more rapidly than traditional breeding methods alone.
A new cultivar, 'US Early Pride' seedless mandarin was released. This cultivar was derived from a seedless mutant of 'Fallglo' an important, but seedy mandarin variety. The seedless mutant has been evaluated for horticultural characteristics as well as consumer acceptance and found to be equivalent to 'Fallglo' in all aspects except for the absence of seeds.	Budwood was released through a plant variety protection certificate to the citrus community.	National and international citrus growers and shippers	Seedless varieties of citrus fruit are preferred in the market and this seedless variety will expand marketing potential for commercial citrus growers and provide consumers with a novel, more convenient variety of citrus fruit.
Disease resistant lettuce germplasm released: Bacterial leaf spot of lettuce is an economically important and unpredictable disease of lettuce in California. ARS researchers released six breeding lines with	Seed was released directly to seed companies and breeders interested.	Lettuce breeders and seed companies.	This germplasm will reduce yield losses to this important necrosis-inducing disease at harvest, and postharvest

good head quality and resistance to Bacterial leaf spot.			losses of whole head and chopped lettuce products.
A sugarbeet germplasm line, SR98, was bred for resistance to damping-off caused by Rhizoctonia, higher sucrose and smooth root, which reduces adhered soil and halves factory soil disposal costs. In addition, SR98 is resistant to the crown and root rot phase of the disease, unlike all smooth-root germplasms released to date, and is resistant to at least one form of Fusarium, which is a root rot of increasing importance in the Great Lakes growing region.	Released to all major international sugarbeet seed companies.	Sugarbeet breeders and seed companies.	This material will be immediately incorporated into commercial breeding programs to enhance stand establishment, reduce losses to Rhizoctonia and Fusarium, and reduce soil waste by 50% during processing.

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

During FY 2010, ARS will

develop technologies and strategies to manage or mitigate pests, pathogens, weather damage, and/or improve crop quality to strengthen the U.S. agricultural production base and provide higher-value products.

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.

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 2011, 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.

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 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.

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

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

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.

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 2009, 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 2009 Accomplishments*:*

1. Illnesses from Clostridium difficile infection have increased recently in North America and Europe due to the emergence of a toxigenic strain identified as North America pulsed-field gel electrophoresis type 1 (NAP-1). The cause of illnesses has been speculated as being derived from consumption of contaminated meat products. However, the information on C. difficile contamination of carcasses during processing in the U.S. and its presence in the U.S. commercially produced ground beef is very limited. ARS scientists in Clay Center, Nebraska, collected the necessary data to determine if C. difficile was a relevant threat to food safety in the U.S. beef supply. C. difficile was found infrequently on cattle hides, and was not found on beef carcasses either early or late in processing. No C. difficile was detected in samples of commercial ground

beef. None of the isolates from hides were identified as the strain of concern, NAP-1.

***Impact*:** This work strongly suggests that C. difficile does not pose a relevant threat in the U.S. beef supply.

2. Some microorganisms, and particularly bacteria, cause serious disease in commercial poultry and can be of importance in causing food poisoning in poultry products reaching the consumer. New methods are needed to minimize the effects of such microorganisms, and development of effective vaccines would be of much benefit. ARS scientists in collaboration with Texas A&M University used high energy electron-beam (E-beam) irradiation to render Salmonella non-viable as an infectious agent, but retain the necessary antigenic properties to stimulate a strong immunological response in poultry. The work established that broiler chickens exposed to E-beam-treated bacteria were much more efficient in fighting off subsequent infections by normal, viable bacteria, meaning that the irradiated bacteria could serve as a vaccine.

   ***Impact*:** This accomplishment is important because, although vaccines against viruses are well-known and relatively easy to create, development of effective vaccines against bacteria has historically been much more difficult. Control of Salmonella continues to be a challenge. E-beam technology appears to be much more effective than X-rays in generating good bacterial vaccines, and should be of great value in development of vaccines to protect poultry from serious diseases while also contributing to enhanced microbial food safety in humans.

3. A Campylobacter coli strain was found that is resistant to high levels of the antibiotic gentamicin. The colonization ability of this C. coli strain in broilers and the effectiveness of the incorporation of gentamicin into plating media on restricting the growth of background microflora were demonstrated. This C. coli strain's unique resistance to high levels of gentamicin now allows for research studies evaluating the ecology of Campylobacter within poultry flocks without regard to the variable presence of natural environmental Campylobacter contamination.

   ***Impact*:** In the absence of this marker, expensive and time-consuming conformational techniques must be used to determine if the recovered organism is the same one that was inoculated. This technology has been shared with other poultry researchers in academia.

4. Dairy cattle are known reservoirs for salmonellae but often the cattle that are harboring Salmonella don't show any signs of illness. Intensive sampling of animals, the environment, bulk milk, and milk filters during a multiyear study of a Salmonella Cerro outbreak on a dairy farm demonstrated that salmonellae could be isolated more consistently from in-line filters than from bulk tank milk, especially at lower levels of herd shedding. The recovery of Salmonella from the milk filter closely paralleled the number of animals that tested positive for Salmonella.

   ***Impact*:** Based on results of this study, milk filter analysis may also be a convenient method for monitoring how many cows in

the herd are harboring Salmonella and is a more sensitive means of testing for the presence of Salmonella, and perhaps other pathogens, in raw milk than testing the milk itself. This may provide critical points for intervention.

5. Cattle are a reservoir for STEC O157 and are known to harbor subtypes not typically found in clinically ill humans. The current method used to characterize diversity in STEC O157 cannot distinguish a subpopulation with increased human virulence. Using DNA sequencing, a set of SNPs has been identified that characterizes genetic diversity within STEC O157 strains of bovine origin, and a subset observed in human strains.

   ***Impact*:** This SNP set will complement current techniques used to classify strains implicated in disease outbreaks, and will help differentiate the genetic differences between strains that cause disease in humans.

Indicator 2

During FY 2009, 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 2009 Accomplishments*:*

1. Fungal resistance to commercial antifungal agents presents a serious problem to both agriculture and medicine. ARS scientists in Albany, California, identified a number of safe, natural products that significantly enhance the effectiveness of commercial fungicides, such as strobilurin and fludioxonil. These natural compounds weaken the ability of fungi to build their cell walls or to respire normally. Once fungi are weakened by “chemosensitization” the commercial products are anywhere from 100 to 1000 fold more effective. ARS in collaboration with scientists at the Centers for Disease Control, Atlanta, Georgia, found chemosensitization to be effective against a number of human pathogenic fungi that cause aspergillosis.

   ***Impact*:** The impact of this work is that these natural products could potentially reduce the amounts of fungicides and drugs necessary to control fungi.

2. Aflatoxin contamination in West Africa is caused by different causal agents in different agroecosystems. An initial step in developing aflatoxin management procedures in a given area is to establish the causal agents of greatest importance in that region. In attempts to improve aflatoxin management in Nigeria, the fungal communities resident in agricultural soils in three key climatic zones was examined. The most likely important causal agent differed among fields, villages, and regions.

   ***Impact*:** This suggests different management strategies may be

necessary in different areas. In the U.S., similar differences in fungal communities in different regions may provide a basis for varying management strategy by region and may provide a basis for selecting resistant cultivars specific for particular causal agents and, as a result, different areas.

3. The benzoxazolinones (MBOA and BOA) are important native allelochemicals providing resistance to corn from pathogenic bacteria, fungi, and insects as well as weed suppression. However, corn pathogens such as Fusarium verticillioides are capable of cohabitating with corn by a mechanism that we discovered involves detoxifying the BOA to the nontoxic metabolites. A key enzyme in this biotransformation is an arylamine N-acetyltransferase (NAT), which was cloned and characterized from F. verticillioides, and we were the first to characterize this enzyme from a filamentous fungus. NAT enzymes may have key roles in metabolizing compounds such as phytochemicals, agrochemicals (e.g., fungicides), and other soil pollutants, but this enzyme may be inhibited by the biocontrol endophytic bacterium, Bacillus mojavensis, thus preventing the F. verticillioides transformation into non-toxic metabolites.

   ***Impact*:** As a results of this bacterial interaction, higher amounts of a more toxic and stable metabolite accumulates. The biocontrol activity of the bacterium is increased because of inactivating this enzyme, increasing not only the biocontrol activity of the bacterium, but possibly enhancing the effectiveness of agrochemicals used to control fungal pathogens.

4. Maize pathologists would benefit from being able to efficiently screen grain from varietal resistance trials for the presence of multiple seed rotting fungal pathogens. A high-speed, low-cost, image based sorting device was recently developed by an ARS Scientist in Manhattan, Kansas, to detect small defects and blemishes on grains and separate damaged/discolored kernels from good kernels. The system proved sensitive enough to detect and remove kernels showing "blue-eye" post-harvest mold damage resulting from infection of the germ region by Aspergillus glaucus. The system has a throughput rate of approximately 75 kernels per second, per channel or 40 Kg/hr. Infected kernels from commercial maize could be differentiated into three symptom categories: asymptomatic, showing 25% to 50% discoloration, and showing over 75% discoloration.

   ***Impact*:** The system can distinguish among symptomatic yellow corn kernels parasitized by different fungal species and is being tested for removal of grains contaminated with aflatoxin and fumonisin in commercial seed samples.

Indicator 3

During FY 2009, 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 2009 Accomplishments*:*

1. It has become evident that Shiga toxin-producing non-O157:H7 enterohemorrhagic E. coli serogroups including O26 and O111 cause a similar illness in humans as E. coli O157:H7. Since non-O157 STEC can be as dangerous as E. coli O157:H7, ARS developed food enrichment, strain isolation protocols, and real-time multiplex polymerase chain reaction assays to detect these pathogens in ground beef.

   ***Impact*:** The technology was transferred to FSIS who are currently conducting a national baseline survey to ascertain the prevalence of the six serogroups of non-O157 STEC that cause the highest number of cases of human illness based on data from the CDC (serogroups O26, O45, O103, O111, O121, and O145). Based on the data obtained, new regulations regarding the presence of these pathogens in food will be established.

2. Definitively characterizing Salmonella species isolated from foods is a critical issue for the USDA-Food Safety Inspection Service and other regulatory agencies. ARS scientists at Athens, Georgia, developed a multiplex polymerase chain reaction (PCR) Salmonella serotyping technique for high-throughput analysis. The multiplex PCR assay can identify the top 50 serotypes isolated which represent 85% of all clinically isolated Salmonella and has been adapted to a high-throughput platform by incorporation of capillary analysis of the multiplex PCR products.

   ***Impact*:** The impact of the accomplishment will be immediate. The technique requires little training, no specific anti-sera, and works in standard DNA sequencing instruments and could replace traditional serotyping for most Salmonella isolates. This allows the determination of up to 90 isolates in 24 hours with very little hands on time at a cost of $1.50/sample as compared to several days and ~$40.00 for traditional serotyping. The technique is currently being tested and validated by several Federal and State public health laboratories in the U.S. and also by the Public Health Agency of Canada.

3. Food safety risks posed by pathogenic bacteria such as Escherichia coli and Salmonella may increase when bacteria remain on inadequately sanitized food processing/handling surfaces. Subsequently, biofilms are produced that increase microbial adhesion and pathogen survival on those surfaces. ARS scientists in Beltsville, Maryland, developed a fluorescence imaging system that can detect microbial biofilms on the surfaces of materials commonly used in food processing and handling (stainless steel, polypropylene plastic, granite).

   ***Impact*:** This work allows identification of biofilms and the potential pathogens contained therein. In association with an industry partner, ARS is developing a portable handheld imaging device that can be used to assist regulatory agencies in their

inspection of food processing and distribution facilities. The technology may also find application for the Department of Homeland Security and the Military.

4. Staphylococcal enterotoxin A (SEA) is a common cause of food poisoning in the US, but common tests for the presence of SEA in food require the use of live animals (kittens or monkeys) or are not sensitive enough to detect small but dangerous amounts of toxin. ARS scientists in Albany, California, developed a new test based on the known property of SEA to stimulate growth of immune cells, using cells grown in culture instead of live animals. The test uses magnetic microbead technology to concentrate toxin from large volumes of sample, and has a read-out with increasing color indicating higher amounts of SEA in the food sample.

   ***Impact*:** Because it is more sensitive and less expensive than other tests, it is useful for application by scientists in both research, regulatory labs, the Department of Homeland Security and the Military.

5. USDA regulations prohibit the sale of systemically diseased chickens for human consumption. Such birds are detected by human inspectors for removal from the processing lines, but human inspection speeds limit the overall throughput of processing plants which are under pressure to increase their production to match rising consumer demand. An imaging system was developed for automated wholesomeness inspection of freshly slaughtered chickens, and in-plant testing on high-speed processing lines (at 140 birds per minute) demonstrated classification accuracies of over 99 percent.

   ***Impact*:** After a U.S. patent application for the imaging technology was filed, the technology was licensed to a CRADA partner for commercial implementation with existing poultry processing systems, and FSIS approval was granted for commercial implementation of the technology for on-line pre-sorting of young chickens. Use of the automated imaging inspection system will allow the poultry industry to reduce food safety hazards associated with cross-contamination and improve online processing efficiencies and while maintaining global competitiveness.

6. Additional investigations were conducted of the QuEChERS approach for the extraction of hundreds of pesticides from many kinds of foods. The approach typically provides 4-fold reductions in sample preparation time, labor, waste, and material expenses over previous methods. This year, our comparison studies of different versions of QuEChERS showed that AOAC Official Method 2007.01 provided the best results for the most pesticides in different fruits and vegetables.

   ***Impact*:** Regulatory laboratories in the USDA, FDA, EPA, states in the US, and countries on 6 continents are routinely using official versions or adaptations of QuEChERS approaches. Major analytical supply companies such as Restek, Sigma-Aldrich, UCT, ThermoFisher, Agilent, Waters, and Varian sell QuEChERS sample preparation products.

Indicator 4

During FY 2009, 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 chmical 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 2009 Accomplishments*:*

1. Water quality for the production of leafy green produce is a critical issue. The California Leafy Green Marketing Agreement (LGMA) recommends that water containing less than 235 MPN (most probable number) Escherichia coli/100 ml be used in irrigating leafy greens in the field. However, no evaluation of these standards had previously been undertaken. ARS scientists in Beltsville, Maryland, evaluated these standards in the production of spinach plants. E. coli were only detected immediately after irrigation and none were recovered on days 1 or 2 after irrigation. Repeated irrigation of spinach plants with water complying with these standards did not increase the persistence of E. coli on foliar surfaces.

   ***Impact*:** These data indicate that these irrigation water standards are sufficiently stringent to limit the introduction and persistence of pathogenic E. coli on the surface of spinach plants. The Food and Drug Administration, and the leafy green produce industry will directly benefit from the impact of this work.

2. Food-borne illness outbreaks associated with consumption of Salmonella spp. contaminated tomatoes are a significant, on-going problem. These outbreaks have negatively impacted public health, consumer confidence in tomatoes, and the U.S. economy. ARS scientists in Beltsville, Maryland, determined the microbial profile of fresh tomatoes, investigated pathogen internalization pathways, and assessed the practicality and efficacy of consumer stem scar removal in reducing food safety risks. Studies revealed that the vast majority of microorganisms were located on or near the stem-scars. The vascular bundles connecting the stem-scar and internal tissues play a critical role in pathogen internalization. Washing tomatoes with chlorinated water effectively inactivates surface attached microorganisms, but not internalized pathogens. Physical removal of stem-scar and underlying tissues, along with surface washing, significantly reduces both surface attached and internalized microorganisms.

   ***Impact*:** This work enables tomato growers and packers to develop reliable strategies and practices to reduce pathogen internalization in post-harvest handling, and by restaurants, harvesters, and processors. This research received a scientific award from the produce industry.

3. Improving the safety of oysters and shrimp is a critical issue for the Food and Drug Administration (FDA). Producers will be under stricter regulatory control due to new legislation proposed by the FDA for implementation in 2010. ARS funded scientists at Mississippi State University evaluated the use of X-ray technology for approved regulatory intervention to reduce bacterial pathogen levels. In half- and whole shell oysters and ready to eat shrimp, over one million

cells of Escherichia coli O157: H7, Salmonella species, Shigella flexneri and Vibrio parahaemolyticus could be killed with X-ray treatment between 2-5kGy. More importantly, X-ray treatment did not kill the oysters even with the highest dose (5 kGy).

***Impact*:** This work will have a direct impact on producers particularly in Southern States who are eager for an alternative pathogen intervention process that does not impact product quality, and reduces or eliminates foodborne pathogens.

4. Dioxins accumulate in the fatty tissues, where they persist, causing skin disease and chronic sequelae including cancer, reproductive and developmental problems, and an increased risk of heart disease and diabetes. ARS scientists in Fargo, North Dakota, conducted a statistical survey of dioxin and dioxin-like compounds in domestic meat and poultry in collaboration with the USDA Food Safety Inspection Service (FSIS). Beef, pork, chicken, and turkey samples were analyzed and 99.6% of the samples were found to be below international maximum residue limits. When compared to a similar survey conducted in 2002, median levels have declined in beef and chicken and remained steady in turkey and pork.

   ***Impact*:** Data from surveys such as this substantiate the safety of the U.S. meat and poultry supply. These data will be used to assure trade partners of the quality of U.S. foods by demonstrating that U.S. products meet maximum dioxin residue limits established by other countries. The data have also been used by regulatory agencies to uncover input sources of dioxins to the food chain (FSIS and FDA), to update estimates of human exposure to dioxin-like compounds (EPA), and to track temporal trends (EPA and USDA).

5. The almond industry in the U.S. is valued at over $4 billion. Currently industry uses hot air for roasting almonds, an inefficient process that is unable to achieve adequate reduction of Salmonella on almonds. ARS scientists in Albany, California, developed a fast heating process for roasting almonds using infrared heat, followed by continuous heating with hot air. A Salmonella surrogate strain on the kernels was decreased 100-fold below the required level 7-logs while also decreasing roasting time by 60%. This method is more cost effective than the current process. Recommendations regarding integration of an infrared heater into existing equipment, and processing parameters for roasting levels, were transferred to the almond industry.

   ***Impact*:** The Almond Board of California is providing support to validate the process, for industry wide adoption, which will subsequently reduce the level of foodborne illnesses and increase trade in particular to the European Union.

6. Numerous outbreaks of pathogenic E. coli related illnesses have been linked to processed leafy greens. Cut lettuce creates nutrient-rich colonization sites for the pathogen. ARS scientists in Albany, CA have shown that pathogenic E.coli can grow 11-fold on shredded lettuce compared to 2-fold on intact lettuce leaves incubated at appropriate conditions. This implies that the infectious dose of E.coli in human beings (<50 cells) can be achieved on cut lettuce in a short time at high temperatures.

***Impact*:** The results indicate that processing conditions are critical for prevention of illnesses by a pathogen with a low infectious dose. These results provide guidance to the produce industry for Hazard Analysis and Critical Control Point (HACCP) programs.

Indicator 5

During FY 2009, 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 2009 Accomplishments*:*

1. Not all strains of Listeria monocytogenes have an equal ability to cause disease in humans, and thus affect public health. In order to assess the capacity to determine relative public health risk ARS completed a comparative genetic analysis of more than 500 isolates collected through the USDA Food Safety Inspection Service (FSIS) surveillance. The research demonstrated that a substantial fraction (48%) of isolates from ready-to-eat (RTE) foods at processing harbor mutations that significantly reduce their virulence and their potential threat to public health. Conversely, strains responsible for the majority of human illnesses are rare (6%) in RTE food at processing, demonstrating that it should be possible to enhance intervention and inspection activities in the rare instances when such isolates are encountered. ARS also found that the strain typing method currently used by USDA-FSIS and public health agencies cannot accurately predict the potential public health risk of individual isolates without integrating information from DNA sequence-based typing technologies that directly target the genetic changes responsible for reduced ability to cause infection. Consequently, ARS developed an integrated subtype database.

   ***Impact*:** The impact of the work will permit public health and regulatory agencies to more fully utilize the data they currently collect to assess risk.

2. Arcobacter butzleri and Campylobacter lari can cause human bacterial gastroenteritis and can be transmitted via contaminated food, water or shellfish. ARS scientists in Albany, California, completed the genomes of human clinical strains of A. butzleri and C. lari and deposited the data in a national public database. Novel genes, metabolic pathways, and potential pathogenicity genes were identified and facilitated production of DNA chips in our lab. These chip arrays were used to compare genomes of many strains and led to development of a novel Arcobacter DNA typing method for analysis rapidly hundreds of additional strains.

   ***Impact*:** These assays will be used for tracking sources of pathogens by regulatory and public health agencies.

3. Each year in the United States an estimated 1.4 million people contract foodborne illnesses due to Salmonella. Most cases of salmonellosis are self-limiting; however, some infections result in invasive salmonellosis, a more severe form of illness requiring antibiotic therapy. Recent studies indicate that drug resistant Salmonella may be more invasive than antibiotic-sensitive Salmonella, and the emergence of multidrug resistant (MDR) Salmonella in the past decade is an issue of increasing concern. ARS scientists at Clay Center, Nebraska, examined the prevalence of MDR Newport associated with cull cattle at slaughter in the United States. Drug resistance phenotypes were determined for 513 MDR Newport isolates. The baseline data collected in this study provide key information for HACCP analysis and cattle processing risk assessment modeling. Additionally, the genetic elements mediating these antibiotic resistances are being characterized in order to better understand how Salmonella acquires and disseminates these resistances.

   ***Impact*:** The results from these studies will aid cattle producers in implementing farm management practices that will reduce the dissemination of MDR pathogens.

4. Salmonella enterica serovar strains are important food-borne pathogens and the ability of the pathogen to survive environmental stress conditions plays a crucial role in the spread of almonelosis. The severity of the illness also varies among various strains of this pathogen. Only limited information exists related to growth, biochemical and genetic characteristics of S. enterica serovar strains isolated from retail foods. We used DNA-based analysis in combination with antibiotic resistance profiles to classify different Salmonella isolates obtained from retail foods. DNA-finger print pattern of eight isolates matched with the CDC/FDA data base of previous outbreak and clinical isolates indicating their potential to cause disease. With the exception of isolates obtained from alligator meat (tetracycline resistant) and orange juice (chloramphenicol and sulfisoxazole resistant), the remainder of the isolates were susceptible to the panel of 15 antimicrobials tested.

   ***Impact*:** The characterization of Salmonella isolates with the proposed scheme enabled us to determine the potential risk associated with individual strains. Both the food-preparation industry and consumers will benefit from the results of this research.

5. Streambed sediments are increasingly recognized as major reservoirs for water-borne bacteria, including pathogenic strains. However, in water quality prediction and assessment tools, the effects of E. coli release due to sediment resuspension on the microbiological quality of surface waters has not been addressed. ARS developed the first bacterial release and deposition module for the ARS-USDA model SWAT and applied it to model bacterial water quality in the rural Southern Pennsylvania systems. Simulations indicated that the predominant source of water-borne bacteria in the watershed throughout most of the year was from sediment-borne bacteria in the streambed, rather than from runoff.

   ***Impact*:** These results are important for the design, evaluation and implementation of conservation and best management practices nationwide in that the work has identified an important source of water-borne bacteria in freshwater streams that is

currently overlooked.

6. Regulatory agencies in the U.S. and European Union (EU) utilize different compliance standards when monitoring commercial processing facilities for the prevalence of Salmonella. In this study, a statistical simulation was conducted to compare the Salmonella performance standards used for chilled broiler carcasses in the U.S. and in the EU. Results indicated that different results may be obtained when utilizing the different standards and that there may be interactions between differences in sampling methods and processing operations.

   ***Impact*:** These findings show that regulatory personnel and commercial processors in the U.S. and EU should be aware of differences in U.S. and EU standards when analyzing Salmonella compliance data.

Measure 4.1.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2009:

During FY 2009, 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.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Demonstrated that salmonellae could be isolated more consistently from in-line filters than from bulk tank milk, especially at lower levels of herd shedding.	Dairy cattle are known reservoirs for salmonellae but often the cattle that are harboring Salmonella don't show any signs of illness. The recovery of Salmonella from the milk filter closely paralleled the number of animals that tested positive for Salmonella.	Dairy farmers, Dairy industry, Federal and State Regulatory Agencies.	Based on results of this study, milk filter analysis may also be a convenient method for monitoring how many cows in the herd are harboring Salmonella and is a more sensitive means of testing for the presence of subclinical Salmonella, and perhaps other pathogens, in raw milk than testing the milk itself. This will also lead to earlier and more effective interventions.
Determined that chemosensitization of fungi makes commercial antifungal products 100 to 1000 fold more effective.	Identified a number of safe, natural products that significantly enhance the effectiveness of commercial fungicides, such as strobilurin and fludioxonil.	Agricultural industry, APHIS, EPA, CDC, FDA, defense agencies, and medical research.	These natural products could potentially reduce the amounts of fungicides and drugs necessary to control fungi in agriculture and medicine.
Developed and validated a PCR based technology for the detection of Shiga toxin-producing non-O157:H7 enterohemorrhagic E. coli	Development of a rapid, high through-put molecular PCR based technology for detecting critical	This information is critical for national public health regulatory agencies such as the USDA-FSIS, CDC, FDA, International	FSIS are currently conducting a national baseline survey to ascertain the prevalence of the six serogroups of non-O157

serogroups.	pathogens in ground beef.	regulatory agencies, and the National Cattleman's Beef Association.	STEC that cause the highest number of cases of human illness based on data from the CDC. Based on the data obtained, new regulations regarding the presence of these pathogens in food will be established.
Evaluated the California Leafy Green Marketing Agreement recommended standards that water containing less than 235 Escherichia coli/100 ml be used in irrigating leafy greens in the field.	Validated that repeated irrigation of spinach plants with water complying with these standards did not increase the persistence of E. coli on foliar surfaces.	The FDA, leafy green producers, processors, and the leafy green produce industry.	These data indicate that these irrigation water standards are sufficiently stringent to limit the introduction and persistence of pathogenic Escherichia coli on the surface of spinach plants.
Demonstrated that a substantial fraction (48%) of Listeria monocytogenes isolates from ready-to-eat foods at processing, harbor mutations that significantly reduce their virulence and their potential to threaten public health. Further, that the strain typing method currently used by public health agencies cannot accurately predict the potential public health risk of individual isolates.	Developed an integrated subtype database using DNA sequence-based technologies that allowed the ability to assess an isolates ability to cause illness; and therefore to determine the relative public health risk.	Federal (USDA-FSIS, FDA) and State public health agencies in the USA, and other international public health and regulatory agencies.	Permit public health and regulatory agencies to more fully utilize Listeria data they currently collect to assess the risk of human disease.

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

During FY 2010, 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.

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.

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.

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.

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.

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.

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.

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 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.

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.

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.

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 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.

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 2009, 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 2009 Accomplishments:

1. The FST is a devastating pest of wooden structures and living trees in the southeastern US following inadvertent importation in the 1940s. Twenty eight FST colonies were collected from 2004-2008, including 21 colonies from Mississippi, 6 colonies from Louisiana, and one from China. Two genotypes of FST were identified in Mississippi, where the first one, GA type, was identical to those reported previously in Georgia, Louisiana, Alabama, and other infested states in U.S.; and the second, AT type, was identified for the first time in southeastern United States. Sequence identity of the AT type of FST with those reported mainly in China provided evidence of at least two introductions of FST to the United States. The termites in Mississippi are potentially transported from the port cities in Mississippi along the Gulf of Mexico because the numerous infestations have been observed along transportation corridors via Interstate 59 in Mississippi and Highway 11, as well as a parallel railway from New Orleans, Louisiana, to Meridian (Lauderdale County), Mississippi. The genetic diversity of FST in Mississippi was expected to be higher than other inland states. However, besides a recently introduced colony from New Orleans, LA, with AT type, twenty colonies collected in south Mississippi had identical genotype, GA type.

   Impact: Understanding that only two introductions of the FST occurred raises confidence in the use of control techniques that target specific gene sequences. This knowledge also enables us to detect additional introduction and know when they happened.

2. Soon after the emergence of the pandemic H1N1 Influenza A virus in April 2009, ARS scientists began research studies with virus samples provided by the Centers for Disease Control and Prevention (CDC). The first step was to address the safety of pork by evaluating whether meat, blood, and tissue from pigs infected with the new 2009 pandemic A/H1N1 influenza virus would be free of infectious virus. Thirty five-week-old cross-bred pigs from a herd free of swine influenza virus were inoculated to determine the susceptibility of swine to the human virus, and also address whether meat, blood, and tissue from pigs infected with the pandemic 2009 A/H1N1 influenza virus are free of infectious virus. Pigs were observed daily for clinical signs of disease and nasal swabs and fresh samples from lung, tonsil, inguinal lymph node, liver, spleen, kidney, skeletal muscle (ham), and colon contents were tested by the most sensitive virus detection assays at 3, 5, and 7 days post-infection. Live 2009 A/H1N1 influenza virus was only detected in the respiratory tract of infected pigs, and the virus did not appear to spread and replicate in other tissues, including muscle (pork meat).

   ***Impact*:** This timely study established the safety of pork should pandemic H1N1 Influenza A virus spread from humans to pigs.

3. ARS scientists at conducted molecular virology studies called “reverse genetic engineering” in secure bio-containment facilities to understand the mechanisms of Classical Swine Fever (CSF) viral pathogenesis, which is a critical step in vaccine discovery research. The results of recent studies have predicted the amino acid sequence of the CSFV protein called NS4B and identified potential receptor molecules of the swine immune system. Changes within this receptor completely decreased the ability of CSFV to cause disease (attenuated), reducing viral replication and limiting spread from the inoculation site to secondary target organs.

   ***Impact*:** This research led to the successful genetic attenuation of the CSF virus and provides the means for genetically engineering vaccines specifically designed for the control and eradication of disease outbreaks, such as providing rapid protection and the ability to differentiate infected from vaccinated animals.

4. ARS scientists have discovered a novel immune protein, the cytokine osteopontin, which was found to be expressed differently in cattle infected with *Mycobacterium avium* subsp. *Paratuberculosis* (Johne’s disease) compared to healthy cattle. Johne’s disease is a chronic, progressive enteric disease of ruminants that is widespread in U.S dairy herds and is a significant economic problem for producers. Despite a voluntary control program for this disease, the incidence continues to rise at a disturbing rate.

   ***Impact*:** This research identified a biomarker that may be used to develop new sensitive and specific diagnostic tools for early detection of infection.

Indicator 2:

During 2009, 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 2009 Accomplishments:

1. *First stereospecific mosquito odorant receptor characterized*.
   There is a need to develop newer, more effective methods to protect humans from blood-sucking insects, like mosquitoes. Biological work at a basic level produces results that may lead to truly innovative solutions to this problem. In this accomplishment at the Invasive Insects Biocontrol and Behavior Laboratory, Beltsville, Maryland, methods were developed for cloning odorant receptor proteins from mosquitoes and expression of the odorant receptors in the membranes of frog eggs. Carefully placed electrodes drew a very small voltage across the membrane and the result current of electricity was monitored. The voltage potential was disrupted when odor chemicals washed across the proteins in the membrane, depolarizing it. In this way, it was possible to characterize the test proteins in the frog egg. One odorant receptor responded specifically to one of two mirror image forms of a compound; this mirror image of the compound is an important attractant for blood feeding insects. This was the first mirror-image-specific odorant receptor discovered and characterized for an invertebrate. This discovery will lead to improvement of molecular design of chemicals that alter the behavior of insects, creating products for more efficient control of mosquitoes and other biting pests.

2. *Mosquito virus infection influences effectiveness of insect repellents*
   Insect repellents are used to prevent bites and subsequent infection with mosquito-borne pathogens, but their effectiveness on the infected mosquitoes that transmit the pathogens was unknown. Funded in part by the Department of Defense' Deployed Warfighter Protection program, scientists at the Center for Medical, Agricultural, and Veterinary Entomology, Gainesville, Florida, collaborated with scientists at the U.S. Army Medical Research Institute for Infectious Diseases to study this problem. Venezuelan equine encephalitis virus (VEEV)-infected *Aedes taeniorhynchus* mosquitoes and their "sham-infected" siblings (i.e., inoculated with VEEV or diluent, respectively) were compared. They found that infected mosquitoes bit a repellent-treated (DEET) hamster long before uninfected mosquitoes bit the hamster. In other experiments, VEEV-infected mosquitoes were not stopped by masking-agent chemicals; whereas, uninfected mosquitoes did not bite a hamster protected by those agents. The results of this work show that repellents will have to be redesigned to be sure that they are effective against the very infected biting insects that are the most important to stop.

3. *Effects of bluetongue-virus infection on feeding by the biting midge vector,* Culicoides sonorensis. *Culicoides sonorensis* (Diptera: Ceratopogonidae) is the primary vector of bluetongue virus (BTV), which affects the health of livestock and movement of animals in North America and Europe. Scientists at the Arthropod Borne Animal Diseases Research Laboratory, Laramie, Wyoming, performed experiments to determine whether infection with BTV affects blood-feeding behavior. Midges were injected with either BTV-infected or BTV-free cell

lysates and were then allowed to blood feed for short (10 min) or long (60 min) periods of time on sheep. Midges that had been infected for 7 days did not feed as rapidly as uninfected midges, nor as rapidly as midges that had been infected only 2 or 4 days. One direct consequence of this research affects risk assessment. Estimates of transmission risk in a particular location would be affected if infected midges required a longer time to feed, affecting economic threshold calculations for these pests.

4. *Salivary gland hypertrophy virus of house flies*
House fly control with chemicals and sanitation is often inadequate for a number of reasons that are beyond the control of the farmer. The Mosquito and Fly Research Unit, Gainesville, Florida, is working on innovative methods for fly control. They have been working with natural enemies of flies, including salivary gland hypertrophy virus (SGHV). This virus belongs to a novel group of viruses that infect salivary glands and block egg production in flies. They performed a field survey that showed the wide distribution of the virus on Danish dairy farms, with maximum infection rates of about 10% of the flies. Transmission studies indicated that the virus was specific to house flies, an important finding because some related species are beneficial in some situations. Danish virus isolates had somewhat higher virulence in lab bioassays than the standard Florida SGHV strain. Transmission tests also demonstrated that virus particles are stored in the crop of the fly and the live virus is deposited in regurgitated material and fecal spots. These results, along with previous studies on surface treatments, suggest that the most effective method for deploying the virus as an operational control tool may be treatment of fly resting sites.

5. *Origin of the invasive Formosan subterranean termite (FST)*
The FST was introduced into the U.S. from Asia in the 1940s. Since then, it has developed into a devastating pest of wooden structures and living trees in the southeastern U.S. The Formosan Subterranean Termite Research Unit, New Orleans, Louisiana, used cutting edge genetic techniques to determine the precise source of the invasive populations. Twenty eight FST colonies were collected from 2004-2008, including 21 colonies from Mississippi, 6 colonies from Louisiana, and one from China. Two genotypes of FST were identified in Mississippi, where the first one, GA type, was identical to those reported previously in Georgia, Louisiana, Alabama, and other infested states in the U.S.; and the second, AT type, was identified for the first time in the southeastern United States. Sequence identity of the AT type of FST with those reported mainly in China provided evidence of at least two introductions of FST to the United States. The termites in Mississippi are potentially transported from the port cities in Mississippi along the Gulf of Mexico because the numerous infestations have been observed along transportation corridors via Interstate 59 in Mississippi and Highway 11, as well as a parallel railway from New Orleans, Louisiana, to Meridian (Lauderdale County), Mississippi. In spite of the abundance and widespread distribution of FST in Mississippi, the genetic diversity is very limited. Twenty colonies collected in that state had the identical GA genotype and there is only a recent introduction of the AT genotype. The fact that there were only two introductions of FST raises confidence in the use of control techniques that target specific gene sequences. This knowledge also enables us to detect additional introductions and know when they happened.

6. *Ant ecology related to fire ant infestations*
The imported fire ant species have replaced native ant fauna in much of the southern United States, harming natural ecology and making it more difficult to

control fire ants. Scientists at the Biological Control of Pests Research Unit, Stoneville, Mississippi, have been studying the basic ecology of ants in order to be able to assess how native ants influence the distribution of invasive ants. Preliminary surveys of ants at selected nurseries in Mississippi that obtain containerized plants from Florida resulted in new distributional records within the state of several exotic ant species and one new state record for an invasive species, *Tapinoma melanocephalum* (the ghost ant). A survey of ants in Noxubee National Wildlife Refuge was completed, resulting in a total of 96 species, including eight new state records, eight exotic species, and two possibly new and undescribed species. A cooperative project with the Natchez Trace National Parkway was initiated to measure changes in the ant community in prairie remnants where eastern red cedar is being removed by different methods. The invasive Asian needle ant, *Pachycondyla chinensis*, was discovered nesting near Birmingham, Alabama, in a natural area. Surveys for ants in three Georgia Sandhill Natural Areas were also completed. A survey of ants in the Great Smoky Mountains National Park was initiatied as part of the All Taxa Biodiversity Inventory. The range of the hybrid (black x red) imported fire ant (HIFA) is continuing to expand. Since polygyny (a colony with multiple queens) and higher population density are typical of HIFA, the fire problem will probably get worse as the black imported fire ant is replaced by the hybrid. In addition, the HIFA queens received multiple inseminations, possibly leading to more rapid adaptation than observed for either the black or the red fire ants. Understanding the movement of ant species is the foundation for managing them to achieve a situation closer to the natural balance prior to the importation of fire ants.

Impact: These discoveries will influence the direction of development of practical products and techniques for integrated pest management of arthropods that damage structures, affect human health, and negatively impact animal agriculture.

7. Although it is well established that aquatic birds are reservoirs for avian influenza virus, the full natural host range among all avian species is not known. Because of the high prevalence of the H5N1 high pathogenicity viruses in Asia, China is an important location for sample collection to determine which birds can serve as host for this virus as well as for other low pathogenicity avian influenza virus. ARS scientists obtained samples collected from land-habitat birds in southern China between 2004 and 2007. These samples were tested for avian influenza virus with polymerase chain reaction (PCR) tests and 2.3% were found to be positive, indicating that species other than waterfowl serve as hosts for the virus. This data improves our understanding of what species may be important in the ecology of avian influenza virus.

   ***Impact*:** These data improves are understanding of what species may be important in the ecology of avian influenza virus.

Measure 4.2.1 Summary of the Major Scientific Discoveries, Technologies Developed, Transferred, and Used in FY 2009:

During FY 2009, ARS reported 10 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.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Fire ant microsatellite markers	Published in peer reviewed journal	Scientific community concerned with fire ants	Allows determination of the origins of individual populations
Fire ants PBAN/pyrokinin proteins identified	Published in peer reviewed journal	Scientific community and industrial community	Suggests completely new methods for controlling fire ants
Identification of biting midge salivary proteins	Published in peer reviewed journal	Scientific community and agricultural community	Provides possibility for vaccines that stop transmission of all pathogens by biting midges
Stable fly microsatellite markers	Published in peer reviewed journal	Scientific community	Allows determination of whether or not there are distinct populations of stable flies in North America
Database of expressed genes in screwworm fly	Published in peer reviewed journal	Scientific community and agricultural regulators	Part of process of developing a male-only strain of screwworm fly for the screwworm eradication program
Characterization of odorant receptors of mosquitoes	Published in peer reviewed journal	Scientific community and industrial community	Provides new mechanism for development of attractants and repellents
ARS scientists conducted pathogenesis studies in pigs to determine the susceptibility of swine to the 2009 pandemic H1N1 Influenza A virus and also address whether meat from pigs infected with this novel virus was free of infectious virus.	This information was published in a relevant peer-reviewed publication: Vincent AL, Lager KM, Harland M, Lorusso A, Zanella E, Ciacci-Zanella JR, Kehrli ME, Jr., Klimov A (2009) Absence of 2009 pandemic H1N1 influenza A virus in fresh pork. *PLoS ONE*	The U.S pork industry.	ARS studies determined that meat was free of virus and therefore safe to eat.
Reverse genetic engineering to understand the mechanisms of Classical Swine Fever (CSF) viral pathogenesis.	This information was published in a peer-reviewed publication: Sainz IF, Gladue DP, Holinka LG, O'Donnell V, Gudmundsdottir I, Prarat MV, Patch JR, Golde WT, Lu Z, Zhu J, Carrillo C, Risatti GR, Borca MV. 2009. Mutations in NS4B of Classical Swine Fever Virus affect virulence in swine. J Virol. 2009 Nov 18. [Epub ahead of print]	The U.S pork industry, the field of virology, and Federal agencies such as APHIS in need of tools to control disease outbreaks.	This research led to the successful targeted attenuation of the CSF virus and provides the means to genetically engineer vaccines for the control and eradication of disease outbreaks.
ARS scientists have discovered a novel immune protein called osteopontin that appears to be associated with Johne's disease.	This information was published in two peer-reviewed publications: 1) Karcher, E.L., Bayles, D.O., Bannantine, J.P., Beitz, D.C., Stabel, J.R. 2008. Osteopontin: A Novel Cytokine Involved in the Regulation of Mycobacterium avium subsp. paratuberculosis Infection in Periparturient Dairy Cattle. Journal of Dairy Science. 91(8):3079-3091 and 2) Karcher, E.L., Johnson, C.S., Beitz, D.C., Stabel, J.R. 2008. Osteopontin Immunoreactivity in the Ileum and	The U.S cattle industries: dairy and beef.	The identification of a potential biomarker for Johne's disease may be used to develop new sensitive and specific diagnostic tools for early detection of infection.

	Ileoceccal Lymph Node of Dairy Cows Naturally Infected with Mycobacterium avium subsp. paratuberculosis. Veterinary Immunology and Immunopathology. 126(1-2):142-148.		
ARS scientists established that avian species in China other than waterfowl serve as hosts for H5N1 Influenza virus.	The results of this study were published in a peer-reviewed publication: Peterson, A.T., Bush, S.E., Spackman, E., Swayne, D.E. 2008. Influenza A virus infections in landbirds, People's Republic of China. Emerging Infectious Diseases. 14(10):1644-1646.	The World Animal Health Organization (OIE) and poultry industries worldwide.	This study improves are understanding of what species may be important in the ecology of avian influenza viruses.

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

During FY 2010, 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.

elucidate arthropod behaviors and physiological mechanisms that either cause damage or which could be used to prevent damage

During FY 2011, 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.

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.

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.

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 2009, ARS will form new partnerships and continue old partnerships with industry, universities, and other government agencies in order too 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 2009 Accomplishments:

1. Newcastle disease (ND) is a significant viral disease of poultry, with virulent strains being responsible for major panzootics and extensive poultry mortality worldwide. The U.S. outbreaks of virulent ND in poultry during 1971-73, 1992, and 2002-03 were attributed to poultry exposures to ND virus (NDV) that was

carried by infected birds introduced into the U.S. Comprehensive and rapid tests to detect and differentiate virulent strains of NDV from the low virulence NDV strains are crucial for surveillance, diagnosis and control of Newcastle disease. The nucleic acid-based (real time RT-PCR) tests currently validated for rapid diagnostic in the U.S. are primarily designed to identify North American viruses and often fail to identify new strains of NDV evolving worldwide. The potential introduction of new lineages of virulent NDV strains represents a significant threat to the US poultry meat production. ARS scientists have developed a bioinformatics based evaluation system centered on the creation of databases and on analysis of genomic sequences for the identification of viruses that have high potential of failing detection using current U.S. testing technologies used for surveillance. ARS scientists' approach have resulted in the identification of the genotypes of viruses circulating in Pakistan, China, Korea, Iran, Turkey, European countries, as well as wild birds in the U.S. that normally would be missed with the current surveillance assays. These finding led to the development of four new RT-PCR based diagnostic assays to help American veterinarians accurately diagnose the presence or introduction of virulent strains of NDV.

Impact: Epidemiological studies to understand what NDV are circulating worldwide are critical to ensure we have the appropriate diagnostic tests to detect disease outbreaks and disease surveillance.

2. Programs for eradication from the U.S. of bovine tuberculosis caused by *Mycobacterium bovis* were initiated in 1917, in large part due to public health concern of bovine tuberculosis as a zoonotic disease. Traditional test and slaughter policies have been effective in lowering the prevalence of disease, but the incidence of new cases has been increasing and efforts to eradicate bovine tuberculosis from the U.S. have not been achieved. Current problems impeding eradication of bovine tuberculosis from the U.S. are the persistence of *Mycobacterium bovis* infection in a wildlife reservoir of free-ranging white-tailed deer. ARS scientists evaluated the accuracy and feasibility of blood-based assays for the detection of tuberculosis in white-tailed deer. Several tests were proved to be highly specific for the disease and were acceptable to policy makers.

   Impact: Establishing the accuracy of blood-based assays for wildlife will allow the Michigan Department of Natural Resources to begin developing control and eradication strategies to control tuberculosis in white-tailed deer and subsequently cattle in Michigan and other Tuberculosis infected states.

3. ARS scientists have developed and validated a polymerase chain reaction (PCR)-based diagnostic test for the detection of chicken- and turkey-origin enteric parvoviruses. This test was based upon the sequence analysis of several field isolates of chicken and turkey parvovirus, which revealed a conserved region within the non-structural (NS) gene. This sequence proved to be very specific and sensitive, detecting parvovirus nucleic acid at very low levels. Further, this assay was used to determine the prevalence of parvovirus infection in poultry flocks in the United States, and an analysis of the PCR products supports the designation of the chicken and turkey parvoviruses as novel members of the Parvovirinae family.

Impact: The results of this research establishes the prevalence of parvovirus infections in U.S poultry flocks and provides a diagnostic tool to further investigate the impact of this virus on poultry production.

Indicator 2:

During 2009, 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 2008 Accomplishments*: None for NP 103.*

Indicator 3:

During 2009, 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 2009 Accomplishments*:*

1. ARS scientists have worked with industry to develop novel biotherapeutic antibodies as feed supplements to enhance the disease resistance of poultry flocks to gastrointestinal pathogens that impact food safety and production gains. Applied advanced technology in avian immunology and genomics have led to identifying novel molecules that have been shown to enhance host innate immunity, decrease early mortality, and reduce the use of antibiotics in poultry production.

   Impact: This technology has the potential to reduce economic losses due to enteric diseases in poultry and decrease the use of many antibiotics that are associated with drug resistances.

Measure 4.2.2 Summary of Major Technologies Developed, Transferred, and Used in FY 2008:

During FY 2009, ARS reported 4 new technologies developed, transferred, and used by the private sector and government agencies to protect animals, people, and property.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
ARS scientists have developed novel biotherapeutic antibodies as feed supplements to	This technology has been published in the scientific literature and has already been adopted by the poultry industry in Mexico: Lee SH, Lillehoj HS, Park DW,	North American poultry industry	This technology has the potential to reduce economic losses due to enteric diseases in poultry

enhance the disease resistance of poultry flocks to gastrointestinal pathogens.	Jang SI, Morales A, García D, Lucio E, Larios R, Victoria G, Marrufo D, Lillehoj EP. 2009. Protective effect of hyperimmune egg yolk IgY antibodies against Eimeria tenella and Eimeria maxima infections. Vet Parasitol.;163(1-2):123-6.		and decrease the use of many antibiotics that are associated with drug resistances.
Development of four new RT-PCR based diagnostic assays to help American veterinarians accurately diagnose the presence or introduction of virulent strains of NDV.	New NDV RT-PCR-based diagnostics were transferred to the National Veterinary Services Laboratories (NVSL) and the National Animal Health Laboratory Network (NAHLN). The results of these studies were published in two peer-reviewed journals: 1) Miller PJ, Decanini EL, Afonso CL. 2009. Newcastle disease: Evolution of genotypes and the related diagnostic challenges. Infect Genet Evol. 2009 Sep 30. [Epub ahead of print] and 2) Miller PJ, Kim LM, Ip HS, Afonso CL. 2009. Evolutionary dynamics of Newcastle disease virus. Virology; 391(1):64-72.	APHIS and NAHLN State Laboratories and poultry industries worldwide.	The potential introduction of new lineages of virulent NDV strains represents a significant threat to the US poultry meat production. The new highly specific diagnostics tests developed by ARS will support NDV surveillance programs and enable rapid responses to disease outbreaks.
ARS scientists evaluated the accuracy and feasibility of blood-based assays for the detection of tuberculosis in white-tailed deer.	The results of these studies were provided to State officials and published in two peer-reviewed publications: 1) O'Brien, D.J., Schmitt, S.M., Lyashchenko, K.P., Waters, W.R., Berry, D.E., Palmer, M.V., Mcnair, J., Greenwald, R., Esfandiari, J., Cosgrove, M.K. 2009. Evaluation of Blood Assays for Detection of Mycobacterium Bovis in White-tailed Deer (Odocoileus Virginianus) in Michigan. Journal of Wildlife Diseases. 45(1):153-164 and 2) Lyashchenko, K.P., Greenwald, R., Esfandiari, J., Chambers, M.A., Vicente, J., Gortazar, C., Santos, N., Correia-Neves, M., Buddle, B.M., Jackson, R., O'Brien, D.J., Schmitt, S., Palmer, M.V., Delahay, R.J., Waters, W.R. 2008. Animal-side Serologic Assay for Rapid Detection of Mycobacterium bovis Infection in Multiple Species of Free-ranging Wildlife. Veterinary Microbiology. 132(3-4):283-292.	Michigan Department of Natural Resources and APHIS	Established the accuracy of blood-based assays to allow the Michigan Department of Natural Resources to begin developing control and eradication strategies to control tuberculosis in white-tailed deer.
ARS scientists have developed and validated a polymerase chain reaction (PCR)-based diagnostic test for the detection of chicken- and turkey-origin enteric parvoviruses.	The results of this research were published in a peer-reviewed publication: Zsak, L., Strother, K.O., Day, J.M. 2009. Development of a polymerase chain reaction procedure for detection of chicken and turkey parvoviruses. Avian Diseases. 53:83-88.	North American poultry industry	The results of this research establishes the prevalence of parvovirus infections in U.S poultry flocks and provides a diagnostic tool to further investigate the impact of this virus on poultry production.

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

During FY 2010, 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 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.

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.

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.

During FY 2011, 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 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.

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 2009, ARS will develop methods to reduce emissions of harmful gases from crop production systems and post-harvest/quarantine treatments.

FY 2009 Accomplishments*:*

1. *Methyl bromide alternatives for cut flower and bulb production.* Cut flower and bulb production operations in California need effective replacements for preplant soil fumigation with methyl bromide, which is typically applied by shanks in field operations and the “hot gas” method in enclosed operations (i.e., greenhouses, hoop houses). Multiple research and demonstration trials conducted by ARS scientists at Davis, California, were completed statewide in commercial plantings of Ranunculs and calla lily (field operations), iris, freesia, and snapdragon (enclosed operations) to test drip applications of chloropicrin and combinations of it with 1,3-dichloropropene and metam sodium as alternatives to shank and hot gas applications of methyl bromide. The trials demonstrated to growers that drip-applied alternatives provide pest control and crop yields equal to or better than those obtained with the conventional methyl bromide treatments.

   ***Impact*:** The work is resulting in commercial transition to the drip alternatives for cut flower and bulb production and is reducing reliance on methyl bromide and reducing fumigant emissions to the atmosphere.

2. *Integration of alternative fumigants with improved plastic mulches for replacement of methyl bromide for strawberry production.* Strawberry fruit

production operations in California need effective replacements for methyl bromide that are compatible with tightening regulatory restrictions. ARS scientists at Davis, California, in collaboration with commercial strawberry growers, completed multiple research and demonstration trials across California's coastal strawberry production districts to test reduced rates of drip-applied fumigant alternatives to methyl bromide in combination with low permeability plastic mulches. The trials demonstrated to growers that low rates of fumigant alternatives (i.e., combinations of chloropicrin with 1,3-dichloropropene), if applied under a low-permeability plastic mulch, can be used to obtain strawberry yields equivalent to those following conventional treatments with methyl bromide -chloropicrin combinations. Furthermore, data were obtained to confirm that the low permeability mulches retain fumigants in soil longer than conventional high density polyethylene mulches, thereby improving fumigant efficacy and reducing atmospheric emissions. This research also has demonstrated the feasibility of gluing impermeable films for broadcast fumigation.

> ***Impact*:** The work has provided strawberry growers with valuable alternatives to methyl bromide that are effective and conducive to use under current regulatory restrictions.

3. *Tree site specific spot fumigation can reduce total fumigant emissions*. Reducing emissions of volatile organic compounds (VOCs) from fumigant pesticides is mandatory in California, especially in "nonattainment areas" like the San Joaquin Valley that do not meet federal air quality standards. When orchards are replanted, soil is fumigated to prevent replant syndrome which can seriously stunt new trees and decrease future productivity. A 2-year field study conducted by ARS scientists in Parlier, California, examined the feasibility of applying fumigant just to the actual future site rather than to the entire orchard to reduce the amount of fumigant that would need to be applied to the orchard and decrease the environmental consequences of fumigation. Cumulative atmospheric emission of the fumigants was estimated to be 18 to 23 percent of the applied active ingredients in plots that had been cover cropped with Sudan grass and 2 to 6 percent in plots that had remained bare for several months before treatment.

> ***Impact*:** Compared to whole orchard fumigation, spot fumigation may achieve a 10-fold reduction in atmospheric volatile organic compounds load from fumigant pesticides.

4. *Alternatives to methyl bromide demonstrated in key crop systems and regions dependent upon methyl bromide.* The phase-out of methyl bromide as a soil fumigant has created an urgent need to find effective alternatives for growers of vegetables, forest nursery seedlings, flowers, and several other crops on a field-scale basis. To test the effectiveness of various methyl bromide alternatives, ARS scientists at Fort Pierce, Florida, conducted 40 large-scale field demonstration trials using the best available, industry-appropriate alternatives to methyl bromide. The alternatives included substitute fumigants and supporting integrated pest management practices. Trials were conducted in five states in partnership with commercial growers at sites ranging in size from half an acre to 58 acres adequately representing the biological and environmental diversity of the production systems. Methyl bromide dependent commodities evaluated included tomato, pepper, eggplant, strawberry, forest nursery seedlings (loblolly pine), sod, ornamentals (caladium), and cut flowers (delphinium).

***Impact*:** These trials demonstrated that technically feasible alternatives to methyl bromide soil fumigation are available.

Indicator 2:

During 2009, 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 2009 Accomplishments*:*

1. *Resistance to reniform nematode successfully transferred into upland cotton from wild relative.* Reniform nematode has become the predominant nematode causing yield loss on cotton in the mid-south area of the United States, and currently there are no commercially available cotton varieties with resistance to this pest. ARS scientists in Stoneville, Mississippi, have successfully transferred resistance to reniform nematode into cotton from a distant relative, *Gossypium aridum*. Genetic experiments showed that the resistance is controlled by a single dominant gene. Molecular markers closely associated with the resistance were identified that will allow cotton breeders to incorporate the resistance into productive cotton varieties more efficiently.

   ***Impact*:** This research has the potential to fill a critical need for cotton varieties resistant to reniform nematode.

Indicator 3:

During 2009, 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 2009 Accomplishments*:*

1. *Determination of effective sampling range of food-based attractants for capture of caribflies.* Sampling range, i.e. the maximum distance from which an insect can reach an attractive source in a given period of time, is an important aspect of trap efficacy. Release/recapture studies using laboratory reared fruit flies have been used traditionally to determine sampling range. However, response of these flies to food-based attractants may not be directly applicable to response of wild flies due to differences in nutritional background. ARS scientists at Miami, Florida, conducted a release/recapture trapping study to determine the sampling range from field-collected caribflies in south Florida. Field collected wild flies were attracted to the food-baited traps from longer distances that laboratory reared flies. Thus trapping data developed with laboratory reared flies would tend to overestimate the population level of wild flies when estimated using food traps.

   ***Impact*:** This information will be used by regulatory agencies, growers and researchers to determine coverage of traps used for population delimitation; for implementation of mass trapping control strategies; to pin-point areas of infestation for precision

targeting of control measures; and to determine the minimum distance between treatments to avoid trap interference in field tests.

2. *Monitoring stored-product insect populations in food processing facilities.* Ongoing research in commercial food facilities conducted by ARS scientists at Manhattan, Kansas, and industry cooperators indicates considerable variation in efficacy against the target pest species, differences in seasonal patterns in pest activity, and geographic variation in species abundance and diversity.

   ***Impact*:** The specific information being generated from this project is currently being used by industry cooperators to help guide their management programs and the combined information from multiple locations will be used to determine average impact of treatments.

3. *Field trials show effectiveness of aerosols.* Small-scale tests have shown the potential of combination treatments with the insect growth regulator methoprene to control the Indianmeal moth. ARS scientists at Manhattan, Kansas, conducted several field trials by exposing eggs of the Indianmeal moth in different foods and on different packaging materials treated with synergized pyrethrins applied alone and in combination with the insect growth regulator methoprene. Results of the field trials show the aerosols penetrated underneath pallets, and the combination of pyrethrin and methoprene was optimal for both best control of eggs and lowest economic cost.

   ***Impact*:** There was some variation depending on the specific diet or package exposed, but overall results show that the aerosols could be used to control the eggs of the Indianmeal moth in a commercial facility.

4. *Development of quarantine strategies to control hessian fly in exported hay.* China, Hong Kong, South Korea, and South Vietnam are emerging markets for U.S. hay exports, and regulatory agencies seek new methods to ensure that Hessian fly, a domestic pest, is not accidentally introduced through hay shipped from the western states. ARS scientists at Parlier, California, developed novel fumigations using a carbon dioxide and phosphine gas mixture and simulated hay drying conditions on the resistant stage of the insect as control techniques to reduce the risk of infestation in exported bales. The National Hay Association supported further research of these hay handling procedures as potential quarantine treatments for Hessian fly.

   ***Impact*:** This work helps protect the U.S. hay export market, which is valued at more than $600 million annually.

Indicator 4:

During 2009, 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 2009 Accomplishments:

1. *Development and application of two protein extraction protocols for proteomic investigations of Rhizoctonia solani to examine virulence and pathogenicity.* *Rhizoctonia solani* (essentially an asexual fungus) is highly intractable to genetic manipulations for pathogenicity studies. Proteomics is a functional genomic approach to identify factors that could be useful to control the pathogen. ARS scientists at Beltsville, Maryland, developed two protocols for purification of total cellular proteins of *R. solani*, resolved proteins in 2-D gels, and identified proteins. Identification of proteins involved in pathogenicity may lead to new means of disease control.

   ***Impact*:** This is the first comprehensive report of proteomic investigation of a known anastomosis group (AG 4) of *R. solani*.

2. *Ultra-low oxygen treatment for postharvest control of western flower thrips on lettuce.* Presence of western flower thrips on U.S. fresh commodities, including lettuce, is a major obstacle to their exportation to Taiwan. ARS researchers at Salinas, California, developed an efficacious, ultralow oxygen (ULO) treatment to control the pest on harvested lettuce. A 3-day storage period immediately prior to ultralow oxygen treatment of different lettuce cultivars achieved complete control of thrips without any negative effects on lettuce quality in a pallet-scale study.

   ***Impact*:** The research reduced overall time needed to complete ULO treatment and thereby made the ULO treatment more practical for commercial adaptation.

Indicator 5:

During 2009, 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 2009 Accomplishments:

1. *New wheat varieties with disease protection increase food security and provide new markets.* ARS researchers at Raleigh, North Carolina, developed a white and a red wheat variety that produce high protein flour. Both varieties have wheat stem rust resistance and provide the first hard wheat varieties as a new market opportunity for southeastern producers. ARS scientists in Pullman, Washington, applied DNA marker selection to develop new club and soft winter white wheat varieties with stripe rust and eyespot resistance along with high yields. The three new varieties meet the highest quality standards for western wheat varieties.

   ***Impact*:** All the new ARS varieties incorporate genetic protection to disease, reducing the need for chemical fungicides and providing more production stability for growers and consumers.

2. *Clove oil as an effective antibacterial treatment for soilless substrates to control Ralstonia solanacearum.* Methyl bromide had been an important component of soilborne plant pathogen control, but due to the phase out of its use, there is a need for developing alternative control strategies. ARS researchers in

Washington, D.C., and Beltsville, Maryland, identified the oil of clove (*Syzygium aromaticum*) as a potential treatment to eradicate major groups of plant pathogenic bacteria. Clove oil inhibited the growth of both gram (+) and gram (-) bacteria and its effect was dose-dependent. The bacteria also displayed different degrees of sensitivity to the clove oil, with Ralstonia being the most sensitive and Rhodococcus the least. In greenhouse experiments, pre-plant treatment of soilless potting mix with a clove oil formulation effectively controlled bacterial wilt of geranium and tomato caused by *R. solanacearum* race 1, biovar 1, resulting in disease-free plants. The phytotoxic effect of clove oil was reduced by extending the evaporation time following treatment of soil.

> ***Impact*:** This antibacterial activity, in addition to previously reported fungicidal and nematicidal properties, makes clove oil a candidate to control various soilborne pathogens in soilless substrates.

3. *Rapid disease assay of Verticillium on lettuce developed.* Conventional greenhouse assays for examining the pathogenicity of the soilborne fungus *Verticillium dahliae* require lengthy testing periods. ARS researchers at Salinas, California, developed a growth chamber technique that enables a more rapid assessment of pathogenicity of *V. dahliae* on lettuce. The technique takes advantage of an early flowering lettuce accession line that develops symptoms quickly and speeds analyses of the *V. dahliae*-lettuce interaction.

   > ***Impact*:** The reduction in time to assess pathogenicity of *V. dahliae* from 100 days to 42 days using this technique represents a significant savings in time and cost.

4. *Web site supports Phytophthora research.* The genus Phytophthora has approximately 90 species and is responsible for a wide range of crop plant diseases on a worldwide basis, but due to similarities in morphological features their identification to a species level can be a challenge and are often incorrect. ARS researchers at Salinas, California and Peoria, Illinois, in collaboration with researchers at Penn State University, University of California at Riverside, and North Carolina State University, developed a Web-based database to enhance understanding of the genus, simplify identification, and stimulate research. The Phytophthora database includes complete morphological descriptions, information on host range and geographical distribution, a comprehensive molecular phylogeny using seven nuclear genes (four mitochondrial genes will be added shortly), and a section on molecular detection and identification.

   > ***Impact*:** The database will serve as a resource for researchers working on the genus as well as a repository of future relevant research progress and information.

5. *Production of polyclonal antisera and a recombinant phage library against enzymes produced by Penicillium expansum, an important post-harvest decay organism*. It is necessary and ecologically responsible to develop alternatives to chemical control for reducing postharvest disease losses in fruit and vegetables. ARS scientists in Kearneysville, West Virginia, and Beltsville, Maryland, have made significant progress toward the production of polyclonal antisera and a phage library against polygalacturonase, an enzyme produced by *Penicillium expansum*, the causal agent of blue mold of apples. Blocking this enzyme

activity on the fruit surface may lead to a novel control strategy to halt postharvest decay caused by *P. expansum* on apples.

***Impact*:** This control strategy could potentially benefit the postharvest industry by reducing dependency on chemical fungicides.

6. *Potatoes resist Colorado potato beetle feeding.* ARS scientists in Beltsville, Maryland, collaborating with The Institute of Genomic Research in Maryland and the University of Alberta in Canada, identified 320 genes in potato leaves that were turned on or off by Colorado potato beetle feeding. Many of the genes are involved in a general beetle defense response, while two encode proteins that produce volatiles known to attract Colorado potato beetle predators. Fewer plant genes are turned on by continuous beetle feeding, suggesting that the plant defense response is enhanced under light versus heavy beetle attack.

   ***Impact*:** Of future interest is using the gene's controls (regulatory regions) to induce plant resistance when the plant is under attack, which will lower the need for chemical insecticides.

Measure 4.2.3 Summary of the Major Technologies Developed, Transferred, and Used in FY 2008:

During FY 2009, 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.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
"Weeds of the South" - A comprehensive description of 400 of the most important agricultural and invasive weeds of the southeastern United States as prepared through a collaboration of ARS and industry scientists.	The newly compiled information was transferred through publication, 12,000 copies released in June 2009	Researchers, extension personnel, consultants, farmers, botanists, weed scientists, horticulturalists, foresters, land managers, master gardeners, garden clubs, landscape managers, educators, and the general public.	The information compiled in this book is being used to identify weeds that threaten crops, pastures, lawns, turf, roadsides, nurseries, etc. State Extension Weed Specialists in Alabama, Mississippi, North Carolina, and Tennessee have placed a copy of "Weeds of the South" in all county agent offices in their respective states.
ARS scientists developed cultivation methods of peanut that combines planting density and mechanical weeding to improve weed control and crop yields.	Transferred through presentations at field days and conferences.	Organic producers in the southeast	Improved yields of organic peanuts.
Based on large-scale dissipation studies, herbicide application	Advice and recommendations for	California Department of	Over a 2-year period, 90 percent control of *Egeria*

methodologies were developed to control the spread of *Egeria densa*, an aquatic weed infesting the waterways of the Sacramento-San Joaquin Delta, a source of water for more than 22 million Californians.	herbicide applications were transferred, as well as recommendations to ensure compliance with the Federal Endangered Species Act "Biological Opinion" under which the California Department of Boating and Waterways *Egeria densa* Control Program operates.	Boating and Waterways, California Department of Water Resources, US Fish and Wildlife Service, National Oceanic and Atmospheric Administration (NOAA)-Fisheries.	was achieved in over 4,000 acres in the Sacramento/ San Joaquin Delta and associated waterways.
Ecologically-based invasive plant management (EBIPM) is a process based model for weed managers to implement site specific integrated weed management strategies to address ecological processes. EBIPM combines State and transition models and successional management models to make the best decisions for a given areas. It can be used for any weed species.	This systems approach is being transferred through decision-support systems, step-by-step guidelines, journals articles, videos, field schools and workshops, landscape-scale demonstrations areas, and one-on-one consultation. On-line materials and user friendly support material are available through an EBIPM website.	Rangeland scientists and Federal, State, regional, and local land managers, ranchers, universities, environmental and stewardship groups, and the general public.	EBIPM is currently being adopted by public and private ranchers in the western United States. This science-based method for management is becoming widely incorporated into University and Extension programs. It has improved the ability to sustainably manage annual grass infested rangeland and has the potential to save millions of dollars in invasive plant management and restoration costs.

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

During FY 2010, 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 2011, 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 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.

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.
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 2009, 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 2009 Accomplishments*:*

1. *Painted maple found to be highly attractive to adult Asian longhorned beetle.* Asian longhorned beetle is a very serious invasive insect from China. Attacking and killing many broadleaf trees in urban areas, including 9 species of maple, the Asian longhorned beetle could potentially kill over 30 percent of all trees in urban and forested areas of the eastern United States. Early detection is paramount to preventing introduction, establishment, and spread of the Asian longhorned beetle; is central to both an effective eradication program and post-eradication program; and, is key to evaluating the efficacy of control approaches. ARS researchers at Newark, Delaware, found that the beetle is particularly attracted to painted maple, and that an encapsulated insecticide can be applied to the tree to kill alighting beetles. Using ARS-developed strategies based on these findings, the painted maple has been adopted as a "sentinel tree" by the California Department of Agriculture (CDFA) and the Canadian Food Inspection Agency for early detection of the beetle. CDFA has now also uses the tree with insecticide

in an “attract-and-kill” strategy. Chemicals isolated from the painted maple were attractive to both sexes of the beetle, and have now been used in traps for detection.

> ***Impact*:** This artificial lure has the potential to significantly improve the ability to determine if, when, and where beetles occur in the United States, as well as to intercept beetles when they first arrive here, prevent their spread, and focus control efforts in areas where the beetle is already killing trees.

2. *Use of screwworm relative to develop cryopreservation protocol.* Since the primary screwworm (*Cochliomyia hominivorax*) has been eradicated from the United States, research on this species is not conducted here due to concerns that the insects might escape quarantine. Cryopreservation methods for providing breeding stock to sterile insect production facilities, nevertheless, still needs improvement. ARS researchers in Fargo, North Dakota, therefore used a surrogate insect, the secondary screwworm (*Cochliomyia macellaria*) to develop long-term preservation protocols.

   > ***Impact*:** Mass-cryopreservation technology will provide needed back-up repositories for primary screwworms reared in facilities for release in the prevention of re-infestation of the Americas by this important agricultural pest.

3. *Lures for monitoring the Asian citrus psyllid.* The Asian citrus psyllid is the vector of the bacterium that causes citrus greening disease (also known as huanglongbing), the most devastating disease of citrus worldwide. Better tools are needed to improve the insect’s detection and monitoring. Since Asian citrus psyllid reproduces and develops only on the young shoots of citrus trees, ARS scientists at Weslaco, Texas, analyzed the chemical compositions of the aromas emitted by the young shoots of several types of citrus and formulated a scent mixture based on their analysis. In laboratory tests, significantly more Asian citrus psyllid were trapped on targets scented with the aromatic mixture than on unscented targets.

   > ***Impact*:** These results indicate the feasibility of developing Asian citrus psyllid attractants based on the aromas emitted by the young shoots of citrus trees.

4. *Cactus moth controlled in Mexico and threat mitigated in the United States.* Since its detection in south Florida in 1989, the Argentine cactus moth has 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 has become an imminent threat to many *Opuntia* cactus species valued as food, forage, and as a wildlife habitat; these cacti are a major plant group contributing to ecosystem structure and biodiversity. ARS scientists from Tifton, Georgia, and Tallahassee, Florida, collaborating with APHIS and SAGARPA (Mexico) colleagues, developed and refined survey methods and control tactics using field sanitation combined with sterile insect releases along the leading edge of the invasion and at new outbreak locations. Mexico fully adopted and implemented these methods and tactics in the operational program that is part of an ongoing U.S.-Mexico bi-national campaign against this invasive pest.

***Impact*:** These actions eradicated established populations of this pest on Alabama barrier islands and islands off the coast of Quintana Roo, Mexico, and mitigated the further westward expansion of pest populations along the Gulf coast. This is the first time any lepidopteran pest has been eradicated from a country in the Western Hemisphere.

5. *Microbial control of Mormon crickets and grasshoppers.* ARS, cooperating with APHIS, is searching for environmentally safe and effective microbial agents to manage outbreaks of Mormon crickets and grasshoppers in the western United States. ARS scientists in Sidney, Montana, demonstrated in a second year of outdoor testing the superiority of a domestic fungus, *Metarhizium* DWR346, to both currently registered, commercial fungal-based insecticides for Mormon cricket control and grasshopper control. This, along with mass production evaluations made at Sidney, point toward the practical potential of this fungus.

   ***Impact*:** As a result, USDA is closer to developing a satisfactory microbial control agent to substitute for the broad-spectrum chemical insecticides currently in use on rangelands.

Indicator 2:

During 2009, 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 2009 Accomplishments*:*

1. *Hydrilla control in Florida with fungus-herbicide combination.* The fungus *Mycoleptodiscus terrestris* is being developed as a bioherbicide for control of the invasive aquatic weed hydrilla which is showing resistance to the most commonly used herbicide, fluoridone. ARS scientists in Peoria, Illinois, demonstrated in field trials that when *Mycoleptodiscus terrestri* was used with low dose rates of the chemical herbicides endothall or penoxsulam there was enhanced hydrilla biomass reduction 3 months following application.

   ***Impact*:** The development of *Mycoleptodiscus terrestris* as a commercial bioherbicide will provide water management specialists with an important non-chemical control tool for this serious aquatic weed.

2. *Four potential biocontrols found for controlling giant reed.* Four promising biological controls that could curb the impact of the invasive plant giant reed in the United States have been found in Spain by ARS scientists in Weslaco, Texas, and Montpelier, France. The giant reed, *Arundo donax*, has been particularly destructive in the southwest United States, where it is an exotic and invasive weed of riparian habitats and irrigation canals. But in its native Spain, the giant reed is kept under control by a host of insects, and ARS scientists have made numerous trips in search of biological controls to bring to the United States. One biocontrol candidate insect attacks the reed's root, and its release has been recommended by the Technical Advisory Group (TAG), a North American organization that oversees releases of weed biological control agents.

Another biological control agent released in Texas in April 2009 attacks the weed's main stem, weakening the plant, reducing its overall height, and causing it to form galls and develop side shoots. A third promising biocontrol agent eats the inside of new shoots of the plant, while a fourth destroys the plant's leaves.

> ***Impact*:** This combined biological control agent approach is sustainable over the long term and complements mechanical and chemical control strategies.

3. *Fungus to control kudzu.* By one estimate, kudzu, an invasive vine, spreads at the rate of 150,000 acres annually, easily outpacing the use of herbicide spraying and mowing, as well increasing the costs of these controls by $6 million annually. ARS researchers in Stoneville, Mississippi, have formulated a naturally occurring fungus as a biologically based herbicide for kudzu that works so quickly kudzu plants sprayed in the morning start showing signs of damage by mid-afternoon. In greenhouse experiments, spray formulations killed 100 percent of kudzu seedlings and 90 to 100 percent of older plants in outdoor trials. Other tests showed that the fungus caused little or no injury to many of the woody plants known to occur in kudzu-infested habitats, including oak, cedar, pine, hickory, pecan, sassafras, and blackberry.

   > ***Impact*:** Besides kudzu, the fungus also showed potential as a pre-emergence bioherbicide, controlling purslane and spurge in transplanted tomatoes.

4. *Borer helps control climbing fern.* Throughout much of Florida's Everglades, an invasive, light-green vine called Old World climbing fern is found on the forest floor. Besides smothering shrubs and even small trees with its dense, spongy mats, the fern also forms soft, twining stems that climb tree trunks. To help stop the fern's vertical and horizontal advance, ARS-funded scientists in Brisbane, Australia, and Florida, have found and studied many insects that are natural enemies of the fern in its homelands – the tropics and subtropics of the Old World, including Australia. ARS scientists have discovered stem borers from several climbing fern species in Southeast Asia, including one from Hong Kong that shows promise as an effective biocontrol candidate of climbing fern.

   > ***Impact*:** Importantly, the scientists have been able to rear it in captivity, an essential step for completing requisite tests of its biology and for assessing its potential use as a biocontrol agent.

5. *Development of ecologically based invasive plant management.* The need for unified ecological theories, principles, frameworks, and models that improve our ability to predict vegetation change and guide the effective and sustained restoration of weed-invaded ecosystems is substantial and unmet. Based on principles synthesized from existing scientific literature and refinement through related research, ARS scientists in Burns, Oregon, developed the ecologically based invasive plant management (EBIPM) model, a process-based model that combines ecological principles and processes with land management for the control of invasive weeds and stabilization of ecosystems. EBIPM was developed to provide a management approach that addresses the underlying ecological causes of invasions and methodologies to alter these key processes to control and displace invasive plants while restoring impacted areas in a desired trajectory, resulting in sustainable and productive range and grass lands.

***Impact*:** This approach is now the basis for an Areawide Pest Management Program designed to reverse the spread of cheatgrass and medusahead in the Great Basin ecosystem.

6. *Saltcedar biological control and assessment.* Saltcedar is an exotic shrub to small tree that has invaded approximately 50 million acres of riparian lands in the western United States. Leaf beetles from Asian and Europe, saltcedar's natural enemies, were located by ARS scientists in Albany, California, tested and released into North American field sites with a range of cooperators including university scientists, USDA APHIS personnel, and state departments of agriculture. The beetles established well, increased exponentially in numbers, spread hundreds of miles, and have repeatedly defoliated saltcedar causing significant weed mortality in many locations. Action agencies are now using these ARS-developed biological control agents to help control saltcedar in over 15 states in the western United States. Post release assessments conducted in 2009 have documented both effective control and safety for potential non-target plant species in many release sites.

   ***Impact*:** In all, no direct feeding damage to non-target populations has been noted with this biological control agent in area-wide releases across more than 15 states, making it a very successful and environmentally friendly project.

Indicator 3:

During 2009, 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 2009 Accomplishments:

1. *A new Reo-like virus identified from "crumbly fruit" disease in raspberry.* Crumbly fruit disease in red raspberry and blackberry significantly decreases fruit quality, making the fruit unusable for the fresh or whole berry markets which are the most profitable for the grower. ARS scientists in Corvallis, Oregon, characterized viruses from diseased plants. The researchers conclusively showed infection with three viruses: Raspberry bushy dwarf virus, Raspberry leaf mottle virus, and a new Reo-like virus, and they developed diagnostic tests for the latter two. A polymerase chain reaction (PCR) test is now being used to identify the vector and native hosts of the Reo-like virus. In addition, plants singly infected with each of the three viruses are being developed to study the role of each virus individually and in various combinations in the crumbly fruit symptom.

   ***Impact*:** These diagnostic tests have been provided to laboratories carrying out virus clean-up programs to ensure that the plants produced are free of these viruses and to laboratories responsible for quarantine and certification to assist their programs.

2. *Fairy ring disease of cranberry: causal agent and life cycle determined*. Fairy ring is a serious fungal disease of cranberry that kills vines and is difficult to

control. The causal agent and mechanism of spread were unknown. ARS scientists in Chatsworth, New Jersey, positively identified the causal agent as a new species of *Helicobasidium*. They further determined that this organism has a complex life cycle and an alternate host that contributes to the genetic diversity and spread of the disease in cultivated cranberry beds.

> ***Impact*:** These discoveries provide needed information to develop better management practices to control fairy ring disease.

3. *Assigning gene functions to the causal agent of sudden oak death*. The DNA sequence of disease-causing organisms can provide clues to their function and potential opportunities to disrupt those functions. However, sequence similarities must be verified biologically rather than simply by computer-generated associations. The majority of the genes sequenced for the fungal pathogen, *Phytophthora ramorum*, that causes sudden oak death, had no experimental evidence supporting their identification until recently.

   > ***Impact*:** ARS scientists in Davis, California, constructed gene expression microarrays for the fungus and obtained baseline gene expression levels during the three life stages of the fungus which facilitates association and demonstration of specific genes with specific biological processes.

4. *Potato zebra chip disease agent identified.* The potato zebra chip disease can cause severe economic loss in all market classes of potatoes. Zebra chip disease has been shown to be transmitted by potato psyllids and has been proposed to be associated with an uncultured bacterium species of Liberibacter. ARS scientists in Beltsville, Maryland, have successfully transmitted zebra chip to healthy potato and tomato plants by grafting and by psyllid feeding, and they consistently detected Liberibacter bacteria. The Liberibacter detected is closely related to Liberibacter associated with diseased plants in New Zealand.

   > ***Impact*:** These data strongly implicate Liberibacter as the primary pathogen causing potato zebra chip disease and provide important new information for tracking and combating zebra chip.

5. *Technological advances in breeding grape for resistance to Pierce's Disease.* Virtually all commercial grape cultivars are susceptible to Pierce's disease (PD), caused by the pathogen *Xylella fastidiosa*. Although some wild grape species from the southern United States are resistant, they are unsuitable for table grape, raisin, and wine production. Current resistance breeding and selection methods require 5 years under natural field conditions and 6 months under controlled greenhouses, and both methods are expensive. ARS researchers in Parlier, California, developed a faster method based on molecular markers to identify resistance traits and demonstrated the usefulness of these markers by tracking resistance genes that were transferred into high-quality susceptible *Vitis vinifera* cultivars that are popular with the grape and wine industry. These scientists also found that plant sap collected from PD-resistant and PD-susceptible grapevines, when added to growth media, showed significant differences in bacterial growth: media containing plant sap from PD-susceptible plants provided enhanced bacterial growth compared to media supplemented with sap from PD-resistant plants.

***Impact*:** These discoveries will be explored to develop new control strategies to breed and select for resistance to PD.

Measure 4.2.4 Summary of the Major Technologies Developed, Transferred, and Used in FY 2008:

During FY 2009, 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.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Development of computer software called The Greenbug Management Decision Support Tool. A computer-based expert system that guides the user through the process of determining economic thresholds and obtaining field sampling data forms.	The Greenbug Management Decision Support Tool is available on the internet at http://entoplp.okstate.edu/gbweb/.	The software is designed for crop consultants, wheat producers, and pest management scientists.	Extension specialists throughout Oklahoma and Texas rely heavily on the system when greenbug outbreaks occur, and some train crop consultants and growers on its use.
Developed software for soil microclimate and weed ecology modeling.	Web-based and downloadable software for estimating soil temperature, soil moisture, solar radiation, and weed behavior.	Scientists, university instructors, crop advisors, and various private industries.	These products enable scientists, crop advisors, and others to make better and more well-informed predictions of crop and weed emergence, which helps them in making more efficient crop and experiment management decisions.
The Arundo wasp *Tetramesa romana* was released in Laredo, TX and Mexico for the control of the invasive weed *Arundo donax* (giant reed).	Following extensive research to ensure the efficacy and safety of the agent, the Arundo wasp was released in a bilateral effort to control giant reed.	International Boundary and Water Commission, Department of Homeland Security, Bureau of Reclamation, Fish and Wildlife Service, Texas Rio Grande Watermaster, Texas Parks and Wildlife, Texas Department of Transportation, Texas Lower Rio Grande Valley Irrigation Districts, PRONATURA Mexico, and CONANP Mexico.	This is the first biological control agent permitted for use against this invasive weed and is the culmination of research from scientists at the ARS European Biological Control Laboratory, Montpellier, France and the Beneficial Insects Research Unit, Weslaco, TX.
A new management Web site called “Scab Smart” was activated by the U.S. Wheat and Barley Scab Initiative, managed by ARS, to	Through the Scab Initiative Web site, publications and press releases, farmer field days, and radio.	Wheat and barley growers and producers.	The benefits of the Scab Initiative research were realized in 2009 with only moderate scab losses reported in a year with weather conditions

provide information on scab forecasting, fungicides, and crop rotation.	in the United States that were conducive to major scab losses in previous years.

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

During FY 2010, 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 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.

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 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.

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 2009, ARS will continue to develop diagnostic assays to detect and differentiate existing, new and/or emerging quarantine arthropod pests, weeds, nematodes, and pathogens.

FY 2009 Accomplishments:

1. *Identification of the causal agent associated with the almond brown line disease.* Almond brown line disease was discovered in California in the 1990s as a graft union disorder in almonds grown on plum rootstock in orchards on marginal land. When the trees are infected by Peach yellow leafroll-associated phytoplasma, they develop a brown necrotic line at the graft union resulting in tree death. It has been difficult to prove the association of phytoplasma in infected almond trees because of lack of a suitable detection assay. ARS scientists in Davis, California, developed a molecular assay and successfully detected this phytoplasma in almond extracts.

   ***Impact*:** This assay can be used to monitor the trees in a commercial orchard impacted by almond brown line disease.

Indicator 2:

During 2009, ARS will continue to expand interdisciplinary research to include means of excluding, managing and/or eradicating quarantine arthropod pests, weeds, nematodes and pathogens.

FY 2009 Accomplishments:

1. *Population genetic analysis infers migration pathways of Phytophthora ramorum in U.S. nurseries. Phytophthora ramorum* is the exotic pathogen that is responsible for sudden oak death in California forests, also termed "ramorum blight" of common ornamentals. ARS scientists at Corvallis, Oregon, conducted a population analysis to infer migration routes of *Phytophthora ramorum* in U.S. nurseries. The nursery trade has moved this pathogen from source populations on the West Coast to locations across the United States. Two eastward migration pathways were revealed, one containing isolates from Connecticut, Oregon, and Washington and the other containing isolates from California and the remaining states.

   ***Impact*:** This work has implications for eradication and management practices of the pathogen in U.S. nurseries.

2. *Transiently-induced silencing of a sugarbeet and tomato virus.* Beet severe curly top virus (BSCT) and related curtoviruses are responsible for severe losses in numerous crops each year, including tomato and sugarbeet. ARS researchers at Salinas, California used virus-induced gene silencing to obtain high-level resistance against BSCT virus and a related curtovirus in tomato and in a related tobacco species. This induced resistance to BSCT virus provided disease control in tomato and a relative of tobacco, but there was limited control in sugarbeet.

   ***Impact*:** The ability to elicit induced silencing of curtoviruses will provide the vegetable and sugarbeet industries with alternative and potentially more effective disease control methods while reducing pesticide usage and without the use of genetically transformed materials.

3. *Development of an effective seed treatment system for an emerging seed-borne virus on tomato.* With an estimated value of $400 million, greenhouse tomato production in the United States has increased significantly in recent years, capturing nearly 46 percent of the U.S. fresh tomato market share. *Pepino mosaic virus (*PepMV), a seed-borne pathogen, is an emerging disease in greenhouse tomato and has a significant impact on production. ARS scientists in Charleston, South Carolina, determined that the PepMV virus particles are located on the surface of the seed coat and thus can be eliminated by various seed treatments with chemo- and thermo-therapies.

   ***Impact*:** This discovery advances uses of seed treatments to deactivate virus infectivity and will facilitate planting of virus-free seed, a high priority of the industry.

4. *Naturally-occurring microbial residents on apple blossom surfaces and their potential use in fire blight control.* Biological control of fire blight of apple and pear with beneficial microorganisms is a viable alternative to the use of antibiotics, which have become less effective due to resistance development in the disease-causing organism. Although some biocontrol agents have now been commercialized for this disease, information regarding population sizes, distributions, and diversities of natural microbial residents on floral surfaces of apple trees and their potential use in disease control was lacking. ARS scientists in Wentachee, Washington, detected a wide diversity of bacteria and yeasts on

apple blossoms and, through laboratory bioassays with detached flowers, identified microbial genera and specific strains that are highly effective in suppressing the pathogen.

***Impact*:** The information will be useful in developing effective microbial mixtures with complementary modes of action and ecological niches for enhancing biological control of fire blight.

5. *Toxicity of a natural antibiotic to nematodes.* Some beneficial bacteria produce 2,4-diacetylphloroglucinol (DAPG), a natural antibiotic, which is active against numerous organisms, including plants, fungi, viruses, and bacteria. ARS scientists in Beltsville, Maryland, in cooperation with scientists from Pennsylvania State University, determined that effects of DAPG also impacted nematodes, but the responses were variable, depending on the nematode species and life stage being studied, and the responses ranged from toxic to stimulatory.

***Impact*:** This research has allowed scientists to determine which species of plant-parasitic nematodes would be optimal targets for application of DAPG-producing biocontrol bacteria in soil treatments.

Indicator 3:

During 2009, 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 2009 Accomplishments:

1. *New insect identification guides* completed. A comprehensive, extensively illustrated two volume book has been completed by ARS scientists in Beltsville, Maryland, entitled "The Manual of Central American Diptera." This book provides the first identification keys for the genera of all flies described from Central America. Other important systematics references include: the flea beetles of Eurasia, including those that are plant pests and others that are used in biocontrol of weeds; ladybird beetles, which are important predators of pest insects; clarification of over 100 aphid names through molecular methods, *e.g.*, the finding that the glasshouse potato aphid is quite diverse in form and biology, yet is revealed by DNA to be only one species; a detailed systematic work including classification, economic importance, and conservation biology that increases the number of world true bugs (Heteroptera) by over 3,000 species; a major description of related sharpshooter leafhoppers (such as the ones that vector Pierce's disease of grape); African flower fly pollinators and biological control agents; flat mite vectors of virus diseases of citrus and coffee; and more than 100 leafmining flies, including their evolution and host-shifting as pests of vegetables and flowers.

***Impact*:** These guides and systematic revisions provide important material for port identifications by the USDA Animal and Plant Health Inspection Service (APHIS), and the evolutionary and biological information is useful to researchers and managers developing pest management systems, including biological control.

2. *Urgent port identifications of insects for APHIS.* This past year, ARS systematists in Beltsville, Maryland, did over 13,608 identifications (6,266 of urgent priority) of 33,647 insects and mites. This service provides a first line of defense against the introduction of potentially invasive species into the United States by recognizing exotic pests as they are intercepted at U.S. ports-of-entry. In addition, the identification of specimens submitted by biological control researchers aids in the selection of beneficial predatory, parasitic, or plant-feeding species of potential value in the control of pestiferous insects, mites, and weeds.

   ***Impact*:** Nine species were reported to the APHIS New Pest Advisory Group as new invaders to North America.

3. *Scientists identify North American genotypes of rush skeletonweed.* Finding effective biocontrols against rush skeletonweed could be easier now that all genotypes of the invasive weed have been identified in North America by ARS scientists in Sidney, Montana, and their collaborators. Rush skeletonweed poses a threat to irrigated lands, dryland cropping areas, and rangelands. It affects the cattle industry by displacing beneficial forage plant species, and its tall, wiry stems hinder the operation of crop harvest machinery. The weed is mainly found in the Pacific Northwest, where it has spread rapidly during the past few decades. However, rush skeletonweed first invaded the eastern United States in the 1870s; it didn't appear in the western states until the 1930s. Since the weed is now rarely found in the eastern part of the country, scientists are unsure whether the western invasion originated from the eastern United States or overseas. Current biocontrol agents – a gall midge, a gall mite, and a rust fungus – do not appear to be effectively controlling the plant's population, in part because not all agents are effective against all genotypes of the weed. Seeing this predicament, the researchers began studying the weed's genealogy in hopes of finding a solution. It was determined that only seven North American genotypes exist, five of which reside in the Pacific Northwest. The group has also found that invasions in Australia and Argentina each contain distinct genotypes. They will be matching invasive genotypes worldwide against those found in the weed's native Eurasian range.

   ***Impact*:** This will help with selecting and testing new biocontrol agents and determining where to implement them.

4. *Morphological Comparison of Morningglory.* Morningglories are a group of troublesome weeds comprised of several species, mostly in the genera Ipomoea and Jacquemontia. Species of morningglories respond differentially to different control methods. ARS scientists at Stoneville, Mississippi, evaluated the morphological characteristics of 76 populations of morningglories collected from eight southern states and identified the most dependable traits to use in separating these species.

   ***Impact*:** The results are being used to determine if specific morphological traits account for differences in herbicide efficacy.

5. *New methods improve the handling of insect pathogenic fungi.* When dried microorganisms are immersed in water, rapid uptake of water can cause lethal damage to cell membranes; this injury is referred to as imbibitional damage. Such damage can ruin the effectiveness of fungi used for biological control of

insect pests. ARS researchers in Ithaca, New York, investigated the effects of moisture content and water temperature on two key fungi, *Metarhizium* and *Beauveria*. In general, the drier the spores and the colder the water, the greater the imbibitional damage. Dry *Metarhizium* spores were highly susceptible to damage, losing significant viability after immersion in water at room temperature, whereas dry *Beauveria* spores were highly resistant to damage, losing substantial viability only after mixing in ice-cold water. Damage was largely preventable in all cases by using warm water for mixing or by hydrating the spores' conidia slowly in a humid environment prior to mixing.

> ***Impact*:** This study underscores an urgent need for microbial control producers to develop user-friendly protocols for safe rehydration of biological control fungi and to include this information on biopesticide labels.

6. *New methodology for host range determination of biological control agents.* Determining host range of classical biological control agents has been a cumbersome process, often involving tests of 50 or more non-target species under conditions that make it difficult to predict results in the field. ARS scientists in Frederick, Maryland, recently developed a procedure to generate best predictors based on disease reactions and host DNA sequences, to determine the probable field host-range of two plant pathogens proposed for classical biological control of Russian thistle. This methodology can be adapted to predict the host range of other classes of weed biological control agents.

> ***Impact*:** The potential impact can be a more accurate and safer evaluation of agent host range with fewer non-target effects once the organism is released in the field.

Indicator 4:

During 2009, 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 2009 Accomplishments:

1. *Factors influencing mummy berry disease severity.* Modeling studies of mummy berry disease of blueberry demonstrated that temperature and the amount and frequency of precipitation in January-March were predictive factors of springtime disease severity.

> ***Impact*:** This research by ARS scientists in Chatsworth, New Jersey, aids in understanding the parameters that affect disease and may contribute to an understanding of ways to reduce infection.

2. *Host status of transgenic plum lines to ring nematode.* The ring nematode, *Mesocriconema xenoplax*, is associated with making peaches more susceptible to peach tree short life (PTSL) tree death. The use of genetic engineering to increase disease resistance in agricultural crops is becoming acceptable and developing into a complementary technique to traditional disease management

methods. Evaluating genetically transformed plum rootstocks for resistance to the ring nematode is important in determining the potential use of these rootstocks as a management tool for the peach industry in the southeastern United States. ARS scientists in Byron, Georgia, found that all three plum lines supported ring nematode reproduction, but one line suppressed nematode populations more than the other two lines.

> ***Impact*:** These data provide useful insights into the potential utilization of a genetically transformed plum rootstock to manage ring nematode in peach in the southeastern United States.

3. *New cotton germplasm has high yield, quality, and root-knot nematode resistance.* Root-knot nematodes cause more damage to the U.S. cotton crop than any other pathogen, and host plant resistance is the most consistently effective means of minimizing the losses. Germplasm with a high level of resistance to root-knot nematodes has been available to cotton breeders for more than 30 years, but the yield and fiber quality of those lines is much less than that of contemporary germplasm. After 8 years of breeding and selection, ARS scientists in Tifton, Georgia, successfully created a germplasm line with a high level of resistance, but which has yield and fiber quality similar to modern cotton varieties.

   > ***Impact*:** This germplasm is an improvement over previous resistant germplasm lines and will be a valuable resource for cotton breeders in developing cultivars with resistance to root-knot nematodes.

4. *Discovery of "watermelon vine decline" resistant germplasm.* Watermelon vine decline is a new and emerging disease, caused by *Squash vein yellowing virus*, which has caused over $60 million in losses in watermelon producing regions of Florida. The disease causes complete collapse of the plant at or near harvest, resulting in unmarketable fruit. ARS scientists in Charleston, South Carolina, and Fort Pierce, Florida, tested wild watermelon plants collected from different regions of the world looking for resistance to vine decline and found several accessions moderately to highly resistant to the disease. However, none of the plants from the wild watermelon collection were completely immune to the virus.

   > ***Impact*:** This wild watermelon germplasm provides an important source of resistance for the development of commercial watermelon varieties with resistance to this economically limiting disease.

5. *New almond hybrid resistant to almond leaf scorch*. Reduced yield and tree mortality make almond leaf scorch disease a critical problem throughout California's 700,000+ almond acres. Through conventional plant breeding with a wild almond relative, a hybrid almond was developed by ARS scientists in Parlier, California, that is better than the standard susceptible almond cultivar 'Butte' at overcoming almond leaf scorch disease. The resistance, called "winter-curing," occurs during the winter months. The new hybrid produces edible almonds that are similar to 'Butte' in color and kernel shape.

   > ***Impact*:** Development of this hybrid demonstrates that a resistant almond variety can be developed through traditional breeding efforts. Almond varieties resistant to leaf scorch

disease will be an economic benefit for the California almond industry.

Indicator 5:

During 2009, ARS will support interagency collaboration for tracking successful exclusion, eradication where possible, and management of quarantine arthropods, weeds, nematodes, and pathogens.

FY 2009 Accomplishments:

1. *Nematode (Paratrichodorus renifer) resistance in blueberry*. The stubby root nematode, *Paratrichodorus renifer*, has been shown to be widespread in established blueberry plantings in the Pacific Northwest. Very little is known about the biology and pathogenicity of this nematode in blueberry. A greenhouse experiment was conducted by ARS scientists in Corvallis, Oregon, to determine the host status of different blueberry genotypes to the plant-parasitic nematode *P. renifer*. Blueberry genotypes with genetic backgrounds including *Vaccinium corymbosum* and *V. angustifolim* were excellent hosts for this nematode, but rabbit-eye blueberry (*V. ashei*) was a very poor host for *P. renifer* with fewer nematodes being recovered than were added to plants. Research is ongoing to continue to understand this potential source of resistance which exists in related blueberry (*Vaccinium sp*.) germplasm.

   ***Impact*:** Knowledge of a resistance mechanism to plant-parasitic nematodes can lead to the development of nematode resistant blueberry varieties.

2. *The genomic sequencing is complete for the bacterial organism associated with Huanglongbing (HLB) disease.* Huanglongbing (HLB), also known as citrus greening, is the most devastating citrus disease for which there is currently no viable means of control. HLB is now widespread in Florida and is an impending threat to the citrus industries in California and Texas. ARS scientists in Fort Pierce, Florida, finished the full genome sequence of *Candidatus Liberibacter asiaticus*, the bacterial organism consistently associated with HLB. Prior to this effort, only limited (less than 50 kb) sequences from three genetic loci were available in Genbank. Annotation of the 1.23Mb genome revealed 1,186 open reading frames, of which 81 percent had a known functional assignment. All sequences have been submitted to GenBank and shared with ARS, university, and other researchers.

   ***Impact*:** Knowledge of the full genome is an important scientific advance and will greatly facilitate HLB research and development of new strategies for control of this devastating pathogen.

3. *Characterizing Ug99 wheat stem rust strains and alternate hosts.* A virulent new wheat stem rust strain, called Ug99, has appeared in Eastern Africa, and more than 80 percent of the world's wheat acreage is vulnerable. ARS researchers in St. Paul, Minnesota, determined that a barberry species, widely distributed in the highlands of Kenya where wheat is grown, was susceptible to wheat stem rust. These results indicate that the barberry is an alternate host for the African Ug99 stem rust and can serve as a source of new rust variants found recently in the

East African region. Researchers in St. Paul also screened thousands of seedlings for U.S. wheat and barley breeders to accelerate breeding of Ug99 resistant varieties.

> ***Impact*:** This new information will advance strategies to control the spread of virulent new wheat stem rust strains and accelerate efforts to develop resistant wheat varieties.

4. *New Fusarium head blight (scab) varieties and management tools developed.* Scab has caused over $1 billion in losses to wheat and barley producers and to the industry in the United States. The U.S. Wheat and Barley Scab Initiative, managed by ARS, is combating scab through the development of resistant wheat varieties and new management tools for producers. New, partially-resistant wheat varieties from university and ARS breeding programs in North Dakota, Minnesota, Michigan, Illinois, Indiana, Kentucky, Virginia, North Carolina, Missouri, Kansas, and other states were developed in 2008 and 2009. Growers are using the resistant varieties, especially in scab prone regions. In North Dakota in 2009, growers planted over 57 percent of the hard red spring wheat acreage in resistant varieties. A new management Web site called "Scab Smart" was activated by the Initiative that provides information on scab forecasting, fungicides, and crop rotation.

   > ***Impact*:** The benefits of the Scab Initiative research were realized in 2009 with only moderate scab losses reported in a year with weather conditions in the United States that were conducive to major scab losses in previous years.

5. *Resistance of soybean germplasm to Asian soybean rust confirmed.* To identify potential sources of resistance to this important rust disease of soybean, ARS personnel from Urbana, Illinois, and Fort Detrick, Maryland, collaborated to screen 16,595 accessions from the USDA Soybean Germplasm Collection. The evaluation data indicated that many of the breeding lines are resistant in either the western locations (Louisiana) or the eastern locations (such as Georgia and Florida), but few are highly resistant in both regions. Soybean breeders are using this information to decide which lines to cross and with which existing breeding populations they should continue to work.

   > ***Impact*:** Development of cultivars with broad and durable resistance to soybean rust in North America, therefore, will require combinations of genes from different sources and will provide sufficient resistance to reduce or eliminate the need for fungicide applications. These lines will be bred further for desirable agronomic traits and high yield.

Measure 4.2.5 Summary of the Major Technologies Developed, Transferred, and Used in FY 2009:

During FY 2009, 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.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Packing house and field experiments between Fort Pierce and Winter Haven, FL ARS scientists lead to new national regulations and expansion of markets for citrus fruit. Studies on the survival of citrus canker bacteria and on fruit as a pathway for bacterial spread and establishment in new areas showed the bacteria were found to decrease rapidly on fruit surfaces and in bacterial lesions on the fruit that are passed through the packinghouse, and were not found to be a significant pathway for establishment of the disease in new areas.	USDA-APHIS reviewed the results from this 2-year study, and amended their national regulations for shipment of citrus fruit out of canker infected areas to non-citrus producing states.	Citrus growers, shippers, and processors in the United States and international markets	This will benefit the national and international citrus market by allowing safe shipment of citrus fruit and open markets to new areas.
ARS scientists in Corvallis, OR developed a diagnostic test, based on PCR, for use in identifying a new Reovirus, Raspberry latent virus, in raspberry that has been associated with crumbly fruit disease in mixed infections with Raspberry bushy dwarf virus and Raspberry leaf mottle virus. The test will facilitate study the role of each virus in the crumbly fruit disease syndrome.	The diagnostic tests have been made available to laboratories carrying out virus clean-up programs to ensure the plants produced are free of these viruses, and to laboratories responsible for quarantine and certification to improve their programs.	State and U.S. national clean plant propagation programs for growers.	This will improve the quality of germplasm that is provided to growers due to the fact that additional viruses will be detected and eliminated from budwood before distribution.
ARS scientists in Charleston, SC developed an effective treatment system for Pepino mosaic virus (PepMV), an emerging seed-borne virus, on tomato seed, an important source of initial virus inoculum to seedlings.	Information was transferred through publication in a refereed journal and directly to tomato seed companies who serve as customers and stakeholders.	Vegetable seed companies, greenhouse and field tomato producers.	This treatment will allow deliver of tomato seed free of this economically limiting virus, which is also transmitted mechanically by the routine handling of plants and fruit during production.
ARS scientists in Corvallis, Oregon, developed a granule formulation of the insect killing fungus, *Metarhizium anisoplaie*, for control of the Black vine weevil, a serious pest of container-grown ornamentals that typically attacks plant roots.	These data demonstrate to the Pacific Northwest nursery industry that this product can be expected to provide at least two growing seasons of effective control when incorporated into media at potting, and is an effective tool for eliminating infestations occurring in existing container-grown plants.	Nursery industry in the Pacific Northwest	A commercially available product was available for the nursery industry in 2008, and in 2009, a CRADA was instituted with Novozyme Biologicals Inc. to develop new use strategies for soil-insects using *M. anisopliae.*

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

During FY 2010, 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.

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

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.

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.

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

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.

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

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 2009, ARS will survey, release data on, and analyze national food consumption patterns of Americans.

FY 2009 Accomplishments:

1. Version 3.0 of the What's In The Foods You Eat Search Tool was released. This provides nutrient profiles for 13,000 foods, familiar portion sizes for each food and the ability for users to adjust portion sizes. The program can be used online or downloaded to a personal computer.

   ***Impact*:** Public release of this search tool allows consumers and researchers to analyze individual foods and by some calculations, meals and daily intake for nutrient adequacy.

Indicator 2:

During 2009, ARS will develop new methods, conduct food composition analyses, and compile databases for known, emerging, and new classes of nutrients.

2. National Nutrient Database for Standard Reference Release 22 was complied and made public on the ARS Web site. It includes up to 143 components for over 7,500 foods.

   ***Impact*:** The primary product of this research is the unique, nationally representative information on nutrient content of the food supply and what Americans are eating in order to assess their food consumption in relation to dietary recommendations designed to maintain health and prevent chronic diseases.

3. The Dietary Supplement Ingredient Database, Release 1 was developed and released in collaboration with NIH's Office of Dietary Supplements. Analytical information on 18 nutrients in vitamin/mineral supplements was compiled and made available on the Internet.

   ***Impact*:** This database is aimed primarily at researchers who will now be able to estimate nutrient intake much more accurately, since up to 50% of Americans take dietary supplements, most of which are multivitamin/mineral tablets.

Measure 5.2.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2008:

During FY 2009, ARS reported 3 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.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Release 22 of the USDA National Nutrient Database for Standard Reference was compiled and released to the public.	The database is freely available and searchable on the ARS Web site. Downloadable versions are also available for use on personal computers.	This database is widely used by USDA's REE and FNS agencies and by other Federal agencies such as FDA's food labeling program. Individuals and health professionals make use of this information.	This database is widely used by researchers, health professionals, businesses that produce diet analysis software, and the public in planning and evaluating diets. In addition, it is used by USDA's REE and FNS Agencies for research, evaluating food assistance programs, and policy formulation.
Version 3.0 of the What's in the Foods You Eat Search Tool was released.	This dataset was made freely available via the Internet. It can be run on the Web or downloaded to a personal computer.	This search tool and accompanying database is aimed primarily at consumers, although it is used by researchers also.	Because this release lists foods commonly eaten in familiar portion sizes that can be adjusted by the user, it is a consumer-friendly version of our more sophisticated databases. This makes the information more accessible to the public, without the need for detailed knowledge of food components or metric measurements.
Release 1 of the Dietary	This dataset was made	This database is aimed	Since half of Americans

Supplement Ingredient Database was compiled and released on the Internet.	freely available via the Internet.	primarily at researchers who are analyzing nutrient intake of the American people.	use dietary supplements, greatly improved estimates of total nutrient intake will be possible.

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

During FY 2010, 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 2011, 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 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.

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 2009, ARS will identify dietary and lifestyle intervention strategies to prevent obesity and promote healthy food choices and eating behaviors.

FY 2009 Accomplishments:

1. Researchers at the ARS nutrition center in Houston, Texas, conducted a school-based intervention in overweight Mexican-American children, which included a high level of instructor-led intervention and parental involvement and led to sustained weight loss over a two year period. Very few studies of this type have extended past one year and most have been unsuccessful.

   ***Impact*:** This study serves as a model for delivering effective interventions for prevention and treatment of obesity in a high-risk population of minority children. Since so few interventions are successful over time, this stands out as a potential paradigm for other groups.

2. In a study of Puerto Rican adults living in Massachusetts, food insecurity was inversely associated with global cognitive performance. Scientists at the ARS nutrition center in Boston, Massachusetts, found that the prevalence of food insecurity in this group was 12 percent, with about half of the group reporting very low food security, and greater food insecurity was associated with lower scores on several tests for mental performance.

   ***Impact*:** As the number of Americans without adequate food supplies increased markedly during the recession, this research emphasizes the importance of USDA nutrition assistance programs in maintaining health.

Indicator 2:

During 2009, ARS will determine the functions, bioavailability, interactions, and requirements for known, emerging, and new classes of nutrients across the lifecycles.

FY 2009 Accomplishments:

1. Scientists from the ARS nutrition centers in Houston, Texas, and Boston, Massachusetts, proved that the second generation of Golden Rice provides enough beta-carotene that is readily converted to vitamin A to satisfy 90% of the estimated average requirement for this essential vitamin in a reasonable serving size for children.

   ***Impact*:** Widespread consumption of this rice would help eliminate vitamin A deficiency, which remains the most prevalent nutrient deficiency in the world leading to blindness and disability.

2. Infants fed formula supplemented with the omega-3 fatty acid DHA, or breast milk that naturally contains this fatty acid, had lower heart rates than those not getting this lipid. Scientists at the ARS Nutrition Center in Little Rock, Arkansas, also identified a positive

effect on heart rate variability, suggesting that DHA—regardless of its source—exerts a developmental effect on the nervous system that controls heart function.

***Impact*:** These results indicated that current infant formulas with the omega-3 fatty acid, DHA, no matter what their protein source, promote normal infant development.

3. In a study among elderly Americans given vitamin D supplements for one year, scientists at the ARS nutrition center in Boston, Massachusetts, found that increased body weight decreases absorption of vitamin D and results in lower blood levels of this essential vitamin. Since Americans are heavier on average than in the past, vitamin D requirements may have increased, in part, as a result of increased body fat.

***Impact*:** These data are important for making recommendations about how much vitamin D is needed to raise blood levels to desirable levels. The requirement for vitamin D is currently under review by the National Academy of Sciences.

Measure 5.2.2 Summary of the Major Technologies Developed, Transferred, and Used in FY 2009:

During FY 2009, ARS reported 5 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.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
School-based intervention leading to sustained weight loss in Mexican-American children.	Publication in peer-reviewed research journal.	Other researchers studying weight control in children; public health community.	This two-year study can serve as a model in high-risk groups for sustained control of excess weight gain.
Scientists at the ARS nutrition center in Boston, MA, found that the prevalence of food insecurity in this group was 12 percent, with about half of that group reporting very low food security, and greater food insecurity was associated with lower scores on several tests for mental performance.	Publication in peer-reviewed research journal.	Other researchers, public health officials, USDA nutrition assistance programs.	As the number of Americans without adequate food supplies increased markedly during the recession, this research emphasizes the importance of USDA nutrition assistance programs in maintaining health.
Scientists from the ARS nutrition centers in Houston and Boston proved that the second generation of Golden Rice provides enough beta-carotene that is readily converted to vitamin A to satisfy 90% of the estimated average requirement for this essential vitamin in a	Publication in peer-reviewed research journal.	Other researchers, public health officials, USDA nutrition assistance programs.	Widespread consumption of this rice would help eliminate vitamin A deficiency, which remains the most prevalent nutrient deficiency in the world leading to blindness and disability.

reasonable serving size for children.			
Scientists at the ARS Nutrition Center in Little Rock, AR also identified a positive effect on heart rate variability, suggesting that omega-3 fat - regardless of the formula it is in - exerts a positive effect on the nervous system that controls heart function.	Publication in peer-reviewed research journal.	Other researchers, public health officials, USDA nutrition assistance programs.	These results indicate that current infant formulas fortified with omega-3 fat, no matter what their protein source, promote normal infant development.
Scientists at the ARS nutrition center in Boston, MA, found that increased body weight decreases absorption of vitamin D and results in lower blood levels of this essential vitamin.	Publication in peer-reviewed research journal.	Other researchers, public health officials, USDA nutrition assistance programs.	Since Americans are heavier on average than in the past, vitamin D requirements may have increased, in part, as a result of increased body fat. These data are important for making recommendations about how much vitamin D is needed to raise blood levels to desirable levels.

Measure 5.2.2 Outyear Performance Plan (the future performance indicators for this Measure)

During FY 2010, 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 2011, 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 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.

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 2009, ARS will publish new findings on metabolic processes that are affected by nutrient intake.

FY 2009 Accomplishments:

1. Scientists at the ARS nutrition center in Boston, Massachusetts, reported that folate levels in the blood influence telomere length, affecting both DNA integrity and DNA methylation in white blood cells of healthy men.

   ***Impact*:** Higher folate levels combined with longer telomeres are associated with slower aging and less cancer.

Indicator 2:

During FY 2009, ARS will discover genetic or epigenetic factors that influence physiologic responses to diet or changes in gene expression in response to dietary intake.

FY 2009 Accomplishments:

1. In a phenomenon known as epigenetics, traits such as obesity can be inherited based not on changes in genes themselves but on the shape of DNA strands. In research at the ARS nutrition center in Houston, Texas, epigenetics was shown to influence the inheritance of obesity in mice, but was modifiable by high consumption of methyl donors, which include some B vitamins and some amino acids.

   ***Impact*:** If these studies in laboratory animals are confirmed in humans, simple dietary changes could prevent an inherited tendency toward obesity.

2. Scientists at the ARS nutrition center in Boston, Massachusetts, found that normal variations in genes that code for chemical messengers made by white blood cells determine the effect of vitamin E on individual immune responses in the elderly. Study participants with polymorphisms in the A allele of tumor necrosis factor-alpha (TNF) who were treated with vitamin E had lower TNF production.

   ***Impact*:** These results indicate only some people will show an anti-inflammatory response from vitamin E supplementation. These findings help to explain the broad range of responses to some nutrients and lay the foundation for individualized nutrition.

3. Scientists at the ARS nutrition center in Boston, Massachusetts, found that normal variations in genes, known as polymorphisms, that determine incorporation of uracil into DNA, but not folate and other one-carbon nutrients, are associated with altered DNA uracil concentration.

   ***Impact*:** Elevated uracil misincorporation may induce mutagenic lesions, possibly leading to cancer. Four gene polymorphisms were identified that may influence cancer risk.

Measure 5.2.3 Summary of the Major Technologies Developed, Transferred, and Used in FY 2009:

During FY 2009, 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.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Scientists at the ARS nutrition center in Boston, MA, reported that folate levels in the blood influence telomere length, affecting both DNA integrity and DNA methylation in white blood cells of healthy men.	Publication in peer-reviewed research journal.	Scientific researchers	Higher folate levels combined with longer telomeres are associated with slower aging and less cancer.
In a phenomenon known as epigenetics, traits such as obesity can be inherited based not on changes in genes themselves but on the shape of DNA strands. In research at the ARS nutrition center in Houston, TX, epigenetics was shown to influence the inheritance of obesity in mice, but was modifiable by high consumption of methyl donors, which include some B vitamins and some amino acids.	Publication in peer-reviewed research journal.	Scientific researchers	If these studies in laboratory animals are confirmed in humans, simple dietary changes could prevent an inherited tendency toward obesity.
Normal variations in genes,	Publication in peer-	Scientific researchers	These results indicate only

called polymorphisms, that code for chemical messengers made by white blood cells determine the effect of vitamin E on individual immune responses in the elderly. Study participants with polymorphisms in the A allele of tumor necrosis factor-alpha (TNF) who were treated with vitamin E had lower TNF production.	reviewed research journal.		some people will show an anti-inflammatory response from vitamin E supplementation. These findings help to explain the broad range of responses to some nutrients and lay the foundation for individualized nutrition.
Normal variations in genes that determine incorporation of uracil into DNA, but not folate and other one-carbon nutrients, are associated with altered DNA uracil concentration.	Publication in peer-reviewed research journal.	Scientific researchers	Elevated uracil misincorporation may induce mutagenic lesions, possibly leading to cancer. Four gene polymorphisms in DNA repair genes were identified that may influence cancer risk.

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

During FY 2010, 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 2011, 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 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.

Objective 5.3: Improve Nutrition Assistance Program Management and Customer Service

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 2009, ARS will develop guidelines for irrigating in urban and agricultural settings with degraded waters.

FY 2009 Accomplishments:

1. Deficit irrigation is a management method to conserve water and energy by supplying only the amount of water necessary to meet crop demands. ARS scientists at Parlier, CA measured canopy temperature as an indicator of drought stress in a peach orchard, using thermal infrared sensors. Results showed that average maximum canopy temperature was significantly higher for treatments that received deficit drip and furrow irrigation than those receiving full irrigation.

   ***Impact*:** Deficit irrigation saved over 50% of the water used with no significant impact on peach yield or quality. The study clearly demonstrated that infrared canopy sensors can be used as an onsite guide for managing deficit irrigation in orchard crops and has application for using poorer quality waters as well.

Indicator 2:

During FY 2009, 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 2009 Accomplishments:

1. Field research conducted over several years has demonstrated that conventional depth subsurface drainpipe systems equipped with an outlet structure to control discharge are as effective as shallow installed drainpipe systems in reducing nitrate loss in the outflow.

   Impact: Retrofitting deeper drains with an outlet pipe structure to control drainage flow could significantly reduce nitrate losses from croplands that discharge into the Mississippi River Basin, reducing the contribution of agricultural drainage to the development of the hypoxic zone in the Gulf of Mexico. Many new and retrofitted drainage systems have already been implemented for controlled drainage in the Midwest.

2. ARS scientists at Ames, IA demonstrated the ability of wood chips to remove nitrate from water at flow rates representative of waters entering subsurface drainage tiles in the field. Complete nitrate removal occurred at the lowest flow rate and 30% was removed at

the highest flow rate. Microbial conversion of nitrate to inert molecular nitrogen gas (i.e., denitrification) was the dominant nitrate removal mechanism; amounts of nitrous oxide, an important greenhouse gas produced during denitrification, were not environmentally significant.

Impact: This knowledge can improve the design of wood chip bioreactors to reduce nitrate exports from subsurface agricultural drainage systems, with significant implications for reducing agriculturally-derived nitrate exports from tile-drained agricultural watersheds.

Indicator 3:

During FY 2009, ARS will develop predictive equations, procedures, and databases that will allow improved estimation of concentrated flow erosion on agricultural fields and construction sites.

FY 2009 Accomplishments*:*

1. Through the 2002 Farm Bill, USDA has been tasked with assessing the effectiveness of federally funded conservation programs through the Conservation Effects Assessment Project (CEAP). ARS scientists at Tifton, GA used the Soil Water Assessment Tool (SWAT) model to simulate the water quality benefits of upland conservation practices (CPs). Erosion or nutrient control practices commonly adopted in the Little River Experimental Watershed (LREW), GA were compared with the simulated impact of riparian forest buffers currently in place in the LREW. Three different priority placement scenarios for implementing CPs were evaluated -- random placement, stream order, and nonpoint source pollutant load. Prioritizing based upon nonpoint source pollutant load yielded more efficient water quality improvements than other implementation schemes. Erosion CPs resulted in the greatest reductions in sediment and phosphorus while nutrient reduction practices were most effective in reducing total stream nitrogen.

   ***Impact*:** This study demonstrates that riparian forest buffers offer the most comprehensive reduction of all three pollutants (nitrate, phosphorus and sediment). Simulation results indicate that the current level of riparian forest cover in the LREW may be the single greatest contributor to nonpoint source pollutant reduction in this watershed.

2. Models that predict the benefits of conservation practices, erosion, and crop growth are dependent on soil physical properties that are time consuming and expensive to measure. Acoustic properties of soils have been found to be indicative of soil physical properties. In collaboration with the National Center of Physical Acoustics, ARS scientists at Oxford, MS have demonstrated a rapid, multi-channel analysis of surface wave method that uses laser Doppler vibrometry as a non-contact sensor to obtain the sound speed profile in soil up to 10 feet below the surface. Temporal variations of the soil profile due to changes in moisture content have been evaluated non-invasively. Sealing/crusting of the surface layer of the soil (less than 2 inches below surface) was detected based on higher sound speeds than those of lower-layer soils.

   Impact: This method has the potential to measure soil properties at different depths, depending upon the wave length employed, in a rapidly deployable, easily moveable, non-contact manner without disturbing the soil.

Measure 6.1.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2009:

During FY 2009, ARS reported 2 agricultural practices and technologies developed and used by customers to enhance water quality and availability.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Floating wave barrier design.	Direct transfer	Lonoke AR Irrigation District.	Full-scale model built and tested for future transfer to user groups and public.
Flash flood forecasting system based on the rainfall-runoff model, KINEROS2.	System installed at two Weather Forecast Offices in Binghamton, NY and Tucson AZ	National Weather Service and general public.	Provides forecasters with an additional tool to assess the potential for flash flooding and estimating timing of flood events.
ArcGIS version (2.0) of the Watershed Assessment Tool (AGWA) that can compute runoff and erosion at different spatial and temporal scales.	Formally announced at a National Meeting and provided on ARS website.	Environmental engineers and scientists in 110 countries have registered and downloaded this product.	Accepted tool within the environmental protection community and adapted by EPA, NASA and used by consultants.
WinSRFR 3.1 is an integrated application for simulation, analysis, and evaluation of irrigation system design, and operation.	Released to NRCS and the general public through the internet.	Irrigation specialists, university extension, consultants, farmers, and scientists with moderate to advanced knowledge of surface irrigation hydraulics	Software helps users to analyze a broad range of surface irrigations systems in order to design and develop operational recommendations.
The Agricultural Land Management Alternatives with Numerical Assessment Criteria (ALMANAC) model.	Training sessions at Temple TX	Researchers in Mississippi, Tennessee, Illinois, and Nevada.	Model used to assess feasibility and impact of switchgrass production systems in a range of soils and environments.
The CONservational Channel Evolution and Pollutant Transport System (CONCEPTS) model is used to evaluate the long-term impact of rehabilitation measures to stabilize stream systems and reduce sediment yield.	Direct release to universities in Minnesota, Tennessee, Colorado and consulting firm in California.	University science and engineering departments and natural resource industry professionals.	Models has been used toquantify sediment loads to Lake Superior, Minnesota River, Canyon Chelly National Park, AZ, and used to evaluate upstream and downstream impacts of dam removal.
Data Access Project Portal (DAP) provides 50 years of high resolution data on precipitations, runoff, sediment, weather, soil moisture, vegetation, and carbon and energy fluxes.	User friendly interface provided to download date from Walnut Gulch Experimental Watershed in Southwest AZ.	Federal, state and local agencies, researchers from university and international institutions.	Data used to set design standards for flood and transport infrastructure, erosion estimates, design storm characteristics, and watershed processes.

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

During FY 2010, ARS will

develop guidelines for water reuse in agricultural systems, including developing criteria for the application of waste water, developing water 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 concentrated flow erosion on agricultural fields and construction sites.

During FY 2011, ARS will

develop guidelines for water reuse in agricultural systems, including developing criteria for the application of waste water, developing water 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 concentrated flow erosion on agricultural fields and construction sites.

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.

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 2009, 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 2009 Accomplishments*:*

1. ARS researchers found that the increase in soybean pod numbers at elevated carbon dioxide was a good predictor of varieties with high yield at high carbon dioxide concentrations.

   ***Impact*:** *Pod production will be used as an indicator to develop soybean varieties that will result in higher yields under increased atmospheric carbon dioxide concentrations.*

Indicator 2:

During FY 2009, 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 2009 Accomplishments*:*

1. ARS researchers developed a simple tool for estimating greenhouse gas emissions and the carbon footprint of dairy farming systems.

   Impact: Producers, consultants of producers, educators, government agencies and others will be able to rapidly evaluate greenhouse gas emissions from dairy farms and the effectiveness of management strategies used to reduce these emissions.

Indicator 3:

During FY 2009, ARS will develop practices which remediate degraded soils.

FY 2009 Accomplishments*:*

1. ARS scientists have shown that common grasses, such as tall fescue, can be used to remove the explosive TNT from contaminated sites.

   ***Impact*:** Contaminated sites can be cleaned up less expensively than traditional methods using multiple harvests of this common agricultural crop.

Indicator 4:

During FY 2009, ARS will develop methods to reduce emissions of harmful gases from crop and animal production systems.

FY 2009 Accomplishments*:*

1. ARS scientists determined that within-crop field areas of higher soil moisture generate considerably higher pesticide volatilization losses than dryer areas and that this is why current physically-based models of pesticide volatilization fail to accurately estimate or predict such losses.

   Impact: Models of pesticide volatilization will be improved and provide a practical basis for decision support systems that will help reduce pesticide losses from agricultural fields, thus improving environmental quality and improving profitability of farming from more efficient use of pesticides.

Indicator 5:

During FY 2009, ARS will develop practices and approaches which mitigate the detrimental effects of tropospheric ozone on agricultural crops.

FY 2009 Accomplishments:

1. Results from greenhouse screening of soybean ancestors for ozone-induced foliar injury were combined with pedigree analysis techniques to predict the ozone resistance of 247 publically-released soybean cultivars. Predicted injury scores suggested that cultivars from the Midwest may be more sensitive to ozone-induced foliar injury than Southern cultivars.

   ***Impact*:** Soybean ancestors with the greatest ozone resistance are not major contributors to current US cultivars and thus represent sources for ozone tolerance genes for integration into new cultivars to reduce yield losses due to ozone damage.

Indicator 6:

During FY 2009, ARS will develop management practices and decision tools to improve soil quality and protect the environment.

FY 2009 Accomplishments:

1. ARS scientists have shown that incorporating cover crops into crop rotations improves traffic ability, increases in-season nitrogen availability, and decreases pressures from crop pests.

   ***Impact*:** The demonstrated benefits provide producers information on the yield and soil quality benefits of returning to the once common practice of growing and incorporating cover crops.

Indicator 7:

During FY 2009, 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 2009 Accomplishments:

1. ARS scientists developed and demonstrated a second generation water treatment system for confined animal production facilities, that when combined with use of a first

generation system developed by ARS results in a 90% reduction of odors as compared to the raw, flushed manure from hog operations.

Impact: Use of the ARS treatment system increases the efficiency of waste water treatment from hog operations and enables hog producers in NC to increase the number of animals in their operations without purchasing more land. The State of NC has officially approved and promoted use of the system.

2. ARS scientists demonstrated that no-till systems reduce nitrous oxide emissions in irrigated cropping systems when compared to conventional-till continuous corn systems.

Impact: This work provides a basis for developing crop management practices to reduce nitrous oxide emissions in irrigated cropping systems in the western US.

Indicator 8:

During FY 2009, 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 2009 Accomplishments:

1. ARS scientists in Columbia, MO demonstrated reductions to corn nitrogen applications with the use of a crop reflectance sensor that better matches the amount of nitrogen being applied with crop need.

***Impact*:** This precision nitrogen application technology reduces loss of excess nitrogen to lakes and streams via runoff, and improves profitability for the producer as yields are maintained with less nitrogen.

Indicator 9:

During FY 2009, 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 2009 Accomplishments:

1. A new Nitrogen Index was developed based on nitrogen balances, annual inputs, soil N dynamics, and yields.

***Impact*:** The index produces qualitative nitrogen loss rankings allowing users to make informed decisions on N management, thus leading to fewer losses of N to waterways, and loss of N as N2O greenhouse gas.

Indicator 10:

During FY 2009, ARS will develop instrumentation and models to measure and predict emission and dispersion of particulate matter and gases from animal production operations.

FY 2009 Accomplishments:

1. ARS and Texas Agrilife Research scientists delivered a state-of-the-science of report on ammonia emissions from cattle feedyards to the National Cattlemen's Beef Association and the Texas Cattle Feeders Association.

   ***Impact*:** The report was used by the National Cattlemen's Beef Association (NCBA) to develop a worksheet used to estimate feedlot ammonia emissions that could be used to meet Emergency Planning and Community Right to Know Act (EPCRA) reporting requirements. The worksheet was delivered online, in newsletters and through an online webinar to NCBA affiliates, which reached about 85% of the cattle feeding industry and allowed the cattle industry to meet the regulatory reporting requirements, despite a very short deadline.

Measure 6.2.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2009:

During FY 2009, 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.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
A new Nitrogen Index	Literature	USDA NRCS; IVIA Spain; Univ. of Puerto Rico	The index produces qualitative nitrogen loss rankings allowing users to make informed decisions on N management
Second generation wastewater treatment system for CAFO facilities	Licensed to private industry	Private industry	Will allow improved management of pathogens, nutrients, emissions from CAFOs.
Risk Assessment from Spent Foundry Sands	Procedure developed and transferred to US EPA. Documented in publication to be released by EPA	US EPA	Risk assessment technique shows there are many acceptable uses for spent foundry sands. Additionally, the procedure will be used as the basis for future risk assessments by the EPA.
Computer code to perform a weighted average of wind data from WINDGEN	Computer code update to WEPS	NRCS	Expands US land area, including the intermountain west, where wind data is

stations for the Wind Erosion Prediction System (WEPS).		lacking so that WEPS can be use to help manage soil for reduced wind erosion.

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

During FY 2010, *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 systems.

deliver 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 animal production operations.

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.

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 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.

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
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 2009, 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 2009 Accomplishments:

1. Western wheatgrass is an important native grass in many rangeland ecosystems, but its low rate of seed production and poor seedling vigor limit its use when quick establishment is needed to stabilize and restore degraded rangelands. ARS scientists at Logan, UT worked with the U.S. Army Corps of Engineers and the NRCS to develop and jointly release "Recovery," a superior and more easily established western wheatgrass. Developed and tested over 10 years, Recovery was designed for reseeding rangelands following severe disturbance, frequent wildfires, and soil erosion.

   ***Impact*:** With a 20% increase in the rate of successful establishment, Recovery allows land managers to use a native grass species to help limit weed infestation and soil erosion in systems where reestablishment of wheatgrass is inhibited by frequent disturbances. Recovery is being recommended by the NRCS and the U.S. Army Corps of Engineers for reseeding private, public, and military training lands throughout the northern Great Plains and Intermountain West.

2. In collaboration with Texas AgriLife Research and the Louisiana State University AgCenter, ARS scientists at College Station, TX developed a new dallisgrass cultivar

called "Sabine" that produces significantly more forage than common dallisgrass while being more tolerant of heavy grazing pressure, and maintaining good nutritional value into the late summer.

Impact: Cattle producers have long needed a more productive forage grass adapted to the hot, humid climate of the southeastern U.S. and Sabine will help meet that need and increase livestock production efficiency. In the short time since Sabine was released, many forage researchers and producers have requested seed and one commercial seed company is now distributing it.

Indicator 2:

During FY 2009, ARS will provide forage and pasture management technologies and strategies that reduce inputs while improving livestock performance and sustaining the environment.

FY 2009 Accomplishments*:*

1. Gastrointestinal parasites are a major health challenge in sheep and goat production in the Southeast. Widespread resistance of gastrointestinal worms to chemical dewormers, plus the desire to control these parasites without risk of chemical residue, has led to the need for alternative parasite management strategies. Rotational grazing of pastures as a means to control internal parasites has been suggested by the U.S. National Organic Program, but has never been examined without the use of chemical dewormers. Working with Louisiana State University and Fort Valley State University, ARS scientists at Booneville, Arkansas determined that rotational grazing of lambs on bermudagrass led a need for fewer deworming treatments. Along with scientists at Auburn University, they also determined that diets containing 50 to 75% of dried sericea lespedeza can reduce worm problems in small ruminants while providing essential nutrients for the animals.

   ***Impact*:** Using lespedeza and rotational grazing as part of an integrated parasite control system gives limited resource farmers and others options to increase economic viability for both conventional and organic sheep and goat production by improving animal health while reducing chemical inputs and concerns over chemical residues.

2. Protein degradation in stored silage is a major economic loss for livestock producers because it forces producers to add more protein supplements to the feed. ARS scientists at Madison, WI made a series of discoveries that will help reduce protein degradation. First, they found that ensiling red clover, a plant that produce a compound called polyphenol oxidase (PPO), resulted in much lower protein loss than other common forages. On further investigation, the scientists found that the presence of PPO was not enough since many other forage plants have PPO but still suffer high levels of protein degradation. They found red clover also had another class of compounds called o-diphenols that must be present with PPO to reduce protein loss during ensiling. The next step was to find ways to overcome the o-diphenol deficiency and they found this could be done by adding chlorogenic acid (an o-diphenol found in many common plants including coffee, dried plums, and the forage tall fescue) during the ensiling process.

   Impact: By inhibiting protein degradation during ensiling process, livestock producers can increase profits because they can use much less much protein supplement. Reducing degradation can be done by either

adding chlorogenic acid extracts during the ensiling process to forages with PPO, or by co-ensiling two forages that complement each other (one with PPO and the other with chlorogenic acid). These management practices will also reduce the amount of nitrogen compounds lost into environment either in the water or air.

3. Switchgrass has high potential as a bioenergy feedstock but producers are reluctant to grow this difficult-to-establish perennial grass because of the current lack of markets for bioenergy feedstocks. Growing switchgrass as animal feed could help expand switchgrass production until conversion facilities come on line, but many animal owners are concerned about saponins, a class of toxic compounds found in switchgrass. Saponins cause liver damage in sheep and horses and increase sensitive to sunlight to the point it can be damaging. Identifying the presence of saponins in switchgrass is easy, but quantifying how much is present is difficult. ARS scientists at Lincoln, NE and Logan, UT developed a method to quantify saponins in switchgrass at different maturity stages and under different management conditions.

   Impact: With improved testing, sheep and horse owners can feed switchgrass knowing they can avoid toxicity problems. This creates a new market for switchgrass that will allow more producers to plant more land in switchgrass and gain experience in its production. This will help ensure there are adequate supplies of switchgrass feedstock available when suitable bioenergy conversion plants are built.

Indicator 3:

During FY 2009, 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 2009 Accomplishments*:*

1. Increased use of prescribed burning on the shortgrass steppes of the Great Plains has been proposed to increase a variety of ecosystem services. Livestock producers are concerns about the impact the burning on forage production. ARS scientists at Cheyenne, WY, and Fort Collins, CO, studied effects of prescribed burns conducted during late winter on forage production, forage nitrogen content, and plant species composition northeastern Colorado. They found that burns conducted under a wide range of precipitation conditions during 1997–2001 did not negatively affect forage production in either the first or the second postburn growing season. Burning followed by a severe drought in 2002 did reduce production by 19% in the second postburn growing season.

   Impact: Except following severe drought, prescribed burns can be conducted in late winter to enhance wildlife habitat, control unpalatable plant species, and restore historic ecological patterns while having a neutral or positive impact on livestock production.

2. To improve human and animal safety, a practical quantitative method was needed for measuring toxic compounds in rayless goldenrod and white snakeroot. White snakeroot (Ageratina altissima) and rayless goldenrod (Isocoma pluriflora) can cause “trembles” in

livestock and "milk sickness" in humans. (Abraham *Lincoln*'s mother died during an epidemic of *milk sickness* caused by drinking *milk* from cows feeding on these poisonous plants.) Managing this problem has been difficult because injuries from plant toxicity have historically been both sporadic and unpredictable. ARS scientists at Logan, UT have developed a quantitative method for measuring benzofuran ketones, the toxic components in these plants. They found that toxicity varied considerably among the different white snakeroot and rayless goldenrod plant collections.

Impact: This new quantitative method will be used to measure toxicity of plants growing in different locations and environmental conditions to assess risks to livestock and to humans consuming milk from pastures containing these plants. This will be particularly important to small, pasture-based dairy farmers serving expanding niche markets for fresh, locally produced milk products.

3. Management practices are needed to reduce wildfires that are increasing in frequency and severity in the western U.S. ARS scientists from Burns, Oregon completed a study comparing burning treatments on sagebrush rangeland that has not been grazed since 1937 with land that had been grazed. Both areas were burned with prescribed fire in 1993. Vegetation measurements were taken 12, 13, and 17 years after the fire. Long-term grazing exclusion resulted in fuel build-up and hotter fires that damaged native grasses which in turn allowed weedy annual plants to invade. The reduction in native grasses and increase in weeds reduced forage availability for both livestock and wildlife while increasing the risk of fire.

Impact: These results provide public and private land managers with science-based rational for simultaneously managing sagebrush rangeland for livestock production, fire reduction, and maintenance of biodiversity through better control of invasive weeds and reducing the risk of wildfires.

Measure 6.3.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2008:

During FY 2009, ARS reported 4 new technologies or strategies provided to managers of pasture, forage and range lands to improve conservation, restore natural resources, and increase profitability.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
A superior seed producer and more easily established western wheatgrass called "Recovery"	Joint public release of germplasm by ARS, U.S. Army Corps of Engineers and the USDA/NRCS	Private and public land managers charged with restoring degraded rangelands, and seed companies	Availability of a native grass for more rapid and cost effective stabilization of degraded rangeland to reduce erosion and improved wildlife habitat
A more grazing tolerant dallisgrass called "Sabine" that has improved nutritional value in late summer	Joint public release of germplasm by ARS, Texas AgriLife Research and the Louisiana State University AgCenter	Livestock producers in the southeastern US, and seed companies	Increased profitability because of better livestock nutrition and reduced need to reseed pastures
Combining diets containing 50 to 75% of dried sericea	Joint tech transfer program by ARS, Louisiana State	Sheep and goat producers and hay growers in the	Improved profitability through reduced use of

lespedeza with rotational grazing can reduce worm problems in small ruminants	University, Fort Valley State University, Auburn University	southeastern U.S.	chemical dewormers that are increasingly ineffective, and new options for organic producers.
A quantitative method for measuring toxic compounds in rayless goldenrod and white snakeroot.	Presentations and trade publications targeting veterinarians and livestock producers	Veterinarians, livestock producers and food-safety regulators dealing with "trembles" in livestock and "milk sickness" in humans	Improved animal health and food safety resulting in greater profitability for pasture-based milk producers serving niche markets

Measure 6.3.1 Outyear Performance Plan (the future performance indicators for this Measure)

During FY 2010, 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 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.

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 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.

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 2009 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.

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."

In FY 2009, the National Agricultural Library (NAL) accomplished core mission objectives and planned for future service improvements in digital content and technologies. Fiscal challenges presented a rationale for NAL and ARS management to consider programmatic actions in FY 2009 and beyond needed to allow NAL to continue to fulfill its mandated mission. In 2008 NAL issued a discussion paper - http://www.nal.usda.gov/about/reports/nal_report_web_041808.pdf - presenting options for satisfying recommendations of recent studies about NAL. NAL continues to explore and implement initiatives to improve and integrate operations and services through cost efficiencies and the application of digital technologies.

Indicator 1:

During FY 2009, NAL will continue to expand and improve services based on customer usage and satisfaction data.

FY 2009 Accomplishments:

1. 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. In 2009 NAL leadership and senior staff completed a planning process for becoming “Digital NAL.” Because NAL’s resources are limited, its customer needs and expectations are broad, and the digital information landscape is constantly changing, hard work was done to identify practical steps to advance the development of “Digital NAL.” The most important priority identified is the completion of the AGRICOLA online catalog of NAL holdings. Without a complete online record, there is no way to identify the full extent of NAL collections, and NAL cannot compare its holdings with those of other institutions, to identify the unique and rare items at NAL which should be digitized first, and to identify which items at NAL are being digitized elsewhere. NAL undertook three assessments of the work and costs required to complete the AGRICOLA online catalog. Results will be available by early 2010. The second priority for NAL in moving towards “Digital NAL” is to complete, in 2010, an assessment by an expert marketing company of NAL’s services and digital presence, with recommendations for actions that will improve knowledge of NAL and NAL digital services. The third priority is to evaluate options for mass digitization, beginning in 2010.

   ***Impact*:** NAL continued to improve services to its broad and large customer base, with an emphasis on digital information products and services.

2. Delivering Information and Research Services. NAL offers customers free access to agricultural information, primarily through its core site, www.nal.usda.gov. The NAL Web site provides federated searching across its suite of specialized Information Center sites and special NAL databases, including AGRICOLA (NAL’s online catalog and index to

journal articles), from a single search box and enables customers to quickly and easily navigate to their subject area of interest. NAL's FY2009 total volume of direct customer transactions exceeded 93 million transactions, a 3 per cent increase over FY2008, and NAL Web services continued to be ranked first, or on the first page, by major Web search engines. Services delivered digitally continued to grow while services based entirely on physical materials continued to decline. Highlights include: *Digitop*: USDA staff executed 1,248,182 full text downloads from DigiTop, 16% more than in FY2008. *Expanded Web 2.0 services*: NAL continued to be an "early adopter" of new technologies within ARS and USDA; InfoFarm, NAL's first and acclaimed blog, was two years old at the end of FY2009; InfoFarm was joined by seven other blogs, an NAL YouTube channel (part of the USDA YouTube channel), mashups, Facebook content, RSS feeds, placement of content/collection links in Wikipedia, Twitter-based services, and other Web 2.0 and social networking innovations. *Citation Analysis Services*: NAL staff provided bibliometric services to the ARS National Program staff and the REEO roadmap effort to help benchmark USDA science output and outcomes. NAL presented data regarding the extent (numbers of publications and numbers of citations), reach (breadth of disciplines citing), and use (what science is being cited and where) of articles published by USDA authors (primarily intramural). *Document Delivery*: About 40,000 document delivery requests were received in FY2009. ARS and USDA requests increased 7 per cent over 2008, at around 15,000 USDA requests, with ~2,800 of those from ARS. APHIS, FS, and ARS remain the agencies with the highest document delivery use. Non-USDA document delivery requests numbered 20,000 requests, a 12 per cent decline from the previous year. The decline can be attributed, in part, to NAL working with libraries and other service providers to be the source of last resort for document delivery/interlibrary loan requests and thus reduce operational costs. Onsite requests held steady at 7,000. *Individual Reference Requests*: 5,505 reference requests were received; 812 from within USDA and 4,693 from outside USDA. 3,820 requests were received digitally, 55 per cent of the total. *Publications Distributed*: 351,936 copies of NAL-produced publications were distributed. *Tours, training events, exhibits, technology demonstrations, etc.*: 111 tours, trainings, exhibits, and demonstrations were delivered in FY2009. *Interagency Web Site Reviews*: Anticipated flat and/or reduced funding in FY2010 prompted a review of interagency Web sites that NAL manages: Nutrition.gov; Invasivespeciesinfo.gov; and IBIDS (Dietary Supplements). NAL staff met with program funders to determine options for realigning programs and to explore opportunities for other sources of revenue. Together they have begun to plan ways to attract funding and avert program shortfalls.

> ***Impact*:** NAL continued to improve services to its broad and large customer base, with an emphasis on digital information products and services.

3. Enriching AGRICOLA**.** At the end of FY2009, AGRICOLA included 5,201,141 records, of which 979,085 were online catalog records and 4,222,056 were indexing records. NAL added 12,236 cataloging records and 73,215 indexing records in FY2009. As mentioned earlier, work began on identifying the number of records that are needed to complete the AGRICOLA online catalog and associated costs. Completing the online AGRICOLA online catalog is the top priority for NAL in moving towards "Digital NAL."

> ***Impact*:** More information is available to NAL customers about the contents of NAL collections and the global agricultural literature.

Measure MI 2.1 Outyear Performance Plan (the future performance indicators for this Measure)

During FY 2010, NAL will continue to expand and improve services based on customer usage and satisfaction data.

During FY 2011, NAL will continue to expand and improve services based on customer usage and satisfaction data.

During FY 2012, 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 2009, NAL will continue to develop partnerships and content for the NDLA.

FY 2009 Accomplishments*:*

1. Developing Digital Content. By the end of FY2009, NAL had digitized 12,982 items (773,620 pages). NAL digitizes items internally on a very limited basis, primarily to respond to urgent requests for content and to capture fragile publications. Large-scale projects pass through an NAL committee that co-ordinates and sets standards for the work that is then accomplished through a contract with an external digitization vendor. With more than 50 million items in the book, journal and special collections, and tens of millions more pages in the manuscript collections, NAL must devise effective processes for the mass digitization of NAL holdings, along with ways to identify items digitized by other institutions. With other libraries, NAL has tested equipment for digitizing large, fragile, and complex printed documents. NAL continues to work with other Federal libraries, land grant, and large research libraries to find solutions to the challenges of digitizing library collections. Digital content from outside NAL is also available via AGRICOLA**:** Over 75,000 articles and 6,000 instructional images are now available via unbreakable hyperlinks from the AGRICOLA Index. NAL also provides access to the full

text of other freely available publications via AGRICOLA.

***Impact*:** Important publications have been digitized to preserve and provide access to them in perpetuity.

2. Building a Digital Repository**.** By the end of FY2009, NAL's digital repository included about 33,000 items - 13,000 items above NAL's FY2009 goal of 20,000 items. About 1,300 items are added each month. NAL staff worked with ARS, ERS and other USDA agencies to identify and transfer key USDA-authored publications to the digital repository. If legislation pending in Congress (S 1373) to expand access to information resulting from federally funded research is adopted, the experience with building a digital repository has prepared NAL to take a lead within USDA in meeting the challenge.

   ***Impact*:** NAL's capabilities to manage a new workflow involving digitization and digital preservation have been demonstrated by its progress in building a digital repository.

3. Developing Public Awareness and Partnerships. *AgNIC*: NAL serves as the secretariat for the Agriculture Network Information Center (AgNIC) Alliance, a voluntary, collaborative partnership that hosts a distributed network of discipline-specific agricultural information Web sites (http://www.agnic.org). AgNIC provides access to high-quality agricultural information selected by its 60 AgNIC partners, including land-grant universities, NAL, and other institutions globally.
   The AgNIC Alliance continues to improve the information technology that supports the AgNIC portal. During 2009, the portal was redesigned and additional features added to create a better search experience and offer Web 2.0 capabilities. AgNIC currently harvests over 25 relevant full-text digital repositories from institutions worldwide in multiple languages, with the number of repositories harvested ever increasing. AgNIC staff and partners presented at multiple national and four international conferences in Belgium, Japan, Costa Rica, and England. *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*:** More important agriculture information has become available on the Web as a result of collaborations among NAL and partners.

Measure 2.2 Outyear Performance Plan (the future performance indicators for this Measure)

During FY 2010, NAL will continue to develop partnerships and content for the NDLA.

During FY 2011, NAL will continue to develop partnerships and content for the NDLA.

During FY 2012, NAL will continue to develop partnerships and content for 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.

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 2009 Accomplishments:

The Agricultural Research Service (ARS) continued to conduct outreach activities in K-12 schools, 1862 universities and colleges, 1890 land-grant universities, 1994 Tribal Colleges and Universities (TCUs), Historically Black Colleges and Universities (HBCUs), and Hispanic Serving Institutions (HSIs). In addition, the agency continued to conduct outreach activities with minority serving organizations and disability programs, such as the Workforce Recruitment 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), ARS Information Staff, and Area ODEO Program Managers (including 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 workshops.

Professional/Science-Based Organizations: Exhibits were set up and hosted at several scientific professional events for the purpose of showcasing ARS careers and employment opportunities and to advocate to specific communities and/or organizations, providing educational materials and interacting with participants. This type of extensive and targeted exposure is essential to improve understanding of ARS mission, employment opportunities, and hiring process.

- American Association for the Advancement of Science
- American Chemical Society Meeting and Expo
- American Indian Science and Engineering Society (AISES) Annual Conference
- American Society of Agricultural and Biological Engineers
- Annual Biomedical Research Conference for Minority Students (ABRCMS)Blacks in Government (BIG)
- Entomological Society Meeting
- Examining Conflicts in Employment Laws Conference (EXCEL)
- Federal Asian Pacific American Council (FAPAC)
- Federally Employed Women Conference (FEW)
- Hispanic Association of Colleges and Universities (HACU) Annual Conference
- Institute of Food Technologists Annual Meeting and Expo
- League of United Latin American Citizens (LULAC)
- Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS) Conference
- National FFA Organization (formerly known as Future Farmers of America until 1988)
- National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE)
- National School Board Association Conference
- National Science Teachers Association National Conference
- National Technology Student Association
- Society for the Advancement of Chicanos and Native Americans in Science (SACNAS)
- Society of American Indian Government Employees (SAIGE) Conference
- Thurgood Marshall Annual Leadership Institute

Other events: ARS staff participated in the following events to promote careers in agriculture and science:

- American Association for the Advancement of Science, Exhibit
- American Society of Agricultural and Biological Engineers
- Confederated Tribes of the Umatilla Indian Reservation Career and Employment Youth Fair at Nixyaawii School (Pacific West Area)
- Delta State University Career Fair
- Fresno, California Job Fair
- Greenville-Westin High School Career Day (Midwest Area)
- Iowa Children's Water Festival
- Leech Lake Tribal College Career Fair (Midwest Area)
- Leland High (Mississippi) School Vocational Center Career Day
- Maryland Association of Boards of Education Conference
- National Ag in the Classroom Conference
- National Conference on Differentiated Instruction
- Selma (Alabama) Early College High School Program (Agriculture School
- Shaw High School Career Day (Mid-South Area)
- Southern University Career Fair, Industry Cluster, Ag Day
- Tuskegee University – Professional Agricultural Workers Annual Conference
- University of Arkansas at Pine Bluff Youth Motivational Task

- University of Mississippi Summer Internship and Fall Career Fairs
- U.S. Congressman Bennie G. Thompson 2nd Congressional District College & Career 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 with the same goals as indicated above:

- Alabama A&M
- Alabama Statue University
- Alcorn State University
- Anne Arundel Community College
- Arizona State University
- Bakersfield College
- Boise State University
- California State University – Fresno
- Central State University
- Delaware State University
- Dillard University
- Fond du Lac Tribal and Community College
- Grand Ronde College (Confederated Tribes)
- Howard University
- Iowa State University
- Lincoln University of Missouri
- Louisiana State University
- Mississippi State University
- Southern University of New Orleans
- Tulane University
- Tuskegee University
- University of Arkansas – Pine Bluff
- University of California – Davis and Riverside
- University of Central Arizona
- University of Central Florida
- University of Delaware
- University of Georgia
- University of Idaho
- University of Illinois
- University of Maryland, Baltimore County
- University of Mississippi
- University of Missouri
- University Wisconsin
- Wallace Community College
- Washington State University
- Xavier University

Other Outreach Activities: The ARS Information Staff conducted the following K-12 outreach activities:

- Developed and posted 14 new Sci-4-Kids stories targeted to kids 8-13 years old. These stories help kids learn about what ARS scientists do and how our science is wired into their everyday lives. Responded to kids' questions about ARS research.

- Coordinated a 3-day all-school science enrichment program for a local elementary school serving a diverse population. The program, "Chemistry in Everyday Life," reached 600 children, including "special needs" students. This is an ongoing program sponsored by Friends of Agricultural Research-Beltsville and Beltsville Agricultural Research Center (BARC) scientists. It features a new theme each year. For the fifth consecutive year, this program was awarded a President's Volunteer Service Award by the President's Council on Service and Civic Participation.

- Coordinated an in-school K-5 science program in junction with Friends of Agricultural Research-Beltsville and the Maryland Agricultural Education Foundation.

- Presented an "ARS Research and Resources" workshop to Roosevelt High School science teachers and a "Beyond the Shopping Cart" talk to middle and high school science teachers participating in a Federal Drug Administration (FDA) sponsored program.

- Served as advisor to and provided materials for ARS participation in the FFA Career Show and Exposition (55,000 vocational high school students and their advisors).

- Served on an ODEO task force to develop ARS-wide recommendations for conducting K-12 outreach.

- Developed an article on phytoremediation for use in the American Chemical Society's "Celebrating Chemistry" Earth Day campaign for use with 4^{th} -6^{th} grade educators.

- Provided ARS materials for dissemination at agricultural awareness days, teacher workshops, and student programs.

- Exhibited at the National Science Teachers Association National Conference (K-College Educators—15,000 attending).

- Partnered with the National Institute of Food and Agriculture's "Agriculture in the Classroom" staff to expand awareness of ARS research through their network by arranging promotion of ARS materials at several educational conferences.

- Hosted 25 teacher/student programs at the National Visitor Center. Over 600 participants were reached, including underrepresented populations and special needs students. The programs focused on a wide variety of topics such as natural resources, nutrition, children's health and nutrition, climate change, insects, bioenergy, technology transfer, and ARS recruitment and careers.

- The Beltsville Area (BA), along with the ARS Information staff exhibited at the NBC-4 Health and Fitness Expo, which is held at the Washington Convention Center in Washington, DC. The venue provides an outstanding opportunity to showcase ARS scientific achievements, the impacts of research on everyday food products, and professional career opportunities available at USDA. More than 80,000 participants from all demographic categories were present, making this one of the most diverse events in the area. We disseminated valuable information on phytonutrients, healthy food choices from the Food Pyramid, email newsletter enrollments, and career opportunities at USDA, specifically within ARS.

Agency Partnerships

USDA Educational Garden
In accordance with Secretary Vilsack's goal of creating a garden at each USDA facility worldwide, the USDA Educational Garden at the ARS Albany, California location was created. Under the leadership of the Pacific West Area (PWA) Director, employees are working in the garden with third graders from a nearby school. The planting has been completed and gardeners are now involved with garden management and maintenance. The Beltsville Area has a similar initiative pending.

Vansville Elementary School, Beltsville, MD
ARS is currently in the process of establishing a MOU with Vansville Elementary School in Beltsville, Maryland. The school is the first "certified" green school in Prince George's County and has a high representation of minorities. Through the MOU, ARS will support the school's mission of promoting respect for the preservation of our planet and its natural resources. The youth at Vansville will be made aware of the latest research at ARS.

1890 National Scholars Program
ODEO continued to support five scholars by providing them with paid internships, use of laptops, tuition, fees and books. One African American female student is currently pursuing a Master's Degree in nutrition with an expected graduation date of summer 2010. The student is employed as a biological science trainee at the ARS Delta Obesity Prevention Research Initiative. The other scholars are enrolled at Tuskegee, Langston, South Carolina State, and Southern Universities, majoring in accounting, agricultural business, civil engineering, and agricultural science respectively. They are employed with ARS during the summer and will tentatively be converted to full time employees upon their graduation.

Four 1890 Land-Grant library deans, directors or alternates participated in the AgNIC Annual Meeting hosted by the NAL. The HBCUs represented were: Alabama A&M University, Delaware State University, Prairie View A&M University (Texas), and University of Maryland Eastern Shore.

American Indian Science and Engineering Society (AISES)
ARS participated in the annual conference of AISES by hosting exhibits to promote careers with ARS and USDA. Over the past years, several ARS staff members have served on the Government Relations Council for AISES. The Associate Area Director for the ARS Mid South Area (MSA) has served on the committee from its inception. The Council provides awards in science, engineering, and technical professionals as leaders for the future. The Associate Area Director also served on the AISES Professional Awards for American Natives in STEM fields. Under his leadership, the MSA has implemented an extramural agreement grant for the AISES Graduate Student Poster competition.

Beltsville, Maryland Elementary School
The ARS BA employees are encouraged to volunteer at science fairs, and the Academic Mind Core Endeavor, an annual event that takes place at the Beltsville Elementary School. The event consists in providing students 100 questions and answers in the areas of science, math, art, health, literature, music and social studies. Our 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 Western Regional Research Center (WRRC) continues the Bridge Internship and Job Preparation Program (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, four WRRC Research Units are participating in the program with a total of 10 students. The diversity of the BIJP is evident in the

enrollment: six Asian males and one Asian female; one Hispanic male; one White female; and one White male. Many of the supervisors who are participating in the BIJP also participated in the formerly named SFWorks program.

Confederated Tribes of the Colville Reservation
The ARS Root Disease and Biological Control Research Unit, PWA, Pullman, Washington, continues to lead a science, technology, engineering, and mathematics (STEM) outreach and engagement program involving ARS, Washington State University (WSU), Bellevue College, Natural Resources and Conversation Service (NRCS), 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 undergraduate 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. The Pipeline Program also partners with the WSU College Assistance Migrant Program (CAMP) to mentor and promote the success of CAMP undergraduate students 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. Past experience has shown that introducing students early to the "culture" of science, math and engineering is a strong stimulus to pursue a career in a STEM profession. 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." Six students have been hired on the Student Temporary Experience Program (STEP) as Bioscience Aids in ARS Research Units at Pullman, Washington. In addition, hundreds of students have been exposed to ARS research programs as part of the activities sponsor by the Pipeline Program.

Conference on Asian Pacific American Leadership (CAPAL)
ARS continues the MOU providing $10,000 annually for the recruitment of two research or management student interns at ARS research locations. Each intern works on a part-time basis at a laboratory research center. They get involved in projects of their interest and are guided by leading researchers, while being fully enrolled in their academic degree programs. This year's summer interns were a rising senior at the University of Hawaii, majoring in food science and human nutrition, who interned at the BARC, and a junior at Stanford University majoring in human biology, who interned at the ARS Berkeley Laboratory in California.

Fortis College, Landover, MD
The MOU allows the BA scientists to serve as mentors to students enrolled in the biological technician program, which has an internship requirement. The scientists provides hands on learning experiences at the ARS laboratories to further enable the students acquire employment as trained laboratory assistants/technicians.

League of United American Citizens (LULAC)
ARS participated in the 2009 LULAC annual conference by hosting an exhibit to showcase the many career opportunities available within ARS and USDA.

Penobscot Nation, Old Town, Maine
The Research Leader (RL) of the ARS North Atlantic Area New England Plant, Soil, and Water Laboratory, Orono, Maine, has worked with the Director of Education, Penobscot Nation and others to identify and employ Native American Research Apprentices for 13 years. To promote opportunities at the New England Plant, Soil, and Water Laboratory, the RL writes "success stories" about Native American students working in the laboratory that are published in the Wabanaki Center newsletter. The Center posts position announcements on their bulletin board and emails them to all Native American students attending the University of Maine. Over the last 13 years, 13 Native American high school students have been hired as research apprentices. A Native American college student was also hired as a biological science aid. The RL ensures each research apprentice receives one-on-one mentoring by assigning each student to work alongside a PhD scientist conducting research on such topics as biological control of plant diseases, sustainable agriculture, and soil science. The RL is currently mentoring the Native American student that was hired in the summer of 2009. He is conducting a research project to measure the impacts of cropping systems on physical soil properties. Such direct mentoring exposes students to the principles and practices of scientific research and ARS leadership. Letting students take responsibility for their own research projects strengthens their confidence, motivation and enthusiasm.

Society for the Advancement of Chicanos and Native Americans in Science (SACNAS)
Agency representatives hosted an exhibit to showcase the many career opportunities available within ARS and USDA.

University of Arizona and United Tribes Technical College (UTTC) Specific Cooperative Agreements (SCAs)
ARS is sustaining and enhancing linkages with TCUs focusing on established cooperative research and employment of American Indian students in agency laboratories by funding two SCAs between the University of Arizona and UTTC. The SCAs are administered by the Northern Plains Area (NPA) Grand Forks Human Nutrition Research Center. The agreements were established in 2005 to provide structured internships for students majoring in agriculture and related disciplines. This collaboration has strengthened our partnership with tribal communities as we work together to accomplish mutual goals. The SCAs are administered by the Grand Forks Human Nutrition Research Center, NPA. Students work with scientists on research projects and at the end of the eight-week internship, report their findings to the research unit. During 2009, eight Native American students received summer employment, which included salary, housing, and transportation. Three of the eight students were enrolled at the UTTC in Bismarck, North Dakota and five students were enrolled at the University of Arizona. The students were assigned internships at three locations in the NPA (Mandan, Fargo, and Grand Forks, North Dakota). Since 2005, 41 internships have been awarded to American Indian students. The funding for the Native American Internship Program has increased each year. In 2005, funding for both agreements totaled $23,300. In 2009, the funding was approximately $67,000. Since 2005, approximately $305,000 has been committed to this program through ARS and NPA funds. Each spring, the NPA Office also sponsors a day-long cultural awareness workshop and a half-day showcase, both of which are held at the UTTC campus. The cultural awareness workshop provides ARS participants an overview of the impact Native American history and culture have on how Native Americans view Western science, including the scientific contributions they themselves have made. During the workshop, ARS participants were asked to step outside the familiar Western world view and examine the Native American tradition and experience from an Indian perspective. Discussions centered around the definition of Who is an Indian? And How Indian People View Research? In addition, there were presentations on cultural differences between the dominant (White) culture and Indian cultures regarding communication, work, and family. An annual survey of all participants (students, scientists, and staff) is conducted by the NPA Area Office to assess program outcomes and determine future needs.

University of Maryland, Baltimore County (UMBC), Meyerhoff Scholarship Program
ARS continues supporting the partnership between ARS and University of Maryland, Baltimore County (UMBC), Meyerhoff Scholarship Program. The program is open to accomplished high school seniors interested in pursuing doctoral study in the sciences or engineering. The scholars, who are top math and science students from across the nation, are committed to the advancement of minorities in the sciences and related fields. ARS conducted its second overview meeting with students and faculty of the Meyerhoff Program at the (BARC and coordinated a one-day event for incoming freshmen (50 students) to the program. This is part of their eight-week Summer Bridge Program. This session was a continuation of efforts to develop an ongoing partnership with the UMBC Meyerhoff Scholarship Program.

USDA-ARS Future Scientists Program
Texas A&M University and ARS Southern Plains Area (SPA) continued supporting this cooperative agreement. The ARS Pacific West Area (PWA) worked with the Director of the Future Scientists Program to arrange visits to five PWA locations (Pullman, Washington; Tucson, Arizona; Riverside, Davis, and Shafter, California) to discuss the Future Scientist Program and the possibility of setting up mini institutes at three of the locations during the summer of 2010. The Pullman and Riverside laboratories were selected because of their close proximity to USDA Hispanic-Serving Institutions liaisons. The goal of the Future Scientists Program is to promote agricultural science in school districts near ARS research laboratories, focusing on hands-on activities aligned with the National Science Education Standards. This collaboration takes the form of a mini-summer institute where 10 teachers spend two days at the selected research location interacting with scientists and technicians to learn about research specific to the laboratory, and bring this experience back to their students. At the end of the year the teachers, a select number of students and their parents, would be invited back to the laboratory for a Student Research Presentation Day where students would present posters and talk about their research experience.

New Initiatives

Annual Tribal College Librarians Institute (TCLI)
The TCLI is an annual week-long program sponsored by the Montana State University Libraries. The National Agricultural Library (NAL) provided financial support to help defray travel costs for 30 attendees from 17 tribal colleges, and also made presentations on NAL services, science.gov resources and Agriculture Network Information Center (AgNIC) opportunities. TCLL is designed to provide continuing education, professional development and networking opportunities for tribal college librarians. The following TCUs participated in the Institute: Little Priest Tribal College, Salish Kootenai College, Wind River Tribal College, Dine' College, Oglala Lakota College, Northwest Indian College, Spokane Tribal College, Ilisagvik College, Lac Courte Oreilles Ojibwa Community College, Haskell University, United Tribes Technical College, Little Big Horn Tribal College, Fort Belknap Tribal College, Sinte Gleska Tribal College, Tohono O'odham Tribal College, Sitting Bull Tribal College, and Fort Peck Community College. One 1994 Tribal College library director from the Fort Berthold Community College (North Dakota) participated in the AgNIC Annual Meeting hosted by the NAL in Beltsville, Maryland.

Asian-American Pacific Islander Task Force
ARS established the Asian-American Pacific Islander (AAPI) Task Force aimed at providing recommendations to senior management to improve the underrepresentation of the AAPI community at senior level positions within the Agency.

Additional Activities:

- Initiated a partnership with the Southern University of Louisiana to establish the Agricultural Research Apprenticeship Program. The program will prepare minority youth for scientific experimental training. ARS secured funding for four years in the amount of $199,000.

- ARS continues the contract with a private local group in Corvallis, Oregon employing 15 trainees in the greenhouses.

- ARS continues to work with the State of Alaska Division of Vocational Rehabilitation to employ a high school student that is disabled. The student is currently working in a volunteer status for ARS and being paid by the state of Alaska.

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 2009 Accomplishments:

ARS continued to review the student programs and encourage managers to convert 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 294 Post-docs. Of the 294, 32 percent are minorities; 32 percent are White females; and 36 percent are White males. Nine or 3 percent of the 294 Post-docs have been converted to career conditional and TERM positions. Of the nine, 33 percent are minorities and females (22 percent are minorities; 11 percent White females) and 67 percent are White males.

SCEPs: ARS has 60 students in active status participating in the SCEP. 36 percent of them are minorities; 30 percent are White females; and 34 percent are White males. Two SCEPs (one White female and one White male) were converted in 2009 to career-conditional positions. 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.

STEPs: ARS currently has 896 STEP students with 20 percent minorities; 49 percent white females; and 31 percent white males.

Workforce Recruitment Program (WRP): ARS had one student from the WRP, which targets students and recent graduates with disabilities. While this appointment was temporary in nature and is not reflected in a permanent disability employment profile, we are hopeful this candidate will be available for permanent employment after completing his/her school commitments.

Ensure that all employees complete mandatory USDA and recommended training.

FY 2009 Accomplishments:

All ARS employees and contractors completed the mandatory training "An Overview of the Americans with Disabilities Amendments Act (ADA)" and the "No Fear" Refresher Course utilizing AgLearn. ARS employees also participated in webinars regarding topics such as Reasonable Accommodation, Diversity, and ADA Amendments Act. Training included, but was not limited to educational videos, brown bag lunch discussions, interactive training class via the internet, reading pamphlets distributed by the Department

and Agency. ARS employees also participated in many of the Department's Diversity Lunch training sessions.

Employees within the Administrative and Financial Management (AFM) received diversity training from the Director of the USDA Office of Workplace Diversity and Inclusion.

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 SEP Managers were involved in the planning of nearly all of the Departmental SEP observances as well as sponsoring Area observances.

Introduce Multigenerational Training and sponsor a Multigenerational Diversity Day.

FY 2009 Accomplishments:

The AFM Deputy Administrator conducted a Multigenerational Training at ARS headquarters and the National Institute of Food and Agriculture.

The Director of the USDA Office of Workplace Diversity and Inclusion conducted a lunch session on "Managing Millennials: An Oxymoron?" to AFM employees.

The NPA ODEO Program Manager made a presentation on diversity in general (including multi-generations) to the NPA New Scientists Orientation.

On April 10, 2009, the NPA ODEO Program Manager gave a presentation to 21 members of the Northern Great Plains Research Laboratory, on diversity entitled "Did You Know?" (aka "Shift Happens"). The theme of the presentation was diversity, especially in relation to globalization, technology, and generations. The PowerPoint presentation was interesting and thought provoking.

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 2009 Accomplishments:

ODEO continues to research the right vehicle to use to begin a formal pilot mentoring program to ensure the development of employees in the competencies needed to accomplish current and future goals. The Human Resources Division developed a mentoring program for new employees and several Area Offices have developed formal mentoring programs to mentor scientists. Mentoring of ARS students is occurring both in the Area and headquarter offices. An Agency-wide pilot mentoring program is under development. The Areas will continue to mentor employees to develop human resources. Some examples are:

- The NPA continues to develop their Category 1 and 4 scientists in the "Newly Appointed Scientist Professional Development Program (NASPDP)." The goals of this program are to assist the scientists to attain standards of performance that will enhance their opportunity for success and to ensure fairness and equity in evaluating professional scientific development.

The NASPDP provides a three-year period to enhance a newly appointed scientist transition into an ARS scientific position and to carefully monitor and evaluate their progress. This program covers 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 has two components: professional development and mentoring. The professional development component includes a panel review of the scientist's accomplishments, while the mentoring component is an opportunity for new scientists to learn about ARS cultures (research, organization, etc.) from a seasoned scientist. Each new scientist (called a protégé) is assigned a mentor (a scientist at or above GS- 14). Except in rare circumstances, protégés and mentors are matched by disciplinary and research backgrounds and interests. 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. The current 33 mentors and protégés are encouraged to interact at least once a month. Since the inception of the program, 19 protégés have successfully completed the NASPDP and mentoring component, and 17 scientists (former protégés) remain in the NPA. Two former protégés resigned from ARS and took other professional positions. Four other scientists also resigned from ARS before completing the three-year program. Of those four resignations, two cited spousal employment issues, one accepted a position in academia, and one took a position with the United States Army.

- The PWA continues the mentoring program for new Administrative Officers (AO). The AO mentoring program is a new and important element of the Area's goal to develop high-performing AOs (and Locations) in 14 business-critical functions within 24 months. The Deputy Area Director meets via conference call with all new AOs and their mentors on a quarterly basis. The format for those conversations is to share information and to get feedback on AO orientation, on-boarding, and training/development efforts. Sections within the Area Office also play an essential role in AO development. Each Section has the responsibility to reach out to new AOs to provide documentation and concise information, answer questions, and provide or advise on appropriate training in support of the 24-month development goal. New AOs are paired with seasoned AOs at locations with similar functions.

- The MWA established a "New Secretary Mentoring Program." As part of this program, new secretaries in the Area attended on-site administrative training to continue to enhance their developmental and professional growth in ARS. As part of this training, the Area ODEO Program Manager presented an introduction to ODEO in ARS and the Area.

- The MSA Area Program Manager served as the ARS Collaborator establishing the Louisiana Research Apprenticeship Program (LA-RAP), which is a 4-year program funded at $199,000. 21 students participated in the program. The program's objectives are: educate students on how to apply for federal employment and student federal opportunities in biotech, and enhance their interest in agricultural sciences by using ARS bulletins and research publications, in addition to provide them with "hands-on" techniques. The new USDA scholar at Southern University was the Valedictorian of his school. His goal is to become a veterinarian researcher.

Maintain and increase involvement in knowledge management and mentoring activities to strengthen our workforce.

FY 2009 Accomplishments:

The Agency Administrator continued to stress to the Administrator's Council the importance of encouraging employees to utilize career development and mentoring program.

The following strategies have been implemented to improve and enhance our efforts in succession planning and management:

1. Continued to provide Situational Leadership II Training to promote partnering and increase collaboration between senior leaders, managers, supervisors and employees. Its use increases organizational awareness and creates an open environment for employees to express their career interest;
2. Utilized Leadership Development Training Programs to promote current employees to higher-level positions, 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, Leadership Evaluation and Development Program for administrative employees GS-11 and above, Executive Leadership Program for mid-level employees GS11/13, ARS Path to Leadership Program for employees at GS-12 and above, Executive Potential Program for employees at GS13/15, and the Executive Professional Excellence and Knowledge for employees at GS-14 and above. These programs are promoted and announced agency-wide in the REE mission areas;
3. Provided career development training as needed to assist employees on how to establish action plans towards career planning and career paths;
4. Provided New RL Training to help RLs in the transition and management of their administrative role, functions and responsibilities;
5. Sent annual reminders to managers and supervisors for Individual Development Plans to be established; and,
6. In February 2009, the RL Advisory Council (RLAC) was chartered by the ARS Administrator in response to findings and recommendations from the RL Survey conducted in April 2008. The Council's membership includes an experienced RL from each Area, several ex officio members who serve in an advisory capacity and an executive secretary. The Council's objectives identified in the charter are: provide RLs a "voice" on issues affecting them; facilitate direct communication among research units, line management, and program management; assist the Agency in leadership succession planning efforts; promote and develop practices that foster professional growth; and identify and recommend solutions to challenges facing RLs. Early initiatives include establishing a web site resource for RLs on a variety of program and administrative topics and identifying priorities. One of these priorities is establishing consistent Agency-wide performance expectations for all Category 1 Research Scientists, including RLs.

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 2009 Accomplishments:

As part of the Management Directive 715 (MD-715), a plan was developed to reinstate the exit interview process to determine why employees are leaving ARS. The Human Resources Division developed a survey, and comments have been compiled from the REE mission areas. Implementation date was scheduled for FY 2009. However, this has been delayed to conduct more research for collecting the data and utilizing the survey results effectively.

- **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 2009 Accomplishments:

Career Development and mentoring. 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 (8)	3 Black females (37.5%)
	5 White females (62.5%)
New Leader Program (10)	4 White females (40%)
	3 White males (30%)
	2 Black females (20%)
	1 Asian female (10%)
Executive Leader (5)	2 Black females (40%)
	2 White females (40%)
	1 Hispanic male (20%)
Executive Potential Program (7)	4 White males (57.1%)
	1 Hispanic male (14.3%)
	1 Asian female (14.3%)
	1 White female (14.3%)

Special Emphasis Programs (SEPs) and EEO-Diversity Advisory Committees.
Employees are encouraged to be part of the SEPs, to continue to educate each other on cultural differences in the workplace. All ARS Areas have established Area EEO-Diversity Advisory Committees, which serve as management tools and advisors to ensure that the targeted groups are represented throughout the workforce. The EEO-Diversity Advisory Committees sponsored special activities supporting SEP observances.

Previously one SEP Manager was assigned for ARS. However, to be more effective, each program now has one representative. The representatives are involved in planning Departmental SEP observances. Employees are encouraged to participate in SEP observances, which are designed to raise awareness and educate employees on the cultural differences and similarities to show the uniqueness that each employee brings to the USDA-ARS workforce.

Career development, leadership, and mentoring programs are as follows:

- The ODEO Outreach and Recruitment Branch conducted Knowledge, Skills, and Abilities (KSAs) Workshop, Resume Writing, and Navigating the Federal Hiring Process Workshop for headquarters employees and 200 HACU interns.

- The PWA continues the New Scientist Mentoring Program established to augment the mentoring new scientists receive from their Research Leader and to assist them in their professional development and integration into ARS. This initiative grew out of a recommendation from the PWA Workforce Diversity Committee.

- **Promote consistency in new employee, Research Leader, and scientist orientation programs throughout ARS regarding all components of the EEO Program.**

FY 2009 Accomplishments:

The ODEO coordinated with the HRD and Area ODEO Program Managers 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 and Mission Statements, current USDA-ARS Area EEO-CR Policy Statements (if applicable); 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.

During FY 2009, the ODEO Director and/or his representative, and the Area ODEO 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 2009 Accomplishments:

The HRD collected, reviewed and analyzed the associated award data to determine equitable distribution for scientists, biological science technicians, and administrative support positions based on race, national origin, gender and disability status. HRD will be partnering with ODEO to develop and implement a roadmap that outlines the internal process to identify the barriers impeding parity among minorities and women in Agency award recognition programs. Based on the established roadmap, HRD will proceed to determine and establish the associated trends and patterns within each Area and conduct a comparative analysis of the findings to identify variances and/or inequitable distributions. The report of findings will be shared with each Area Director.

- **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 2009 Accomplishments:

ARS is ensuring visibility of civil rights to all employees by having location representatives on the EEO-Diversity Committees and SEPs. 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 the personnel of ODEO, Area ODEO Program Managers, and location contacts relating to ODEO issues.

Other outreach, diversity, and equal opportunity awareness activities may include, but not limited to, brown bag lunches, SEP events, etc.

ODEO continued to maintain visibility throughout the Agency by participating in the varied programs and activities listed herein. ODEO continued to encourage the Area ODEO Program Managers to visit Location offices to assist with outreach, diversity, and equal opportunity.

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 2009 Accomplishments:

Improved Human Capital Management

Accomplishments: HRD formed a "SWAT" team to monitor, develop action procedures, implement, and provide progress reports on the OPM Hiring Reform 09 initiative. HRD staff members also assisted in the USDA development of their hiring reform effort and an AFM staff member continues to serve on the USDA oversight committee. HRD staff also developed an Employee Orientation Survey for the Department to assist in their data collection efforts. HRD provided the Department with an accountability report for the REE agencies in November 2009.

HRD continues to maintain and provide system enhancements to their e-systems which benefit all REE employees and meets (actually exceeds) the OPM goal of improving human resources customer service to all employees. The primary emphasis in this area is associated with the e-OPF system and the e-SF-52 system. HRD also has continued to review, update, and sometimes automate internal standard operating procedures to benefit the REE clientele. This work includes the hiring of foreign nationals, the

re-employment priority list, the hiring of re-employed annuitants, and the direct hiring of Veterinary Medical Officers.

HRD continues to develop a performance management policy issuance and is also developing an electronic library of performance elements and standards which will eventually encompass all REE agencies. Generic performance plans were issued for ARS category 1 scientific positions. All REE employee performance appraisals were processed to ensure the distribution of performance awards in a timely manner. The design and development of an ARS New Supervisor Training Program started in 2009 while the numerous career development programs, orientation, administrative workshops, and HR webcast presentations have continued to educate and improve the performance of REE employees.

HRD participated in a 2009 audit of its operations, systems, services, and procedures by the Department and OPM. HRD received an excellent overall audit rating and has incorporated and implemented the recommendations made by the audit team. In addition, HRD has continued to perform employee data reviews as prescribed in the REE Accountability Plan to ensure the accuracy of all employee information.

Improved Financial Management

Accomplishments: ARS continues to meet Departmental and Treasury accounting and reporting challenges, including resolving accounting and financial reporting issues, and responding to audit inquiries and addressing related issues. ARS has sustained a clean audit opinion (as subsumed within USDA's' financial statements), and successfully closed out the fiscal year.

Successfully helped to lead the REE initiative to prepare for the March 1, 2010, Financial Management Modernization Initiative (FMMI) implementation. As part of this process, participated in the pre-implementation clean-up process, and worked with the department, vendor and REE agencies to develop policies and procedures to support the implementation, including testing the new system.

ARS continues to promote and provide web based access to all travel related documents, policies, and procedures. We implemented employee access to travel card usage information through the use of the USBank Access Online system, providing them a one-stop location for paying their account, updating demographic information, accessing statements online, and reviewing and potentially disputing transactions.

ARS continues to review and develop policy and procedures manuals to assist employees and issuing bulletins on timely travel information, including the use and management of the travel card policy, local travel, and requirements for receipts and maintaining travel records.

Improved Accountability and Stewardship of the ARS Asset Management Program

Accomplishments:

- In the American Recovery and Reinvestment Act of 2009 ARS received $176,000,000, for work on critical deferred maintenance at Agricultural Research Service facilities. These funds will significantly contribute to the accomplishment of the ARS Strategic Planning Initiative to Improve Real Property Management, with the result that research will be accomplished more efficiently and effectively. This work will reduce the backlog of critical deferred maintenance at ARS facilities by approximately 56 percent and slow the growth in deferred maintenance throughout ARS.

- The revised P&P 134.2, Energy, Water and Sustainability Policy, was issued in FY 2009. Over 25% of ARS facilities received energy audits in FY 2009. ARS received technical assistance from DOE funded by ARRA for 15 different projects ranging from training to energy audits and

renewable energy studies. UESCs and ESPCs are being utilized to identify and implement energy conservation measures. Two ESPCs, one in Gainesville FL and another covering the entire state of Texas, were awarded saving over $200,000 per year each. Ten locations received energy upgrades through an interagency agreement with Bonneville Power Administration. Advanced electric meters are being installed at major facilities. ARS participated in the Road Test of the Public Sector Protocol for green house gas inventories. ARS continues its energy awareness program. According to NFC records, in FY 2009 ARS reduced electricity consumption by 15.9% and natural gas consumption by 3.7%. ARS continues to purchase Renewable Energy Credits to satisfy its statutory requirements for renewable energy.

Improved Acquisition and Personal Property Management

Accomplishments:

- The Acquisition & Property Division (APD) served as a "super-user" during the Corporate Property Automated Information System (CPAIS) quality assurance (QA) testing, working with programmers to determine viable options and resolutions for issues. APD participated in concurrent user-acceptance testing (UAT), involving field participants as testers. APD arranged for an ARS only "train the trainer" sessions for Area property management officers for hands-on training, allowing for a training environment that was unique to ARS processes. APD conducted six webinars to introduce CPAIS functionality to ARS property and financial employees nationwide. APD served on the CPAIS conversion team developing processes and certification procedures to ensure conversion of accurate data. Due to numerous functionality/design issues identified during QA and UAT that were unresolved by the various "go-live" dates, USDA has delayed deployment of CPAIS until FY2011. APD continues to participate with USDA's Office of Property Management (OPPM) on CPAIS design, requirements, and interface issues.

- APD diligently monitors personal property suspense and inventory compliance to ensure that all property transactions are reconciled within 60 days of payment and there are no more than 2 inventories delinquent at the end of the month. APD works with field property officers to provide guidance to reconcile transactions to ensure financial integrity, minimizing potential negative impact to the REE General Ledger. APD monitors budget object code (BOC) use for new assets, identifying corrections needed to ensure only capitalized assets are depreciated. With the second largest inventory in USDA, ARS averages 175 accountable property assets per month, with a monthly inventory increase of $2.5 million, and over 1200 inventories, oversight is necessary for data integrity.

- APD worked with the Areas to prepare and submit vehicle replacement requests to the General Services Administration for over 1800 vehicles using ARRA funds. GSA allocated over 750 vehicles to ARS, with an overall acquisition savings of $13.9 million and increase average miles per gallon savings from 17 mpg to 25 mpg. ARS received over 200 hybrids and over 200 alternative fueled vehicles, helping ARS reduce its annual fuel consumption.

- APD worked with USDA's Charge Card Center, US Bank, and VISA to monitor and analyze reporting data to identify significant compromises in obtaining electronic fleet operational costs (maintenance costs, fuel costs, and fuel types) after USDA's conversion to US Bank/VISA Fleet Card. US Bank and VISA worked on several fixes during FY2009, without success until September. As a result of APD's recommendations, all USDA agencies will see an increase in detailed fleet cost data in FY2010.

- APD continues to provide guidance and assistance in the use of U.S. Bank's electronic reconciliation system (Access Online) for REE employees.

- APD represents 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 will focus on process improvement and implementation of necessary updates to documentation, training, and Department-wide guidance to ensure knowledge transfer and process sustainability.

- APD continues to provide web-based training to REE Coordinators on U.S. Bank's reconciliation system and management and oversight responsibilities for the purchase card program.

- APD assisted the Office of Small and Disadvantaged Business Utilization in developing the web-based AbilityOne Program Training. The training explains the purpose and provides an overview of the AbilityOne Program. This training is mandatory for all USDA purchase cardholders and approving officials. The training is available on demand via AgLearn.

Improved Accountability & Program Stewardship of the ARS Extramural Agreements Program

Accomplishments:

- Successfully developed and implemented new policies and procedures for ensuring timely closeout of extramural agreements. EAD developed and deployed an automated closeout module in the ARIS/AIMS System. Mandatory use of the closeout module improved accountability over unused funds remaining on expired agreements.

  Successfully implemented mandatory maintenance training for all ARS Authorized Departmental Officer's Designated Representatives (ADODRs). The training material provided ADODRs with knowledge of responsibilities required to effectively monitor extramural agreements. Delivery of the maintenance training to ARS ADODRs, ensured effective and efficient administration and close out of extramural agreements. During 2009, EAD published P&P 703.0, Closeout Procedures for Extramural Agreements, and P&P 704.0, Research Support Agreements.

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 2011, 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 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

Performance Measure 1.2 Emphasize employee continuous improvement.
Indicators:

By FY 2011, 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 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.

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 2011, AFM will:
Develop a program/process to assimilate and support new employees to increase retention.
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 2012, AFM will:
Develop a program/process to assimilate and support new employees to increase retention.
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 2011, AFM will:
Publish and implement Succession Plans in ARS, CSREES, and ERS.
Develop and implement a supervisory training program.

By FY 2012, AFM will:
Publish and implement Succession Plans in ARS, CSREES, and ERS.
Develop and implement a supervisory training 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 2011, AFM will:
Actively respond to annual OIG audit of REE-wide financial statements and resolve audit concerns within established due dates.

By FY 2012, 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 2011, 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 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.

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 2011, 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.
Explore and identify data-mining opportunities for ad-hoc reporting from ORACLE-based applications, including software and training requirements.

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.

Explore and identify data-mining opportunities for ad-hoc reporting from ORACLE-based applications, including software and training requirements.

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 2011, AFM will:
Implement new purchase card; 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 2012, AFM will:
Implement new purchase card; 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.

Performance Measure 3.2 REE Agencies realize cost savings and receive best value through leveraging their energy buying power.
Indicators:

By FY 2011, AFM will:
Coordinate between APD and FD to develop and implement a comprehensive energy buying plan.

By FY 2012, AFM will:
Coordinate between APD and FD to develop and implement a comprehensive energy buying plan.

Performance Measure 3.3 REE agencies realize cost savings and receive best value through effective fleet management.
Indicators:

By FY 2011, 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 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.

Performance Measure 3.4 Develop metrices for REE acquisitions.
Indicators:

By FY 2011, AFM will:
Consider ATS or other applications (e.g. the new purchase card system)
Consider any other applications for integration (CATS/ATS)

By FY 2012, AFM will:
Consider ATS or other applications (e.g. the new purchase card system)
Consider any other applications for integration (CATS/ATS)

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 2011, 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 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.

Performance Measure 4.2 Maintain a robust Real Property Asset Management program.
Indicators:

By FY 2011, 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.
Begin the planning and coordination process for the CSREES move from the Waterfront

Building.

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.
Begin the planning and coordination process for the CSREES move from the Waterfront Building.

Performance Measure 4.3 Implement Energy Policy Act (EPACT) 2005 and the Energy Independence and Security Act of 2007
Indicators:

By FY 2011, 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 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.

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 2011, 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 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).

Performance Measure 5.2 Ensure fiscal and financial systems are fully integrated into the agreement process.
Indicators:

By FY 2011, 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 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.

Performance Measure 5.3 Agreement business processes are measured for effectiveness and efficiency.
Indicators:

By FY 2011, AFM will:
Develop metrics to evaluate agreement process
Measure timeliness of account reconciliation to ensure timely closeouts.

By FY 2012, AFM will:
Develop metrics to evaluate agreement process
Measure timeliness of account reconciliation to ensure timely closeouts.

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 2011, AFM will:
Develop an Executive Information System (EIS), i.e. "Dashboard", with financial, HR, agreements, procurement, property, and facilities data points.

Develop an employee service and information site with career data, personal data, calendars, chat rooms, etc.

By FY 2012, AFM will:

Develop an Executive Information System (EIS), i.e. "Dashboard", with financial, HR, agreements, procurement, property, and facilities data points.
Develop an employee service and information site with career data, personal data, calendars, chat rooms, etc.

Performance Measure 6.2 Ensure that new or modified administrative processes or information systems effect measurable, qualitative improvements.
Indicators:

By FY 2011, AFM will:

Develop an applications enterprise architecture map which identifies the current state and proposed future state of AFM-wide applications (from which to establish priorities).
Identify key business processes most important to HQ, scientists, and Locations, and which also require the most amount of time and resources, and then focus on two of these processes to automate, integrate, streamline, and improve.
Improve the public AFM Web site ensuring that the information provided is commensurate with agency identified priorities and that access to administrative and financial (AFM) information is clear and user friendly.

By FY 2012, AFM will:

Develop an applications enterprise architecture map which identifies the current state and proposed future state of AFM-wide applications (from which to establish priorities).
Identify key business processes most important to HQ, scientists, and Locations, and which also require the most amount of time and resources, and then focus on two of these processes to automate, integrate, streamline, and improve.
Improve the public AFM Web site ensuring that the information provided is commensurate with agency identified priorities and that access to administrative and financial (AFM) information is clear and user friendly.

ARS Office of the Chief Information Officer (OCIO) Management Initiatives

Overview of Management Initiatives

ARS works through its Office of the Chief Information Officer (OCIO) to enable more effective and efficient research mission delivery through a strengthened information and technology management program. The premise of this program is based on the following vision statement:

> *ARS information systems are mission driven and responsive to customer needs; they are reliable, secure, user friendly, relevant, innovative, well planned, and managed effectively.*

Effective information systems flow from mission requirements. This relationship dictates a structured, comprehensive, and ongoing review of information systems and the technology needed to support ARS mission and internal and external customer needs. Because ARS is the government entity uniquely responsible for creating new knowledge and the data, information, and technology necessary for a sustainable and globally competitive American agriculture, the Agency's information technology program must provide a safe and reliable environment to support the creation, storage, and dissemination of this knowledge.

The ARS OCIO works in consultation with the ARS Executive Information Technology (IT) Steering Committee to define the strategic direction of the Agency's information technology program in the ARS IT Strategic Plan, which defines ARS' IT strategic goals, objectives, and strategies. The plan identifies key information management issues and provides the framework for developing integrated information systems and technology through further definition and specification of architecture components and information elements. OCIO then works in coordination with the Agency's IT specialists to implement these IT strategies with broad Agencywide impact.

Expand Electronic Government

OCIO facilitates the Agency's implementation of broad Federally and USDA-mandated IT programs focused on expanding electronic government. OCIO will continue to work with the USDA Office of the Chief Information Officer (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.