

Introduction

ARS Annual Performance Report for FY 2010 and Performance Plan for FY 2011 - 2013

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

The National Programs focus the work of the Agency on achieving the goals defined in the ARS Strategic Plan 2003-2007. The research priorities for each National Program are established with extensive input from customers, stakeholders, and partners, which is received, in part, at a series of National Program Workshops. A detailed Action Plan developed for each National Program is available on the ARS home page, www.ars.usda.gov; 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

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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 2010, ARS will develop new or improved, or more environmentally friendly processing technologies.

FY 2010 Accomplishments:

Incorporating lignin biosynthesis mutants (bmr6 or bmr12 – aka brown midrib) into sorghum grain lines reduces lignin content and increases cell wall digestibility. Although lower lignin content can increase biofuel yield, it is commonly believed that low-lignin varieties are more susceptible to disease. But in both field and greenhouse studies, ARS researchers found that brown midrib lines were actually more resistant to infection by *Fusarium* fungi. In fact, one *Fusarium* species commonly-found in wild-type grain was not detected in bmr12 grain. This research shows that crops modified for increased cellulosic biofuel yield are not necessarily more susceptible to pathogens and could even be more resistant.

Impact: This research enables the breeding of biomass energy crops that will produce lower-cost biofuels than existing biomass crops.

A major concern associated with corn ethanol fuel is the relatively low energy efficiency of its life-cycle production, a situation resulting in large part from the high-energy required for distilling ethanol from the fermentation broth. In addition, the fermentative conversion of biomass to ethanol involves especially low concentrations of ethanol, so the distillation step requires even larger amounts of energy. ARS scientists invented a new membrane-based ethanol-recovery process that exhibits twice the flux of conventional membrane systems. The novel fabrication

process lays an ultra-thin, low-permeability layer of active zeolite on a very permeable, large-pore rubber support. A patent application has been filed on the technique, which enables an energy-efficient alternative for ethanol production.

Impact: This research enables more energy-efficient and lower-cost processes for bioethanol production than the commercial processes currently in use.

Napiergrass, a high-yield perennial, is a promising feedstock for the emerging cellulosic biofuels industry in the Southeast U.S. ARS scientists studied the rain-fed growth of napiergrass under three fertilizer treatments – no fertilizer, poultry litter, and inorganic fertilizer. Relative to the unfertilized control, napiergrass grown with either poultry litter or inorganic fertilizers exhibited yields that were 17% and 48% greater in the second and third year of growth, respectively.

Impact: This research helps to enable best management practices for biomass feedstock production systems in the Southeast.

ARS researchers developed and released Ho 02-113, a high-fiber, low-sucrose sugar cane cultivar which is more resistant to smut infection than L 79-1002, which ARS released in 2007.

Impact: This research helps to enable the commercial production of energy cane.

ARS scientists in collaboration with CSIRO (Australia) used a high-throughput phenotyping platform (phenomics) to characterize over 100 natural accessions of *Brachypodium*, as a simple model for studying grass cell walls and enabling rapid improvements in plant traits for biofuels production. Extensive natural variation in several traits relevant to biofuels including, cell wall composition, stem density and fermentability have been found. ARS researchers also created over 4,000 T-DNA lines this year and released over 4,000 T-DNA lines made in the prior year to the public through a newly established T-DNA website.

In addition, ARS scientists, in collaboration with Department of Energy (DOE) and other researchers, annotated the entire *Brachypodium* genome. A paper describing the results was published in *Nature* and the genomic information is now publically available on several databases. In addition, a project to resequence additional accessions was initiated. To date, four lines have been resequenced and the analysis of the sequences has been initiated.

Impact: Scientists will use this knowledge of *Brachypodium*'s genome sequence to improve traits in energy crops and grain species.

Indicator 2

During FY 2010, ARS will develop new or improved methods to measure or predict quality.

FY 2010 Accomplishments:

Corn stover, the most abundant biomass resource today, can be an attractive feedstock for biofuel production. However, research is needed to enable breeding of corn with higher yields of ethanol. ARS and University of Minnesota showed that genetic traits affecting cellulosic ethanol yield (cellulose, lignin, and glucose release) had moderate to high heritability and were not

negatively correlated with grain yield. Further, they identified genetic markers for cell wall traits important for cellulosic ethanol production. Their work enables the use of marker-assisted selection to breed corn which exhibits both higher yields of cellulosic ethanol (from stover) and higher yields of grain.

In addition, University of Minnesota scientists discovered a corn mutant with reduced ferulate cross-linking in stover; and ARS scientists showed that the mutant was more easily digested to fermentable sugars. Research is continuing to isolate the mutated gene in order to breed a superior feedstock for both biofuels production and corn silage production.

Impact: This research enables the breeding of new corn varieties with stover which will make lower-cost biofuels than stover from the current varieties of corn.

Growing feedstocks for biofuel production on marginal croplands such as CRP (Conservation Reserve Program) would minimize food-vs-fuel concerns. ARS scientists determined the effects of plant species composition, diversity, above ground biomass, and chemical composition on potential biofuel yield across major Northeastern ecoregions. Their analyses showed that CRP lands with a high proportion of native warm-season prairie grasses have the potential to produce more than 600 gallons of ethanol per acre, while still maintaining the ecological benefits of the perennial grasses.

In another study, ARS scientists showed that annual biomass yields and plant density of switchgrass stands in the Northeast remained stable over a 20 year period.

Impact: This research helps to enable the production of perennial grasses for bioenergy production.

ARS scientists working together with the Noble Foundation produced the first published genetic map for switchgrass. With this map, scientists can genetically dissect, identify and assemble loci responsible for many high value traits.

Impact: This research enables breeders to better recombine, evaluate and enhance switchgrass varieties exhibiting desired traits.

Producing biodiesel fuel from soybean oil with high levels of oleic acid significantly improves cold-flow properties and oxidative stability. ARS scientists identified and combined mutant alleles of two soybean fatty acid desaturase genes, resulting in beans with high oleic acid content. The researchers also developed molecular markers for these genes thereby facilitating the breeding of soybean varieties containing this valuable trait.

Impact: This research enables the breeding of improved varieties of soybeans for biodiesel production.

Indicator 3

During FY 2010, ARS will develop technologies leading to new or improved products from renewable resources and agricultural residues and wastes.

FY 2010 Accomplishments:

Weeds limit switchgrass establishment from seed, but few herbicides are labeled for switchgrass establishment. By applying quinclorac, which provides effective control of grassy weeds, plus atrazine, which provides good broadleaf weed control, ARS scientists generated good switchgrass stands for a variety of ecotypes throughout the Great Plains. By using herbicides and other good management practices, switchgrass yields in the first year following planting were half of full and were at full production in the second year. This research enabled the labeling of quinclorac for switchgrass establishment in the Great Plains.

Impact: This research helps to enable the commercial production of switchgrass for bioenergy.

One reason why cellulosic ethanol is much more expensive than corn-based ethanol is that biomass contains both hexoses, such as glucose, and pentoses, such as xylose. Corn-based ethanol is produced with brewers yeast, which converts only glucose; and although new microorganisms have been developed to convert both hexoses and pentoses to ethanol, these recombinant organisms ferment glucose preferentially and do not begin to metabolize pentoses until low glucose concentrations have been reached. As a result, fermentations times are long and the pentoses are not fully converted. To overcome these hurdles, researchers at ARS and Iowa State University co-developed a two-stage simultaneous saccharification and fermentation process. In the first stage pentoses are released and fermented to ethanol using an organism capable of highly efficient pentose metabolism. In the second stage glucose is released and simultaneously converted to ethanol with brewers yeast. Using this process, an ethanol yield of 85 gal/ton was achieved from corn stover. If the traditional process that ferments only glucose had been used, the yield would have been only 65 gal/ton.

Impact: This research lowers the production cost of cellulosic ethanol.

Beta-D-xylosidase from the bacterium *Selenomonas ruminantium* is the most efficient enzyme for releasing the sugar xylose from biomass, but high concentrations of xylose inhibit this enzyme. ARS scientists developed a mutated enzyme which tolerates 3X higher sugar concentrations and so lowers the production costs for cellulosic ethanol.

Impact: This research helps to enable the commercial production of cellulosic ethanol.

Livestock farmers with anaerobic digesters can increase their income by charging tipping fees for food waste and adding the waste to their digesters. ARS scientists showed that anaerobically digesting mixtures of swine (or dairy) manure and 5% pulped food waste produced about 20% more biogas than containing only 1% food waste. Food waste is typically pulped before trucking in order to dewater it and thereby reduce hauling costs. ARS scientists also showed that digester pH must be controlled when manures (especially dairy cow manures) are co-digested with food wastes. In large-scale digesters, pH is typically controlled by adjusting the fraction of food waste added.

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ARS scientists also showed that adding switchgrass to a high-solids anaerobic digester increased the biogas yield from dairy manure about four-fold. They also found that the increased yield is the same for green switchgrass (harvested in July) or senescent/brown switchgrass (harvested in January) although the point of harvest changes the timing of optimal biogas production.

Impact: This research improves the profitability of manure digestion.

Fishmeal, the traditional feed for aquaculture, has become very expensive (~\$1,500/ton) due to declining marine stocks. ARS researchers, in collaboration with South Dakota State University, determined that a feed combination of 40% DDGS (a co-product of corn ethanol production), 9.5% soybean meal and 24% fishmeal resulted in the highest weight gain in Yellow Perch. Replacing the current diet in Yellow Perch aquaculture (40% fishmeal) with the DDGS-based diet could save the industry nearly \$9 million annually.

Impact: This research improves the profitability of fresh-water aquaculture.

Measure 2.1.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2010:

During FY 2010, ARS reported on 5 technological breakthroughs or scientific advancements that made significant contributions toward reducing the cost and increasing profitability, improving the efficiency, increasing the yield, and increasing the sustainability of producing or converting biobased feedstocks into biofuels.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Membrane fabrication technique to produce membranes for ethanol purification	Technology available for licensing	Manufacturers of membrane separation equipment	Lower-cost and more energy-efficient processes for bioethanol production
Disease-resistant variety of energy cane	Germplasm available for cultivation or breeding	Farmers in Coastal Plains of Southeast U.S.	Enable the commercial production of high-biomass varieties of sugarcane
Genes for high-oleic soybeans	Germplasm and gene markers for breeding	Seed companies	Higher performance biodiesel
Two-stage saccharification and fermentation process for cellulosic ethanol	Published research results	Biorefiners of cellulosic biomass	Cellulosic ethanol is more commercially viable
Highly active saccharification enzyme	Technology available for licensing	Enzyme manufacturing companies	Cellulosic ethanol is more commercially viable

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

During FY 2011, ARS will

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

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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.

During FY 2013, ARS will

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

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

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

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 2010, ARS will develop technologies leading to new or improved products from renewable agricultural resources, residues and wastes.

FY 2010 Accomplishments:

Table grapes rot and spoil after harvest unless actions are taken to preserve them, such as the fumigation of grape storage rooms with sulfur dioxide; however, growers of 'organic' grapes cannot use sulfur dioxide and need an acceptable option. Researchers in Parlier, California, evaluated ozone fumigation in Parlier and in two commercial cold storages. Ozone gas, an approved substance for use by 'organic' growers under the USDA National Organic Program rules, reduced rot and approximately doubled the storage life of the grapes in cold storage from 2-3 weeks to 4-5 weeks.

Impact: This work provides a useful alternative method to reduce rot and extend the storage life of grapes in this industry, which produced 99 million boxes worth approximately \$1,200,000,000 in California in 2008, of which approximately 5% were classified as 'organic'.

Researchers in Albany, California, in collaboration with Cooper Tire and Rubber and the National Renewable Energy Laboratory, conducted a Life Cycle Analysis comparing petroleum-based and bio-based material usage in tire manufacturing. The analysis estimated the potential impact of biobased materials technology on reducing oil dependency related to 1) raw material manufacture; 2) gasoline savings from improved fuel efficiency; 3) net energy savings associated in making raw materials; and 4) the potential impact on greenhouse gas emissions. The use of natural rubber in all tire components was premised.

Impact: The analysis effectively demonstrated the positive contributions the U.S. tire industry could make toward the goal of decreasing petroleum dependency by converting from petroleum based materials to non-petroleum based materials.

A starch-oil composite gel fat replacer for ground meat applications was developed by scientists at Peoria, Illinois, and commercialized by a commercial partner and licensee, resulting in large scale production of a fat replacer gel and sales of reduced fat ground beef patties. Recently the color and flavor attributes of the gel were improved by adding clean label colorants and flavors. Use of the gels allows the conversion of 93-95% lean beef, which tends to yield a chewy and dry cooked patty, to a low-fat alternative with consistently observed tenderness, juiciness, and flavor (delivered in the lipid phase of the gel). Similar results of this technology were also demonstrated in meatballs and pork sausages.

Impact: The company plans to expand the marketing of the low-fat patties to large volume institutional customers as well as broaden the product line to include emulsified meat products such as frankfurters and lunch meats. The availability of this technology, which delivers significant fat (and calorie) reduction while enhancing product quality, will ultimately enable progress in addressing consumer obesity and increasing acceptance of healthier alternatives to traditionally high fat foods.

Canker and melanose diseases cause postharvest rejection of citrus fruit. Pre-harvest sprays of a wax emulsion combined with pesticide, applied by scientists from Winter Haven, Florida, along with industry cooperators, was successful in reducing canker bacteria and melanose fungus on citrus leaves and fruit in the field, resulting in less inoculum when the fruit entered the packing

house and less postharvest decay and eliminations. The reason for the reduced pathogen load due to the pre-harvest treatment was because the wax spray allowed the pesticide to remain longer on the tree during rain events.

Impact: This process reduces postharvest problems and resulted in a patent application.

Pterostilbene is a naturally-occurring phenolic compound in blueberries and an analog of resveratrol which is the well-known polyphenol in grapes and wine. Scientists at Oxford, Mississippi, showed that pterostilbene is a more effective cholesterol lowering agent than resveratrol in laboratory animals, as far as activating a protein that plays a major role in lipid metabolism and transport. In another animal study, pterostilbene was shown to reverse memory and cognition deficits.

Impact: For these activities and the potential for similar effects in humans, pterostilbene was licensed by a company (ChromaDex). Commercialization of pterostilbene under the tradename pTeroPure™ was launched in April 2010. pTeroPure™ pterostilbene is now on the market for use as a pure compound, or mixed with other natural compounds as dietary supplements. More pterostilbene products are expected to be on the market in the coming years.

Indicator 2

During FY 2010, ARS will develop new or improved methods to measure or predict quality, or to sort by quality.

FY 2010 Accomplishments:

For almonds, initial moisture content and moisture migration are critical for safe storage and the preservation of their quality attributes, and there is a need for real-time monitoring of moisture content at different stages of processing. At the request of the Almond Board of California, engineers at Athens, Georgia, adapted a microwave dielectric method, which was originally developed for grains and seeds, to rapidly predict moisture content in almond kernels.

Impact: Adoption of this technology by almond growers and processors will allow them to improve the quality of almonds, avoid spoilage and waste, and maintain their position as the global market leader.

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

During FY 2010, 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.

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Describe the Technology	Describe the Transfer	Identify the Customer	Impact
Expanded Polystyrene (EPS) and Expanded Polypropylene (EPP) are used to make non-biodegradable protective packaging materials, a \$2.2 billion industry. Engineers at Lubbock, TX, developed six cotton byproduct blends and mechanical processing techniques that allowed for the cooperator to manufacture 100% biodegradable packaging composites, using their technology, which outperformed EPS and EPP.	CRADA	Ecovative Design, LLC	The cotton byproduct protective packaging material resulting from this research allowed the cooperator to launch the product in 2010 with a Fortune 500 company and gain the interest of two other Fortune 500 companies. More widespread use of cotton byproducts is expected within the next few years.
There is a great demand in the U.S. and world-wide for increased development and use of biobased products. Scientists at Peoria, IL, developed and patented a biobased lubricant called estolides which have physical properties that can make them a leader in fulfilling demand for the increased development of bio-based lubricants in the U.S.	CRADA	LubriGreen (formerly called Peaks and Prairies, LLC)	A private sector partner has advanced commercialization, production and availability of the product to future customer/industry users. The first commercial production will take place in early FY 2011. Development of estolides will lessen our demand on foreign oil while decreasing the amounts of petroleum-based pollutants being released into the environment.
Engineers in Manhattan, KS, developed technology to measure traits of single wheat kernels using near-infrared spectroscopy (NIRS). This technique can also determine traits of single insects, such as species and age.	In cooperative work with the Centers for Disease Control (CDC), Atlanta, GA, and the Ifakara Health Institute, Ifakara, Tanzania, the researchers showed that the technology determines mosquito species and age with about 90% accuracy.	Centers for Disease Control (CDC), Atlanta, GA, the Ifakara Health Institute, Ifakara, Tanzania, and researchers in England, Austria, and Australia.	These findings have importance for monitoring control programs where species identification and reduction in the proportion of older mosquitoes that have the ability to transmit malaria is an important outcome. The technique has been adopted by the CDC and researchers in England, Austria, Australia, and Tanzania.
Engineers at Manhattan, KS, developed a low cost color image based sorting device for grains which has unprecedented accuracy, throughput, and low cost for inspection/sorting systems.	Engineers at Manhattan, KS, transferred the low cost color image based sorting device for grains to National Manufacturing through a CRADA. A CRADA with Jolly Time Popcorn is also in place to adapt the machine for sorting popcorn, and the camera design has been transferred to an electronics manufacturer	National Manufacturing, Jolly Time Popcorn, Short Dog Electronics.	These instruments have been sold to various seed breeders and seed foundations in the US and internationally. These instruments have been extensively used for separation of large bulks of popcorn, yellow and brown flax, red and white wheat, scab-damaged wheat, and removing weed seeds from seed stocks to improve

STRATEGIC GOAL 2

(Short Dog Electronics).

quality of breeding lines and end-use products. North Dakota State University seed foundation states that the machines shortened production time for yellow flax by one year, increased production by 20%, and reduced contaminants by 90% over past practices. Other users report similar impact.

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

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

During FY 2013, ARS will

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

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

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 2010, ARS will develop new production practices and decision support tools that increase profitability and improve environmental quality.

FY 2010 Accomplishments:

Impact:

Measure 2.2.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2010:

During FY 2010, ARS reported on ____ new technologies and systems developed and used by customers that utilize new configurations of practices and technologies to reduce the cost and increase profitability, improve the efficiency or increase the yield, and increase the sustainability of production.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact

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

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.

During FY 2013, ARS will

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 2010, ARS will identify underlying genetic and physiologic mechanisms impacting reproductive efficiency, nutrient conversion, and growth in food animals.

FY 2010 Accomplishments:

Microbial diversity in the bovine rumen. Scientists at ARS and the J Craig Venter Institute completed a survey of the unique diversity of microbial populations in the rumen of cows fed forage diets and established protocols for use in future investigation. This work established guidelines for conducting future research examining the rumen micro-biome. The observed bacterial diversity was between 3181 to 7483 species-level taxonomic units (individual organisms), the largest number observed for a ruminant species. This diversity was dominated by Bacteroidales, unknown bacteria, Clostridiales and Bacteroidetes taxa. There was a considerable difference in microbial diversity between cows from which the samples came. The fungal community was sequenced to saturation and also resulted in identification of a novel unknown fungal group. Raw extrusa should be suitable for future studies on rumen microbial diversity.

Impact: These results will help the dairy industry improve the efficiency of dairy cattle diets and minimize the output of greenhouse gases by dairy cattle through manipulation of the bovine ruminal community.

Excellent fertility during spring breeding of Romanov crossbred ewes. Most breeds of sheep are far more fertile during fall breeding than spring breeding, resulting in the vast majority of lambs being born in the spring. The seasonal production of lambs adversely affects product availability for consumers and is a major production and marketing obstacle for the U.S. sheep industry. To address this problem, producers have traditionally used crossbred ewes of Dorset, Finnsheep and Rambouillet breeding to achieve fertility rates ranging from 60 to 70% when breeding in the

late spring. ARS scientists documented that Romanov crossbred ewes realized fertility rates of 87 to 89% when exposed during May, regardless of the remaining breed composition (Dorper, Dorset, Katahdin, Rambouillet, and White Dorper).

Impact: These results indicate that commercial sheep producers can better overcome the seasonal constraint of fertility rate by use of Romanov crossbred ewes when breeding in late spring and will better able to meet the year round production requirements to address consumer demand for US lamb products.

Year-round spawning achieved with pompano. Lack of sustained year-round production of juveniles for grow-out operations is one of the foremost bottlenecks of marine finfish aquaculture. Spawning induction protocols were developed and tested. Spawning performance of Florida pompano broodstock, measured as number of eggs, fertilization, egg quality, and hatch rate was quantified over a 12 month period. Spawning was achieved in 10 months of the year having an average production rate of 1.9 million eggs/year with no discernable diminishment in egg quality over time.

Impact: This work demonstrates Florida pompano seedstock can be produced year-round from a small population of broodstock, and overcoming one of the key bottlenecks to marine finfish aquaculture.

Development of protocols to simplify control of sexual maturation in salmonids. In several states and regions, only non-reproductive (i.e. sterile) fish can be used for stocking or fee fishing operations. This rule is meant to control spread of genes from non-native fish stocked into public waters. Procedures developed by ARS Scientists at Leetown, WV, simplify and standardize generation of sterile rainbow trout and Atlantic salmon. These procedures were shown to also work well with brook trout and brown trout. Production of sterile fish for stocking is important to many small rural aquaculture businesses where only sterile fish can be used due to environmental considerations.

Impact: A commercial Atlantic salmon farming operation and a state hatchery have successfully applied the procedures to produce sterile salmon and brook trout, respectively.

Indicator 2

During FY 2010, ARS will develop technologies leading to improved marketability of animal products.

FY 2010 Accomplishments:

Commercial genotyping tools impact bovine livestock research and the dairy AI industry. The success in the development and application of SNP marker panels by ARS to genomic research in cattle fueled development of additional SNP panels for cattle. ARS led the development of a low (Illumina 3K) and a high density (Illumina 777K) panel, and their impact on the industry is anticipated to be high as testing of different genetic improvement paradigms based on cheaper SNP panels begins. The BovineSNP50 assay panel, developed by ARS remains the global de facto standard for cattle genomics research and genetic prediction use with sales having surpassed 500,000 samples..

Impact: Adoption of these technologies has had a tremendous economic impact on the dairy industry and has resulted in significantly improved genetic prediction accuracies and enhanced genetic progress.

Infrared beak trimming improves hen welfare. Beak trimming, using a hot blade, is a common practice in the poultry industry that is often criticized as potentially painful or inhumane. ARS researchers investigated an alternative method of beak trimming which uses an infrared laser similar to those used in biomedical procedures. In this research both laser and hot blade trimming treatments were applied on production hens from 5 to 35 weeks of age. Hens which were beak-trimmed using the infrared laser method showed an improvement in performance and a reduction in stress levels.

Impact: These results suggest that the infrared beak treatment provides a more welfare friendly means of beak trimming, allowing birds to display more efficient feeding behavior with less morphological abnormalities of the beak stumps which increase the efficiency of egg production and increase the marketability of eggs to consumers.

Noninvasive tenderness prediction system accurately predicts tenderness of beef cuts. The U.S. beef industry and the Agricultural Marketing Service (AMS) have sought implementation of standards for tenderness claims. To this end, industry and AMS need instrumentation to noninvasively predict tenderness of meats. Previously, ARS scientists had developed a noninvasive method to predict tenderness of the ribeye muscle of beef carcasses based on visible and near infrared (VISNIR) spectroscopy. Under a trust agreement between ARS and the National Cattlemen's Beef Association, ARS scientists determined that the existing system could also predict tenderness of other muscles of the carcass. Additionally, we obtained similar results with application of VISNIR directly to the exposed gluteus medius on the anterior end of top sirloin subprimals either during carcass fabrication or after aging.

Impact: These results suggest this technology can be efficiently and cost-effectively utilized by virtually all segments of the industry to control variation in tenderness, which will greatly enhance the industry's ability to improve tenderness and consumer acceptance and consumption of U.S. beef products

Improved soy concentrate for aquafeeds. Soy protein concentrate (SPC) is a highly nutritious ingredient in aquafeeds, but is currently too expensive to be practical. ARS researchers in Aberdeen, ID, have developed a modified method for the production of feed grade SPC and are working with CRADA partner in pilot scale testing and possible commercialization.

Impact: Availability of a feed grade SPC will make fish meal free diets more cost effective, and the aquaculture industry more sustainable.

Development of a highly efficient Catfish Egg Incubator. Traditional catfish egg incubators (moving paddles to circulate water) have been used for nearly a century but require a high water exchange rate and lose efficiency at egg loading rates above 15 lbs per trough. ARS researchers at Stoneville, Mississippi, in collaboration with industry partners, have developed a new incubator (the see-saw) which can incubate more eggs and use less water and labor.

Impact: In comparison with the traditional incubator, the see-saw produced two and a half times as many swim-up fry. Additional studies indicate that eggs can be hatched in the see-saw using 10-20% as much water, saving considerable labor, space, ground water, and energy for pumps and heaters. In commercial field trials thus far over 100 M egg have been hatched.

Indicator 3

During FY 2010, ARS will identify genes and their function leading to DNA tests for use in food animal genetic improvement programs.

FY 2010 Accomplishments:

Identification of 13 markers affecting gilt reproductive performance in commercial swine. Currently, a large number (over 20%) of females retained for breeding in commercial swine production fail to produce two litters largely due to poor reproductive performance. Genotypic data were collected by ARS scientists on 700 boars contributed by industry partners. Phenotypic data on each of the boars' daughters were available and their deviations from contemporary group means were used as phenotypes for each boar. Similar data were available for 123 boars used in the ARS-USMARC commercial population. Two significant markers were detected for number born dead, nine suggestive markers were detected for number born alive, and two suggestive markers were detected for weaning-to-estrus interval.

Impact: These findings can have immediate impact in commercial populations once tools are developed and validated to better identify gilts with superior genetic merit for reproductive efficiency. Improved reproductive performance improves the production efficiency of the pork production for producers.

Evaluation of host chicken genetic effect on vaccine efficacy. Vaccines have proven to be the most effective and economical method to combat infectious diseases in humans as well as livestock. Efforts to improve vaccine protective efficiency have continued and expanded. Host genetic differences were investigated by ARS scientists for influence on a Marek's disease (MD) vaccine efficacy using unique genetic lines of chickens. These results suggest that host genetics play an important role influencing MD vaccine protection efficiency as demonstrated by significant interactions between vaccine protection and individual genetic line. Continued analyses of the research data further suggested that different genetic lines of chickens respond to the same vaccine with different protective efficiency.

Impact: These results underscore the need for more comprehensive development of chicken vaccines specific to individual genetic lines and possibly for varying production environments.

Molecular tests for stress tolerance genes in Pacific oysters. Selective breeding of Pacific oysters to improve agronomic performance is in early stages. Scientists from the ARS Shellfish Genetics Program in Newport, Oregon demonstrated that higher expression levels of stress-response related genes in Pacific oysters are associated with of poor growth and survival in field trials.

Impact: This research indicates that molecular testing in the laboratory may provide a rapid, low-cost method for identifying superior performance in the field. These assays will help scientists predict performance and accelerate genetic improvement efforts.

Discovered genetic basis for Biotype 2 (BT2) disease caused by *Yersinia ruckeri*. Biotype 2 variants of the bacterium *Yersinia ruckeri*, the causative agent of enteric redmouth, are an emerging disease problem in US and European finfish aquaculture. Scientists at the National Center for Cool and Cold Water Aquaculture identified four mutations, each in a different bacterial strain, that cause the loss of motility and enzyme (lipase) secretion that define Biotype 2 *Yersinia ruckeri* strains. All four mutations were in genes that encode essential components of the flagellar apparatus which allows the bacterium to swim and secrete certain enzymes. Our results demonstrate that the Biotype 2 phenotype has emerged separately at least four times.

Impact: This differentiation of pathogen lineages is being used to assess the risk of BT2 disease and for development of specific vaccines and treatment strategies.

Indicator 4

During FY 2010, 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 2010 Accomplishments:

Turkey genome assembly completed for the turkey industry. Scientists from ARS, Virginia Tech's Bioinformatics Institute and the University of Maryland's Center for Bioinformatics and Computational Biology completed the genomic map of turkey, which will serve as the cornerstone for the development of sophisticated genomic technologies for the turkey industry. The turkey genome assembly was further strengthened when physical, comparative and genetic maps built by researchers from Michigan State University and the University of Minnesota were used to match additional DNA sequences to the turkey chromosomes. At completion, the original partnership expanded to include 68 scientists affiliated with 28 national and international research institutions. This project illustrates the rapid pace of genomic sequencing technology improvements. The turkey genome was sequenced in less than a year at an estimated cost of \$250,000 compared to the cost of the original bovine genome sequence which cost an estimated \$53,000,000.

Impact: The information gleaned from this project will help breeders develop improved commercial turkey lines and significantly increase genetic progress for economically important traits, increasing value of turkey products for both producers and consumers.

Construction of the first genome-wide integrated genetic map for rainbow trout. ARS Scientists at the National Center for Cool and Cold Water Aquaculture (NCCCWA) in Leetown, WV are using molecular genetic technologies to enhance selective breeding of important aquaculture production traits. This requires the development of tools such as genetic maps, which characterize the order and distance between genetic markers, and physical maps which contain overlapping DNA fragments from chromosomes. A comprehensive map integrating the genetic and physical maps was constructed by connecting 274 reference points throughout the 29 chromosomes of the trout genome.

Impact: This integrated mapping resource will be used to reveal associations in the inheritance of superior production traits with the genes which underlie them.

Indicator 5

During FY 2010, ARS will continue to characterize germplasm of food animals for traits of importance.

FY 2010 Accomplishments:

Efficient Use of Cryopreserved Boar Semen. Germplasm collected and stored in a gene bank will become a limited resource as it is used over time. Therefore, optimizing the number of motile cells to inseminate in a sow is important. To address this issue, an experiment evaluating the optimal insemination dose (1.0, 0.75, 0.5, and 0.25 billion sperm) for boar semen was performed. ARS scientists cryopreserved all boars' samples, performed pre-freeze and post-thaw analysis of the semen samples, and provided input into statistical analysis with university collaborators. The experiment found no statistical differences in pregnancy rate. However, the 0.25 treatment had numerically fewer pregnant sows. To ascertain the dose most appropriate to use if semen is limited, the total number of fetuses per sow inseminated was multiplied by the number of potential doses available if only one billion motile sperm cells existed. The results suggest that the optimal dose of semen to utilize per insemination was between 0.50 and 0.75 billion motile sperm cells.

Impact: This information significantly aids the National Animal Germplasm Program in planning germplasm collections and assures that effective use of stored germplasm can be made when needed. For industry the results suggest that inseminating sows with one or two billion cells may exceed what is adequate to create a pregnancy with a sufficient litter size when inseminations are properly timed during estrus.

Arctic charr selected for increased growth. Arctic charr have a flavor many consumers feel is superior to trout and salmon. Scientists at the National Cold Water Marine Aquaculture Center in Franklin, ME evaluated the growth of two different arctic charr stocks for culture in recirculating aquaculture systems. Development of a breeding program for US arctic charr stocks could alleviate some of the production problems limiting expansion of arctic charr culture and provide a source of germplasm with improved production traits.

Impact: A charr line selected for fast growth and delayed sexual maturity will be released for cooperative research evaluations and commercial production in the fall of 2010.

Indicator 6

During FY 2010, ARS will develop improved cryopreservation technology for storage of animal germplasm and continue to increase the stocks of germplasm stored within the National Animal Germplasm Program repository.

FY 2010 Accomplishments:

National Animal Germplasm Program (NAGP) – FY2010 Collection Summary (1). This section summarizes the NAGP increases and impact over the past 5 years. The national collection of animal genetic resources held by ARS, ended FY10 with 599,112 germplasm and tissue samples from 13,638 individual animals of agronomically important animal species. Over the past five years the collection has grown linearly and increased in size by 163%. To date the collection contains samples from 32 different species, 143 breeds, and 181 specialized lines across all life forms in the collection. The collection is the largest national repository in the world and is at least twice as large as any of the European gene bank collections.

Table 1. Summary of Animal Numbers and Germplasm and Tissue Inventory by Species, Breed within Species, and Line within Breed and Species.

Common Name	Species	Breeds	Lines	Number of Individuals	Units of Germplasm	Contribution to Inventory
Aquatic Freshwater	13	0	24	690	20,444	3.35%

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Fish						
Aquatic Invertebrates	3	0	3	213	7,198	1.18%
Aquatic Marine Fish	6	0	0	15	823	0.13%
Beef Cattle	2	47	7	2,867	123,261	20.18%
Bison	1	0	1	73	1,565	0.26%
Chicken	1	11	100	1,411	6,502	1.06%
Dairy Cattle	1	12	1	4,997	175,847	28.78%
Elk	1	0	0	4	340	0.06%
Goat	1	14	0	392	9,536	1.56%
Pig	1	21	30	1,238	196,288	32.13%
Screwworm	1	0	10	10	19,350	3.17%
Sheep	1	38	5	1,728	49,779	8.15%
Total:	32	143	181	13,638	610,933	100%

Impact: The USDA - NAGP repository serves a vital role in protecting and preserving economically valuable germplasm and genetic diversity for the livestock industries. The animal germplasm program has demonstrated significant growth over the past 5 years and is the leading preservation effort in the world for animals.

Measure 2.2.2 Summary of the Major Technologies Developed, Transferred, and Used in FY 2010:

During FY 2010, 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
Genetic evaluations for conception rate in dairy cattle.	ARS researchers in Beltsville, MD developed new genetic evaluation procedures to address the declining fertility of the US dairy herd which was adopted by the industry and incorporated into the genetic evaluation program provided to producers.	U.S. dairy cattle producers.	Increased rates of fertility will be produced using these tools in the field to select for dairy cow fertility and reproductive efficiency.
Commercial genotyping tools for the beef and dairy industries.	ARS led the development of a low (3K) and a high density (777K) panel, for use in the evaluation of beef and dairy animals through whole genome selection programs and specific trait or breeding program application for industry. These tools are now being commercially	Beef and dairy producers and genetic evaluation system managers for these industries.	This technology will facilitate higher accuracy genetic evaluations and increased genetic progress across a wide range of breeds and breeding program objectives for the beef and dairy industries. This technology will be rapidly adopted and will have a significant impact

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	marketed through various genetic testing labs around the world and are available to all producers.		on the production efficiency and profitability of these industries.
A method to determine newborn piglet colostrum consumption.	ARS lead the development of a rapid on-site method to determine that a newborn piglet has consumed adequate colostrum was developed and implemented for industry. It has been presented at various industry meetings and is being marketed to pork producers through various venues.	US pork producers.	This technology will enable producers to decrease pre-weaning mortality and improve production efficiencies by identifying sows that fail to initiate milk production after farrowing and by identifying piglets that have not received adequate colostrum. This diagnosis will enable producers to decrease piglet mortality through intervention and treatment.
Improved efficiency in hybrid catfish production. Transfer: Customer/user. Impact/outcome:	ARS researchers in Stoneville, MS, visited all commercial hybrid catfish production facilities to advise, demonstrate techniques and conduct experiments to address hybrid production difficulties.	U.S. catfish fingerling producers	Improved efficiency in hybrid catfish production led to increased commercial production of hybrid catfish compared with the previous year
Improved Atlantic salmon germplasm selected for increased growth	approximately 500,000 eggs from the USDA ARS National Cold Water Marine Aquaculture Center's Atlantic salmon breeding program were transferred to the Maine Aquaculture Association. for commercial distribution	Atlantic salmon industry stakeholders	Utilization of the 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
Water treatment processing in fish culture systems	Information on recirculating systems system management delivered in lectures, meetings and one on one venues	Fish farmers, environmental non-government organizations, and academic colleagues.	Training fish farmers and other interested people, how to successfully run and manage recirculating aquaculture systems
Copper sulfate to control fungus on eggs	This research has been presented at various venues, including 5 national scientific meetings, regional extension workshops and several industry stakeholder meetings	Extension agents, catfish hatchery managers	The difference in cost of treating eggs to control fungus with the recommended rate of copper sulfate and the labeled rates of formalin and hydrogen peroxide is significant. Approximately half of the catfish hatcheries are using copper sulfate. This technology was selected as the 2010 winner of the Federal Lab Consortium, Mid-Continent region Excellence in Technology Transfer award

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

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.

During FY 2013, ARS will

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

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

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

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

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

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.

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 2010, 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 2010 Accomplishments:

New application procedures increase herbicide efficacy. The wide use of the herbicide glyphosate (Round-Up) on crops can create a situation where target weeds begin to develop a resistance, thus making the herbicide less effective. When this happens, it can require applicators to use more and more glyphosate in their treatments, which increases costs to both applicators and farmers and further exacerbates the weed resistance phenomenon. To address this growing problem, ARS researchers in College Station, Texas, studied how spray droplet size affects glyphosate effectiveness. The work showed that a higher spray droplet density (number of droplets per given area) results in better weed control. An added benefit is that using less glyphosate to achieve the desired result also serves to slow down the process of weeds developing glyphosate resistance. Increasing the useful lifetime of an important and environmentally friendly herbicide like glyphosate also pushes into the future the need to shift to more expensive, environmentally harsh chemicals for weed control.

Impact: This knowledge allows applicators to adjust their application equipment in a manner to achieve good weed kill while using significantly less glyphosate and resulting in significant cost savings.

Hand-held machine for assessing two-spotted spider mite damage in cotton. The two-spotted spider mite is an important pest of cotton and many other field crops. Early detection of plant damage caused by the mite is difficult because initial infestations tend to be scattered in small areas in the field. ARS researchers in College Station, Texas, adapted a hand-held light-reflecting (multispectral) instrument to detect the mite in growing cotton and beans. The instrument is capable of reliably distinguishing mite infested plants from non-infested plants, and is capable of differentiating between light, medium, and heavy spider mite infestations on cotton.

Impact: This new technology will be very useful in detecting early spider mite infestations in cotton and other crops, and will guide rapid-response control procedures to assure effective protection of crops from mite damage; using the lowest amount of pesticide possible, with a minimum of adverse environmental impacts.

Optimized aerial application treatments. With rising operational costs, including fuel and chemical inputs, and an increasing concern and awareness of the damaging effects of spray drift away from targeted treatment areas, it is critical that aerial applicators maximize the efficiency of the spray treatments they apply. ARS researchers in College Station, Texas evaluated conventional and innovative application technologies, at varying spray rates and droplet sizes, to determine optimum deposition on the specified target. The work showed that optimum spray deposition within a dense plant canopy can be achieved with significantly larger droplets than those found in small droplet sprays that are highly driftable and that can thus cause damage to non-targeted plants and other negative environmental effects. This accomplishment is important because it provides guidance to the aerial application industry on the proper use of spray treatments that will provide the desired results, while significantly reducing off-target movement of the sprays and the adverse environmental impacts which can result.

Impact: These results will also help applicators to address new spray conditions and requirements that may develop due to climate changes in their region.

Sugar beet seed germination under high salt concentrations. High salt concentrations in soils are common in sugarbeet growing areas. Poor seedling establishment is a key limiting factor in sugar beet production, and numerous causes have been suggested, including high salt-soil environments. Poor seedling establishment means that far more seeds are required to ensure optimum production. To identify key breeding lines that enhance seedling vigor and ensure

optimum germination and establishment, the response to salt stress on germination and production was determined. Two different responses to saline environments were found – one resulted in a dose-dependent reduction in germination percent, and the other mode was a time-delayed germination rate, but less overall reduction in total germination.

Impact: As a result of this study, valuable, new germplasm was identified with tolerance to salt stress during germination that will be available to sugar beet seed companies for further development.

Indicator 2

During FY 2010, ARS will maintain and enhance genetic and genomic databases and make information accessible via standard software from the Internet.

FY 2010 Accomplishments:

The Legume Information System (LIS) interlinks genetic and genomic information across food and forage legumes. The global production of legume crops, including soybean, common bean, lentils, chickpea, pigeonpea, fava bean, and more, is crucial for global food security and human nutrition. Yet few legume crop research and breeding communities have the full complement of genomic and genetic resources to sustain a modern breeding program. ARS scientists in Ames, Iowa, together with scientists at the National Center for Genome Resources (NCGR), Santa Fe, New Mexico, have addressed this critical need through the Legume Information System (LIS) – a Web site and database that serves as a long-term data repository and a portal interlinking the genetic and genomic resources of a growing number of legume species. The LIS provides powerful new tools to retrieve, analyze, compare, and visualize legume genetic data. It enables domestic and international researchers to apply knowledge collated from legumes with complete genome sequences to develop additional genomic resources for the genetic improvement of other legume crops.

Impact: The LIS provides powerful new tools to retrieve, analyze, compare, and visualize legume genetic data. It enables domestic and international researchers to apply knowledge collated from legumes with complete genome sequences to develop additional genomic resources for the genetic improvement of other legume crops.

The corn haplotype map (HapMap) provides new insights into corn breeding at the genome level. Genetic diversity is the raw material for germplasm improvement by breeders. ARS scientists in Ithaca and Cold Spring Harbor, New York, and Columbia, Missouri, produced a high-resolution haplotype map of DNA sequence differences for the genomes of 25 carefully selected lines of corn. More than 3 million DNA sequence differences between the B73 reference genome sequence and the 25 diverse lines were identified. The data revealed that approximately 130 regions of the corn genome have been selected strongly over the years by breeders and thus contain agriculturally important and valuable genes.

Impact: The comparison of the DNA sequence variation data and genetic data revealed that 15 percent of corn genes are in regions characterized by low rates of genetic recombination, or chromosome shuffling, indicating that regions of the maize genome have been underexploited by breeders and thus represent potential sources of germplasm improvement.

Integrating the soybean genome sequence with the soybean genetic map and developing an encyclopedia of soybean gene messages. The full genome sequence of the soybean was difficult to assemble because of its large size and complexity. ARS researchers in Ames, Iowa, working with the U.S. Department of Energy and ARS collaborators in Beltsville, Maryland, helped to assemble the sequence and to integrate the whole genome sequence with the soybean genetic map. Thus, the sequence is now correlated with soybean traits collected during the last 30 years (~85 distinct mapped traits). Plant breeders can now begin to understand at a molecular level the genes that govern the traits for which they breed. Soybean has nearly 50,000 genes within its genome, but the function for most of these genes is unknown. Knowing when and how much each gene is turned on will help determine the gene's function. ARS scientists at Ames, Iowa, analyzed many millions of gene messages from 14 tissues or stages of development. This resulted in a "gene Atlas", which will be critical to the eventual identification of the function for all the genes in the soybean genome.

Impact: This is an important addition to our knowledge about soybean and, will be an invaluable tool for developing improved varieties.

Indicator 3

During FY 2010, 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 2010 Accomplishments:

Genome-wide analysis identifies genes involved in Southern corn leaf blight resistance. Southern corn leaf blight causes losses in corn production, but resistance breeding is difficult because of the many genes associated with this complex trait. To identify Southern corn leaf blight resistance genes, ARS researchers in Raleigh, North Carolina, have exploited new corn genomic information and genetic resources, including the corn genome sequence, the Nested Association Mapping population, and the maize Haplotype Map, with 1.6 million DNA markers. The preceding tools were generated with support from the USDA, National Science Foundation, and the U.S. Department of Energy. ARS researchers applied genome-wide analysis methods to pinpoint specific DNA sequence variations associated with Southern corn leaf blight resistance throughout the genome.

Impact: This discovery will enable crop breeders to develop corn with genetic protection to Southern corn leaf blight.

Progress in lowering barley feed grain phosphorus content. A valuable strategy to reduce the environmental impact of dairy and beef production and other forms of animal agriculture is to minimize the amount of nutrients in feeds to a level that both maintains productivity and results in reduced waste. This is a key concern for higher than necessary levels of feed grain phosphorus and the resulting high phosphorus level in animal waste. ARS researchers in Aberdeen, Idaho, demonstrated that one function of the barley *lpa1* (low phytate) gene is to generate a signal in the developing seed that regulates the amount of phosphorus transported into it from the mother plant. This provides new information that plant geneticists can apply to reduce total seed phosphorous. In complementary research, ARS researchers in Aberdeen released four new germplasm lines with highly digestible phosphorous in the important commercial categories of barley.

Impact: All this new information and genetic resources will advance the development of environmentally friendly feeds that lower phosphorous levels in animal waste and manure.

Molecular control network governing early crop seedling establishment and photosynthesis deciphered. Seedling establishment is an important trait that impacts crop production globally as well as adaptation to global change. However, the genetic and molecular determinants for improving seedling establishment are not well defined. At germination a seed must activate dormant pathways, and commence vigorous growth in darkness toward the soil surface, where upon exposure to light the photoreceptor phytochrome promotes a second transformation into the photosynthetically active state. ARS scientists in Albany, California, revealed that light activated phytochrome binds to a cohort of PIF (Phytochrome-Interacting Factors) proteins inducing their rapid degradation, thus releasing genes responsible for photosynthesis and green seedling growth.

Impact: This research establishes a foundation of basic information for the genetic determinants for improving crop stand establishment in target crops.

RNA controls seed production. Seed production and plant development are initiated by a double fertilization event during pollination that triggers both embryo and endosperm development. The coordination of these processes is highly susceptible to stresses associated with global climate change, including heat and water stress. ARS scientists in Albany, California, are genetically dissecting the cell and molecular processes responsible for the coordination of fertilization in plants. Genetic and molecular studies revealed that in male sperm cells, two genes work together to produce a natural double-stranded RNA molecule that down-regulates the activity of a control gene that functions specifically in sperm. Plants whose sperm cells lack this important natural double-stranded RNA molecule rarely complete double fertilization and hence seed set is reduced.

Impact: This discovery established a new paradigm for the role of natural double-stranded RNA molecules in coordinating plant development and seed production.

Discovery of a master regulator gene involved in barley disease defense. Cell death is a key component of disease resistance. Hence, new information about the molecular mechanisms of cell death can provide insight into how to protect plants from disease. ARS researchers in Ames, Iowa, have used a combined strategy of high-throughput transcript profiling with classical genetic analysis of cell death mutants to identify a barley gene that regulates cell death. The gene encodes a key ribosomal RNA processing protein, so the results suggest a role of rRNA processing genes in mediating plant defense responses. The gene appears to be a master regulator that controls the expression of dozens of other genes, which are necessary for plant survival, stature, and yield.

Impact: This discovery, also supported by the National Science Foundation-Plant Genome Research Program, provides new information that can be exploited by plant scientists in designing more effective mechanisms to protect plants from disease.

Indicator 4

During FY 2010, 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 2010 Accomplishments:

Identifying key sorghum lines for bioethanol production. Sorghum with high sugar content (sweet sorghum) is an important biofuel crop, but its genetic content must be characterized before it can be bred and incorporated into genetic research efficiently. Researchers at ARS' genebank in Griffin, Georgia, analyzed 96 sweet sorghum samples with DNA genetic markers to determine their genetic variability and population structure.

Impact: *This new genetic information for these sweet sorghums will enable breeders to develop superior sweet sorghum cultivars for bioethanol production.*

New germplasm and genetic resources developed to protect wheat and barley from the Ug99 stem rust. Wheat and barley germplasm with resistance to the virulent Ug99 stem rust strain is urgently needed to protect the global grain supply. ARS researchers in Raleigh, North Carolina; Aberdeen, Idaho; and St. Paul, Minnesota, evaluated 4,000 wheat and barley varieties and germplasm lines in Njoro, Kenya, for resistance to Ug99 stem rust. Lines were submitted from more than 25 public and private sector U.S. breeding programs. ARS researchers in Raleigh also developed 750 wheat lines with stem rust genes combined in two, three, four, and five gene stacks (or pyramids). These lines also have gene combinations for leaf and stripe (yellow) rusts. The researchers in Raleigh also developed and distributed 30 advanced lines of wheat incorporating multiple-gene resistance to stem rust race Ug99 to wheat breeders in 32 countries in cooperation with the International Wheat and Maize Improvement Center in Mexico. This information will enable breeders in the United States to identify and deploy resistance to Ug99 stem rust in advance of the pathogen ever arriving in the United States.

Impact: *These lines will greatly aid U.S. and international wheat breeders develop better worldwide resistance to stem rust race Ug99.*

Can rice be considered a healthy starch for consumers? The incidence of diabetes has dramatically increased in recent years in the United States. Starchy foods, like rice, are not recommended for people managing diabetes. ARS scientists in New Orleans, Louisiana, and Beaumont, Texas, evaluated 16 commercial rice cultivars and found that they differed in starch digestibility. Some cultivars had high levels of resistant and slowly digestible starch, indicating that, when consumed, the sugars would be slowly released into the bloodstream, as compared to other rice cultivars. This is important to consumers interested in moderating sugar in their diet.

Impact: *This study demonstrated that rice cultivars differ in the amount of nutritionally important starch fractions and offers the opportunity for developing new cultivars with improved dietary benefits.*

Potato germplasm resistant to cold-induced sweetening and acrylamide development in tubers. Potato tubers stored at temperatures less than 10°C accumulate glucose and fructose in a process referred to as cold-induced sweetening. Such tubers produce dark colored, bitter tasting chips and fries with unacceptable amounts of acrylamide, a chemical compound that has been identified as detrimental to human health. One way to prevent these problems is to breed new

cultivars with resistance to cold-induced sweetening. ARS researchers in Madison, Wisconsin, have conducted an extensive evaluation of wild relatives of cultivated potato to identify species with extreme resistance to cold-induced sweetening. They also quantified sugar composition and asparagine content in tubers of these wild species.

Impact: Because glucose, fructose, and asparagine are involved in the fried chip off-color and in the formation of acrylamide, these data will be of interest to potato breeders who want to minimize these problems by incorporating germplasm resistant to cold-induced sweetening into cultivated potato, and to food scientists seeking materials that can serve as more effective models for the contribution of each substance to chip color and acrylamide formation.

Indicator 5

During FY 2010, 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 2010 Accomplishments:

ARS scientists develop innovative, genome-wide selection methods to make crop breeding more efficient and faster. Genome-wide selection methods which incorporate DNA genome sequence information are potentially more effective than breeding methods based on trait selection and molecular markers. However, when ARS scientists in Ithaca, New York, simulated 20 cycles of breeding, they determined that genome-wide selection methods provided short-term gains, but became less effective after multiple cycles of genetic selection. With that insight, the scientists developed an improved breeding method that capitalizes on molecular marker data to make genome-wide predictions, but also maintains genetic diversity and minimizes the loss of favorable traits during genetic selection. Through this method, the researchers demonstrated that genome-wide selection out-performed trait (phenotypic) selection in both the short and long terms.

Impact: These new breeding tools provide practical methods for plant breeders to adopt genomic selection methods that substantially improve long-term benefit without reducing rapid initial gains.

Development of “intragenic” potatoes containing a late blight-resistance gene. The commercial introduction of crop plants improved by biotechnology has been limited by negative public perceptions for the safety of transgenic foods. These negative perceptions are being addressed, in part, by developing novel methods for in vitro genetic modification, referred to as “intragenic” technology. This method of gene introduction results in transgenic lines that contain no foreign DNA. ARS scientists in Albany, California, in cooperation with scientists at the J.R. Simplot Co., in Boise, Idaho, have successfully developed intragenic potatoes that contain a gene from wild potatoes known to confer resistance to the most devastating of potato diseases, late blight – the cause of the Irish potato famine, and which still plagues growers today. These potatoes do not contain any non-potato DNA, and were generated in vitro without selection (i.e. they do not contain antibiotic/herbicide resistance genes as markers).

Impact: Intragenic lines with late blight-resistance in the greenhouse and under field conditions will represent an important option for preventing losses to late blight.

New molecular breeding tools for heart-healthy oats. The oat genome is so large and complex that little genetic information and molecular markers have been available to assist oat breeding. This has meant that breeding for sustainable oat production and increased nutritional value has been slowed. In 2010, ARS researchers in Aberdeen, Idaho, and Albany, California, applied innovative DNA sequencing methods to produce 650,000 oat gene DNA sequence fragments. In addition, ARS researchers in Aberdeen teamed with ARS scientists in Fargo, North Dakota, and Raleigh, North Carolina, to develop the first oat-based single nucleotide polymorphism (SNP) markers. More than 700 SNP markers, which are highly useful to plant breeders, have been developed. The research was supported by ARS with additional funding from General Mills, North American Millers Association, and the USDA National Institute of Food and Agriculture. These major advances in molecular markers are publicly available to all oat breeders.

Impact: This plethora of new tools will enable oat breeders to use molecular markers for the first time to select and accelerate breeding for agronomic traits, disease resistance, and nutritional quality (high fiber and beta-glucans).

Tracking peanut gene expression patterns. To understand and structure and function of the genome of the peanut, a comprehensive tool for dissecting its complex genetic mechanisms is needed. ARS scientists in Lubbock, Texas, developed a tool to analyze changes in the expression of 49,205 peanut genes and tested the utility of this tool on a variety of peanut tissues. This is the first large-scale, publicly available tool for determining which specific peanut genes are active out of all genes that exist within the peanut plant.

Impact: The results generated by this tool will provide starting points for in-depth studies on finding candidate genes that can be utilized in reverse genetics to assign gene functions and identify specific molecular mechanisms of peanut response to environmental signals, developmental stages, and yield quality characteristics.

Discovery of natural variation in ozone tolerance in soybean. Ozone, the atmospheric pollutant, is responsible for billions of dollars in lost crop production each year. The effects of ground level ozone on soybean photosynthesis, seed yield, and antioxidant production, were investigated in 10 different soybean cultivars by ARS scientists in Urbana, Illinois. Doubling background ozone decreased soybean yields on average by 17 percent, but the variation in response among cultivars and years ranged from 8 to 37 percent. Chlorophyll content and photosynthetic parameters were positively correlated with seed yield, while antioxidant capacity was negatively correlated with photosynthesis and seed yield, suggesting a trade-off between antioxidant metabolism and carbon gain. Ozone exposure response curves indicated that there has not been a significant improvement in the tolerance of commercial soybean cultivars to ozone in the past 30 years.

Impact: The discovery of genetic variation in ozone tolerance in non-commercial soybean cultivars is an important step toward improving ozone tolerance in commercial soybeans through breeding.

Indicator 6

During FY 2010, ARS will construct and maintain physical, genetic, and transcript maps to facilitate comparative analyses among plant genomes.

FY 2010 Accomplishments:

Cacao genome sequenced. Cacao, the source of chocolate, is a multi-billion dollar international commodity grown by several million small farmers in tropical developing nations. Threatened by many virulent diseases and damaging pests, cacao requires new tree types with inherent resistance to pests and diseases, plus high yields and fine cocoa quality. Currently, cacao breeders lack DNA genetic markers required for rapid selection of trees with desired traits at the seedling stage, rather than at maturity. ARS scientists in Miami, Florida, and Stoneville, Mississippi, with collaborators at Mars, Inc., IBM, and several U.S. universities enlisted a novel mixture of traditional and leading-edge techniques to fully sequence the genome of a particular cacao variety that shares ancestry with many of the trees grown world-wide.

Impact: This genome sequence can now be compared with genetic information from other cacao varieties with different properties to rapidly identify many thousands of genetic markers, and thereby accelerate cacao genetic improvement to benefit farmers and cocoa processors globally.

Discovery of 33,065 new simple sequence repeat DNA markers to enrich scientific understanding of the soybean genome. With the recent release of the complete DNA sequence for the soybean genome, the task now at hand is identifying large numbers of DNA markers located throughout the 20 soybean chromosomes. ARS scientists in Beltsville, Maryland, collaborating with ARS scientists in Ames, Iowa, screened the DNA sequence of the 20 soybean chromosomes and identified more than 33,000 simple sequence repeat (SSR) DNA markers with a high probability for effectively locating the positions of genes on the soybean chromosomes, information which will enhance DNA marker-assisted soybean breeding. A database was created that contains the information required to effectively apply these markers, including the specific position of each marker on the 20 soybean chromosomes. This information is publicly available on SoyBase (<http://soybase.org>), the USDA ARS Soybean Genome Database. The information will be useful in fine-mapping for genes, a process that involves identification of markers that are very tightly linked to a targeted gene. A genetic fine map for a specific gene locus is one standard route for identifying and locating markers situated as closely as possible for both sides of the targeted gene. In soybeans, this process has been hindered by lack of that type of information.

Impact: Researchers can now identify specific soybean genes for further analyses or for crop improvement by transgenic technology.

Localizing genes for cold hardiness in grape. Grapevines grown in many regions of 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 can survive -40° F. To understand the genetic control of freezing tolerance, the genomic locations of grape genes controlling freezing tolerance were identified by ARS researchers in Geneva, New York.

Impact: Mapping this trait is the first step for developing an assay that will improve the selection efficiency within grape breeding programs for this trait and generating improved cultivars of grape for cold climates.

New corn genetic resources developed for high-fiber products. Corn lines with higher levels of slowly digestible starch could provide new sources of high-fiber food products. ARS scientists in

Ames, Iowa, in collaboration with Iowa State University researchers, have applied traditional breeding methods to modern and exotic corn germplasm to develop lines with higher levels of slowly digestible starch. Cooking characteristics and the effects of heating on end-product quality have been determined.

Impact: These new corn lines provide new types of starch for food processing and development of high-fiber products.

Indicator 7

During FY 2010, ARS will identify, acquire, and expand plant germplasm collections so as to enhance their diversity.

FY 2010 Accomplishments:

Key genetic tools for grain and biofuel crop improvement research are safeguarded. The genomes of the major grains wheat and barley and the biofuel crop switchgrass are so large and complicated that analyzing their genetic function and structure requires special genetic tools. Researchers from the ARS genebank in Pullman, Washington, greatly expanded the collection of genetic lines of *Brachypodium* (purple false brome), a small, rapidly flowering grass, with a relatively tiny genome which has been completely sequenced. Knowledge gained about the gene content, structure, and arrangement of this “model plant” can be readily extended to gene discovery and functional analyses of related grain and bioenergy crops.

Impact: Thus, by safeguarding and distributing a large collection of different lines of this key genetic tool, ARS genebanks are catalyzing efforts to map and manipulate key traits for genetically improving major crops. Key genetic tools for grain and biofuel crop improvement research are safeguarded.

New methods developed for safeguarding invaluable citrus plants. Oranges, grapefruit, lemons, limes, and other citrus trees are highly susceptible to many lethal diseases, damaging pests, and low temperatures. Breeding citrus resistant to the preceding perils is one of the most effective means of protecting this multi-billion dollar crop. Key resistance genes often occur in the invaluable genetic resources comprising unimproved dooryard varieties and wild citrus species. These genetic resources are often reproduced as clones, and are currently maintained in field orchards and screen houses because long-term storage of citrus clonal vegetative tissue has been infeasible. Researchers in ARS' genebank in Ft. Collins, Colorado, developed new “micrografting” recovery methods that enable clonal citrus samples to be stored at the temperature of liquid nitrogen and successfully re-propagated.

Impact: Storing duplicate clonal samples in secure genebank vaults will safeguard these precious materials from disease, damage, or loss suffered in field orchards and screen houses, and will enable them to be distributed to researchers more efficiently.

More than 535,000 samples of crop genetic diversity conserved and distributed to researchers. During fiscal year (FY) 2010, the 20-plus genebanks in the USDA ARS National Plant Germplasm System (NPGS) added more than 5,800 new samples, so that a total of more than 535,000 distinct types of more than 13,400 plant species are now 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 150,000 – 50,000 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.

Improvement in the nutritional quality of rice grain. Arsenic is a common, natural element in agricultural soils, and low concentrations do occur in all food crops, including rice. High concentrations, though, are not desirable because of its potential detrimental impact on plant growth and yield and its potential toxicity to humans. ARS scientists in Stuttgart, Arkansas, along with researchers at Texas A&M University and the University of Arkansas, evaluated for arsenic content 25 cultivars selected from the USDA rice germplasm collection. The researchers identified rice cultivars that have 50 percent lower arsenic content compared to other cultivars and developed field management practices that can reduce accumulation of arsenic in rice grain.

Impact: Breeders and researchers can use the identified cultivars with low arsenic concentrations as parents to develop new cultivars with improved nutritional value. Farmers can use the new cultural management practices to assure high nutritional quality of the rice grain.

Indicator 8

During FY 2010, ARS will strengthen evaluation and breeding programs for specialty crops that have increasing economic importance.

FY 2010 Accomplishments:

Accelerating introduction of powdery mildew resistant table, raisin, and wine grape cultivars through marker-assisted selection. New cultivars with powdery mildew resistance are desired by grape growers, but durability of this resistance is critical due to the cost of vineyard establishment and the necessary longevity of grapevines. ARS researchers in Geneva, New York, successfully documented that some resistances in breeding programs could be overcome quickly by common pathogen isolates and communicated a need for breeders to incorporate (or “pyramid”) multiple resistance genes into new cultivars. The researchers applied molecular markers to track these resistance genes and to accelerate the breeding of varieties with durable, multi-gene resistance. They also identified a source of powdery mildew resistance that prevents the pathogen penetration and appears to be durable by itself. They are applying molecular markers to track the introgression of this resistance gene into high quality raisin, table, and wine grapes.

Impact: Varieties bred with broad spectrum powdery mildew resistance would save growers between \$100 to 400 per acre per year in pesticide costs and reduce direct and indirect effects of pesticide application.

Method to enhance propagation of woody plants. Shoot regeneration from leaves of known fruit varieties is a preferred method of regeneration of transgenic plants, because the transgenic plant is identical to the variety except for the inserted gene. Genetically engineered stone fruit plants are currently made from seedlings, so they are all genetically different from the original variety. The seedlings are preferred, because leaves from varieties of plum and other stone fruits generally will not regenerate plants. ARS researchers in Kearneysville, West Virginia, found that, when plum leaves express an inserted corn gene, KNOX1, they produced shoots in high frequency.

Impact: This is the first report of plant regeneration from leaves of a woody perennial fruit tree, such as plum, using a regeneration-inducing gene from corn.

Late-flowering blackberries are sweeter and higher in antioxidants. ARS researchers in Beltsville, Maryland, compared 122 blackberry cultivars and breeding selections for antioxidant levels, flavor, flowering season, and fruiting season to help farmers and blackberry breeders better select blackberry varieties. In addition to finding a tremendous range for all traits observed, late-flowering blackberries tended to be sweeter and higher in antioxidants.

Impact: This information can be applied by breeders to develop new varieties that extend the growing season.

Developing beans adapted to growth under high temperatures. Common bean (*Phaseolus vulgaris* L.) is a vital part of the diet in many areas of the world. Bean reproductive development is particularly sensitive to high temperature stress, resulting in yield reduction and limited adaptation to warmer climates. ARS scientists in Mayaguez, Puerto Rico, with cooperators at the University of Puerto Rico, Cornell University, and the University of Tennessee, developed two kidney bean varieties that are tolerant to high temperature conditions. One variety is tolerant to high day and night temperature stress, while the second is tolerant to high daytime temperature stress and moderate nighttime temperature stress.

Impact: These kidney beans yield more grain under hot summer conditions when grown by farmers in regions prone to high temperature stress. In addition, they can be used for improving heat tolerance in other large-seeded beans through breeding and selection.

'HoneySweet' plum conditionally registered by EPA. There are limited sources of Plum pox virus (PPV) resistance in stonefruits. 'HoneySweet', a plum genetically engineered for resistance to PPV, which had previously been deregulated by the USDA Animal and Plant Health Inspection Service and the FDA, is now conditionally registered by EPA. 'HoneySweet' is the result of more than 20 years of research by ARS researchers in Kearneysville, West Virginia, and other ARS and European collaborators. It was resistant to PPV in test plots in Europe over the last 10 or more years.

Impact: When commercially available, it will be the first genetically engineered disease-resistant temperate fruit tree available to U.S. growers, providing them a high quality, fresh market, PPV-resistant plum. It can also serve as a breeding parent to reliably and efficiently introduce the resistance trait into additional new plum varieties.

Release of new apple rootstocks. ARS researchers in Geneva, New York, released four new apple rootstocks:

- G.214, a dwarfing, precocious, productive rootstock resistant to fire blight, with multiple disease resistance (fire blight, phytophthora root rot, and wooly apple aphid) that has performed very well in replant trials under organic management and is tailored to fresh market high density apple production amenable to mechanization.
- G.890, a semi-dwarfing productive tree resistant to fire blight that has performed well in difficult replant soils in Washington State and is tailored to fresh and processing apple production.
- G.210 is semi-dwarfing, has survived the series of inoculations with apple rootstock pathogens (*Erwinia amylovora*, *Phytophthora cactorum*, wooly apple aphid), and is tolerant to the replant disease complex.

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- G.969, a semi dwarfing productive plant, is resistant to fire blight and serves as a superior rootstock for weaker or more difficult scion varieties like ‘Honeycrisp.’

All these rootstocks were tested in the field for productivity and precocity and performed very well when compared to other rootstocks with similar vigor characteristics.

Impact: These rootstocks have been transferred to the nursery industry for large scale production and are expected to have a major role in sustainable apple production for years to come.

Measure 2.2.3 Summary of the Major Technologies Developed, Transferred, and Used in FY 2010:

During FY 2010, 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
TASSEL, a leading software tool for genetic association mapping in plants that was developed by ARS scientists at Ithaca, NY, and is available on the Web.	In 2010, 695 individuals downloaded TASSEL from the Web at www.maizegenetics.net . An additional 3,100 individuals used the software online.	Industry (all major seed companies) and university scientists.	The 2010 version of Tassel has been cited over 100 times in recent research publications.
Maize SNP50 BeadChip, for maize genotyping and genetic studies. ARS scientists at Columbia, MO and Ithaca, NY, worked with scientists at Illumina Inc., Institut National de la Recherche Agronomique (INRA), France, and Syngenta, Inc., to develop a 50,000 single nucleotide polymorphism (SNP) chip for the maize community.	Ideas and data were developed by the consortium. Data was transferred to Illumina, Inc. for product design and production. (product information)	Maize SNP50 BeadChip is sold to University and industry researchers for genotyping and genetic studies.	The Maize SNP50B BeadChip is used by public and industry scientists worldwide. The Maize SNP50 BeadChip represents a 35-fold increase in the public SNP markers available.
A field-deployable, direct tissue blot immunosorbent assay to detect Citrus Tristeza Virus (CTV), which continues to be a major limiting disease of citrus in California.	A private diagnostics company has aided in the development of this assay, and will market it to growers.	Citrus growers will use it to monitor their citrus trees themselves.	The assay, which has been used to monitor CTV infection in thousands of budwood trees and nursery increase blocks, will save growers time and the costs of paying an outside party to conduct the tests, and allow them to immediately remove infected trees, thus, meeting the rigorous standard of maintaining

STRATEGIC GOAL 2

Advanced breeding lines of two lettuce varieties were developed for longer shelf life in fresh-cut salad mixes.	Seed companies have incorporated the two advanced breeding lines with improved shelf life and complete resistance to lettuce dieback, which negatively impacts the shelf-life of popular romaine and leaf lettuces.	Lettuce growers and producers.	and selling virus-free stock and propagations. This new germplasm will allow producers in Salinas Valley, California, to incorporate this trait into their varieties to extend shelf life for the fresh-cut salad mixes.
Identification of citrus-specific genes through a publically available genome sequence of the citrus rootstock 'Carizzo'	No prior citrus genomic sequence had been made publically available until the recent release of this sequence at the Web address: http://citrus.pw.usda.gov/ .	ARS, university, and private industry citrus researchers are using this information to identify citrus DNA sequences useful in expressing resistance genes for important diseases, including citrus greening and citrus canker.	The limited amount of publicly accessible citrus genomic sequence data has significantly impeded application of this process to citrus improvement. This data have been employed to identify sequences that enable high-level expression of introduced genes in vascular tissue, where the causal agent of citrus greening, is found, which offers the opportunity to apply this information to develop resistant trees.
ARS scientists with collaborators at Mars, Inc., IBM, and several U.S. universities sequenced the genome of a particular cacao variety that shares ancestry with many of the trees grown world-wide.	The genome sequence data are transferred to cacao researchers and breeders world-wide via the Web site www.cacaogenomedb.org/main	Cacao breeders and researchers who are genetically improving the cacao tree to increase profitability and quality of life for several million small farmers in tropical developing nations.	Currently, cacao breeders lack DNA genetic markers required for rapid selection of trees with desired traits at the seedling stage, rather than at maturity. The new cacao genome sequence can now be compared with genetic information from other cacao varieties with different properties to rapidly identify thousands of genetic markers, and thereby accelerate cacao genetic improvement.
30 advanced lines of wheat having multiple-gene resistance to stem rust race Ug99 were developed and distributed by ARS researchers in Raleigh, North Carolina, in cooperation with the International Wheat and Maize Improvement Center in Mexico to wheat breeders in 32 countries.	Seeds were transferred to wheat breeders.	Wheat breeders and governments of 32 countries.	Enables U.S. and international wheat breeders to develop better worldwide resistance to stem rust Ug99 in advance of the pathogen arriving in the United States.
ARS scientists identified and released more than 33,000 Simple Sequence Repeat (SSR) DNA markers in soybean for use in marker-assisted soybean breeding and for high resolution gene mapping studies.	Data publicly available at SoyBase the USDA ARS Soybean Genome Database. (http://soybase.org)	Public and private soybean breeders.	DNA markers enhance the genetic improvement of soybean by breeders and enable geneticists to identify the genes responsible for high value target traits.

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

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.

STRATEGIC GOAL 2

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

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

During FY 2013, ARS will

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

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

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

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

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

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

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.

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 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.

FY 2010 Accomplishments:

All serotypes of Salmonella are considered human pathogens, and thus their elimination on dairy farms would decrease the consumer's risk of infection. A vaccine that could control or eliminate Salmonella in dairy cattle would be an efficient means of reducing the public's exposure to this pathogen in milk and meat. ARS scientists in Beltsville, Maryland, in collaboration with scientists at The Pennsylvania State University, have documented a long-term infection of dairy cattle with Salmonella serotypes Cerro and Kentucky on a farm in Pennsylvania. A novel component vaccine was developed to control Salmonella Newport infections, and was tested for its ability to eliminate infections by these apparently commensal serotypes.

Impact: The SRP vaccine did not offer any control over other Salmonella serotypes in a 3 year study in which calves, heifers, and dry cows were vaccinated. This result has been seen with specific serotype vaccines in other food animal species. However, an unexpected finding was slightly higher milk production was seen from vaccinated cows relative to unvaccinated cows. This latter impact is of significance to the dairy industry and FDA.

An understanding of the mechanism that promotes adherence of O157:H7 to epithelial cells can provide valuable information with regards to genes and proteins essential for O157:H7

colonization of bovine intestines. By comparing two mutant strains with the parent strain of O157:H7 in adherence assays, ARS researchers at Ames, Iowa, found that increased motility was detrimental to adherence while increased expression of specific structures and other molecules on bacterial cell surface increased adherence to epithelial cells.

Impact: This work is a key to the understanding of the role of various cell surface molecules in colonization and/or long-term persistence of O157:H7 in cattle intestines and to the potential use of these molecules in whole-cell vaccines for reducing O157:H7 colonization and persistence in cattle. The role of adherence to gut cells has been identified as critical to understanding O157:H7 colonization in cattle. This work may also have application to better understanding of emerging non-O157 STECS.

Soils at the feedlot pen surface are a source for transmission of *E. coli* O157:H7 and a target for preharvest control measures to reduce this pathogen in cattle. Solarization is a pre-planting pathogen and pest control technique used in food and ornamental crop production that utilizes solar energy to heat the soil. ARS scientists at Clay Center, Nebraska, determined that soil solarization is effective for reducing *E. coli* O157:H7 and generic *E. coli* from feedlot pen surfaces. Generic *E. coli* levels were reduced by 99.9% after 10 weeks of soil solarization but remained unchanged in unsolarized soils. *E. coli* O157:H7 was no longer detectable by 8 weeks of solarization, but could still be detected in unsolarized soils at 10 weeks.

Impact: Use of soil solarization may reduce the transmission and persistence of this pathogen among cattle and the production environment. This provides one pre-harvest control measure that might be used in addition to control measures further along the production chain. This technology is important in that it had an effect on multiple *E. coli*.

Potent steroid hormones such as estrogen are frequently detected in environmental samples despite laboratory results suggesting that transport in soil/water systems would be improbable. Two mechanisms were discovered by ARS and North Dakota State University Researchers in Fargo, North Dakota, that help to explain hormone transport. One involves hormone transport as water-soluble conjugates, which may readily be transported off an animal production site to be subsequently degraded back to parent hormone. The other involves association of steroid hormones with suspended organic particles, which are highly mobile in the environment.

Impact: These results are significant in understanding the fate, transport and behavior of these compounds, and provide the basis needed to devise means to reduce their environmental release. These studies provide important data for the Environmental Protection Association.

The intensity of lighting, and also the light/dark cycle (total hours in light and dark during a 24-hour period) are factors used in commercial broiler grow-out to ensure bird health and improve production (growth rate, etc.). There is limited information on how lighting might affect how *Salmonella* colonizes or otherwise affects the growing birds. ARS researchers at College Station, Texas, working with colleagues at Mississippi State University, showed that different lighting protocols do in fact affect *Salmonella* colonization of the birds.

Impact: This finding is important because it indicates that appropriate lighting protocols can reduce *Salmonella* levels in broilers. If such protocols are confirmed to be compatible with necessary production parameters, they can be implemented simply and with little if any added costs to produce birds with lower levels of *Salmonella* and provide

an efficient potential preharvest control measure.

Indicator 2

During FY 2010, 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 2010 Accomplishments:

Maize pathologists would benefit from being able to efficiently screen grain from varietal resistance trials for the presence of multiple seed rotting fungal pathogens. ARS scientists in Peoria, Illinois, evaluated the performance of a rapid single kernel sorter that receives near-infrared reflectance spectra (NIRS) from kernels tumbling down a light tube and color image based sorting devices recently developed by ARS in Manhattan, Kansas. This technology was used to discriminate corn kernels infected by eight fungus species at different levels of infection. Discrimination was done according to the level of infection and the mold species.

Impact: The color imaging system was not as efficient as the NIRS system in discriminating between infected and healthy corn kernels; however, the instrument has a lower cost and a higher throughput rate of approximately 75 kernels/per channel or 40 Kg/hr. The system is being evaluated by industry for removal of grains contaminated with aflatoxin and fumonisin in commercial seed samples.

The Navel Orange Worm (NOW) is the major insect pest of the California tree nut industry requiring a great deal of pesticidal control. Improved and more efficient means of control are needed. One approach would be to develop lures and monitoring methods based on host volatiles that are attractive to these insects. Researchers in Albany, California, developed new instrumentation for collection of volatile compounds from almond and pistachio orchards. Nearly 200 compounds were identified as candidate attractants of NOW based on laboratory and field methods, with some blends being more active as attractants than current, commercially available lures.

Impact: Discovery of any effective natural lures for the control of NOW would have a major impact on California agriculture in that this insect destroys millions of dollars of tree nuts annually, and tree nut are valued at \$4-6 billion in trade.

Aflatoxins are potent fungal produced toxins that frequently contaminate foods in both the U.S. and Africa, and improved methods to prevent aflatoxin contamination are needed. To date, the most successful strategy for limiting aflatoxin contamination of crops is a biocontrol where atoxigenic strains of *Aspergillus flavus* (strains that lack the ability to produce aflatoxins) competitively exclude aflatoxin producers from environments where crops are grown. In the U.S., atoxigenic strains native to North America are commercially available for aflatoxin management. In several African nations the food staples of corn and peanuts are frequently contaminated with aflatoxins and humans consume unsafe aflatoxin levels. ARS researchers in Tucson, Arizona, in collaboration with colleagues at the International Institute of Tropical Agriculture and the

University of Arizona have selected atoxigenic strains of *Aspergillus flavus* useful in biological control and native to Nigeria and Kenya.

Impact: Tests of the Nigerian strains in farmers' fields in Nigeria demonstrated excellent efficacy at reducing contamination. The work demonstrates that effective atoxigenic strains can be isolated even from areas with severe contamination. The identified strains are a potential resource for reducing human exposure to aflatoxins in both East and West Africa. Advances made in biological control in Africa will help optimization of biocontrol in the U.S. and serve to improve food security worldwide. The reduction of human exposure to aflatoxins is also an important public health issue to reduce stunting in children, potential liver disease, cancer and death.

Cyclopiazonic acid (CPA) is a mycotoxin produced by *Aspergillus* and *Penicillium* species that grow on feedstuffs and human foods. It is often found in association with aflatoxin contamination, and was implicated as having a role in Turkey X disease. In collaboration with the National Peanut Research Laboratory (NPRL), ARS researchers in Tifton, Georgia, identified the gene cluster involved in CPA formation and characterized associated biosynthetic genes. The CPA gene cluster is located next to the aflatoxin gene cluster. Using this information, studies confirmed that the biopesticide Afla-Guard® (active ingredient is *A. flavus* NRRL21886), developed at NPRL and commercialized by Syngenta Crop Protection.

Impact: Afla-Guard® does not contain the CPA and AF gene clusters, which ensures the safe application of this genuine nontoxic *A. flavus* strain in the field as a biocontrol agent. The co-location of the aflatoxin and CPA biosynthetic gene clusters on the fungal chromosome suggests how the fungus could make these two harmful compounds together based on one signal that allows the “turning on” of the genetic machinery within the fungus.

Development of non-destructive hyperspectral imaging methodology would be critical in identifying mycotoxin contaminated crops. A patent application has been filed by Mississippi State University for an invention involving ARS scientists in New Orleans, Louisiana, and Mississippi State University scientists located at Stennis Space Center, Mississippi. The invention is an algorithm (mathematical analysis) for aflatoxin identification.

Impact: This will provide the basis for the detection in corn of aflatoxin and its possible quantification as well. These efforts could provide a much-needed rapid, non-destructive and accurate method for detection of aflatoxin in corn which could be used in a variety of environments including grain elevators, and field testing. This has potential international impact for use in developing countries with high levels of contamination such as those in East Africa (Nigeria, Kenya).

Indicator 3

During FY 2010, 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 2010 Accomplishments:

It has become evident that Shiga toxin-producing E. coli (STEC) serogroups, including E. coli O26, O45, O103, O111, O121, and O145 cause a similar illness in humans as E. coli O157:H7. Since non-O157 STEC can be as dangerous as E. coli O157:H7, the USDA-FSIS is currently ascertaining the prevalence in beef of these six serogroups of non-O157 STEC to determine if beef is a vehicle of infection for these pathogens. At the request of the FSIS, methods consisting of food enrichment, detection by the polymerase chain reaction targeting important virulence genes, and strain isolation protocols were developed by ARS researchers in Wyndmoor, Pennsylvania, to detect and identify these pathogens in beef. ARS scientists spent time in FSIS regulatory laboratories and also helped with training for these new methods.

Impact: The detection and isolation protocols are useful for the food industry and are being employed in surveys by the FSIS to determine the presence of these important emerging pathogens in beef. Based on the data obtained, new regulations regarding the presence of these pathogens in food will be established to ensure the safety of the food supply. These data are critical for industry and for regulatory agencies to respond to emerging pathogens in food safety.

The potential use of ricin as a bioweapon in food highlights the necessity for developing detection methods that work well for food samples. ARS scientists in Albany, California, used a new method for the detection of ricin in three economically important food matrices. The method exploits the specificity of antibodies with the enormous amplification provided by the polymerase chain reaction (PCR) technique, to enable measurement of about 1 billionth of a gram of this toxin in a meatball-sized portion of ground beef.

Impact: This technique could be used in regulatory laboratories charged with defending the U.S. food supply and by investigators seeking the source of foodborne contaminants. This ARS laboratory is unique in developing these technologies.

Because the soil bacterium Clostridium botulinum occurs so widely, the deadly neurotoxin it produces commonly causes severe food poisoning. ARS scientists in Albany, California, developed a sensitive test for botulinum neurotoxin serotype B, the second most common form of this toxin. The test was used to detect toxin in artificially contaminated milk. The method uses new monoclonal antibodies developed in the Albany laboratory and could detect less than one billionth of a gram of toxin in a teaspoonful of milk.

Impact: This assay is fifty times more sensitive than the standard mouse bioassay, and will contribute to our ability to assure the safety and security of the food supply.

Currently used industry testing programs require the ability to detect E. coli O157:H7 in samples of beef trim or ground beef at levels as low as 1 colony forming unit (CFU) per 375 grams. ARS scientists at Clay Center, Nebraska, put forth a reliable protocol for generating a control inoculum for verification testing at this low concentration and evaluated its use. Studies showed that 1 CFU was an unrealistic goal for use as a control because at this concentration half of all samples received no cells when inoculated. Detection of 3 CFU was much more reliable by culture isolation and two commercial assays.

Impact: These results have immediate impact on testing labs and beef processors monitoring E. coli O157:H7. This work is critical to industry to meet their HACCP standards and verification testing.

Development of a method to detect microcracks in shell eggs is a critical issue for the USDA-Agricultural Marketing Service (AMS) since microcracks may allow Salmonella contamination of eggs for human consumption. ARS previously developed a laboratory-based detection system that has an extremely high rate of accuracy (99.6 %); however, it has not been tested in a truly commercial application. When two USDA AMS egg graders assessed the quality of same 3,000 eggs, the grader utilizing the modified pressure microcrack detection system more accurately determined the overall grade of the eggs (according to USDA grade standards).

Impact: Although using the microcrack detection system did increase grading time approximately five minutes per set of 100 eggs, the increased overall accuracy could lead to more time between grading lots. Professional egg graders utilizing the modified pressure microcrack detection system during grading will increase both the safety and quality of eggs reaching consumers.

Indicator 4

During FY 2010, ARS will determine the microbial ecology and transmission of human pathogens during animal, plant, and seafood (shellfish) processing, and identify the critical control points to reduce contamination. Develop innovative postharvest intervention strategies for improving the microbial and chemical safety of foods while reducing the impact on quality and consumer acceptance. Ensure that these technologies can be implemented into HACCP and GMP protocols and have efficacy for approval by FSIS and FDA.

FY 2010 Accomplishments:

Limited information is available on ecological interactions influencing persistence of different E. coli O157:H7 strains on lettuce. The survival of six strains of E. coli O157:H7 isolated from produce and environmental samples on Romaine lettuce was evaluated. Romaine lettuce (3 weeks old) grown in steam-pasteurized organic soil was inoculated with 6 log cfu of E. coli O157:H7 per leaf. Three of the six E. coli O157:H7 strains were non-detectable on lettuce leaves after 7 days. Five E. coli O157:H7 strains persisted after 14 days as determined by MPN, whereas only two isolates were recovered after 14 days by direct plating. Enrichment MPN assay is required to detect persistence of low numbers of E. coli O157:H7 on lettuce.

Impact: The study indicated rapid die off of E. coli O157:H7 once inoculated onto lettuce. This could be due to environmental stresses as well as the foreign nature of foliar surfaces for enteric pathogens. This research will help in understanding the ecology of E.coli O157:H7 in produce and may highlight risk factors that can be used for potential control or intervention strategies.

There is concern that human pathogens attached to fresh produce and packaged may change their virulence attributes with time. ARS researchers at Beltsville, Maryland, examined lettuce stored under commercial modified atmosphere packaging (MAP) that was inoculated with E. coli O157:H7. Three different MAP conditions were used to determine if E. coli O157:H7 on lettuce under MAP and stored at abusive conditions may become more virulent than under non-MAP

conditions. Lettuce contaminated with *E. coli* O157:H7 was stored at abusive temperatures (15°C) or at refrigerated temperatures (4°C). Results indicated that specific MAP conditions influenced in the increased expression of specific virulence factors in *E. coli* O157:H7 after three days of storage at 15°C. Expression of virulence factors at 4°C did not indicate any apparent differences.

Impact: This work shows that fresh-cut lettuce stored under commercial MAP conditions can potentially increase the virulence of the pathogen. The increased expression of virulence factors can lead to more potential foodborne illness. As a result, this work will provide potential intervention strategies and important data for FDA.

Beverages can occasionally become contaminated by the pathogen *E. coli* O157:H7 and *Listeria monocytogenes*, leading to product recalls and foodborne illness outbreaks. Antimicrobial packaging films and coatings were developed by ARS researchers at Wyndmoor, Pennsylvania, for pathogen control in strawberry purees, milk and liquid egg products. Generally recognized as safe (GRAS) antimicrobial compounds, singly and in combinations, were incorporated into polylactic acid polymer films or coated on glass jars. The antimicrobial treatments inactivated more than 99.99 percent of *E. coli* O157:H7 in strawberry purees and completely inactivated *L. monocytogenes* in milk and liquid egg white.

Impact: The antimicrobial coating has the potential to reduce product recalls and foodborne illness outbreaks due to contamination by *E. coli* O157:H7 or *L. monocytogenes*.

The USDA-Food Safety Inspection Service (FSIS) expressed concern about the ability consumers to correctly cook/heat foods using microwave technology. A temperature-controlled microwave oven was used by ARS Researchers at Wyndmoor, Pennsylvania, for in-package pasteurization of a simulated product containing raw chicken breast meat and gravy. This microwave heating system, modified from a commercial inverter-based microwave oven (2245 MHz, 1.25 KW), and equipped with an infrared sensor and a data acquisition system, was used to cook chicken meat in gravy contaminated with a four-strain cocktail of *Salmonella*.

Impact: This study demonstrated that *Salmonella* inoculated onto raw chicken meat in the simulated product can be completely eliminated with a proper selection of heating strategies. This work will assist the FSIS/FDA to develop new time and temperature requirements for microwave cooking of poultry.

The number of *Salmonella* cells contaminating produce necessary to make humans sick remains unclear. *Salmonella* remains undigested in the food vacuoles of the common protist, *Tetrahymena*, and is released as viable cells in its fecal pellets. Microarray gene expression profiling of *S. Typhimurium* cells in *Tetrahymena* revealed that many genes required for survival and replication within human cells also had increased expression in *Tetrahymena*. Furthermore, ARS researchers in Albany, California, showed that the pathogen is more acid resistant in *Tetrahymena* fecal pellets than as free cells.

Impact: These results indicate that passage through this protozoan confers on *Salmonella* physiological advantages relevant to its contamination cycle and may lower the number of cells that can make a human sick. These studies have provided important data on the potential role of protozoa and its interaction with foodborne pathogens.

Indicator 5

During FY 2010, 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 2010 Accomplishments:

The initial source of the contamination in outbreaks of *E. coli* O157 linked to leafy vegetables produced in the Salinas Valley in California remains unknown. Therefore, there is a great need to establish a baseline for the environmental prevalence of *E. coli* O157 and non-O157 *E. coli* in this important agricultural region. In collaboration with the University of California at Davis and the California USDA APHIS Wildlife Services, ARS researchers at Albany, California, have isolated over 3,000 strains of *E. coli* O157 and non-O157:H7 Shiga-toxin-positive *E. coli* from 12,000 samples from water, animals and their feces, crops and soil, and have determined their MLVA and *ompA* type, and virulence gene profile. ARS has submitted several *E. coli* O157 PFGE profiles to CDC PulseNet. *E. coli* O157 and non-O157 *E. coli* prevalence varies considerably among sources, with the highest prevalence associated with cattle feces (7% and 33%, respectively), but that other animal species also are a significant source of the pathogens.

Impact: This information provides the industry and public health agencies with the first epidemiological data for *E. coli* in this important agricultural region of the U.S. and will be used to develop good agricultural practice for produce production. This study also provides the necessary study design and collaborations to be used by the produce industry and FDA to test potential intervention and control strategies.

Pathogen hot spots can significantly affect the microbiological water quality in streams and reservoirs. The concentrations of pathogens and indicator bacteria (*E. coli*) in surface waters are dependent on several processes, including transport to waters as well as within waters. Previous research has shown that *E. coli* runoff from field's accounts for a relatively small percentage of *E. coli* measured in the water column after rainfall events. ARS researchers in Beltsville, Maryland, conducted an artificial high flow event in a stream by introducing a large volume of water directly into the stream (simulating a heavy rainfall event) in order to quantify in-stream transport. The suspension of *E. coli* from bottom sediments into the water-column and subsequent resettling as *E. coli* moved downstream were monitored. In addition, a model of bacterial suspension and transport was developed applicable to small creeks/streams. Both measurements and modeling showed that the release of *E. coli* from a single "hot spot" in the bottom sediment affected microbiological water quality far downstream.

Impact: These results are important in the evaluation of the role of bottom sediments in their impact on microbiological water quality degradation, which can be mistakenly attributed to agricultural practices. This information is useful for growers and regulators relying on water quality monitoring in identifying important environmental microorganism reservoirs that affects microbiological water quality for recreational and irrigation purposes. This work highlights the importance of water quality in the production of fruits and vegetables and its potential role in food safety.

Multiple species of the fungus *Fusarium* can infect crop plants and contaminate them with toxins, such as the carcinogens fumonisins. Thus, there is a need for diagnostic methods to distinguish between species of the fungus. Genes responsible for biosynthesis of fumonisin toxins are located next to one another in a gene cluster. Through DNA sequence analyses, ARS scientists in Peoria, Illinois, have demonstrated that the fumonisin gene cluster is located at different positions along chromosomes in different species of *Fusarium*. They also identified significant variation in the DNA sequences of individual fumonisin biosynthetic genes among some species. They used the variation in the cluster position and the variation in DNA sequences of genes to develop DNA-based markers that can be used to distinguish between different fumonisin-producing species of *Fusarium*.

Impact: The DNA markers are diagnostic tools that can be used to determine which species of *Fusarium* are present in crop plants and allow early intervention for prevention of toxin contamination in food and feed.

PFGE and antibiogram patterns have been used to evaluate the diversity within and between individual isolates within *Salmonella* serotypes. The objectives of the study were to evaluate the PFGE and antimicrobial resistance patterns of *Salmonella* broiler carcass rinse isolates and compare pattern similarity to those isolates found in the USDA-VetNet database. *Salmonella* isolates (n=176) originated from post-pick broiler carcass rinse samples. Antimicrobial resistance diversity as well as the PFGE diversity was studied for eight different *S. enterica* serotypes: Agona; Berta; Heidelberg; 4,5,12:i:-; Kentucky; Kiambu; Mbandaka; and Senftenberg. Overall, eight different antibiogram patterns were observed across all isolates. *S. Kentucky* isolates exhibited the greatest heterogeneity with six different antimicrobial resistance patterns within 13 different PFGE patterns. Isolates among both serotypes were pan-susceptible. Compared to patterns within the USDA-VetNet database, a total of 10 new *Salmonella* PFGE XbaI patterns were identified with six new patterns originating from *S. Kentucky* isolates. The *S. Kiambu* isolates all had a unique XbaI pattern that has a slight band shift difference from a *S. Kiambu* pattern only seen twice before in diagnostic cattle samples.

Impact: The identification of new patterns suggests that further work needs to be conducted on how culture methods can influence recovery of certain *Salmonella* serotypes as well as diversity within those serotypes. The isolates from this study originated from cultivation method combinations that are not commonly used by regulatory agencies to recover *Salmonella* from poultry carcasses.

Although chickens infected with *Salmonella* Enteritidis do not deposit this pathogen inside egg yolks very often, bacteria from the surrounding albumen might penetrate through the vitelline membrane that surrounds the yolk and begin rapid and extensive growth in the nutrient-rich interior contents of the yolk prior to egg refrigeration. ARS researchers in Athens, Georgia, used a laboratory egg contamination model to assess the ability of an *S. Enteritidis* strain to penetrate into the yolk contents during 24 hours of incubation at 30° C in eggs from six genetically distinct lines of commercial laying hens simulating potential conditions under federal *S. Enteritidis* control regulations that allow unrefrigerated storage of eggs on farms for up to 36 hours.

Impact: These results demonstrate that penetration of *S. Enteritidis* to reach the yolk contents and multiply to more dangerous levels can occur during unrefrigerated storage of eggs from diverse lines of laying hens, reinforcing the importance of prompt refrigeration of eggs for protecting consumers. This information is particularly important for the FDA, industry and consumers considering the recent major outbreaks of egg associated foodborne illness.

Measure 4.1.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2010:

During FY 2010, 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 solarization of soil may reduce the transmission and persistence of E. coli O157:H7 pathogen among cattle and the production environment.	Soils at the feedlot pen surface are a source for transmission of E. coli O157:H7 and a target for preharvest control measures to reduce this pathogen in cattle.	Farmers, cattle producers, American Meat Institute, National Cattleman's Association, USDA-Food Safety Inspection Service	Soil solarization is an effective intervention for reducing E. coli strains from feedlot pen surfaces, subsequent transmission to cattle, and ground beef derived from animal sources. Reduction of this pathogen and its toxigenic relatives is a critical goal for industry and regulatory agencies, as a means of improving public health.
Development of selected atoxigenic strains of <i>Aspergillus flavus</i> for use as biological control agents in several African countries.	Aflatoxins are potent fungal toxins that frequently contaminate foods. Improved methods to prevent aflatoxin contamination are needed. The most successful strategy is biocontrol where atoxigenic strains competitively exclude aflatoxin producers from environment.	Countries in East and West Africa such as Nigeria and Kenya; USDA-FAS; Gates Foundation, World Bank, World Health Organization	The identified strains are a resource for reducing human exposure to aflatoxins. Advances made in biological control in Africa will help optimization of biocontrol in the US and serve to improve food security worldwide.
Developed new methods for the detection of ricin and <i>Clostridium botulinum</i> neurotoxin B, the second most common form of this toxin.	Validated new methods for the detection of ricin and <i>Clostridium botulinum</i> neurotoxin B in various food matrices.	FDA, FSIS, Military, DHS and other related security agencies	These assays will contribute to our ability to assure the safety and security of the food supply.
Demonstrated that <i>Salmonella</i> on raw chicken meat can be completely eliminated with a proper selection of microwave time/ heating strategies.	Validated the time/temperature relationships in microwave cooking to kill pathogenic <i>Salmonella</i> .	FSIS, FDA, and consumers, food processors	Assist the FSIS and FDA to develop new time and temperature requirements for microwave cooking of poultry.
Determined the source of E. coli O157 and non-O157 E. coli in fresh produce production areas. Determined that prevalence varies among sources, with the highest	Developed an extensive database of E. coli O157 and non-O157:H7 Shiga-toxin-positive E. coli strains from >12,000 samples from water, animals and their feces, crops and soil,	University of California at Davis, USDA APHIS Wildlife Services, CDC PulseNet, FDA, produce industry, State and local agricultural and public health departments	This information provides the industry, public health and related agencies with the first epidemiological data for pathogenic E. coli strains in this important agricultural region of the

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prevalence in cattle feces. Other animal species such as pigs also are a significant source of the pathogens.	and have determined their MLVA and ompA type, and virulence gene profile.	US. Data will be used to develop good agricultural practice for fresh produce production.
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Measure 4.1.1 Outyear Performance Plan (the future performance indicators for this Measure)

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

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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.

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

During FY 2013, ARS will

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

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

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

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

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

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

Performance Measures

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

Baseline 2005

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

Target 2011

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

Indicator 1

During FY 2010, 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 2010 Accomplishments:

New ways to stop mosquito bites. Insect repellents applied to the skin are widely used to prevent mosquitoes from biting, but they are usually used as a last resort when other forms of control have failed. The promise of highly effective, easy-to-use repellents depends on a precise

understanding of how these useful chemicals work. ARS researchers at Beltsville, MD showed that insect repellents confuse mosquitoes in the manner that they stimulate the organs mosquitoes use to find humans. In the absence of other odors, the repellents activate the organs in a way that does not occur in nature, probably interfering with the ability of the mosquito to find a host. If odors are present that would usually attract the mosquitoes to a host, the repellents prevent detection organs from sensing the chemicals that would normally direct the mosquito to the host. The research demonstrates that repellents can have positive and negative effects on mosquito reception.

Impact: After we understand how repellents work, we will be able to develop chemicals that work more precisely with the hope that we can manage mosquito behavior more effectively. Products could include more powerful insect repellents, spatial repellents that keep mosquitoes out of a home or backyard, and “herding” chemicals that put mosquito populations into areas where they either cause no harm or where they can be killed.

Until recently gastrointestinal parasites were considered a minor health problem to the animal industry due to the development of safe and efficacious anti-parasitic drugs and strategies. A national survey of cattle intestinal parasites and their response to antiparasiticide drug (anthelmintic) treatment was conducted. The results of the study of randomly selected cattle operations demonstrated a wide distribution of resistance to anthelmintic treatment. In nearly all cases, the resistant species was a historically minor species, *Cooperia*.

Impact: These results demonstrate that the overuse of anthelmintics has selected for drug resistant intestinal parasites and has also changed the population dynamics of parasites on pasture and resulted in selection of a species with an increased ability to cause damage to the host.

Indicator 2:

During 2010, 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 2010 Accomplishments:

Vaccines to stop the cattle fever tick. Cattle fever ticks are a world-wide pest of cattle that decimate the economics of the industry by exsanguination of animals and by transmission of key diseases like babesiosis and anaplasmosis. These diseases not only reduce the efficiency of production, they also prevent trade in live animals. The cattle fever tick is a current threat to international food security and an imminent threat to the cattle industry in the southern US, where the tick was eradicated during a period between 1907 and 1943. ARS scientists in Kerrville, Texas, collaborating with scientists from EMBRAPA Brazil, identified two anti-cattle tick vaccine candidates in cattle trials. These candidates had been prioritized in a prior ARS project through bioinformatic and molecular biological approaches. In the cattle trials conducted in Brazil, the candidates outperformed the recombinant Bm86 Campo Grande antigen, which is an antigen similar to that used in the only current commercially available anti-tick vaccine. An invention disclosure was filed and cattle trials are scheduled to evaluate various parameters in the vaccination protocol to optimize efficacy.

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Impact: The worldwide use of a consistently effective anti-tick vaccine in cattle would reduce production costs associated with tick treatment and contribute to the maintenance of the eradication of cattle fever tick in the US.

Measure 4.2.1 Summary of the Major Scientific Discoveries, Technologies Developed, Transferred, and Used in FY 2010:

During FY 2010, ARS reported 6 new scientific discoveries, transferred and used by the scientific community, the private sector, and government agencies to develop control measures to manage priority endemic and foreign animal disease threats.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
How mosquito repellents work	Talks and publications	Mosquito abatement, public health, DoD	Better repellents
New bed bug attractants	Talks and publications	Pest control industry, public health, housing authorities	Better detection and baited products
Stable fly odorant reception and physiology	Talks and publications	Cattlemen, public	New toxicants, effective repellents
Cattle fever tick genomics	Talks, publications, GENE BANK	Cattlemen, APHIS, Texas Animal Health Commission	New vaccines, new toxicants, detection of resistance
Alteration of mosquito behavior by insecticides	Talks, publications	DoD, public health, US AID	Accurate risk assessment of disease transmission, new control strategies
Genomics of Formosan subterranean termite	Talks, publications, GENE BANK	Public, pest control industry, housing	New targets for toxicants, new methods for biofuel production
Assess the extent of anthelmintic resistance in beef cattle	This information was published in 2 peer-reviewed publications: 1)Gasbarre, L.C., Smith, L.L., Hoberg, E.P. Pilitt, P.A. 2009. Further characterization of a cattle nematode population with demonstrated resistance to current anthelmintics. Veterinary Parasitology. 166:275-280. 2)Gasbarre, L.C., Smith, L.L., Lichtenfels, J.R., Pilitt, P.A. 2009. The development and identification of cattle nematode parasites resistant to multiple classes of anthelmintics in a commercial cattle population in the U. S. Veterinary Parasitology. 166:281-285.	Beef industry	The research determined that the level of anthelmintic resistance is significant in beef cattle so new strategies need to be developed for parasite control.

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

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.

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

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 2010, 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 2010 Accomplishments:

Cutting edge genomics applied to stable fly control . Complete sequencing of key arthropod species has formed a library of gene sequences which has been essential in the process of unlocking the identification of genes in many other species of pests. ARS scientists in Kerrville, TX have used more streamlined methods of gene identification to find 21 genes associated with host seeking and egg-laying in stable flies, including the first olfactory and taste receptors to be reported for this significant livestock pest. They were also able to find the specific change in a gene that results in resistance to the commonly-used veterinary pesticide, permethrin. Through laboratory selection, University of Florida researchers previously obtained a 15-fold resistance to permethrin in a strain of stable flies. In collaboration with Gainesville, Florida, an ARS scientist at Kerrville, Texas, identified a mutation in the stable fly sodium channel gene that associates with the observed resistant phenotype.

Impact: Among the many potential products from these discoveries are highly specific molecular pesticides, design of chemicals that alter stable fly behavior, and methods for field detection of insecticide resistance.

Equine prioplasmosis is a disease cause by blood parasites. It is considered a foreign animal disease in the U.S. During 2010, the U.S. encountered emergence of this organism which will be very expensive to the equine industry due to blocking of export and importation of horses. A method to eliminate persistent infection and transmission risk from horses infected with Babesia caballi.

Impact: This has proven critical to the equine industry as it will enable the U.S. to retain its piroplasmosis-free status and enable treated horses to resume their prior functions.

Indicator 2:

During 2010, 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 2010 Accomplishments:

A million dollar savings by strategic releases of screwworm flies. The screwworm fly lays eggs in wounds and then burrows into the flesh of humans, cattle, and other mammals, often with fatal results. This horrific pest was eradicated from the entire continent of North America by systematic release of sterile males and a barrier of sterile males continuously released in Panama prevents reintroduction of screwworm fly from South America. ARS researchers of the Screwworm Research Unit in Kerrville, Texas, and Panama reviewed and analyzed release technologies to improve screwworm fly dispersal relative to where, when, and how many sterile flies are released in the barrier zone. Quantitative calculations were based on screwworm biology and modeling of results, as well as application of global information systems.

Impact: Recommendations with supporting data presented to the Panama – U.S. Commission for Eradication of Screwworm (COPEG) would (1) result in updated equipment on-board dispersal aircraft, (2) strategically reduce the number of flies dispersed, and (3) save up to \$1,000,000 annually.

Indicator 3:

During 2010, 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 2010 Accomplishments:

Gene silencing, a novel method for mosquito control (Components 1 and 2). Toxicants with new modes of action and high specificity are being investigated for mosquito control. Using gene silencing technology or RNA interference (RNAi), ARS scientists in Gainesville, FL have designed molecules that inhibit expression of critical proteins in mosquitoes that results in mortality. We have shown that these molecules can be delivered to adult mosquitoes through the cuticle, with other possible delivery methods under investigation. A new Cooperative Research and Development Agreement with industry will enable large-scale production of RNAi molecules to investigate new carriers and delivery methods to mosquitoes. We are currently awaiting issuance of a patent, which was applied for by the U.S. Department of Agriculture in March 2007.

Impact: This technology will provide completely safe insecticides based on natural chemicals and easily modified for different purposes and to avoid resistance.

Measure 4.2.2 Summary of Major Technologies Developed, Transferred, and Used in FY 2010:

During FY 2010, ARS reported 3 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
RNAi for control of mosquitoes and fire ants	CRDA	Public, pest control industry, public health	Entirely new class of insecticides that are totally safe
Measured release of screwworm flies	Direct instruction, publication	Panamanian-American Commission for the Eradication of Screwworm Flies	Decrease costs by as much as 10%
Genetic markers in stable flies	Publication, GENE BANK	Cattle industry, public health	Possible new toxicants, detection of resistance
Elimination of infection of horses with Babesia Caballi.	Presentation to equine groups and publication in peer-reviewed journals: Schwint, N. O., Ueti, M. W., Palmer, G. H., Kappmeyer, L. L., Hines, M. T., Cordes, R. T., Knowles, D. P., and G. A. Scoles. 2009. Imidocarb dipropionate clears persistent <i>Babesia caballi</i> infection with elimination of transmission potential. Antimicrobial Agents and Chemotherapy, 52(10):5327-4332	Equine industry, APHIS	Elimination of the organism in infected horses will enable the U.S. equine industry to maintain piroplasmosis-free status and horses to resume prior function.

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

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.

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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.

Baseline 2006**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 2010, ARS will develop methods to reduce emissions of harmful gases from crop production systems and post-harvest/quarantine treatments.

FY 2010 Accomplishments:

Oxygen increases toxicity of phosphine to insect pests. Phosphine is a slow-acting fumigant in controlling insects, and treatment time can last over 10 days for some insects, limiting the usefulness of this fumigant as a quarantine treatment for fresh produce. For low temperature phosphine fumigation of fresh commodities, treatment is even longer as the toxicity of phosphine decreases at lower temperatures. Shortening treatment would increase turnover time of fumigation chambers and reduce fumigation cost. ARS researchers in Salinas, California, found significant synergistic effects of oxygen in increasing the toxicity of phosphine against all life stages of various insect pests which resulted in significant reductions in treatment time for pest control.

Impact: The synergism may have significant practical implications in developing more effective and shorter fumigation treatment for postharvest pests especially for low temperature phosphine fumigation on perishable commodities.

Low permeable films reduce fumigant emissions. In comparison with the use of standard polyethylene films, the use of low permeability films allows lower doses of fumigant to be used and also reduces the amount of fumigant, which might cause unintended environmental damage, released to the atmosphere. A new low permeable film, referred to as totally impermeable film or TIF, effectively reduced fumigant emissions in laboratory tests, though no field data was available. ARS scientists in Parlier, California, conducted a large field trial to test the new film for reducing fumigant emissions. The TIF peak emission rate was as much as 10 times lower than that from standard polyethylene (PE) film. Over a 6-day field-covering period, the total emission loss with TIF was reduced below 2 percent of total fumigant applied, compared to 30 percent emission with the PE film. However, the emission surge upon cutting the TIF tarp was much higher than with the PE film, indicating that a longer waiting time would be needed with TIF to reduce potential exposure risks.

Impact: The research showed that using this new film will help improve buffer zone restrictions and enable many fields to be fumigated under the newly amended U.S. EPA regulations.

Alternatives to methyl bromide demonstrated in key crop systems and regions formerly dependent solely upon methyl bromide. Key crop systems have relied solely on fumigation with

methyl bromide for pest and pathogen control, but use of this fumigant is being phased out worldwide under the Montreal Protocol. ARS scientists in Fort Pierce, Florida, along with university collaborators, conducted 48 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 partnership with commercial growers at sites adequately representing the biological and environmental diversity of the production systems of tomato, pepper, eggplant, strawberry, forest nursery seedlings (loblolly pine), sod, ornamentals (caladium), and cut flowers (delphinium). Grower demonstration trials were performed on all of those commodities and turf and cucumber in Alabama, Florida, Georgia, South Carolina, and North Carolina. The size of each grower demonstration trial ranged from one-half acre to 58 acres.

Impact: These trials demonstrated that technically feasible alternatives to methyl bromide soil fumigation are available and can control pests adequately without the environmentally damaging effects of methyl bromide.

Indicator 2:

During 2010, 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 2010 Accomplishments:

New sources of resistance to diverse soybean diseases. In collaboration with scientists at U.S. and Canadian universities, ARS researchers in Urbana, Illinois, identified resistance to Asian soybean rust, caused by the fungus *Phakopsora pachyrhizi*, in soybean breeding lines and in commercially available varieties. Because the pathogen mutates to overcome plant resistance genes, identification and utilization of diverse resistance genes for breeding programs is important for long-term management of soybean rust. This research tells growers which commercial varieties can be used against current forms of the soybean rust pathogen and identified new sources of resistance to incorporate into future varieties. This research further identified the regions of the soybean chromosomes containing genes that confer resistance to seed transmission of soybean mosaic virus, as well as commercial soybean varieties with resistance to *Phytophthora* root rot and stem rot.

Impact: This information will be used to develop soybeans with resistance to multiple pathogens.

Developing gladiolus plants resistant to cucumber mosaic virus. Cucumber mosaic virus (CMV) is an important plant virus, with over 1,000 susceptible hosts, including gladiolus for which there is no natural resistance. Symptoms drastically reduce yield and include dramatic flower streaking that makes them unmarketable. ARS scientists in Beltsville, Maryland, genetically transformed and selected gladiolus plants that are resistant to infection by CMV. A highly sensitive method for diagnosis of CMV was also developed by these researchers to detect very low levels of infection needed for this kind of plant transformation.

Impact: This research will facilitate the evaluation of virus resistance in transgenic gladiolus plants to yield improved floral quality and productivity, and methods developed can be transferred to the many crops affected by CMV.

Resistance to Eutypa dieback identified in grapevines. Eutypa dieback, caused by the fungus *Eutypa lata*, impacts all vineyard production systems (wine, table, raisin, and juice) and affects all U.S. grape-growing regions, with net income losses of \$260 million annually for wine grapes alone. Given that preventative sprays must be used each year throughout a lengthy period of susceptibility, coupled with the fact that infections are chronic once established, disease-resistant grape varieties are highly desirable as an effective, long-term, and environmentally sensitive solution to fungicides. ARS scientists in Davis, California, identified Eutypa-resistant grape hybrids by screening plant material from the ARS National Clonal Germplasm Repositories in Davis, California, and Geneva, New York. These results are based on a greenhouse experiment carried out by inoculations of a virulent strain of the fungus to non-grafted vines, including seven commercial varieties of *Vitis vinifera* and seven experimental varieties of *Vitis* species or interspecific hybrids, the latter of which are components of breeding programs in California, New York, and Australia.

Impact: As these Eutypa-resistant hybrids are also resistant to the destructive and widespread fruit and foliar pathogens powdery and downy mildews, establishing vineyards with such varieties, or using them to breed other varieties, is likely to reduce pesticide use and, thus, lessen the impacts of grape production on human health.

Indicator 3:

During 2010, 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 2010 Accomplishments:

New control solutions for aphids developed based on neuropeptide hormone technology. Pest aphids cause hundreds of millions of dollars of crop damage every year, and many populations have already acquired resistance against insecticides used for control. ARS researchers in College Station, Texas, in cooperation with British colleagues, developed an entirely new approach for the control of pest aphids. The technology is based on developing versions of natural aphid hormones (known as neuropeptides) that resist metabolism (inactivation) by natural aphid body enzymes. Natural neuropeptides in aphids and other insects regulate critical life processes such as water balance and digestion. Some of the neuropeptide "mimics" developed by this work match or even exceed the potency of current insecticides used in aphid control.

Impact: While the development of a commercially viable neuropeptide technology for aphid control has not yet been realized, this accomplishment is moving the work forward, and is catalyzing related work by other scientists in industry, academia, and government.

Characterization of insect specific pathogens for insect biocontrol. As an alternative to pesticides, insect specific pathogens are promising, but they are often costly compared to chemical pesticides. Biopesticides use chemicals produced by microbes and are more cost-effective. This year ARS researchers in Beltsville, Maryland, made progress in: Determining promising characteristics of the bacteria *Bacillus thuringiensis* (Bt) isolates exploited for their insecticidal toxin genes in transgenic crops; Characterizing *Chromobacterium subtsugae*, a promising bacterium that kills sucking insects such as stink bug which Bt does not kill; and Discovered some insect viruses (baculoviruses) that kill pest caterpillars at lower dosages than commercially sold baculoviruses (which kill faster).

Impact: *Chromobacterium subtsugae* is a naturally occurring option for organic growers to use in biocontrol of sucking insects and is in the process of EPA registration.

Indicator 4:

During 2010, 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 2010 Accomplishments:

New grass demography data improves re-vegetation success in rangeland restoration. Degraded rangeland can be difficult to restore because invasive species can often be successful in these systems, while establishment of native species' seedlings is not. Augmentative seeding can help overcome this limitation, however it can be expensive and success rates are variable. ARS scientists in Burns, Oregon, examined the demography of grass species to determine at what life stage seeding failure is most likely, and they determined that the most critical period for native species establishment was the transition between germination and emergence. They also demonstrated that important plant traits for establishment – for both invasive and native species in low nitrogen soils, such as degraded rangeland – were early germination, root growth at low temperature, and a high specific leaf area. Also, ARS scientists in Sidney, Montana, demonstrated that the environment in which plants are grown can impact the traits carried over to seed progeny, i.e., drought-stressed plants produce drought-tolerant seeds.

Impact: The results of these studies will be valuable to researchers and land managers in the selection and use of native species lines in restoring degraded rangeland.

Weed seed production can be plant density dependent. Yellow starthistle is an important invasive rangeland alien weed in the western United States. Six species of insects that damage flower heads have been introduced for biological control of this weed. However, it is not known whether insects that directly destroy seed are inherently more effective than those that attack other plant parts. ARS scientists in Reno, Nevada, demonstrated in field experiments that putting more seed in field plots resulted in more plants if densities were initially low, but regardless of the number of plants that grew, all the plots produced about the same amount of seeds one year later. This is because plants at low densities produce more seed than those at high densities, thus compensating for the initially low density of seeds.

Impact: This demonstrates that the affect of population on fecundity of invasive plants should be assessed when determining the types of insect natural enemies/predators to search for and develop for biological control.

Indicator 5:

During 2010, 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 2010 Accomplishments:

Understanding the changing nature of Cercospora leafspot in sugarbeet. Fungi can develop resistance to fungicides for agricultural use through different means – either through mutations or sexual reproduction, which increases genetic diversity. Leaf spotting diseases caused by

Cercospora species cause significant losses on numerous crops worldwide. *Cercospora beticola* is responsible for sugarbeet leaf spot, a disease costing sugarbeet producers millions of dollars a year. Previously, *C. beticola* was only known to reproduce asexually. However, field isolates of *C. beticola* are well-known for high levels of variability, particularly with regard to developing fungicide resistance, making disease management more difficult for growers. ARS scientists in Fargo, North Dakota, have characterized the mating type genes of *C. beticola*, genes that are known to be required for sexual reproduction. The research results suggest that *C. beticola* mating type genes are still active and may play a role in sexual reproduction of this fungus.

Impact: This information is useful for plant breeders when selecting parents for developing disease resistant sugarbeet and is useful for plant pathologists to help explain how *C. beticola* is able to gain resistance to fungicides.

Century-old mystery of the life cycle of wheat and barley stripe rust solved and protected wheat varieties released. Stripe rust (also called yellow rust) of wheat and barley causes significant wheat and barley crop losses worldwide, but the life cycle of the rust fungus has long baffled scientists. ARS scientists in St. Paul, Minnesota, made the first identification of an alternate host for any type of stripe rust pathogen by demonstrating that several species of barberry serve as alternate hosts for the cereal rust. Stripe rust is known to be one of the most variable cereal rust pathogens and this discovery suggests that recombination on susceptible barberry species is playing a key role in contributing to pathogen variability. Another advance in cereal stripe rust protection was made by ARS researchers at Pullman, Washington, who exploited stripe rust resistance assays and molecular markers to develop more than 10 new stripe rust-resistant wheat varieties in partnership with ARS and land grant university wheat breeding programs.

Impact: This information can assist crop breeders in developing entirely new strategies to protect cereals from stripe rust losses.

Root to root spread of the sudden oak death pathogen Phytophthora ramorum was documented under flooded conditions. Sudden oak death is established in California and Oregon, but not yet established in the eastern United States. When sprouted acorns were exposed to different concentrations of spores of *P. ramorum*, as little as one spore per milliliter caused infection within 24 hours in all four eastern U.S. oak species tested. Forty-six plant species of economic or ecological importance to the eastern United States were evaluated for their ability to support root infection and production of *P. ramorum* spores. Many of these species supported higher populations of the pathogen than a highly susceptible control species, *Viburnum tinus*.

Impact: This information will be valuable for risk evaluation and regulatory decision-making.

Measure 4.2.3 Summary of the Major Technologies Developed, Transferred, and Used in FY 2010:

During FY 2010, 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	Describe the	Identify the	Impact
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STRATEGIC GOAL 4

Technology	Transfer	Customer	
<p>Three Web sites for the plant pathogen Phytophthora were established. One site contains specific information on molecular diagnostics on <i>P. ramorum</i>, the cause of sudden oak death. The other two provide phylogentic, molecular diagnostic, and DNA sequence information for the genus Phytophthora. The sites also provide techniques and tips for using the genetic information.</p>	<p>The Web sites are publically available at www.ars.usda.gov/Research/docs.htm?docid=8728; www.phytophthoradb.org; and http://phytophthora-id.org.</p>	<p>Scientists and regulatory personnel interested in molecular diagnostics for the quarantine pathogen <i>P. ramorum</i>, as well as identification of unknown isolates using molecular criteria. One of the sites also has general information on individual species for use by students and instructors looking for a broader type of information on individual species.</p>	<p>Many diseases caused by Phytophthora species are of economic importance due both to direct yield losses and quarantine significance. The Web sites are a valuable, publically-available resource for Phytophthora researchers and for regulators.</p>
<p>Published taxonomic Web pages for critical pest insects, including: aphids; coccids; scales; whiteflies; true bugs (such as the marmorated stink bug); parasitoid, predatory, and plant-attacking wasps; moths; fruit flies; wood-boring beetles; lady beetles; and mites.</p>	<p>Informational pages were placed on ARS Web sites.</p>	<p>Insect taxonomists, biological control practitioners, USDA APHIS, extension agents, and home owners.</p>	<p>These pages are being used to develop insect and weed biocontrol programs, for exclusion of pests to protect our borders, and by home owners to control garden pests.</p>
<p>Alternatives to methyl bromide use in key crop systems and regions dependent on methyl bromide.</p>	<p>Researchers conducted 30 field and lecture presentations on methods to implement methyl bromide alternatives. Presentations at field and classroom meetings and scientific conferences were made.</p>	<p>Growers, nurserymen, and extension scientists.</p>	<p>Illustrating possible alternatives will smooth transition to methyl bromide alternatives among customers/users.</p>
<p>Insect cell lines were developed for use in studying the effects of chemicals on cells, culturing insect viruses, and producing proteins from those viruses.</p>	<p>Cultures of several moth, wasp, and beetle cell lines were sent to end users.</p>	<p>Cell culture recipients include scientists associated with universities, public schools, and industry, both domestically and overseas in countries from Australia to Japan.</p>	<p>These cultures are being used to study the effects of parasitoid wasp venom and wasp-associated viruses on moth cells; wasp and bee viruses on wasp cells; the circadian rhythm and physiological and ecological factors on non-target insects such as the Monarch</p>

butterfly; search for compounds with insecticidal activity; and evaluate the effects of herbs as nutrients for insects. Other cell lines are being used to produce insect viruses for use in biocontrol of important pest insects. And pharmaceutical companies are using these cultures for mass production of drugs.

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

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.

STRATEGIC GOAL 4

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

During FY 2013, ARS will

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

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

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

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 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.

FY 2010 Accomplishments:

Great Plains Wheat Production Guide published. There is a need for effective educational products to enhance adoption of areawide pest management (AWPM) approaches for Russian wheat aphid, greenbug, and other pests, weeds, and diseases in winter wheat. ARS scientists in Stillwater, Oklahoma, developed products for technology transfer of AWPM techniques, in conjunction with collaborators from the University of Nebraska, Texas AgriLife Research, Colorado State University, Kansas State University, and Oklahoma State University.

Impact: The researchers produced and published a comprehensive, "Wheat Production Guide for the Great Plains." The guide represents a key educational tool for summarizing findings from the project and integrating them with other aspects of wheat production.

Control strategy mitigates the threat of the invasive Argentine cactus moth in the United States and eradicates the pest in Mexico. Since its detection in south Florida in 1989, the Argentine

cactus moth has expanded its range each year along the Atlantic Coast and west along the Gulf Coast to the barrier islands of Mississippi. This moth has become an imminent threat to many *Opuntia* cactus species which are valued as food, forage, wildlife habitat, and a major plant group contributing to ecosystem structure and biodiversity. ARS researchers in Tifton, Georgia, and Tallahassee, Florida, in collaboration with the USDA Animal and Plant Health Inspection Service (APHIS), 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. With the cooperation of ARS, APHIS, and SAGARPA (Mexico's department of agriculture), Mexico continues to adopt and implement these methods and tactics in the operational program that is part of an ongoing United States-Mexico bi-national campaign against this invasive pest.

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

Successful release of a new introduced tarnished plant bug natural enemy in the Mid-Atlantic region. Tarnished plant bug (TPB) injures a large number of crops throughout the United States. A previously introduced European natural enemy of TPB, *Peristenus digoneutis* (a parasitoid), was successfully established in the northeastern United States, where it has helped to reduce this pest's populations. However, *Peristenus digoneutis* has not moved into hotter areas of the United States. In cooperation with Delaware State University and the New Jersey Department of Agriculture, ARS researchers in Newark, Delaware, conducted field releases of a second European natural enemy, *Peristenus relictus*, which is adapted to hot climates, in the Mid-Atlantic region during the past 3 years.

Impact: Recovery surveys have shown that *Peristenus relictus* is becoming established. This year, a geographic population of *Peristenus relictus* from Morocco is being released in more southern U.S. locations. ARS scientists in Newark anticipate that these releases will cause similar reductions in TPB populations as those that have occurred in the Northeast.

Detection methods and sampling protocols for Asian citrus psyllid, the vector of citrus greening disease. Growers interested in utilizing spray thresholds for the psyllid, or comparing infestation levels of psyllids in different groups of citrus trees, need a reliable sampling protocol to estimate psyllid densities. The need for psyllid detection tools in areas being monitored for psyllid invasion is especially important in California, Arizona, and Florida. ARS researchers in Fort Pierce, Florida, found that yellow, green, or lime green sticky traps were more effective than stem-tap samples for detecting adult psyllids when populations were scarce.

Impact: A stem-tap sampling protocol was developed that provided estimates of an adequate precision level, defined at one or more psyllids per sample. These methods will aid response to the citrus greening crisis in Florida by providing a more accurate sampling and monitoring protocol.

Indicator 2:

During 2010, 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 2010 Accomplishments:

Aerial release methods for the arundo wasps developed. Ground releases of the arundo wasp *Tetramesa romana* to control *Arundo donax* (giant reed) are not practical in the remote areas of the Rio Grande Basin of Texas because of poor roads and the dense thickets these weeds form; thickets that inhibit uniform dispersal of the wasps. *Arundo donax* can out compete and displace native vegetation in riparian zones, reduce wildlife habitat, increase fire risks, interfere with flood control, and create a security problem along the southern border of the United States and Mexico. ARS scientists in Weslaco, Texas, in collaboration with USDA Animal and Plant Health Inspection Service equipment specialists at Moore Air Base in Edinburg, Texas, have developed technology to contain, transport, and release arundo wasps from light aircraft. Specialized cardboard boxes filled with chilled arundo wasps were accurately dropped into the narrow corridor of *Arundo donax* thickets with minimal mortality to the biological control agents.

Impact: This technology will be used by action agencies to extend the use of the arundo wasp to the far reaches of the Rio Grande River where *Arundo donax* (giant reed) invades.

A monitoring system for detecting herbicide treated fields. The effectiveness of herbicide treatments against pest weeds can vary substantially among different fields, and new methods are needed to accurately map herbicide performance over entire fields or even multiple field complexes. ARS researchers in College Station, Texas, showed that a type of instrument that measures light reflectance off plant surfaces can be effectively used to detect and measure the relative weed killing effects of the herbicide glyphosate. The technique, known as multispectral reflectance, can be adapted for use on either aerial or ground based application equipment.

Impact: The work is important because it provides a new approach to accurately evaluate herbicide effectiveness under real world conditions; with the ultimate result that herbicide application protocols can be adjusted to assure maximum effectiveness with a minimum of chemical used.

Brazilian waterweed management. *Egeria densa* (Brazilian waterweed) spread in the Sacramento-San Joaquin Delta greatly impacts commercial navigation as well as potable and irrigation water delivery for over 23 million Californians. ARS scientists in Reno, Nevada, in collaboration with state and other Federal agencies, developed an effective herbicide control strategy that can reduce *Egeria densa* cover by 50 to 75 percent and biomass by 90 percent.

Impact: This control strategy, when coupled with other methods under development such as biological control, could significantly reduce the impacts of this invasive plant on U.S. waterways.

Knowing the invader to improve the success of control. The perennial pepperweed plant invasion in the United States includes more than one species. Plants can be hard to identify to species

level using morphology alone. If the invasive species is misidentified, searches for insects and diseases that can be imported to control the invasion can be done using the wrong plant species or in the wrong region of the world. ARS researchers in Sidney, Montana, used DNA data on perennial pepperweed plants from the United States and Asia and found that the invasion in the United States includes two species, *Lepidium latifolium* and *Lepidium affine*. These two perennial pepperweed species have different ranges in Asia, and perhaps different insect and pathogen agents that attack them.

Impact: Biological control researchers will now include both of these species in the search for control agents to be used in the United States.

Indicator 3:

During 2010, 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 2010 Accomplishments:

Multiple approaches developed to combat the citrus greening disease. Because of the difficulty in cultivating the bacteria (*Candidatus Liberibacter asiaticus*), presumed to cause Huanglongbing (HLB) or citrus greening disease, and in propagating and maintaining a large number of HLB-infected plants, it is extremely difficult to screen potential chemicals for HLB therapy and control. Recent advances by ARS scientists in Fort Pierce, Florida, in this area include: Developing a method for rapid detection of the pathogen; Identifying a combination of two chemicals that eliminates the pathogen associated with citrus HLB in the plant, and Fully sequencing the genome of the presumed pathogen.

Impact: These new developments will greatly facilitate HLB research and the development of new strategies for control of this devastating disease.

New leads in biocontrol and monitoring of the Asian citrus psyllid, a vector of huanglongbing (citrus greening). To optimize biocontrol, researchers need to know the pest's biotype and origin. Using genetic analysis, ARS researchers in Weslaco, Texas, have found that the Asian citrus psyllid invaded North and South America in separate introductions. Each introduction likely originated from different Asian countries. The next steps were to locate the regions of these psyllids then search them for natural enemies. In related work, the Weslaco scientists, in collaboration with ARS scientists in Peoria, Illinois, and Fort Pierce, Florida, found that in laboratory tests psyllids died within five days when exposed to a Texas strain of a fungal insect pathogen, *Isaria fumosorosea*. Further, the adults picked up spores of the fungus from baited cards, with up to 70 percent of adults dying in 10 days. Work to monitor these control efforts was given a boost by researchers in Weslaco who found that the adult psyllids were attracted to petitgrain oil from sour orange trees. The oil is relatively inexpensive and commercially available as an essential oil. Because it can be used to lure psyllids to traps it could make an important monitoring or control tool.

Impact: These results demonstrated that the Texas strain of the fungus has the potential for controlling the psyllid, and could be a valuable option for those areas where commercial control efforts cannot be employed, such as dooryards; if an auto-disseminator can be developed it could be employed in commercial orchards as well.

New approaches to controlling nematodes in watermelon through grafting. Root-knot nematodes (*Meloidogyne* species) cause extensive damage to root systems of watermelon and many other vegetable crops, resulting in significant yield losses. Aside from soil fumigation, which continues to have limited use, host plant resistance is the preferred means of control, if available. In recent years, the U.S. watermelon industry has developed an interest in planting grafted watermelons for imparting resistance to soil-inhabiting pests and diseases. ARS scientists in Charleston, South Carolina, have identified wild watermelon (*Citrullus lanatus* var. *citroides*) lines resistant to root-knot nematodes. These lines were evaluated as rootstocks for grafted watermelon in field tests in South Carolina and Florida. The root-knot nematode-resistant lines performed well as rootstocks, and produced high yields for the grafted watermelon plants.

Impact: These wild watermelon rootstocks could be a useful alternative to soil fumigation with pesticides, such as methyl bromide, for managing root-knot nematodes in watermelon fields and in organic production. Also, they can be useful for seed companies interested in developing rootstock varieties for grafted watermelon.

Avoiding phytotoxicity of mustard seed meals to crop plants. Mustard seed meal contains naturally occurring chemicals that make them of interest as management agents for weeds and soilborne pathogens. Previous studies indicated that seed meal from two species of mustard, *Brassica juncea* and *Sinapis alba*, are toxic to nematodes. Because of the potential for phytotoxicity of these meals, it is advantageous to know the amount of time required between mustard seed meal application and planting of a crop to avoid phytotoxicity. ARS scientists in Beltsville, Maryland, and Corvallis, Oregon, tested the meals alone and in combinations to determine toxicity to pepper seedlings and to germinating lettuce seeds. Treatment with *B. juncea* seed meal tended to be the least toxic overall to pepper seedlings, indicating that nematotoxic rates of *B. juncea* could be applied relatively close to the time of pepper transplant.

Impact: This research is valuable to scientists optimizing the use of seed meal amendments for managing plant-parasitic nematodes without toxicity to crop plants. Growers eventually will benefit from the new nematode control practices.

Measure 4.2.4 Summary of the Major Technologies Developed, Transferred, and Used in FY 2010:

During FY 2010, 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
Improved dispersal technology for distributing the Arundo wasp <i>Tetramesa romana</i> for control of the invasive weed <i>Arundo donax</i> (giant reed).	Methods for packaging and the aerial release of the agent were demonstrated to action agencies.	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	Wide spread but accurate delivery of the agent into areas infested with <i>A. donax</i> but difficult to access by land while minimizing negative impacts on the agent. Consequently, the efficacy of the agent and its intended impact on

STRATEGIC GOAL 4

		Transportation; Texas Lower Rio Grande Valley Irrigation Districts; PRONATURA Mexico; and CONANP Mexico.	controlling this invasive weed has been greatly improved.
Development of technology for production of water persistent microsclerotia of fungi such as <i>Mycleptodiscus terrestris</i> for biocontrol of aquatic weeds.	Foreign patent applications and fees were supported by our CRADA partner and U.S. patent licensee SePRO Corp. for development of this technology in Canada, New Zealand, and Australia.	This technology and the foreign patent protection will be used by the licensees.	Safe, effective, non-chemical aquatic weed control tools will become commercially available for use in ponds, lakes, rivers, and streams.
Determination of selection intensity of Syngenta's mCry3A rootworm-targeted transgenic corn on the western corn rootworm.	A Syngenta CRADA was initiated, including a 3-year amendment to develop a resistant colony to the rootworm-resistant transgenic corn.	Syngenta Biotechnology, Inc.; Syngenta Seeds; growers who buy their seed; and the EPA.	This work will be part of the re-registration of MIR604 transgenic corn from protection against corn rootworms.
Development of interactive computer software called the Grass Seed Stem Rust Estimator, that produces information about the likely hazard of disease under prevailing weather and crop conditions after the user selects input information for farm location, scouting observations, and previous fungicide use.	The Grass Seed Stem Rust Estimator has been made publically available on the Internet at http://uspest.org/gci-bin/stemrust1.pl	The interactive web site is designed for disease managers, including growers, crop consultants, and extension agents.	The site generated several hits per months during the 3 month growing season and there are reports of its usefulness to disease managers.

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

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.

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

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

During FY 2013, ARS will

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

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

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

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 2010, ARS will continue to develop diagnostic assays to detect and differentiate existing, new and/or emerging quarantine arthropod pests, weeds, nematodes, and pathogens.

FY 2010 Accomplishments:

Identification of the causal agent associated with the almond brownline disease. Almond brownline 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 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 non-availability 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 will be used to monitor the trees in a commercial orchard impacted by almond brownline disease.

A sensitive molecular diagnostics test was developed to detect potato cyst nematodes. Current traditional methods for validation of the presence of potato cyst nematodes in suspected soils have relied upon physical appearance, tests with susceptible potato plants, and DNA sequencing, all of which are time-consuming and expensive to perform. ARS researchers in Ithaca, New York, have developed highly specific and sensitive molecular methods for the differentiation of the two species of potato cyst nematode which currently exist in the United States. These new molecular diagnostic methods offer rapid, specific, and sensitive identification of potato cyst nematode species compared to traditional methods. The high degree of specificity and sensitivity

of these methods should permit nematode detection in soil extracts that contain extremely low amounts of nematode DNA.

Impact: The methods will provide a valuable detection tool useful in nematode regulatory and quarantine programs throughout the United States. A conventional patent application has been filed for the techniques, and the method has been shared with USDA Animal and Plant Health Inspection Service for internal validation.

An efficient diagnostic system for sensitive detection of 14 different viruses infecting important crops. The serological method – Enzyme Linked Immunosorbent Assay or ELISA – is the most commonly used technique in plant virus detection. Real-time polymerase chain reaction (real-time PCR) is quickly gaining greater utilization in plant virus detection due to its sensitivity. However, two major factors limit the practical application of real-time PCR in routine virus detection – the slow sample processing and primer specificity. ARS scientists in Charleston, South Carolina, developed a combination of the two methods – immunocapture real-time PCR technology – that allows efficient processing of large numbers of samples for simultaneous virus detection. Accordingly, the industry partner has developed various testing kits based on this technology and started offering a new line of products in 2010.

Impact: The success of this technology will help U.S. growers acquire timely and accurate information about the virus infection status in their crop plants. Thus, the appropriate disease management measures may be deployed either to prevent the onset of the diseases or to effectively manage such diseases.

Accurate identification of pathogens causing brown patch disease in turfgrasses. *Rhizoctonia* species, which cause brown patch disease in turfgrasses, are considered one of the most important pathogens on turf. The traditional method of identifying *Rhizoctonia* species, by hyphal anastomosis reactions, is often unreliable and time consuming. An ARS scientist in Beltsville, Maryland, and cooperators analyzed DNA sequences of *Rhizoctonia* isolates from Maryland and Virginia to develop an efficient molecular detection assay of the pathogens causing brown patch disease of turfgrasses.

Impact: Development of more accurate molecular identification of *Rhizoctonia* species will help in developing resistant turfgrass cultivars and in proper management of brown patch disease.

Indicator 2:

During 2010, ARS will continue to expand interdisciplinary research to include means of excluding, managing and/or eradicating quarantine arthropod pests, weeds, nematodes and pathogens.

FY 2010 Accomplishments:

New Phomopsis species identified from grapevine. Phomopsis cane and leaf spot, caused by the fungus *Phomopsis viticola*, is a destructive foliar disease in eastern North American vineyards, and its control requires a minimum of four preventative sprays per growing season. Infections can become so numerous on leaves and stems that the vine drops many of its leaves or the stems are girdled (and the fruit subsequently shrivels). ARS scientists in Davis, California, and Beltsville, Maryland, in cooperation with scientists from University of California-Riverside, and

Cornell University, Geneva, New York, identified two new species not previously found on grapevines: *P. fukushii* and *Diaporthe eres*. The researchers are currently evaluating the virulence of these new species, in comparison to *P. viticola*, on potted plants in the greenhouse.

Impact: If these new species infect grapevines via pruning wounds, then standard controls aimed at preventing infections of leaves and stems may not be effective against pruning wound infection.

New selective insecticides for whitefly management. Sweet potato whitefly is a major pest of agriculture worldwide. One difficulty in controlling this pest is its ability to develop resistance to insecticides. Although effective and selective insecticides are currently available for whitefly management, and there are recommended procedures for their use that helps minimize resistance development, it is prudent to have additional replacement chemistries available in the event that resistance does develop. ARS scientists in Maricopa, Arizona, in collaboration with scientists at the University of Arizona, demonstrated that two new compounds (cyazypyr and rynaxypyr) are toxic to whiteflies, but not to their natural enemies. Whereas one new compound, pyrifluquinazon, was highly toxic to whitefly but was not selective, i.e., it killed more than just whiteflies. Because of their selectivity, these two new compounds (Cyazypyr and rynaxypyr) will be particularly useful in integrated pest management programs that utilize natural enemies of whitefly as an additional control measure.

Impact: The knowledge of the whitefly control properties of these new chemistries will be of value in preventing disruptions in cotton production due to the sudden development of resistance in sweet potato whitefly to chemicals currently used for their control.

Indicator 3:

During 2010, 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 2010 Accomplishments:

Insect and mite systematics help safeguard the Nation's agriculture. Invasive species cause hundreds of billions of dollars in losses in the United States each year. Systematics collections are essential for addressing these threats. During the past year, ARS scientists in Beltsville, Maryland, used these insect and mite collections to conduct 46,000 identifications, including over 6,000 considered urgent by the USDA Animal and Plant Health Inspection Service, from specimens collected at U.S. ports. In addition, this research generated knowledge of moths that is assisting the "Discover Life in America" effort to document all life in the Great Smoky Mountains National Park for the purpose of biodiversity education. The scientists are also discovering clues to host-parasite evolution through leaf mining fly systematics, and conducting extensive biological and ecological studies of a new parasitic wasp found for the important invasive emerald ash borer. These researchers produced electronic identification tools for invasive fruit flies; descriptions of new parasitic wasps that attack leaf mining flies and other wasps used for biocontrol of the invasive weed, Old World climbing fern; and identified flea beetles used for biocontrol of other invasive weeds.

Impact: These applications are being used to prevent the introduction of new invasive species and manage established ones.

Fungi show promise in insect biocontrol. Based on fungal cultures maintained in the ARS Entomopathogenic Fungus collection (which has accessioned 856 new isolates this past year alone), ARS scientists in Ithaca, New York, and Beltsville, Maryland, have made progress in revising the phylogenies of the key fungal pathogens *Beauveria* and *Metarhizium*. This group of scientists, along with ARS collaborators in Weslaco, Texas, is describing *Isaria poprawskii* as a new species that tolerates high temperatures and is pathogenic to whiteflies and other pests of the Lower Rio Grande Valley. The above mentioned group, along with Brazilian collaborators, is also describing other insect-pathogenic fungi from Triatomine insect vectors of Chagas disease. Researchers in Ithaca have also found ways to increase the shelf-life of fungus-based insecticides, which is key to their storage and use in hot climates such as the Lower Rio Grande Valley. Combined conditions of low moisture and low oxygen preserved fungal conidial spores for more than one year at 40°C, the longest survival of the conidia of an insect-pathogenic fungus. Another strategy for increasing the effectiveness of a fungus is to use it with low doses of insecticides. Researchers in Ithaca found that fungus applied in combination with a one-tenth application rate of imidacloprid (an insecticide) provided moderate protection against the invasive pest emerald ash borer.

Impact: This insect-pathogenic fungus is very safe, and may lead to more cost-effective, environmentally safe biocontrol strategies for land managers.

Indicator 4:

During 2010, 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 2010 Accomplishments:

Cause of “crumbly fruit” of raspberry identified. The cause of the economically limiting disease called crumbly fruit of raspberry was found to be a previously unknown member of the reovirus group. ARS researchers in Corvallis, Oregon, together with Oregon State University, characterized the virus, developed a detection method, and demonstrated that the virus is transmitted by aphids.

Impact: The virus test is being used in ongoing clean plant certification for berry crops and virus elimination programs to ensure virus-free plants are being made available to the industry. Because aphids spread the crumbly fruit virus quickly in the field, using virus-free planting stock and aphid control will be required to minimize the impact of this destructive virus on raspberry production in the future.

Mobile pathogenicity chromosomes identified that explains how harmless fungi can change into plant killers in wheat and barley scab. Keeping plants healthy is all about keeping one step ahead of the microbes that can harm them. Fungi that cause plant disease have an uncanny knack for changing and overcoming disease resistance genes that scientists work so hard to breed into plants. *Fusarium* species are among the most important pathogenic fungi and include *Fusarium graminearum* that causes wheat *Fusarium* head blight or scab. Using comparative genomics, ARS researchers in St. Paul, Minnesota, have determined that *Fusarium* fungal pathogens have the unusual ability to pass particular chromosomes between strains and convert harmless fungi into pathogens. This process explains why new strains of fungi can arise quickly and threaten crops.

Impact: The discovery means scientists can now start working on a means to thwart the trading of chromosomes and the disease-causing ability that comes with them.

Source of blueberry scorch virus dissemination. Blueberry scorch virus (BIScV) was appearing in newly planted blueberry fields in a pattern atypical for normal spread by the insect vector of this disease. ARS scientists in Beltsville, Maryland, determined that blueberries propagated at nurseries can be infected with BIScV, but not show any symptoms. The infected plants are then shipped to farms where the virus symptoms appear within the next 2-5 years.

Impact: This prompted a state-wide nursery inspection system to identify infected source plants and prevent further distribution.

Indicator 5:

During 2010, ARS will support interagency collaboration for tracking successful exclusion, eradication where possible, and management of quarantine arthropods, weeds, nematodes, and pathogens.

FY 2010 Accomplishments:

Discovery of genes for enzymes that mediate insect response to bacterial infection. Insect immunity is mediated by biochemical signals that stimulate specific immune reactions. Inhibiting the formation of these signals has the effect of crippling insect immunity. ARS researchers in Columbia, Missouri, in collaboration with scientists at Kansas State University and Andong National University, Korea, identified five genes that encode variations on a specific enzyme involved in mediating insect immune responses. Inhibiting the expression of four of the genes effectively crippled insect immune reactions to bacterial infection. This demonstrates a completely novel concept, crippling immune genes, in biological control research.

Impact: Developing specific agents to impair insect immune functions can be a feasible and important contribution to sustainable agriculture.

Microbial control of the invasive cactus moth. The invasive cactus moth is a serious threat to native cacti in the southwestern United States and the cactus industry in Mexico. ARS scientists in Tallahassee, Florida, in collaboration with scientists at Florida A&M University assessed the use of fungal entomopathogens against the egg and early larval stages of the moth, because these life stages are found outside the cactus pads. Young larvae of *Cactoblastis cactorum* were found to be susceptible to both *Metarhizium anisopliae* and *Beauveria bassiana*, with *M. anisopliae* being extremely virulent.

Impact: This knowledge will be of value to researchers developing biological control strategies for the cactus moth.

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

FY 2010:

During FY 2010, 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
Improved dispersal technology for distributing the Arundo wasp <i>Tetramesa romana</i> for control of the invasive weed <i>Arundo donax</i> (giant reed).	Methods for packaging and the aerial release of the agent were demonstrated to action agencies.	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.	Wide spread but accurate delivery of the agent into areas infested with <i>A. donax</i> but difficult to access by land while minimizing negative impacts on the agent. Consequently, the efficacy of the agent and its intended impact on controlling this invasive weed has been greatly improved.
Development of technology for production of water persistent microsclerotia of fungi such as <i>Mycropleptodiscus terrestris</i> for biocontrol of aquatic weeds.	Foreign patent applications and fees were supported by our CRADA partner and U.S. patent licensee SePRO Corp. for development of this technology in Canada, New Zealand, and Australia.	This technology and the foreign patent protection will be used by the licensees.	Safe, effective, non-chemical aquatic weed control tools will become commercially available for use in ponds, lakes, rivers, and streams.
Determination of selection intensity of Syngenta's mCry3A rootworm-targeted transgenic corn on the western corn rootworm.	A Syngenta CRADA was initiated, including a 3-year amendment to develop a resistant colony to the rootworm-resistant transgenic corn.	Syngenta Biotechnology, Inc.; Syngenta Seeds; growers who buy their seed; and the EPA.	This work will be part of the re-registration of MIR604 transgenic corn from protection against corn rootworms.
Development of interactive computer software called the Grass Seed Stem Rust Estimator, that produces information about the likely hazard of disease under prevailing weather and crop conditions after the user selects input information for farm location, scouting observations, and previous fungicide use.	The Grass Seed Stem Rust Estimator has been made publically available on the Internet at http://uspest.org/gci-bin/stemrust1.pl	The interactive web site is designed for disease managers, including growers, crop consultants, and extension agents.	The site generated several hits per months during the 3 month growing season and there are reports of its usefulness to disease managers.

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

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.

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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

During FY 2013, ARS will

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

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

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

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

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

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Strategic Goal 5:

Improve the Nation's Nutrition and Health

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

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

OBJECTIVE 5.1: ENSURE ACCESS TO NUTRITIOUS FOOD

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

OBJECTIVE 5.2: PROMOTE HEALTHIER EATING HABITS AND LIFESTYLES

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

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

Performance Measures

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

Baseline 2005

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

Target 2011

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

Indicator 1:

During FY 2010, ARS will survey, release data on, and analyze national food consumption patterns of Americans.

FY 2010 Accomplishments:

ARS released the “What We Eat in America” diet survey data from NHANES for 2007-2008. This is the only nationally representative survey of what foods and nutrients Americans are eating.

Impact: Federal nutrition policy, estimates of safe and adequate intake of nutrients (Dietary Reference Intakes) established by the Institute of Medicine, and estimates of exposure to pesticides calculated by the HHS, Environmental Protection Agency are examples of programs that require accurate and nationally representative dietary survey information. In addition, this database is widely used by researchers at universities who analyze the data for correlations with indicators of health and disease to predict healthy dietary patterns.

ARS released version 4.1 of the Food and Nutrient Database for Dietary Studies that includes more than 13,500 foods with typical portion sizes and nutrient content.

Impact: This database is used for the What We Eat in America/NHANES national dietary survey and by the USDA's Center for Nutrition Policy and Promotion as the foundation of the MyPyramid individualized nutrient intake calculations. The Web site hosting MyPyramid is one of the most widely accessed Federal Web sites.

Indicator 2:

During 2010, ARS will develop new methods, conduct food composition analyses, and compile databases for known, emerging, and new classes of nutrients.

FY 2010 Accomplishments:

ARS published the USDA National Nutrient Databank for Standard Reference, Release 23.

Impact: This database is the gold standard used by all commercial suppliers of nutrient data and many other countries. It is used by the public, researchers, clinicians, and other Federal agencies. The database is freely available on the Web and for download to personal computers.

A special interest database listing Oxygen Radical Absorbance Capacity (ORAC) of selected foods, Release 2 was made available.

Impact: ORAC values are indicative of the amount of antioxidant nutrients in foods. This release added 49 foods bringing the total to 326. Many researchers use these data to estimate health benefits of fruits and vegetables; the food industry uses this information to set research priorities and for advertising potential health benefits from their products.

An analytical method involving liquid chromatography and mass spectrometry was published to characterize phenolic compounds in Brassica vegetables. This led to the identification of 71 compounds, 10 of which had not been previously reported.

Impact: Identification of compounds with possible health benefits enables researchers to study whether there is a relation between intake and improved health. Development of a new method allows research questions about these compounds to be answered.

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

FY 2010:

During FY 2010, ARS reported 5 new databases developed and released to ARS customers to establish Federal dietary policy guidelines, food assistance and feeding programs, and food labeling to safeguard the health of the American people.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
What We Eat in America (WWEIA) diet survey	Data are released on the Web and are free to	Researchers at universities, other Federal	WWEIA is the only nationally representative

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	researchers and the public.	agencies such as FDA, EPA, NIH that conduct further analyses. The public is able to analyze their own intakes.	diet survey. It is used by hundreds of researchers studying the relation of foods or nutrients with various health endpoints.
Food and Nutrient Database for Dietary Studies, Ver 4.1	Data are released on the Web and are free to researchers and the public.	Primarily, other Federal agencies including USDA/CNPP.	CNPP uses this to build model diets that meet the Dietary Guidelines for Americans.
Release 23 of the USDA National Nutrient Database for Standard Reference	Data are released on the Web and are free to researchers and the public.	This database is widely used by USDA's REE, and FNS agencies and by other Federal agencies such as FDA's food labeling program. Health professionals and the public also use these data.	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.
Oxygen Radical Absorbance Capacity (ORAC) Special Interest Database, Release 2	Data are released on the Web and are free to researchers and the public.	The primary users are researchers at universities; other users are the fruit and vegetable industry.	These data are used to tie antioxidant content to health benefits of fruits and vegetables. Plant breeders and processor aim at increasing the ORAC value of foods to increase health benefits.
New method for analysis of phenolic compounds in foods was developed.	Published in a peer-reviewed scientific journal.	Researchers.	Newly discovered constituents of plant foods will enable researchers to determine if these are responsible for health effects of eating foods from the cabbage family.

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

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.

During FY 2013, ARS will

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

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

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 2010, ARS will identify dietary and lifestyle intervention strategies to prevent obesity and promote healthy food choices and eating behaviors.

FY 2010 Accomplishments:

Researchers at the ARS lab in Houston, Texas, found that 12 weeks of moderate intensity exercise four times per week in lean and obese sedentary adolescents did not change overall energy expenditure and increased the ability of lean, but not obese, subjects to metabolize fat.

Impact: These data suggest that even more exercise and/or calorie restriction is an essential component of a successful weight control strategy and that obese teens require more exercise than their lean counterparts to increase fat burning.

Scientists at the ARS lab in Houston, Texas, evaluated 2-year outcomes testing and instructor-led versus a self-help weight maintenance program among overweight Mexican-American children.

Impact: Children in the instructor-led intervention had greater decreases in weight and blood lipids as well as an improvement in body composition. Few studies have tracked participants for 2 years and this particular intervention remained successful, in contrast to most that show weight regain, often after 6 months.

Indicator 2:

During 2010, ARS will determine the functions, bioavailability, interactions, and requirements for known, emerging, and new classes of nutrients across the lifecycles.

FY 2010 Accomplishments:

Scientists at the ARS lab in Boston, Massachusetts, conducted a meta-analysis of available data linking vitamin D with risk of falls in the elderly and concluded that at least 700 International Units of vitamin D was needed daily.

Impact: This analysis was incorporated into the Institute of Medicine report on Dietary Reference Intakes for Calcium and Vitamin D that was published in November 2010. These data were the primary ones used for recommendations about vitamin D intake in the elderly.

ARS scientists at Beltsville, Maryland, determined that beta-carotene conversion to vitamin A decreases as the dose increases.

Impact: Beta-carotene is the orange pigment found in carrots, sweet potatoes, and similar colored vegetables and is converted in the body to vitamin A. Over-consumption of vitamin A is a real concern because of negative health effects so it is reassuring for recommendations about diet and supplements, especially for people with kidney disease who have problems metabolizing vitamin A.

Measure 5.2.2 Summary of the Major Technologies Developed, Transferred, and Used in FY 2010:

During FY 2010, ARS reported 3 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
Dietary Reference Intakes for Calcium and Vitamin D report from the Institute of Medicine	Authoritative report from the National Academies released on the web and via print.	Clinicians, dietitians, researchers, food industry, regulatory agencies, and the public.	Sets the recommended amounts for these two nutrients. Used to recommend foods to meet requirements in Federal feeding programs, used for food labeling and fortification of foods by industry.
Institute of Medicine report on Providing Health and Safe Foods as We Age	Authoritative report from the National Academies released on the web and via print.	Food industry, researchers, government agencies, and dietitians.	The number of adults over 65 will double in the next 20 years. Nutritional needs change with age and the immune system declines so the food industry will respond with new products and regulators must ensure safe food for the aging population.
Institute of Medicine report	Authoritative report from	Food industry, regulatory	This report examined

of Front-of-Package Nutrition Rating systems and Symbols.	the National Academies released on the web and via print.	agencies, researchers.	strengths and limitations of existing labeling systems and recommended specific information that labels should provide on food packages. This report will be used by FDA in establishing front-of-package labeling for foods.
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Measure 5.2.2 Outyear Performance Plan (the future performance indicators for this Measure)

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.

During FY 2013, ARS will

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

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

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.

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 2010, ARS will publish new findings on metabolic processes that are affected by nutrient intake.

FY 2010 Accomplishments:

Scientists at the ARS lab in Boston, Massachusetts, tested the dietary ratio of animal to vegetable protein for effects on serum cholesterol and other risk factors for heart disease. They found only a few small differences out of more than two dozen factors tested.

Impact: This theory has been studied for almost 40 years, mostly in laboratory animals, yet has been used to make dietary recommendations. This controlled study will result in more accurate diet suggestions for those concerned about heart disease.

Researchers at the ARS lab in Little Rock, Arkansas, studied infants fed breast milk, cow's milk formula, or soy formula to measure development of brain electrical activity during the first year of life. Those who were breast-fed had significantly different brain activity compared to the two formula-fed groups, which were similar.

Impact: Variations in brain activity reflect diet's influence on development of brain structure and function that could put infants on different developmental trajectories. Longer-term follow-up will determine if choice of infant feeding has effects on brain functions. No previous study on the influence of formula feeding has ever examined brain development.

ARS scientists from Davis, California, discovered oxygenated metabolites of fatty acids in the blood of volunteers and their response to consumption of omega-3 fats. Levels of so-called oxylipins were altered by omega-3 feeding.

Impact: While omega-3 fats have been associated with a variety of health benefits, the biological mechanism remains unknown. These newly discovered compounds have biological activity in test tubes and it is expected that large heart disease studies will now include oxylipins to determine if these are the mediators of the health benefits.

Indicator 2:

During FY 2010, ARS will discover genetic or epigenetic factors that influence physiologic responses to diet or changes in gene expression in response to dietary intake.

FY 2010 Accomplishments:

ARS funded researchers in Boston, Massachusetts, identified a gene that regulates lipid metabolism in the bloodstream which is strongly linked to obesity only when people with that variant consume a diet high in saturated fat.

Impact: This finding will contribute to efforts to identify individuals susceptible to diet-induced obesity and will ultimately allow for individualized dietary recommendations to reduce the risks of obesity and heart disease.

ARS scientists at Davis, California, found that a common genetic variant in the major plasma vitamin B12 transport protein of older Latinos affects delivery of the vitamin to tissues and the blood levels of homocysteine, a metabolite associated with heart disease.

Impact: The prevalence of this gene variant is lower in this population than in Caucasians. Since the association between vitamin B12 and homocysteine is modified by this variant, more focused dietary recommendations may be possible for this ethnic group.

Measure 5.2.3 Summary of the Major Technologies Developed, Transferred, and Used in FY 2010:

During FY 2010, ARS reported 5 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
Comparison of animal and vegetable protein in diet for effects on cardiovascular disease risk factors.	Paper published in peer-reviewed scientific journal.	Researchers, policy makers.	The Dietary Guidelines for Americans released in 2010 emphasize plant-based foods. No previous controlled human study had tested this and minimal risk alteration occurred with any ratio of animal to vegetable protein.
Infants fed breast milk, cow's milk formula or soy formula were tested from brain electrical activity during the first year of life.	Paper published in peer-reviewed scientific journal.	Researchers, policy makers.	A few countries have banned soy formula because of perceived adverse health effects but in the absence of evidence. In this study, both types of formulas resulted in similar brain development but both were different from breast feeding. Additional follow-

			up continues to determine if the changes observed result in functional differences.
Discovery of oxygenated metabolic products of fatty acids in the blood of volunteers that respond to omega-3 fat consumption.	Paper published in peer-reviewed scientific journal	Researchers.	While omega-3 fats are associated with a variety of beneficial health endpoints, how they work is unknown. These newly discovered compounds will be studied by researchers as markers of reduced risk.
Discovery of a gene variant that increases risk of obesity when people consume saturated fat.	Paper published in peer-reviewed scientific journal.	Researchers, policy makers.	Response to eating saturated fat among the population varies considerably. Identification of genes that contribute to this variation will lead to personalized, more accurate, dietary recommendations.
Identification of a genetic variation in a blood protein that transports vitamin B12 among Hispanics.	Paper published in peer-reviewed scientific journal.	Researchers, policy makers.	Nutrient recommendations differ based on genetic variation. This study will help refine vitamin needs for a minority group at increased risk for health problems.

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

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.

During FY 2013, ARS will

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

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

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 2010, ARS will develop guidelines for irrigating in urban and agricultural settings with degraded waters.

FY 2010 Accomplishments:

New guidelines of the Food and Agriculture Organization of the United Nations (FAO) were developed for water quality criteria for irrigation by ARS scientists in Riverside, CA. These guidelines allow increased use of marginal waters and treated wastewaters for irrigation. Field and laboratory studies were used to refine earlier water quality criteria relating infiltration hazard to pH, Sodium Adsorption Ratio (SAR), and salinity. These guidelines replace earlier FAO criteria that did not consider pH and underestimated the adverse impact of even slight increases in SAR on water infiltration.

Impact: Results from this work provide water quality specialists, water planners, regulatory agencies, and producers with an improved ability to evaluate the infiltration hazards associated with application of a specific irrigation water composition. The improved guidelines ensure safer use of saline waters for irrigation and thus extend the supply of fresh water resources.

A scientific team led by an ARS Scientist at Riverside, CA, used satellite imagery to assess and map 300,000 hectares of North Dakota's and Minnesota's Red River Valley (RRV). The team found that 53 percent of the variability in soil salinity measured *in situ* was correlated with a vegetation (crop) index derived from MODIS satellite imagery averaged over 7 years of data collection. The observed relationship between soil salinity measured in the field and the satellite-derived vegetation (crop) index was used to assess whether the land was eligible for inclusion in the Conservation Reserve Program (a federal program that sets aside marginally productive land for conservation purposes).

Impact: Rising salinity levels in RRV soils have been linked to increasing in precipitation and rising water tables resulting from climate change. This technology provides NRCS with protocols and guidelines for mapping soil salinity over hundreds of thousands of hectares in the RRV. The technique has for land managers and policy makers across the globe who need a regional-scale tool for measuring and inventorying soil salinity in agricultural fields where salt buildup can lower crop yields.

Indicator 2:

During FY 2010, 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 2010 Accomplishments:

ARS scientists at Ames, IA, developed a method to use soil and land cover databases combined with modeling to estimate the extent that land currently used to grow corn in the Midwest would be suitable for drainage water management – a practice with the potential to reduce nitrate loss. Considering the cost of control structures, redesign of new drainage systems, and payments to farmers to adjust the control structures to reduce nitrate losses, the cost per kg of nitrate removed from drainage water by DWM was estimated at \$2.71 (\$1.23/lb). While this is more than the current cost of nitrogen fertilizer, it represents a competitively priced alternative method for removing nitrate from agricultural drainage waters that does not involve taking arable land out of production.

Impact: Both farmers and state and federal action agencies can use this information to set priorities for the expenditure of conservation funds to improve surface water quality. These estimates indicate that 4.8 million ha of land currently used to grow corn in the Midwest would be suitable for DWM, with the potential to reduce nitrate loss by approximately 83,000 metric tons (91,300 tons) per year.

ARS scientists at University Park, PA, installed a curtain of gypsum (calcium sulfate) along the border of a field from which high loads of phosphorus had previously been recorded in groundwater. During the first rainstorms after installation, the new curtain (or permeable reactive barrier) removed 38-59% of the dissolved phosphorus in groundwater. Efforts are underway to expand the testing of this water quality enhancement practice to other areas in the region.

Impact: The loss of phosphorus in shallow groundwater leaving fields of the Delmarva Peninsula can account for more than 90% of the phosphorus exported by drainage ditches to tributaries of the Chesapeake Bay.

Indicator 3:

During FY 2010, ARS will develop predictive equations, procedures, and databases that will allow improved estimation of concentrated flow erosion on agricultural fields and construction sites.

FY 2010 Accomplishments:

A Cooperative effort between ARS scientists at West Lafayette, IN., Pullman, WA, and Washington State University resulted in the release of the Water Erosion Prediction Project (WEPP) model version 2010.1 in January 2010. The new model version performs much better in validation studies and contains significant improvements in the prediction of soil freezing and thawing, as well as snow accumulation and runoff resulting from snow melting.

Impact: This model release provides thousands of WEPP model users throughout the U.S. and world, with better predictions of runoff, soil loss and sediment yield from

hillslope profiles and small field-scale watersheds. Users in areas experiencing substantial erosion from snowmelt on thawing soils should notice particularly better performance.

Measure 6.1.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2010:

During FY 2010, 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
A new version of the Water Erosion Prediction Project (WEPP) model (version 2010.1)	Made available to users in the US and throughout the world.	Land managers and conservationists charged with predicting runoff, soil loss, and sediment yield from hill slope profiles and small field-scale watersheds.	Users in areas experiencing substantial erosion from snowmelt on thawing soils should notice particularly better performance.
New FAO guidelines for water quality criteria for irrigation with marginal waters and treated wastewaters.	Replaced earlier FAO guidelines that did not consider pH, and underestimated even slight increases in SAR on water infiltration.	Water quality specialists, water planners, regulatory agencies, and producers using, managing, or regulating the use of marginal waters and treated wastewaters for irrigation.	Improved ability to evaluate the infiltration hazards associated with the application of marginal waters or treated wastewaters of specific composition for irrigation purposes. The improved guidelines ensure safer use of saline waters for irrigation, thus increasing the supply of water sources available to support irrigated agriculture.

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

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.

During FY 2013, ARS will

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

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

develop new or improved conservation practices to better protect water resources, improving the overall effectiveness of USDA conservation programs.

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

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 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.

FY 2010 Accomplishments:

ARS scientists determined that the incidence of both pitch canker and fusiform rust were lower on loblolly pines grown under elevated atmospheric carbon dioxide; fusiform rust took longer to develop on red oak seedlings exposed to elevated carbon dioxide; and carbon dioxide did not affect disease severity.

Impact: Some plants may benefit from the rising level of carbon dioxide (CO₂) through decreased fungal disease incidence. This documents a beneficial impact of enhanced atmospheric CO₂ associated with climate change that may provide additional options for risk management of plant disease outbreaks.

Indicator 2:

During FY 2010, 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 2010 Accomplishments:

ARS scientists in Temple, TX determined that increasing CO₂ concentration may increase soil C storage in grassland ecosystems by stimulating root production and turnover.

Impact: This information identifies a factor controlling the process of carbon sequestration in grasslands and provides a characteristic to focus on when developing and managing grass varieties to maximize carbon sequestration.

ARS researchers in St. Paul, MN showed that specialized, coated urea fertilizer products designed to release nitrogen slowly over the growing season reduce N₂O greenhouse gas emissions, better match N supply to plant uptake to maintain yields, and reduce costs associated with split applications of conventional fertilizer.

Impact: Coated urea fertilizer as a GHG reduction technology has yield and economic incentives, thus improving the probability of its adoption by producers.

Indicator 3:

During FY 2010, ARS will develop practices which remediate degraded soils.

FY 2010 Accomplishments:

ARS scientists in Ames, IA determined that biochar, a form of charcoal produced while making renewable fuels with the process of pyrolysis, can be added to soil to increase carbon storage and improve soil quality.

Impact: A co-product of renewable energy will provide an added benefit as a soil amendment to enhance the quality of degraded and weathered soils, thus increasing the desirable environmental and potentially economic aspects of bio-based fuels.

Indicator 4:

During FY 2010, ARS will develop methods to reduce emissions of harmful gases from crop and animal production systems.

FY 2010 Accomplishments:

ARS scientists at University Park developed new equations to better estimate ammonia emissions from dairies that was incorporated into a decision support tool to enable increased nitrogen use efficiency, thus reducing ammonia emissions and increasing profit margins.

Impact: The new findings are being integrated into a decision support tool that will enable producers to evaluate the effects of nitrogen management and thus ammonia mitigation strategies, on the total air emissions from farms

Indicator 5:

During FY 2010, ARS will develop practices and approaches which mitigate the detrimental effects of tropospheric ozone on agricultural crops.

FY 2010 Accomplishments:

Yield loss trends based on conventional ground-based instrumentation and satellite-derived tropospheric ozone measurements were found to be statistically significant and consistent with results obtained from open-top chamber experiments conducted by ARS researchers in Raleigh, NC and in central Illinois.

Impact: Extrapolation of these findings supports previous studies that estimate the global economic loss from ozone damage to the farming community of more than \$10 billion annually.

Indicator 6:

During FY 2010, ARS will develop management practices and decision tools to improve soil quality and protect the environment.

FY 2010 Accomplishments:

ARS scientists at Lubbock, TX found that introducing a rotation of cotton with high biomass crops, such as forage sorghum and a winter rye cover crop, produced increases in microbial biomass carbon and nitrogen, and the activities of enzymes important for nutrient cycling in as little as three years.

Impact: This provides a new management option for a cropping system that can improve soil quality and functioning.

Indicator 7:

During FY 2010, 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 2010 Accomplishments:

ARS researchers in Beltsville, MD, Ames, IA, and Riverside, CA demonstrated that herbicide volatilization for Metolachlor and atrazine herbicides were much greater than runoff losses even though runoff was thought to be the major loss pathway.

Impact: This research demonstrates that 1) volatilization is perhaps the least understood yet potentially most important loss pathway for some common herbicides, 2) there is a critical need to reduce herbicide volatilization as a means of reducing chemical losses from farms to the environment, 3) current models for predicting herbicide emissions are inadequate, 4) economic losses from volatilization of herbicides are most likely greater than previously thought, and 5) current best management practices and regulatory policies for reducing emissions from farms may be in need of revision for desired protection of air and water resources.

Indicator 8:

During FY 2010, 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 2010 Accomplishments:

ARS researchers determined that waiting at least four weeks before mixing or turning stored dairy manure compost piles reduces carbon dioxide, methane, and nitrous oxide greenhouse gas emissions (GHG) from the piles.

Impact: A practice for dairies to reduce GHG emissions with a high probability of adoption because of its simplicity, has been verified and recommended.

Ammonia generation from litter in poultry houses reduces bird growth, and is partly determined by litter moisture content. ARS scientist in Mississippi State, MS, identified the critical litter moisture level that maximizes ammonia generation during broiler meat bird production across the range of temperatures encountered from summer to winter in Mississippi.

Impact: This provides a threshold metric for managing litter when seeking to reduce ammonia generation. A conservative estimate shows that reducing/limiting in-house ammonia generation by only 10% of the poultry broiler houses in Mississippi equates to more than \$26 million in additional grower revenues due to increased bird growth.

ARS scientists in Mississippi State, MS measured the antibiotic resistance patterns of Staphylococcus, Escherichia coli, and Enterococcus in poultry house aerosols and determined that resistance increased as the flock cycle progressed through the sell-off period, and that resistance dropped to baseline levels between flocks.

Impact: This documents the variability of antibiotic resistance during the production cycle and thus identifies critical periods when extra precautions are needed for worker protection and better control of aerosols to limit potential house-to-house contamination by resistant bacteria. This is expected to be used to alter production practices and production facilities.

Indicator 9:

During FY 2010, 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 2010 Accomplishments:

Cooperative research among several Northeast Land-grant Universities and ARS scientists in Beltsville produced a web-based nitrogen management tool describing best management practices for dairy farms that utilizes a whole-farm perspective.

Impact: The web site has been publicized in several popular press articles and is proving to be an important resource for Extension agents, dairy consultants, NRCS agents, and nutrient managers as they develop site-specific whole-farm nutrient management plans for Northeastern dairies.

A new Nitrogen Trading Tool (NTT) Concept and Nitrogen Loss and Environmental Assessment Package with Geographic Information System capability (NLEAP-GIS) were developed by ARS scientists in Fort Collins, CO to help assess the effects of management practices on nitrogen use efficiencies (NUE) and the potential to trade improvements in NUE in air and water quality markets.

Impact: ARS scientists cooperated with ERS scientists to conduct evaluations of the effects of management practices on NUE across several states and the current state of nitrogen management on cropland. The NTT and NLEAP-GIS were transferred to NRCS-National Water Management Center and Arkansas State University, and are being used to assess management practices in the Arkansas Delta.

Indicator 10:

During FY 2010, ARS will develop instrumentation and models to measure and predict emission and dispersion of particulate matter and gases from animal production operations.

FY 2010 Accomplishments:

ARS researchers from Bushland, TX and Kimberly, ID in collaboration with researchers at West Texas A&M University and Texas AgriLife Research measured atmospheric ammonia

concentrations and ammonia emissions for two years at two commercial feedyards and determined that monthly ammonia-nitrogen losses, as a fraction of fed nitrogen, ranged from 19 to 85% of fed nitrogen, with lowest fractional loss during winter months and greatest loss during summer months.

Impact: Reliable, accurate data accounting for seasonal variability is available to 1) validate and verify process models of emissions, 2) provide the dairy and cattle industries with accurate data to gauge regulatory compliance, and 3) provide policy-makers with accurate, comprehensive data from which to build ammonia emissions inventories and regulations.

FY2010 Accomplishment: A rapid and simple field-based sieving protocol for determining the susceptibility of soils to erosion by wind, the Wind Erodible Fraction (WEF), was developed by ARS researchers in Manhattan, KS to provide a useful tool for planning farming production strategies.

Impact: The protocol is now being used by NRCS in the field on a limited test-basis as a quick method for determining temporal WEF and is being incorporated into the NRCS National Agronomy Manual of policy and procedures for wind erosion. NRCS is now better-equipped to help landowners increase air quality and improve soil sustainability via reductions of wind-eroded soil.

Measure 6.2.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2010:

During FY 2010, 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
ARS Scientists at Florence, South Carolina, and business cooperators have developed a streamlined second-generation swine manure management process that delivers healthier pigs, healthier profits, and a healthier environment. A U.S. Patent 7,674,379 was issued in 2010	The new technology is being commercialized by Terra Blue Inc., of Clinton, N.C.	Pork producers nationwide. North Carolina producers specifically.	State of NC has allowed increased animal numbers on constant sized operational footprint when this technology is utilized.
A nitrogen management tool incorporating best management practices for dairy farms. Contains components on: concerns about N losses, crop and soil N management, feed storage N management, dairy herd N management including	Made web-accessible by Cornell University: www.DairyN.cornell.edu	Northeastern U.S. dairy farms.	Publicized by popular press; extension agents, dairy consultants, NRCS agents, and nutrient managers are using the tool extensively.

precision feeding, manure storage N management, and integrating the above components into a whole-farm system.			
A rapid and simple field-based sieving protocol for determining susceptibility of soils to erosion by wind expressed as Wind Erodeable Fraction (WEF) was developed.	The protocol was described in a report delivered to Natural Resources Conservation Service (NRCS).	Landowners, farmers, construction industry, Department of Defense.	Now being used by NRCS in the field on a limited test-basis as a quick method for determining temporal WEF; also being incorporated into the NRCS National Agronomy Manual of policy and procedures for wind erosion.
Nitrogen Trading Tool (NTT) Concept developed to help assess the effects of management practices on nitrogen use efficiencies (NUE) and the potential to trade improvements in NUE in air and water quality markets.	Delivery of program outputs to collaborators.	ERS	Collaborative study with ERS to evaluate effects of management practices on NUE across several states and the current state of nitrogen management on cropland.
Nitrogen Loss and Environmental Assessment Package with Geographic Information System capability (NLEAP-GIS) – a geospatial version of NLEAP.	Direct transfer of programs and documentation.	NRCS, Arkansas State University	The NTT and NLEAP-GIS are being used to assess management practices in the Arkansas Delta by NRCS and Arkansas State University.

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

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.

During FY 2013, ARS will

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

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

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

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

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

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

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 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.

FY 2010 Accomplishments:

Interest in switchgrass as a bioenergy feedstock has overshadowed its traditional uses for livestock grazing and being harvested for hay and silage. ARS scientists at Raleigh, NC in collaboration with North Carolina State University evaluated switchgrass germplasm using criteria of yield potential, in vitro dry matter disappearance, and crude protein in a weighted index to develop and release three new switchgrass cultivars adapted to the southeast for multipurpose use: 'BoMaster' for high yield, 'Colony' for improved cellulose concentration and yield, and 'Performer' for improved forage quality. Seed for all 3 cultivars will be available commercially for large scale plantings in 2011.

Impact: Switchgrass is a native grass that is better adapted to local conditions and requires fewer inputs such as fertilizer than the commonly used introduced grass varieties. Having three new switchgrass varieties available that have higher yield and better quality will enable livestock producers to reduce input costs and increase profitability. Also adapting these new switchgrass varieties will give southeast producers the opportunity to establish, grow, and use switchgrass so they will be ready to provide bioenergy feedstocks as markets develop.

Indicator 2:

During FY 2010, ARS will provide forage and pasture management technologies and strategies that reduce inputs while improving livestock performance and sustaining the environment.

FY 2010 Accomplishments:

The impact of switchgrass production on soil carbon is important to know so the environmental consequences of large-scale biofuels production can be estimated. In 1998, ARS scientists at Lincoln, NE and Ft. Collins, CO initiated a switchgrass soil C sequestration study in eastern Nebraska. The study included two switchgrass cultivars, three nitrogen (N) fertilizer rates and two harvest treatments. In the 9 years following grass establishment, soil C increased at rate of 0.9 U.S. tons/acre per year in plots in which best management practices were used. Biomass yields and C sequestration was significantly greater in plots in which N fertilizer was used than in plots where no fertilizer was applied. These results confirm switchgrass soil C sequestration data previously obtained by ARS scientists at Lincoln, NE and Mandan, ND in a shorter five-year study on ten farms in NE, SD, and ND.

Impact: Growing switchgrass in the northeastern Great Plains can increase carbon sequestration to enhance environmental sustainability while producing bioenergy feedstocks that contribute significantly to meeting national goals for green energy.

Pastures dominated by yellow bluestem grass are important for livestock production in the southern Great Plains. These pastures are often burned or sprayed with herbicides annually to control weedy species in the belief that these treatments will increase forage production and livestock performance. However, producers were not certain these costly practices justified the expense and environmental risk. ARS scientists at Woodward, OK, in collaboration with Kansas State University, evaluated these practices and found that regular prescribed fire or herbicide applications in the spring are not necessary for the optimal management of Yellow bluestem pastures and do not increase livestock performance. Adequate fertilization and proper grazing management are more effective annual treatments.

Impact: Eliminating use ineffective herbicide and fire treatments and diverting resources into effective grazing and fertilization practices will result in increased profitability while reducing the environmental risks associated with burns and herbicide usage.

Indicator 3:

During FY 2010, 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 2010 Accomplishments:

During the fall and winter, low forage production and poor nutritional content of western rangelands limits their grazing value for livestock and wildlife. ARS scientists in Logan, Utah, in cooperation with animal scientists with Utah State University, compared the carrying capacity and livestock performance of traditional winter pastures dominated by crested wheatgrass and cheatgrass (an invasive annual weed) versus similar rangelands seeded with forage kochia and crested wheatgrass. The rangelands with forage kochia had higher crude protein, and increased carrying capacity by six-fold as compared to the non-treated rangelands. Cattle on rangelands with forage kochia had higher increases in body condition than cattle on the crested wheatgrass/cheatgrass rangelands.

Impact: This research demonstrates that seeding western rangelands with forage kochia can improve productivity and economic viability of livestock production in the western U.S. by providing increased amounts of nutritious forage during the fall and winter. This increase in forage is also benefits wildlife. These increases in productivity strengthen rural communities and provide a model for increasing global food security on the world's vast rangeland areas.

Following wildfires, cheatgrass, an invasive weed, outcompetes native vegetation and now dominates millions of acres of rangeland in the western United States. Each year, millions of dollars are unsuccessfully invested in planting desirable species in post-fire efforts to restore native vegetation. ARS scientists at Boise, Idaho studied the germination response of cheatgrass and 5 different native bunchgrasses and developed a model simulating potential germination response for any set of weather conditions occurring over the 38 years. By comparing potential response over such a long time period, the researchers confirmed that on average, cheatgrass is from 2-5 times faster than other species in early germination and successful establishment that allows the represses other vegetation. However they also identified weather conditions that favored the establishment of the more desirable native species plant.

Impact: The model linking climatic conditions with establishment success of a variety of plants in an important addition in developing viable integrated strategies for controlling cheatgrass and restoring native vegetation. With this improved understanding of climatic requirements for establishment of different species, land managers can make more cost-effective decisions about what native grasses to seed as part of rangeland restoration in a given year.

Overgrazing and fire suppression have contributed to an increased abundance of shrubs in rangelands throughout the world. Increases in shrubs have come at the expense of grasses, but

little is known about how this shift in vegetation dominance affects grassland ecosystem functions. ARS scientists in Mandan, ND studied the influence of shrub expansion on soil carbon and nitrogen in northern U.S. mixed-grass prairie grasslands. They found that carbon and nitrogen was greater in the surface six inches of soil under established shrubs as compared to grass-dominated areas. Accumulation of soil carbon and nitrogen under shrubs may contribute to 'islands of fertility' that reduce greenhouse gases. With a long-term rotation strategy, shrub-dominated areas could be converted to grasslands that would take advantage of the higher fertility to increase livestock production. The grasslands could then be rotated back to shrub-dominated areas.

Impact: Managing rangelands as a mosaic of grass and shrub lands through the use of grazing and fire along with selective reseeding will increase biodiversity that would favor various combinations of wildlife and livestock while providing more stable sequestration of carbon and nitrogen. This management strategy would be particularly useful for increasing food security in parts of the world where shrubs are needed to provide fuel wood and building materials while grassy areas are essential to sustainable livestock production.

Measure 6.3.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2010:

During FY 2010, ARS reported 3 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
Three superior switchgrass varieties for the mid-Atlantic states called BoMaster ,Colony, and Performer	Joint release of germplasm by ARS and North Carolina State University	Landowner seeking to grass varieties that can be used for livestock grazing, hay or bioenergy feedstocks and seed companies	Availability of a multiuse native grass will give producers greater options for meeting changing market demands and increase biodiversity
Planting the shrub, forage kochia ,with crested wheatgrass on rangelands to increase forage quality	Field days, presentations and trade publications targeting public and private land managers and livestock producers	Public and private land managers interested in increasing forage quality for livestock and wildlife in the fall and winter	Six-fold increase in carrying capacity for grazing livestock and wildlife increases profitability and wildlife opportunities. The combination also helps control cheatgrass.
Replacing fire and herbicides with grazing and fertility management to control weeds in Yellow bluestem pastures in the Great Plains.	Field days, presentations and trade publications targeting livestock producers	Cattle producers in the southwestern Great Plains.	Improved profitability because of lower input costs to raise pasture productivity and reduced risk of adverse environmental impacts by reducing use of fire and herbicides.

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

During FY 2013, ARS will

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

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

provide rangeland management technologies and strategies that reduce inputs while improving livestock performance and sustaining the environment, including reducing the risks of wildfires, invasive weeds, and other threats, by stabilizing, restoring, and monitoring degraded rangeland in an affordable and sustainable manner.

ARS Management Initiatives

ARS is continually assessing the relevance, quality, and performance of its research, providing agricultural information to the public through the National Agricultural Library and print and electronic media, ensuring adequate facilities to support Agency research, and ensuring a workplace conducive to personal and professional development.

MANAGEMENT INITIATIVE 1: ENSURING THE QUALITY, RELEVANCE, AND PERFORMANCE OF ARS RESEARCH (COVERS ALL RESEARCH OBJECTIVES)

The Office of Management and Budget (OMB) has established Governmentwide R&D Investment Criteria that are designed to assess the relevance, quality, and performance of Federally funded research, and ARS adopted the R&D Investment Criteria as a tool to measure its research. To establish the relevancy of the Agency's research programs, ARS relies on organized interactions with customers, stakeholders, and partners. Peer reviews conducted by the Office of Scientific Quality Review (OSQR) and the Research Position Evaluation System (RPES) ensure the quality of the Agency's research and scientific workforce. All research projects are assessed annually to determine the number of currently approved milestones that were met/not met during the preceding fiscal year. Near the end of the 5-year program cycle, National Programs are subject to retrospective reviews, which verify the scientific impact and programmatic relevance of the work conducted under each National Program Action Plan.

Performance Measure

MI 1.1 Relevance: ARS' basic, applied, and developmental research programs are well conceived, have specific programmatic goals, address high priority national needs, and have direct relevancy in achieving ARS' long-term goals.

Baseline 2004

As assessed against the Program Action Plans, the Agency's long-term goals, and the priority needs of U.S. agriculture, 97.1% of ARS' projects were conducting highly relevant research.

Target 2011

100% of ARS' projects will be conducting highly relevant research.

MI 1.2 Quality: ARS' research projects are reviewed for quality by National Program using independent external peer review panels at the beginning of the 5-year National Program cycle.

Baseline 2005

Using an average based on cumulative scores for the past five years, 76.1% of projects received scores of No, Minor, Moderate revision needed upon initial review and, overall, 97% received such scores by the completion of the review.

Target 2011

Using a cumulative five-year average, 80% of the projects reviewed will receive initial scores of No, Minor, or Moderate revision needed and 98% receive such scores by completion of review.

Baseline 2005

RPES conducted 392 scientific peer reviews of ARS scientists: 181 (46.2%) were upgraded, 203 (51.8%) remained in grade or were referred to the Super Grade Panel, 3 (0.8%) could not be graded because of insufficient information, and 5 (1.3%) had a grade/category problem.

Target 2011

RPES will conduct 400 scientific peer reviews of ARS scientists.

MI 1.3 Performance: ARS will monitor the percentage of annual research project milestones met.

Baseline 2004

85.3% of ARS project milestones were fully or substantially met.

Target 2011

89% of ARS' project milestones will be fully or substantially met.

Baseline 2004

NPS completed three National Program Reviews.

Target 2011

NPS will complete National Program Reviews for all Programs in the first 5-year cycle and will begin reviews for the programs currently in the second 5-year cycle.

FY 2010 Accomplishments are reported under the USDA Performance Accountability Report and OMB PART requirements.

MANAGEMENT INITIATIVE 2: ENSURE PROVISION AND PERMANENT ACCESS OF QUALITY AGRICULTURAL INFORMATION FOR USDA, THE NATION, AND THE GLOBAL AGRICULTURAL COMMUNITY VIA THE NATIONAL AGRICULTURAL LIBRARY

The [National Agricultural Library](#) (NAL) has statutory mandates to identify, collect, preserve in perpetuity, and provide access to quality information relevant to agriculture; serve as one of four national libraries; serve as USDA's library; provide leadership in developing and operating a comprehensive agricultural library and information network; and provide specialized information services through such NAL information centers and programs as the [Animal Welfare Information Center](#) (AWIC), the [Rural Information Center](#) (RIC), the [Food Safety Research Information Office](#), and the [Agriculture Network Information Center](#) (AgNIC). The library serves a large and broad customer base, including such audiences as policymakers, researchers, agricultural specialists, farmers, members of the library, educational and agribusiness sectors, food stamp recipients, and the general public. Recently, the library, with partners in the land-grant university and agricultural information service communities, has initiated development of the National Digital Library for Agriculture (NDLA).

Performance Measures

MI 2.1 The services and collections of the National Agricultural Library continue to meet the needs of its customers.

Baseline 2005

The National Agricultural Library total annual volume of customer service transactions exceeded 82 million.

Target 2011

The National Agricultural Library total annual volume of customer service transactions exceeds 145 million.

Indicator 1:

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

FY 2010 Accomplishments:

The National Agricultural Library (NAL) is the largest and most accessible agricultural research library in the world. It provides service directly to the staff of USDA and to the public, primarily via the NAL Web site, <http://www.nal.usda.gov>. NAL was created with the U.S. Department of Agriculture (USDA) in 1862 and was named in 1962 a national library by Congress (7USC§3125a), as "the primary agricultural information resource of the United States." NAL is the premier library for collecting, managing, and disseminating agricultural knowledge. The Library is the repository of our Nation's agricultural heritage, the provider of world-class information, and the wellspring for generating new fundamental knowledge and advancing scientific discovery. It is a priceless national resource that, through its services, programs, information products, and Web-based tools and technologies, serves anyone who needs agricultural information. The Library's vision is "advancing access to global information for agriculture."

Progress Towards Becoming "Digital NAL". For decades, NAL has delivered some services and content digitally. The goal of "Digital NAL" is to deliver information about *all* NAL programs and services digitally and to deliver as much content and as many services digitally as are permitted by law, technology, and funding. Because NAL's resources are limited, its customer needs and expectations are broad, and the digital information landscape is constantly changing, practical steps have been identified to advance the development of "Digital NAL." A number of projects to re-engineer NAL operations and improve NAL's digital services will be completed in FY2011. In addition to projects to increase and improve retrieval of information from NAL's Web site and databases, the Library's information technology infrastructure is being reinforced and brought up to date. The NAL collection development policy is being revised. The DigiTop and DigiCALS services for USDA personnel are being combined and re-engineered. Growth of the AGRICOLA index has been identified as a critical immediate task required to further a Digital NAL. This will involve increasing significantly the number of articles indexed annually. To accomplish this, a fundamental transformation is necessary from human generated index entries to automated indexing using specialized computer applications. The process has started for acquiring an automated indexing application, expanding the NAL thesaurus, and adjusting the indexing workflow. The indexers will become editors performing quality control and systems tuning with a goal to increase annual production to more than 200,000 articles in the next few years.

Impact: Services were expanded and improved and new initiatives were begun to support further expansion and improvement.

Delivering Information and Research Services. NAL provides free access to agricultural information, primarily through its core Web site, www.nal.usda.gov. NAL's FY2010 total volume of direct customer transactions exceeded 90 million transactions. Services delivered digitally continued to grow while services based entirely on physical materials continued to decline. Examples of accomplishments and progress include:

- DigiTop usage increased while document delivery services decreased. USDA staff executed 1,353,306 full text downloads from NAL's DigiTop (Digital Desktop for USDA) service, posting a 7.5% increase in downloads from FY2009. In contrast document delivery requests received by NAL decreased by 20 percent (34,469) as more material became available online. 100% of document delivery requests were received electronically and 84%

- delivered electronically. Reference transactions increased 15.6% to 15,451.
- Program outreach and instruction increased. There was a 13.8% increase in presentations by Public Services staff and a more than 100% increase in the number of customers reached. NAL staff exhibited at numerous events and conferences to increase visibility of NAL services and products. Venues included: Future Farmers of America annual conference; USDA People's Garden; USDA Earth Day; USDA Agricultural Festival; USDA National Nutrition Month; Preservation Week; Charles Valentine Memorial Lecture; Sustainable Agriculture & Food Systems Assoc.; Joint Annual Meetings of the American Dairy Science Association, Poultry Science Association, American Society of Animal Science, Asociación Mexicana de Producción Animal, and Canadian Society of Animal Science; 20th Annual Social Marketing in Public Health Conference; and the Food Safety Education Conference. NAL continues to look strategically at how it can increase its reach by targeting high impact events.
 - NAL's AFSIC received project funds to support organic livestock producers and researchers. The Alternative Farming Systems Information Center received \$114,000 from USDA's National Institute of Food and Agriculture and Agricultural Marketing Service to select, digitize, and make publicly available important USDA publications on organic livestock production.
 - NAL received project funds to support digital conversion of the USDA Pomological Watercolor Collection. The Library received \$206,600 from The Ceres Trust to fund the conversion of more than 7,000 original watercolor paintings of the USDA Pomological Watercolor Collection.
 - NAL's AFSIC/RIC received \$1.5 million grant to help beginning farmers and ranchers start and stay in farming and ranching. NAL's Rural and Alternative Farming Systems Information Center Information Centers, in partnership with the American Farm Bureau Federation, were awarded a five-year grant to create and implement a National Curriculum and Training Clearinghouse, called <http://www.Start2Farm.gov>.
 - NAL receives renewed funding to digitize Fruit and Vegetable Market News Reports collection. Funding received from USDA/AMS since 2006 has supported digitization of over 2,200 titles (~78,800 pages) of AMS Reports which provide detailed marketing information for fruit and vegetable commodities at domestic wholesale markets and production areas, since 1916.
 - Michelle Obama's www.LetsMove.gov. NAL's Food and Nutrition Information Center/Nutrition.gov specialists provided advice and digital content to populate the Let's Move: America's Move to Raise a Healthier Generation of Kids Web site, launched in February, from NAL's SNAP-ED Connection's Recipe Finder database, Food Assistance Resource List, and Healthy Meals Resource System. The content supplied by NAL supports the First Lady's four pillars aimed at solving the childhood obesity epidemic within a generation.
 - Directory of Chefs Partnering with Let's Move! The NAL Food and Nutrition Information Center's Directory of Chefs was selected by the White House to use as the basis for the First Lady's Chefs Move to Schools Web site. The Directory matches chefs with schools to improve meals, enhance food workers' skills and teach children about better nutrition. Working under a very short timeline, NAL staff made improvements and enhancements to the existing database. Two new features were created: a geographic display; and a browsable list by state. The May launch was followed by other events which featured the new directory and encouraged new registration. As of the end of FY 2010, over 1897 chefs and more than 1415 schools had signed up to participate.
 - NAL supports USDA's Know Your Farmer Know Your Food Initiative. NAL provides staff to triage and respond to reference requests which come to the KYF2 site and helped create a seasonal poster series promoting Farm-to-Table healthy eating and eating local. The posters and associated educational materials complement the KYF2 concept and promote access to NAL food, nutrition, and sustainable agriculture information services.

- NAL's Food and Nutrition Center developed a new online tool that calculates an individual's daily nutrient recommendations based on the Dietary Reference Intakes (DRI). The Interactive DRI for Healthcare Professionals, <http://fnic.nal.usda.gov/interactiveDRI>, available for registered dietitians, doctors, nurse practitioners, and others interested in dietary planning, resulted from collaboration with the DHHS Office of Disease Prevention and Health Promotion and was featured at the American Dietetic Association's Food and Nutrition Conference and Expo.
- Safety Net Preservation Workshop. A workshop entitled "Can We Relax Yet? Assessing the Risks to Library Collections and Operations" was hosted by NAL in June. Library professionals learned practical approaches to risk assessment and risk management models for collections. The NAL building was used for the workshop exercise; as a result, valuable feedback was received for action. The workshop was provided in support of a cooperative disaster response network of Federal libraries and was co-sponsored by NAL, the Library of Congress and LYRASIS.
- When Beans Were Bullets: War-Era Food Posters. On June 21, NAL opened a new exhibit of food-themed posters from the World War I and World War II eras. Cory Bernat, now a project archivist at the National Park Service, independently developed the exhibit based on research she did for her Master's thesis at the University of Maryland, uncovering the educational and patriotic gems among unprocessed posters within NAL's Special Collections. Venues for the exhibit include: NAL; Whitten Building; South Building Cafeteria; and FDA. An online version is available at: http://www.good-potato.com/beans_are_bullets/index.html. Reproductions of popular posters were developed for sale by NAL.
- Heirloom Apple Event Focuses on Diversity and NAL Collections. On September 17, PSD hosted a roundtable discussion on heirloom apples that drew over 100 people from across the Washington area. Seven noted apple experts addressed the very serious issue of dwindling apple varieties and the steps being taken to preserve them. NAL's unparalleled collections in pomology helped shape and inform their research over the years. Speakers from ARS and NIFA provided context, addressing the important relationship between USDA and private growers and the role of USDA in apple research. PSD staff mounted an exhibition of heirloom apples varieties from the USDA Pomological Watercolor Collection, produced a special bibliography, and reproduced images for sale.
- NAL's Food Safety Information Center partnered with United Kingdom's Microbiological Safety of Food Funders Group (MSFFG). The partnership will enable new international food safety research project records to be added to the Research Projects Database at the NAL Food Safety Research Information Office (FSRIO). The initial load included 459 new projects.
- Integration of DigiTop and Current Awareness Literature Service. Mark Logic software system was procured to integrate the Current Awareness Literature Service and DigiTop services beginning January 2011. Cost savings and a more robust search and discovery platform for USDA staff are among the expected outcomes.
- NAL tests reference transaction management software. The Research and Reader Services Team completed pilot testing of RefTracker – a commercial software product that integrates processing, response and statistical data management for reference transactions by library research staff. A Decision on acquisition will be made in FY 2011.
- Reorganization of NAL's Public Services Division. NAL completed a major divisional restructuring that is scalable and reflects current workflows, synergies, fiscal realities and opportunities for growth. A major benefit is better alignment of functions to support customer services.

Impact: Services were expanded and improved.

Developing Decision Support Tools for Science-Based Sustainability Practices. Concern for the environment has increased consumers' interest in how agricultural products are grown and made. As a result, researchers and the food industry are working to better assess the environmental impacts of processes and activities that span an agricultural product's life cycle, from the acquisition of raw materials to the product's eventual disposal. Currently, however, few information resources devoted to this life cycle inventory exist, particularly for products originating in North America. NAL has begun an initiative to build a database of data sets gauging the material and energy inputs of production processes, along with the outputs released to the environment during production, use and disposal. This life cycle assessment database can then be expanded to include data from other industries, so that one can evaluate the potential environmental impacts of products throughout their life cycle and the processes in place to produce them. Such data can then inform decisions about changing processes or the materials that go into them to reduce the burden on the environment. NAL expects a test set of data to be ready by spring of 2011.

Impact: Because this is a new initiative, impact will be reported beginning in FY2012.

Building a Digital Repository. During FY 2010, NAL added approximately 10,000 items to its digital repository. By the end of FY2010, NAL's digital repository included ~42,000 items; ~750 items are added each month. In June, 2010, the Library began a re-engineering project to unify the existing three platforms into a single platform with a simplified search interface and a streamlined process for adding items and descriptions. This project should be completed in June 2011.

Impact: Services were expanded and improved.

Enriching AGRICOLA. At the end of FY2010 AGRICOLA included 4,937,064 records, of which 1,004,968 were online catalog records and 3,932,096 were indexing records. NAL added 5,814 cataloging records and 34,312 indexing records in FY2010. This is a slower pace than previous years and reflects the reallocation of indexers from production to implementing automated indexing, as well as the end of funding for contract cataloging projects.

Impact: Services were expanded.

Developing Public Awareness and Partnerships.

- **AgNIC:** NAL serves as the secretariat for the Agriculture Network Information Center (AgNIC) Alliance, a voluntary, collaborative partnership that hosts an international distributed network of discipline-specific agricultural information Web sites (<http://www.agnic.org>). AgNIC provides access to high-quality agricultural information selected by its 62 AgNIC partners, including land-grant universities, NAL, and other institutions around the world. The AgNIC Alliance continues to improve the information technology that supports the AgNIC portal. During 2010, the focus was to build content. The AgNIC search now incorporates 2/3 of the AGRICOLA database and 1.5 million PubMed records which include links to local libraries owning the items, in case people would like to borrow them locally. Along with Web 2.0 services, AgNIC harvests over 30 relevant full-text digital repositories from institutions worldwide, in multiple languages, with the number of repositories harvested ever increasing. During the first six months of the year, AgNIC launched an Animal Health Portal, <http://animalhealth.agnic.org/>, working with Oklahoma State University and Washington State University. This portal utilizes the AgNIC technologies which are all Open Source, or freely available. AgNIC accepted two new partners during the year: Fort Valley State University, to create a comprehensive collection of information on "goat meat", and SANREM CRSP

(Virginia Tech) to support Sustainable Agriculture and Natural Resource Development for developing countries.

- *Vivo*. NAL began working with ARS to establish a semantic web application that enables the discovery of research and scholarship across the USDA. The application will allow better discovery for networking, collaboration and research. VIVO will also allow citizens to better discover USDA research. This application is called “VIVO” and is an Open Source, or free application jointly developed by Cornell University and the University of Florida. NAL will host VIVO for USDA.
- *Interagency partnerships*: NAL continued to be very active in developing and maintaining partnerships to provide digital information services. Nutrition.gov, invasivespeciesinfo.gov, science.gov, and worldwidescience.org are multi-agency and multi-national Web portals to which NAL contributes digital content and leadership. NAL also continued to participate actively in other interagency groups such as PHPartners (Public Health) and CENDI (scientific and technical information management) to promote and leverage NAL’s work.

Impact: Services were expanded and improved.

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

During FY 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.

During FY 2013, 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 2010, NAL will

FY 2010 Accomplishments:

1. NAL ceased work on the NDLA at the end of FY2009 due to lack of funding.

Impact: NAL did not achieve the goals for the NDLA.

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

During FY 2011, NAL will not continue work on the NDLA.

During FY 2012, NAL will not continue work on the NDLA.

During FY 2013, NAL will not continue work on the NDLA.

MANAGEMENT INITIATIVE 3: DEVELOP A MODEL EQUAL EMPLOYMENT OPPORTUNITY (EEO) PROGRAM THAT WILL PROVIDE INFRASTRUCTURE NECESSARY TO CREATE AND MAINTAIN A DIVERSIFIED WORKPLACE FREE FROM DISCRIMINATION, HARASSMENT, OR RETALIATION, AND CHARACTERIZED BY AN ATMOSPHERE OF INCLUSION AND CAREER DEVELOPMENT OPPORTUNITIES.

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 2010 Accomplishments:

The Agricultural Research Service (ARS) continued to conduct outreach activities in K-12 schools and colleges and universities including the 1862, 1890, and 1994 Land Grant Institutions and minority serving institutions such as Hispanic-Serving Institutions (HSIs), Historically Black Colleges and Universities (HBCUs), and Tribal Colleges and Universities (TCUs). Additionally, the Agency continued to conduct outreach activities with minority serving organizations [i.e., Society for Advancement of Chicanos/Latinos and Native Americans in Science (SACNAS); Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS), Thurgood Marshall College Fund, Conference on Asian Pacific American Leadership (CAPAL)], and the Workforce Recruitment Program (WRP), USDA/1890 National Scholars Program, etc.

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), Area ODEO Program Managers (including the Area EEO/Diversity Committees and Special Emphasis Program Managers), and ARS Information Staff. ARS staff participated in several of the planned events including, but not limited to resume critiques and career exploration/professional development workshops.

Professional/Science-Based Organizations: Exhibits were set up and hosted at several scientific professional events and/or provided support to professional/science based organizations 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.

- Annual Biomedical Research Conference for Minority Students (ABRCMS)
- American Chemical Society Conference
- American Dietetic Association's Food & Nutrition Conference & EXPO
- American Indian Science and Engineering Society (AISES) Annual Conference
- Blacks in Government (BIG)
- 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 & Food Expo
- League of United Latin American Citizens (LULAC)
- Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS) Annual Career Fair and Training Conference
- National FFA Organization
- National Technology Student Association
- Society for the Advancement of Chicanos and Native Americans in Science (SACNAS)

- Thurgood Marshall Annual Leadership Institute Recruitment Conference and Career Fair
- Women of Color in Science, Technology, Engineering, and Mathematics (S.T.E.M.) Conference

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

- Agriculture in the Classroom National Conference
- Agricultural Outlook Forum
- ALARC Program Tempe Unified School District (NAA)
- American Farm Bureau Federation
- American Phytopathological Society
- American School Counselors Association
- Annual Conference of the Soil and Water Conservation Society
- Berkeley County Youth Fair (NAA)
- Confederated Tribes of the Grand Ronde
- Council for Excellence in Government's Public Service Recognition Week
- Federation for the Societies of Experimental Biology Conference
- 4th Annual Civil Service Job Fair
- Grand Columbia Council, Skookum District Cub Scout Day Camp (PWA)
- HHS/USDA Nutrition Summit—"Changing the Food Environment: Making it Happen"
- Illinois Agri Women Career Day
- Maryland State Conference on Gifted and Talented Education
- Morgan County Fair, West Virginia
- National Conference on Differentiated Instruction
- National Renewable Energy Summit
- National Science Teachers Association
- National School Boards Association Annual Conference
- NBC4 Health & Fitness EXPO
- NIH Consensus Development Conference on Lactose Intolerance and Health
- Pendleton Career Day
- Jefferson County/FLOC Science Olympiad (NAA)
- Tuskegee University – Professional Agricultural Workers Annual Conference
- University of Arkansas at Pine Bluff Youth Motivational Taskforce
- U.S. Congressman Bennie G. Thompson 2nd Congressional District College & Career Fair
- U.S. Congressman Ted Kaufman Job Fair
- USDA's Earth Day Celebration
- USDA's AgriCULTURAL Festival
- USDA's Science Week
- Western Apicultural Society Annual Meeting
- Western Idaho State Fair
- Women Mentor's Career Day

Colleges/Universities Events: ARS staff participated in career fairs and career day events hosted by the following colleges and universities with the same goals as indicated above:

- Arizona State University
- Bakersfield College
- Boise State University
- California State University – Bakersfield
- Central Arizona College
- Central State University

- Delgado University
- Fond du Lac Tribal and Community College
- Grambling State University
- Grand Ronde College (Confederated Tribes)
- Heritage College Job Fair
- Iowa State University
- Lincoln University
- Michigan State University
- Mississippi State University
- Northeastern Illinois University
- Oregon State University
- Purdue University
- South Carolina State University
- Southern University and A&M College
- Tuskegee University
- University of Alaska-Fairbanks
- University of Arkansas – Pine Bluff
- University of California – Davis and Riverside
- University of Delaware
- University of Georgia
- University of Illinois
- University of Minnesota
- University of Missouri
- Wallace Community College
- Washington State University
- West Virginia State University
- Xavier University
- Yakima Valley Community College

K-12 Activities:

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

- Developed and launched redesigned Sci4Kids website teaching children about the importance of agricultural science in their daily lives. Since its debut, Sci4Kids has posted more than 140 stories about what ARS scientists do and the discoveries they've made. The site "Teachers Desk" includes classroom resources and activities designed to stimulate kids' learning about agricultural research. Sci4Kids operates with the recognition that today's children are tomorrow's farmers, scientists, policy makers, and consumers.
- Partnered with, served as advisor to, and/or supplied materials to ARS staff, teachers and teacher trainers, and others for exhibiting at conferences, workshops, state fairs, Ag days, Summer Ag Institutes, open houses, tours, and other activities. Supplied thousands of materials for use in a variety of outreach activities across the nation.
- Fostered continuing partnership with the National Institute of Food and Agriculture's Agriculture in the Classroom program, expanding awareness of ARS research through their nationwide network by arranging dissemination of our research information at educational conferences we do not attend and numerous other venues targeted to educators and students.
- Coordinated an in-school K-5 science program in junction with Friends of Agricultural Research-Beltsville and the Maryland Agricultural Education Foundation.

- Coordinated a science enrichment program for 6th and 7th graders at Beltsville Academy.
- Presented a “Beyond the Shopping Cart” talk to middle and high school science teachers participating in a Food and Drug Administration/National Science Teachers Association-sponsored program.

Agency Partnerships:

USDA Educational/People’s Garden

In accordance with Secretary Vilsack’s goal of creating a garden at each USDA facility worldwide, ARS has supported the initiative by accomplishing the following:

Beltsville Area (BA) Student Discovery Garden

Spearheaded by the BA Diversity Taskforce Science, Technology, Education, and Outreach (STEO) Subcommittee, planning for the garden began in the fall of 2009. The garden supports First Lady Michelle Obama's effort to have a garden as a teaching tool for urban children.

The Beltsville Area Diversity Taskforce Science, Technology, Education, and Outreach (STEO) Subcommittee continues the maintenance of the pesticide- and herbicide-free Student Discovery Garden at the Beltsville Area Research Center (BARC). Planting beds are filled with sterilized soil, as a protective measure for the middle-school students who are expected to be the predominant age group served by this teaching tool. This project supports First Lady Michelle Obama’s effort to have a garden as a teaching tool for urban children. The garden is composed of seven sections, each exhibiting a different aspect of BARC research, from the breeding of native crops, to urban garden containers. Each section features a poster providing relevant educational information. A three-foot-wide sidewalk permits easy access for close viewing of exhibits. Students at all levels have been actively involved in maintaining the garden and visiting for hands-on educational experiences.

Mid South Area (MSA)

As a result of a visit by the First Lady of the United States, the Jackson Public School System (JPSS) in Mississippi has allocated land for a new project headed by the MSA “Ag-Team”, whom will lead JPSS into a new arena of education success through “Agriculture”. Aligning with the First Lady’s “Let’s Move!” Campaign, the project will consist of the Fall 2010 and the Spring 2011 “Vegetable Education Garden” at designated K-12 schools utilizing the USDA Food Pyramid. With this allocated land, the MSA “Ag-Team” will be providing top-notch reliable expert inputs, cutting edge technology in conjunction with the two Land-Grant Institutions (1862 Institution – Mississippi State University and 1890 Institution – Alcorn State University), a supply of K-12 JPSS students, dedicated faculty, and productive fertile soil will develop into a productive quality, safe, healthy food supply agriculture model project in Central Mississippi.

Midwest Area

- (1) The National Soil Erosion Laboratory, West Lafayette, Indiana established a People’s Garden to donate food for the local food shelf.
- (2) Urbana, Illinois established a People’s Garden called the *Three Sisters Garden* and was highlighted in two recent news articles in the *Champaign News Gazette* and also highlighted nationally in the *People’s Garden Update*. The produce from the Garden is going to be donated to the Champaign-Urbana Public Health District which, in turn, will distribute the produce to public health district clients as an incentive for them to buy more fresh fruits and vegetables and to support local specialty growers. If someone redeems

food coupons from the Women, Infants and Children (WIC) Program at the District farmers market or uses a Link Card to purchase produce, the person will also receive some edamame, green beans, sweet corn, or whatever is available from the People's Garden so they get more for their money and more variety of nutritious foods. Urbana has planted 6 sweet corn hybrids that have been improved by the University of Illinois; 16 ARS cultivars of edamame, a type of soybean; green beans; and pumpkins. (3) Peoria, Illinois started a vegetable garden showcasing regionally-adapted varieties, with produce donated to local food pantries. About 75 pounds of produce has already been harvested and distributed. (4) Ames, Iowa's involvement with the Beloit Learning Garden, a project to help children in rehabilitative treatment work together in a garden to form new associations, gain confidence, and learn about growing plants, is now part of the People's Garden initiative. All produce is going to the Beloit cafeteria and the Bethesda Food Pantry. The Beloit children spend weekly afternoons working in the garden and put into practice what they have learned about gardening and food production from both the volunteers in the garden and a newly formed 4H group on the campus of the Beloit Children's Treatment Center. (5) East Lansing, Michigan started a People's Garden and will be donating the produce to a local charity.

North Atlantic Area (NAA)

The Robert Holley Cente, Ithaca, NY, actively participated in the 'People's Garden initiative' with an estimated 9,600 pounds of produce, donated to local food banks and charities. An estimated 300 volunteer hours from all three location units was put into this effort.

Pacific West Area (PWA)

The PWA was the first Area in ARS to support the Secretary's initiative by creating the USDA Educational Garden at the ARS Albany, California location. Under the leadership of the 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.

Southern Plains Area (SPA)

- (1) The Conversation and Production Research Laboratory, Bushland, Texas planted 1,200 square feet of tomatoes, peppers, onions, cucumbers and sweet potatoes, sweet corn, pinto beans and squash in raised beds. The produce will be donated to High Plains Food Bank, which serves Amarillo, Texas and the High Plains Area.
- (2) SPA Office, College Station, Texas established a People's Butterfly Garden, which is certified and registered by Monarch Watch as an official Monarch Waystation, consists of over 100 butterfly attracting plants, signage, rainfall collectors, trash composter, and raised container beds with vegetables and herbs. The project is a collaborative effort between the Area Office and Boy Scouts of America Troop 383 of Bryan, Texas. During the month of July 2010, USDA's Texas State Farms Service Agency in College Station, Texas made a commitment to join the partnership.
- (3) Knipling-Bushland U.S. Livestock Insects Research Laboratory, Kerrville, Texas has three plots of gardens, Xeriscape, native perennials, and native wildflowers.
- (4) South Central Agricultural Research Laboratory, Lane, Oklahoma partnered with the Choctaw Nation to provide the site for the Choctaw Community Garden as well as maintain, harvest, and distribute the produce. The garden consists of vegetables including corn, peppers, cucumber, okra, tomatoes, and eggplant.

Beltsville 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 in Maryland. The event consists in providing students 100 questions and answers in the areas of science, math, art, health, literature, music, and social studies. The employees assist in testing the students in their ability to provide as many correct answers as possible.

Vansville Elementary School, Beltsville, MD

ARS is currently in the process of establishing a Memorandum of Understanding (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.

Penobscot Nation, Old Town, Maine

The Research Leader (RL) of the ARS NAA New England Plant, Soil, and Water Laboratory in 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 reports on “success stories about Native American students working in the laboratory that are published in the Wabanaki Center newsletter. The Center posts vacancy 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.

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, 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.

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 provide hands-on learning experiences at the ARS laboratories to further enable the students acquire employment as trained laboratory assistants/technicians.

Public Service Recognition Week

The Information Staff, BARC and the ODEO participated in the Public Service Recognition Week (PSRW) at the National Mall in Washington, DC. Celebrated since 1985 and sponsored by the Partnership for

Public Service, the PSRW is a nationwide education campaign honoring the men and women who serve our nation. This year's theme "Innovation and Opportunity" provided the American people the opportunity to see the breath of groundbreaking work being done in government, send a message about the importance of a strong civil service, and inspire a new generation to serve our country. ARS exhibited about the Agency's work, mission, and services. The theme was "Child Obesity."

USDA-ARS Future Scientists Program

ARS' SPA and the USDA Hispanic-Serving Institutions (HSIs) National Program continued collaborating with the College of Science's Center for Mathematics and Science Education at Texas A&M University in College Station, Texas. The program is designed to reach out to communities and K-12 schools with hands-on, inquiry-based activities that link them with USDA/ARS scientists, laboratory sites and current agricultural science research. It is being expanded under the auspices of the USDA HSI National Program to a national model with a K-12 focus on insect life cycles using the USDA/ARS research on the corn earworm (*Helicoverpa zea*) as a model at each laboratory site, plus a secondary focus on one area of local research e.g. Honey Bee (*Apis mellifera*) research at the USDA/ARS laboratory in Tucson, Arizona.

The following activities, which focus on the program's goal to inspire K-12 students to continue their studies in science, were held during the third and fourth quarters of FY 2010:

1. Four research facilities in the Pacific West Area engaged in Student Research Presentation Days during May 2010 as follows:
 - **Southwest Watershed Research Center in Tombstone, Arizona:** On May 17, a group of students from eight schools (elementary, middle and high school) made presentations at Tombstone High School. Three of the Center's research personnel – a plant physiologist, a research hydrologist, a supervisory hydrologic technician and hydrologic technician served on the Scientists Question and Answer Panel.
 - **Carl Hayden Bee Research Center in Tucson, Arizona:** On May 18 the Center hosted a group of students, teachers, parents and administrators from three high schools; one middle school and one elementary school. After the students' presentations, the Center's research leader, two research entomologists and an insect biological science technician served on the Scientists Question and Answer Panel.
 - **U.S. Salinity Laboratory in Riverside, California:** On May 20, the Center hosted five high schools including 5th and 7th grade students from the California School for the Deaf Riverside. The Laboratory's Center Director and the HSI's Education Advisor welcomed the students. After the students' presentations, three soil scientists and one research plant pathologist served on the Scientists Question and Answer Panel.
 - **San Joaquin Valley Agricultural Sciences Center in Parlier, California:** On May 21, the Center hosted a group of high school students from eight schools. The Center's Director and the HSI Education Advisor welcomed the group.

2. Two research facilities in the SAA held teacher summer institutes during June 2010 as follows:
 - **Tropical Agriculture Research Station in Mayaguez, Puerto Rico:** On June 8 and 9 the Station hosted 17 teachers. The Station's Director welcomed the teachers and showed a video covering research being conducted at the Station. Additional research

presentations included an entomologist explaining his research on insects as well as having the teachers examine a live, feeding fruit fly with digital microscopes.

- **Subtropical Horticulture Research Station in Miami, Florida:** On June 21-22, the Station hosted 20 teachers from 10 schools. The research scientists and technicians gave presentations and tours on insect behavior, and a wind tunnel in operation for insect flight testing. The teachers also witnessed an experiment on insect attractants in an outdoor flight enclosure; a life stages of the butterfly; and a demonstration on electroantennography showing how insects detect or react to various scents.
3. SPA scientists shipped 20 caterpillars to 3rd grade teachers at McDermott Elementary School in Little Rock, Arkansas for 24 students. The teachers, who had attended Future Scientists Program presentations at various conferences and had accessed information on the web sites that is associated with the program, will guide the students on their study of insect life cycles.

Confederated Tribes of Colville Reservation

The ARS Root Disease and Biological Control Research Unit, PWA, Pullman, Washington, continues to lead a STEM outreach and engagement program 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 undergraduates students; (5) connecting students to employment opportunities in STEM professions; and (6) development of a biofuels program on the Colville Reservation. The Pipeline Program enhances students' interest in science and math through monthly visits to Nespelem School and Paschal Sherma 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. The Pipeline Program is a portable platform that can be used for science and math outreach and education to other groups of Americans, who are traditionally underrepresented in STEM professions. The mission of the program is extending the benefits of science and math to all Americans. Native American students participating in the Pipeline program in junior high school and high school in 2005 are now enrolling at WSU. The key to success is engaging students in grade school and keep them in STEM programs through high school and they will see the benefits of a college education. The enrollment of students has increased by 24 percent since 2005 (over four-fold of the 34 original students). Eight students have been hired on the Student Temporary Experience Program (STEP) as Bioscience Aids in ARS Research Units at Pullman, Washington. In addition, over 1,000 students have been exposed to ARS research programs as part of the activities sponsor by the Pipeline Program.

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 (funding totaled \$23,300) 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. Students work with scientists on research projects and at the end of the eight-week internship, report their findings to the research unit. During 2010, five Native American students received summer employment, which included salary, housing, and transportation. Four of the five students were enrolled at the UTTC in Bismarck, North Dakota and one student was 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, 44 internships have been awarded to American Indian students. In 2010, the funding was approximately \$29,290.

USDA/1890 National Scholars Program

ODEO continued to support seven 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 Spring 2011. The student is employed as a nutritionist student trainee at the ARS Delta Obesity Prevention Research Initiative. The other scholars are enrolled at Tuskegee University, Langston University, South Carolina State University, Southern A&M University, and Alabama A&M University with majors in accounting, agricultural business, civil engineering, and dietetics. They are employed with ARS during the summer and will be converted to full time employees upon their graduation. ODEO participated in the planning and execution of the orientation and leadership development conference for the new scholars of the 1890 National Scholars Program held at the University of Maryland Eastern Shore. The ODEO team of the Cooperative Resolution Program conducted a session on conflict management to 25 scholars from across the country. ODEO staff also presented a workshop on Etiquette Basics during the Orientation.

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. In FY 2010, ARS had three female interns working in the Beltsville Area Human Research Center (one was unable to fulfill the commitment in 2009): a Junior at University of Georgia majoring in food science; a Junior at University of Hawaii, majoring in nutrition, both interned with the Food Surveys Research group, and a Junior at Tulane University interning with the Nutrient Data Laboratory

American Indian Science and Engineering Society (AISES)

ARS participated in the 2010 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 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 STEM related disciplines. Under his leadership, the MSA has implemented an extramural agreement grant for the AISES Graduate Student Poster competition.

Annual Biomedical Research Conference for Minority Students (ABRCMS)

ARS participated in the ABRCMS by interacting with the students and professionals in an effort to increase the external visibility of ARS and to promote research opportunities. ABRCMS is the largest professional conference for biomedical, behavior, and mathematics students—attracting approximately 1,494 students from over 285 U.S. colleges. Aligned with the REE mission and strategic plan of the Agency, ABRCMS is designed to increase the number of students, specifically minorities in the STEM related disciplines.

League of United Americans (LULAC) Annual Conference and Career Fair

ODEO represented ARS at the League of United American Citizens (LULAC) convention and career fair that took place in Albuquerque, New Mexico. The event offered a variety of workshops for students, civil rights practitioners and federal employees to over 5,000 participants. During the career fair, ODEO shared a booth with other USDA agencies to distribute promotional information and vacancy announcements. In addition to the ODEO staff, two scientists from the SPA were at the booth during different days to talk to students about their professional experience with ARS. LULAC is the oldest Hispanic organization working to advance the economic, political, educational and civil rights of Hispanics in the United States.

Society for the Advancement of Chicanos and Native Americans in Science (SACNAS)

ARS representatives hosted an exhibit to showcase the many career opportunities available within ARS and USDA. SACNAS provides unparalleled conference activities for students, postdocs, educators, administrators, and researchers in all disciplines of science, mathematics, and engineering.

Federal Asian Pacific American Council (FAPAC)

ARS was one of the top sponsors at the 25th Annual Conference held at the Gaylord Convention Center, National Harbor, Maryland. ARS leadership was present at the conference and facilitated a workshop. Agency officials also participated on a variety of panels and had exhibition booths at the event. FAPAC is a nonprofit, nonpartisan organization representing the civilian and military Asian Pacific American (APA) employees in the Federal and District of Columbia governments. FAPAC promotes equal opportunity and cultural diversity for APAs within the Federal Government.

New Initiatives

The ARS Riverside Location (U.S. Salinity Laboratory and National Clonal Germplasm Repository for Citrus and Dates) hosted three biology teachers from local high schools on a program to address the national shortage of professionals ready to enter the fields of STEM. This is an educational outreach initiative between U.S. Department of Education and California Polytechnic-Pomona in collaboration with industries, universities, and government agencies.

Additional Activities

- Four 1890 Land-Grant library deans, directors or alternates participated in the AgNIC Annual Meeting hosted by the National Agricultural Library. The HBCUs represented were: Alabama A&M University, Delaware State University, Prairie View A&M University (Texas), and UMES.
- Additionally, through NAL's Surplus Book Program with the Library of Congress, NAL acquired and shipped 408 books to minority serving institutions.
- 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.
- ARS continues to contract with a private local group in Corvallis, Oregon employing 15 trainees in the

greenhouses.

- **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 2010 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 306 Post-docs (38 percent are White males; 35 percent are White females; 9 percent are Asian females; 9 percent are Asian females; 3 percent are African American females; 3 percent are Hispanic males; 1 percent are African American males; 1 percent are Hispanic females; .32 percent are American Indian females; 32 percent are American Indian males; and .32 are Multi-race). Of the 306, there were 109 new hires (43 percent are White females; 32 percent are White males; 7 percent are Asian females; 7 percent are Asian males; 5 percent are Hispanic males; 2 percent are African American males; .9 percent are African American females; .9 percent are American Indian females; .9 percent American Indian males; and .9 percent are Hispanic females). Eleven or 4 percent of the 306 Post-docs have been converted to career conditional and TERM positions. Of the 11 conversions, 34 percent are minorities and females (23 percent are minorities and 11 percent White females) and 66 percent are White males.

SCEPs: ARS has 54 students in active status. Thirty-three (33) percent of them are minorities; 33 percent are White females; and 33 percent are White males. Six SCEPs (two White males, two White females, one African American male and one African American female) were converted in 2010 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 1,285 STEP students with 25 percent minorities; 40 percent White males, and 35 percent White females.

Workforce Recruitment Program (WRP): ARS had one student participating in 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 student will be available for permanent employment after completing his/her school commitments.

- **Ensure that all employees complete mandatory USDA and recommended training.**

FY 2010 Accomplishments:

The USDA Office of the Assistant Secretary for Civil Rights did not require mandatory training in

2010. However, the ARS Disability Program Manager conducted training regarding outreach, diversity, and equal opportunity, including the reasonable accommodation process at the following: New Employee Orientation sessions; AFM workshops; New Research Leader sessions; NAA EEO Committee Meeting, BARC, NAL, and the other agencies within the REE mission area.

■ **Introduce Multigenerational Training and sponsor a Multigenerational Diversity Day.**

FY 2010 Accomplishments:

Multigenerational trainings continue throughout ARS at leadership meetings and upon request by managers.

■ **Determine if there is a need to create and maintain a formal pilot mentoring program to develop ARS' human capital to its fullest extent.**

FY 2010 Accomplishments:

The Human Resources Division (HRD) developed a mentoring program for new HRD employees and several Area Offices have developed formal mentoring programs to mentor scientists. Informal mentoring of ARS students is occurring both in the Area and headquarter offices. The Areas will continue to mentor employees to develop human resources. Some examples are:

- The MSA Louisiana Research Apprenticeship Program (LA-RAP) continues. The LA-RAP is a 4-year program funded at \$199,000. There are 21 students 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 1890 scholar at the Southern University participated in the spring of 2010. She is one of the top students in the LA-RAP and her goal is to become a dietitian. She is currently set to intern for the summer of 2011 sponsored by the Food Processing and Sensory Research Unit (satellite location in Baton Rouge). She will be focusing on (1) developing technologies for predicting and assessing the nutritional, sensory, and processing quality attributes of foods before and after processing; and (2) conducting research to prevent unhealthy weight gain in children and adults. Plans are for her to participate in national student competition conference in 2011 with oral or poster presentations.
- The MWA's "New Secretary Mentoring Program" continues. The program is designed for new secretaries in the Area to continue to enhance their developmental and professional growth in ARS. As part of the training, the Area ODEO Program Manager presents an introduction to ODEO in ARS and the Area.
- 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. There are currently 25 matches (all Category 1 scientists), 56 percent are males and 44 percent are females. Since the inception of the program in 2005, 37 protégés have successfully completed the NASPDP and mentoring component. Of these 37, 31 have had at least one Research Position Evaluation Staff

(RPES) review, and 21 (68 percent of the 31) were promoted and 10 (32 percent) were retained. The overall retention rate of scientists who have been assigned to the NASPDP is 81 percent. Of the 13 (19 percent) who have left ARS, three were the result of a location closure, one passed away, two cited spousal/partner career issues, six took other jobs, and one was terminated from his position due to performance. Five of the thirteen (13) who have left ARS/NPA were reviewed in RPES and four of those were promoted and one was retained, the other eight left before having a RPES review.

- The PWA continues the mentoring program for new Administrative Officers (AO). The AO mentoring program is an 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.

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

FY 2010 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, and Executive Potential Program for employees at GS13-15. These programs are promoted and announced agency-wide in the REE mission area;
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. The RL Advisory Council (RLAC) continues to pursue its objectives identified in the charter: 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

for RLs on a variety of program and administrative topics and identifying priorities. The RLAC has developed a preliminary project agenda and goals to attract, hire, and retain quality scientists.

- **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.**

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 (HRD) developed a survey, and comments have been compiled from the REE mission areas. HRD and ODEO will collaborate on the most effective method to collect the data and utilize the survey results with a tentative implementation date of 2012.

- **Encourage employees to utilize the ARS programs such as career development, mentoring, and Special Emphasis Programs, and to serve on EEO/Diversity Advisory Committees.**

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 (2 sessions – 6 participants)	4 White females (66 percent) 1 African American male (17 percent) 1 Hispanic female (17 percent)
New Leader Program (2 sessions – 9 participants)	7 White females (78 percent) 1 African American female (11 percent) 1 African American male (11 percent)
Executive Leadership Program (2 sessions – 5 participants)	2 White females (40 percent) 2 White males (40 percent) 1 African American female (20 percent)
Executive Potential Program (5 participants)	2 White males (40 percent) 1 Asian female (20 percent) 1 Hispanic male (20 percent) 1 White female (20 percent)
Management Development Center Courses (11 participants)	4 White females (36 percent) 4 White males (36 percent) 2 African American females (18 percent) 1 Asian female (9 percent)
Federal Executive Institute Training (4 participants)	3 White females (75 percent) 1 White male (25 percent)

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. To ensure effectiveness, ARS continues to have one representative per program. 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.

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

FY 2010 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 and/or Area (if applicable) EEO-CR Policy Statements; ARS Sexual Harassment Policy Statement; Anti-Harassment Policy Statement; Reasonable Accommodation Brochure; EEO Complaint Process; DR-4300-010, Civil Rights Accountability Policy and Procedures; and EEO Mediation/Alternative Dispute Resolution information. The ODEO 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 2010 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 partnered with ODEO in the development and implementation of 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 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 2010 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. Questions were developed for the CARE e-survey to evaluate the efficiency and delivery of ODEO services conducted at the Location, Area, and Headquarters. The results will assist in providing assistance to the Location/Area being reviewed. 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 2010 Accomplishments:

AFM Goal 1: Improved Human Capital Management

Objective: Research, Education, and Economics Agencies have a highly qualified diverse workforce to fully accomplish the REE mission.

Performance Measure 1.1 Hire people with agency-desired skill sets.

Indicators:

By FY 2012, AFM will:

*Identify current and future skills gaps within each REE agency
Actively recruit to ensure maximum opportunity for all
Develop a sound marketing strategy to attract top candidates
Develop metrics to guide improvement in the hiring process*

By FY 2013, AFM will:

*Identify current and future skills gaps within each REE agency
Actively recruit to ensure maximum opportunity for all
Develop a sound marketing strategy to attract top candidates
Develop metrics to guide improvement in the hiring process*

Performance Measure 1.2 Emphasize employee continuous improvement.

Indicators:

By FY 2012, AFM will:

*Develop a career development template to assist employees to grow in the agency.
Develop and implement an employee continuous education requirement.
Retain and share corporate knowledge by defining/developing and implementing
Knowledge Management.*

By FY 2013, AFM will:

*Develop a career development template to assist employees to grow in the agency.
Develop and implement an employee continuous education requirement.
Retain and share corporate knowledge by defining/developing and implementing
Knowledge Management.*

Performance Measure 1.3 REE Agencies retain/achieve top ranking in USDA as “Best Places to Work” as reported in the Federal Human Capital Survey.

Indicators:

By FY 2012, AFM will:

*Develop a program/process to assimilate and support new employees to increase retention.
Implement the Performance Appraisal Assessment Tool (PAAT) in order to improve performance management and reward processes and actions.
Expand/implement maxiflex, telework, Career Patterns and other programs and flexibilities to assist employees in balancing work and personal responsibilities.*

By FY 2013, AFM will:

*Develop a program/process to assimilate and support new employees to increase retention.
Implement the Performance Appraisal Assessment Tool (PAAT) in order to improve performance management and reward processes and actions.
Expand/implement maxiflex, telework, Career Patterns and other programs and flexibilities to assist employees in balancing work and personal responsibilities.*

Performance Measure 1.4 Improve “Leading People” skills of all leaders, supervisors, and managers.

Indicators:

By FY 2012, AFM will:

*Publish and implement Succession Plans in ARS, CSREES, and ERS.
Develop and implement a supervisory training program.*

By FY 2013, 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 2012, AFM will:

Actively respond to annual OIG audit of REE-wide financial statements and resolve audit concerns within established due dates.

By FY 2013, AFM will:

Actively respond to annual OIG audit of REE-wide financial statements and resolve audit concerns within established due dates.

Performance Measure 2.2 All REE travelers are supported by a professional, customer oriented Travel and Transportation staff and Web-based systems are operational.

Indicators:

By FY 2012, AFM will:

*Implement GovTrip throughout REE ensuring it's operational and documented for end-users.
Conduct GovTrip post-implementation review and effect process changes as necessary.*

By FY 2013, AFM will:

*Implement GovTrip throughout REE ensuring it's operational and documented for end-users.
Conduct GovTrip post-implementation review and effect process changes as necessary.*

Performance Measure 2.3 CATS is fully implemented on ARIS/ORACLE platform, meets needs of ARS users, and maximizes opportunities for financial data integration.

Indicators:

By FY 2012, AFM will:

Identify multiple data exchange opportunities between SAMS, ARMPS, CATS, ARIS and other non-financial ORACLE-based applications to reduce the need for duplicate data entry and increase operating efficiency.

By FY 2013, AFM will:

Identify multiple data exchange opportunities between SAMS, ARMPS, CATS, ARIS and other non-financial ORACLE-based applications to reduce the need for duplicate data entry and increase operating efficiency.

AFM Goal 3: Improved Real and Personal Property Management

Objective: Agencies receive effective and automated services for acquisition and personal property management.

Performance Measure 3.1 Acquisition & Property Division, Facilities Division, Area, Locations, and REE agencies partner to effectively implement and administer E-commerce initiatives and custom electronic information exchange.

Indicators:

By FY 2012, AFM will:

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 2013, 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 2012, AFM will:

Coordinate between APD and FD to develop and implement a comprehensive energy buying plan.

By FY 2013, 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 2012, AFM will:

*Review vehicle procurements for minimum size needed for mission.
Maximize use of alternative fuels and alternative fuel vehicles.
Monitor fleet fuel use for methods for overall fuel savings.*

By FY 2013, AFM will:

*Review vehicle procurements for minimum size needed for mission.
Maximize use of alternative fuels and alternative fuel vehicles.
Monitor fleet fuel use for methods for overall fuel savings.*

Performance Measure 3.4 Develop metrics for REE acquisitions.

Indicators:

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)*

By FY 2013, 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 2012, AFM will:

*Identify and protect ARS infrastructure and real property assets.
Work with Office of Homeland Security to establish protocols for validating high priority physical security needs.
Analyze trends regarding employee safety and wellbeing with the goal of reducing worker*

injuries and OMSP exposures to workplace hazards, and implement corrective action.

By FY 2013, AFM will:

*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 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.*

By FY 2013, 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 2012, AFM will:

*Establish roles and responsibilities of AFM/Areas/Locations/State Offices in implementing EPACT 2005 and the Energy Independence and Security Act of 2007 goals.
Maximize the use of no cost/low cost energy management programs.*

Evaluate how to allocate energy reduction/renewable energy initiatives across ARS in a manner that maximizes progress in meeting Agency EPACT 2005 and the Energy Independence and Security Act of 2007 goals.

By FY 2013, AFM will:

*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 2012, AFM will:

*Continue training programs on authorized uses of Extramural Agreements.
Develop automated notification of reporting due dates.
Continue developing awareness of fiscal accountability, and ensure legitimate commitment and sufficiency of funds.
Consolidate interim and annual reporting requirements (AD-421 process).*

By FY 2013, AFM will:

*Continue training programs on authorized uses of Extramural Agreements.
Develop automated notification of reporting due dates.
Continue developing awareness of fiscal accountability, and ensure legitimate commitment and sufficiency of funds.
Consolidate interim and annual reporting requirements (AD-421 process).*

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

Indicators:

By FY 2012, AFM will:

*Develop efficient billing and accounting processes.
Develop process to close agreements in a timely manner.
Review other agencies' business processes for automated agreement account reconciliation and closeout. Consider implementing best business practices.*

By FY 2013, AFM will:

*Develop efficient billing and accounting processes.
Develop process to close agreements in a timely manner.
Review other agencies' business processes for automated agreement account reconciliation and closeout. Consider implementing best business practices.*

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

Indicators:

By FY 2012, AFM will:

*Develop metrics to evaluate agreement process
Measure timeliness of account reconciliation to ensure timely closeouts.*

By FY 2013, AFM will:

*Develop metrics to evaluate agreement process
Measure timeliness of account reconciliation to ensure timely closeouts.*

AFM Goal 6: Improved Electronic Access to AFM Information and Business Applications.

Objective: AFM applications fully meet REE needs for administrative and financial management information and guidance in support of improved productivity, service, and reduced costs.

Performance Measure 6.1 Ensure employees have access to personal and professional resources.

Indicators:

By FY 2012, AFM will:

*Develop 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 2013, 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 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.

By FY 2013, 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.