

Introduction

ARS Annual Performance Report for FY 2007

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 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

STRATEGIC GOAL 1

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.

TABLE OF CONTENTS

Strategic Goal 1: Enhance International Competitiveness of American Agriculture	6
Strategic Goal 2: Enhance the Competitiveness and Sustainability of Rural and Farm Economies.....	8
Strategic Goal 3: Support Increased Economic Opportunities and Improved Quality of Life in Rural America	32
Strategic Goal 4: Enhance Protection and Safety of the Nation’s Agriculture and Food Supply	33
Strategic Goal 5: Improve the Nation’s Nutrition and Health	63
Strategic Goal 6: Protect and Enhance the Nation’s Natural Resource Base and Environment.....	72
ARS Management Initiatives	90
ARS Administrative and Financial Management (AFM) Initiatives	107
ARS Office of the Chief Information Officer (OCIO) Management Initiatives	109

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 2007, ARS will develop improved biomass plants, sustainable biomass production systems, and efficient handling and storage technology for biomass feed stocks.

FY 2007 Accomplishments:

1. ARS developed a process for pelleting distillers dried grains with solubles (DDGS) on a commercial scale. Utilizing traditional feed milling equipment, high quality pellets were produced without the use of binders and without affecting nutrient composition. Additionally, pelleting significantly increased the bulk density of ddgs (from 9.1 to 20.1%) and decreased the angle of repose (from 18.3 to 19.2%) thereby increasing ddgs flowability, a major issue in ddgs storage and transport.
Impact: pelleting increases the value of ddgs to the feedlot industry and could expand DDGS use into rangeland settings.
2. ARS developed an energy-efficient process for converting wheat straw to butanol. after a dilute-acid pretreatment, wheat straw was enzymatically saccharified and simultaneously fermented to butanol. the process does not require a post-pretreatment detoxification step, thus resulting in significant cost savings. further, gas-stripping the fermentation broth to remove butanol avoided product inhibition of the fermentation and maintained high rates of butanol production.
Impact: The integrated saccharification, fermentation, and recovery process (SSFR) significantly reduces the cost of producing butanol from lignocellulosic feedstock.
3. Identifying beneficial genes and gene combinations for bioenergy production is quite difficult in complex, polyploid genomes such as switchgrass. Fortunately, ARS identified a diploid variety of switchgrass, thereby enabling genome sequencing, simplifying genetic map construction, and allowing determination of population structure with regard to polyploidy.
Impact: With a diploid line available, switchgrass varieties with desirable traits for biofuels production can be developed using established breeding techniques.

Indicator 2

During FY 2007, ARS will develop technology and systems that improve the efficiency, economics, and sustainability of energy production from agricultural biomass.

FY 2007 Accomplishments:

1. In collaboration with South Dakota State University (SDSU), ARS developed balanced feed rations for tilapia consisting primarily of DDGS (up to 60%), soy meal and corn flour. The pelleted feeds had excellent nutritional and physical properties, including floatability; and the level of expensive fish meal required for these formulations was only 6% (by weight).
Impact: Distillers dried grains with solubles (DDGS) could be an inexpensive protein source in aquaculture. A production-scale feeding trial is currently underway at SDSU.
2. ARS developed a new, solvent-free, enzymatic process to remove the oil-rich corn germ. The process recovers 80-90% of the corn germ and does not require heat.
Impact: This enzymatic process allows corn ethanol plants to produce corn oil co-product without using hexane, a hazardous organic solvent, as is the current practice.
3. ARS developed a corn oil extraction process that produces an oil with levels of lutein and zeaxanthin (beneficial phytonutrients) that are ~100 times higher than commercial corn oil. At these levels, a mere two tablespoons per day of the ethanol-extracted corn oil should slow the progression of age-related macular degeneration.
Impact: Because of the significant health benefits, a high-lutein&zeaxanthin oil should sell for a higher price, thus returning more co-product value to the producer.

Indicator 3

During FY 2007, ARS develop develop renewable energy technology and systems to meet on-farm and remote rural needs and to enhance the rural economy.

FY 2007 Accomplishments:

1. Most biodiesel, a renewable and biodegradable diesel fuel, is produced from refined vegetable oils. However, the high cost of these oils would not make biodiesel production economically feasible. Greases are lower-cost feedstocks, but their high free fatty acid (FFA) content makes them difficult to use in a conventional biodiesel plant. In collaboration with a university partner, ARS developed immobilized acid catalysts that are highly efficient in esterifying FFAs to biodiesel.
Impact: This novel technology will expand the production of biodiesel fuels from greases and other inexpensive, second-use fats and oils.
2. Glycerol, a co-product of biodiesel production, continues to drop in price as biodiesel volumes increase and traditional markets for glycerol become highly saturated. To create new, value-added markets for glycerol, ARS developed a variety of polyesters by reacting glycerol with adipic, azelaic, suberic, and sebacic acids. The resulting polymers are biodegradable and can be used as weed barriers and for controlled-release of fertilizers or pesticides.
Impact: The production of biodegradable polyesters from glycerol would open a large, value-added outlet for biodiesel co-product.

2.1.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2007:

During FY 2007, ARS reported on five 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 that are in use.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
--------------------------------	------------------------------	------------------------------	---------------

STRATEGIC GOAL 5

1. Validating net energy of ethanol from switchgrass	published work	Multiple private investors, corporations, and government agencies	Report was distributed world-wide in media within a week of publication. Very positive net energy values fully validates public and private investments being made in cellulosic ethanol from perennials such as switchgrass.
2. Pelletizing DDGS	process/product demonstration and published work	-Roskamp; Andritz-Sprout; VeraSun Energy	Customers using ARS data to install/operate DDGS pelleting equipment in ethanol plants and plan for plant expansions & process improvements
3. Convert corn fiber byproducts to ethanol	published work and joint partnerships	Aventine Renewable Energy	Customer is testing technology on demonstration scale
4. Fuel ethanol from barley thereby enabling local farmers to generate additional revenue from growing winter barley as a cover crop (with soy) and reducing nutrient pollution of sensitive waterways	published work, workshops, CRADA	Osage (VA), Genencor	Customer used ARS data to secure \$150 million funding for 3 barley-to-ethanol plants on East Coast
5. New corn oil with high levels of lutein and zeaxanthin (phytonutrients that reduce or prevent onset of macular degeneration)	CRADA and published work	Prairie Gold, Inc	Customer is building a plant to produce fuel ethanol and premium corn oil co-product

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

ARS

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 2007, ARS will develop technologies leading to new or improved products from renewable agricultural resources, residues and wastes.

FY 2007 Accomplishments:

1. ARS researchers at Winter Haven, Florida, in collaboration with breeders at the University of Florida, evaluated tomato lines for flavor, color and horticultural characteristics, including sensory and chemical analyses, resulting in the development of a flavorful, high lycopene tomato.
Impact A new tomato variety, 'FloraLee', was released by the University of Florida due to these collaborative efforts. Improved flavor in tomatoes will encourage their consumption, thus enhancing the health of U.S. consumers by providing essential nutrients such as lycopene.
2. Scientists at Wyndmoor, Pennsylvania, using shear or extrusion processing, developed and patented texturized whey protein, a new whey protein ingredient. The process alters the functionality of whey protein isolate and whey protein concentrates allowing them to be used to fortify a wide variety of food products without changing, and in many cases, improving the functional properties of the food. Whey protein can improve the amino acid balance and complements starches and grain-derived flours.
Impact A CRADA partner and licensee of the technology opened a processing plant to manufacture protein-enriched snack products that are currently being marketed nationwide. This research provided a healthy new snack product for consumers and increased market opportunities for dairy products.
3. Researchers at ARS Albany, CA, developed and licensed a technology for forming 100% fruit health bars from fruit, that added value and created new markets for pears and other fruits.
Impact: A new bar formulation was developed in collaboration with a small company that enabled production of a new line of organic 100% fruit bars, called Bear Bars. This research increased grower profits while assisting consumers around the globe in meeting their daily requirements for fruits through the development of healthy, convenient organic 100% fruit bars.
4. Researchers at Albany, California, in cooperation with a CRADA partner, commercialized biodegradable, single-use food containers, such as plates, bowls and cups, derived from cereal starches and fiber composites.
Impact Transfer of this technology to a third party licensee facilitated start-up of a commercial production facility located in Springfield, Missouri. This facility is providing an expanding market for renewable, biodegradable single-use items from cereal starches.

Indicator 2

During FY 2007, ARS will develop new or improved methods to measure or predict quality, or to sort by quality.

FY 2007 Accomplishments:

1. In cooperation with a private sector partner, researchers at New Orleans, Louisiana, built a materials handling system for evaluating sample fabrics for levels of white specks. The system incorporates the automated version of AutoRate, an image analysis system for measuring white specks that is unbiased for different operators.
Impact: A fully automated version of this system performed superbly in evaluating white specks. The system also measures dark specks, which can be used to evaluate seed coat fragments in greige (unfinished) fabrics.
2. Grain kernels infested by insects may show no indication on their exterior, but often contain hidden larvae. ARS Engineers at Manhattan, Kansas, modified a simple laboratory roller mill system to measure and analyze the electrical conductance of wheat as it was crushed. This facilitated detection of wheat kernels with live insects hidden inside. Furthermore, the apparatus is low cost (~\$1500 for parts) and can inspect a one kg sample in less than two minutes.
Impact: This technology helps grain handlers and millers detect grain that is infested. Early detection stops the growth of insect population and prevents damage to the grains. This technology has been transferred to a major cereal manufacturer.
3. Because of the large variability associated with the test procedures, lots may be misclassified when handlers, exporters, importers, and regulatory agencies test treenuts for aflatoxin which may cause an economic loss to the industry and increase the health dangers to the consumer. ARS researchers at Raleigh, North Carolina, developed models to evaluate the performance of sampling plan designs for almonds, hazelnuts, and pistachios.
Impact: The Codex Committee on Contaminants in Foods (CCCF) has used the data provided by USDA/ARS, as part of the U.S. delegation, to recommend a harmonized sampling plan to detect aflatoxin in treenuts traded in international markets for CCCF approval. The U.S. almond industry, which provides 70% of the world's demands for almonds, has used the model to develop an industry wide aflatoxin-testing program for almonds marketed in the export trade that would reduce lots rejected upon retesting in the EU.

2.1.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2007:

During FY 2007, ARS reported on four new technologies adopted for uses that provide food crops and products with higher quality and extended shelf life; convenient and acceptable healthy foods; non-food, non-fuel biobased products with cost and performance features comparable or superior to petroleum-based products; and valuable co-products from agricultural residues and processing wastes that are in use.

Describe the Technology	Describe the Transfer	Identify the Customer	Impact
1. Scientists at Wyndmoor, Pennsylvania, using shear or extrusion processing,	A CRADA partner and licensee opened a processing plant to manufacture the protein-enriched	Harden Foods, Inc., Philadelphia, PA /Consumers	Snacks are almost a daily staple. Snacks lacking adequate proportions of nutrients such as proteins are the norm,

<p>developed and patented texturized whey protein, a new whey protein ingredient. The process alters the functionality of whey protein isolate and whey protein concentrates allowing them to be used to fortify a wide variety of food products without changing, and in many cases, improving the functional properties of the food. Whey protein can improve the amino acid balance and complements starches and grain-derived flours.</p>	<p>snack products that are currently being marketed nationwide.</p>	<p>and such snacks have been implicated as contributing to the growing obesity epidemic. To combat obesity, new nutritious products are needed. This research provided a healthy new snack product for consumers and increased market opportunities for dairy products.</p>	
<p>2. Researchers at ARS Albany, CA, developed and licensed a technology for forming 100% fruit health bars from fruit, that added value and created new markets for pears and other fruits.</p>	<p>A new bar formulation was developed in collaboration with a small company that enabled production of a new line of 100% fruit bars that are organic, called Bear Bars.</p>	<p>Mountain Organic Foods, LLC, Moraga, CA / Consumers</p>	<p>This research increased grower profits while assisting consumers around the globe in meeting their daily requirements for fruits through the development of healthy, convenient organic 100% fruit bars.</p>
<p>3. Development of biodegradable food packaging from renewable plant materials is needed to promote new uses for surplus farm commodities, and help American farmers as well</p>	<p>Researchers at Albany, California, in cooperation with a CRADA partner, commercialized single-use items, such as plates, bowls and cups, derived from cereal starches and fiber composites.</p>	<p>Technical transfer to third party licensees facilitated start-up of commercial processes, including a commercial production facility located in Springfield, Missouri.</p>	<p>This facility is providing an expanding market for renewable, biodegradable single-use items from cereal starches.</p>

as agro-industry.	<p>4. Grain kernels infested by insects may show no indication on their exterior, but often contain hidden larvae. ARS Engineers at Manhattan, Kansas, modified a simple laboratory roller mill system to measure and analyze the electrical conductance of wheat as it was crushed. This facilitated detection of wheat kernels with live insects hidden inside. Furthermore, the apparatus is low cost (~\$1500 for parts) and can inspect a one kg sample in less than two minutes.</p>	<p>This technology has been transferred to a major cereal manufacturer.</p>	<p>This technology helps grain handlers and millers detect grain that is infested.</p>	<p>Early detection stops the growth of insect population and prevents damage to the grains.</p>
-------------------	---	--	---	---

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 2007, ARS will develop new production practices and decision support tools that increase profitability and improve environmental quality.

FY 2007 Accomplishment:

1. Even as the benefits of using cover crops continue to be reported, it is not known how many farmers are actually using cover crops, and what keeps more from doing so. ARS scientists at the Nation Soil Tilth Laboratory in Ames, Iowa are working with collaborators at Iowa State University to find out how many farmers in the Corn Belt use cover crops in their production systems. It was found farmers who grow a greater diversity of crops were more likely to use cover crops, but only 18 percent of farmers in the region reported ever using cover crops — and only 8 percent had planted cover crops in the fall of 2005. Eighty percent of farmers use some sort of other conservation practices, and indicated they believed cover crops improve soil conditions by reducing erosion and increasing soil organic matter. However, over a quarter of farmers perceived that cover crops are too expensive to use, and over a third believed that planting cover crops took too much time.

Impact: These findings quantify the actual lack of acceptance by farmers to use cover crops and provide researchers, extension specialist, USDA-NRCS conservation planners, and Technical Service Providers specific guidance as to how specific research and outreach activities should be designed to demonstrate cover crops will increase profits and reduce risks so that farmers will be confident to use this management strategy.

2.2.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2007:

During FY 2007, reported on four 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
1. Strip tillage management system for small seeded crops.	Technical information based on research adopted by users.	Sugarbeet growers in the Northern Great Plains U.S.	Use of strip tillage has increased from none to 30,000 acres since 2004. Using strip tillage has reduced fuel use six-fold and fertilizer use by 10%. Continued increased use is expected by sugarbeet farmers in Montana, Idaho, and Nebraska.
2. Cover crop management system for U.S. date production.	Technical information based on research that has been adopted by users.	Date growers in the Coachella Valley in southeastern California.	Within three years of implementing the cover cropping system, tree growth per year tripled, yields significantly increased by an average of 12

			<p>to 20%, and fruit quality also improved. At the same time, production cost was reduced by \$100 per acre due to savings on cultivation, fertilizer, and water. Approximately 45% of the date orchards in Coachella Valley are using the cover cropping system. In addition, this technology has been extended to other crops resulting in an increase of cover cropping acreage from 500 to 25,000 acres in the Coachella Valley, including use in approximately 40% of the grape acreage.</p>
3. The Crop Sequence Calculator.	A user-friendly computer software program that assists agricultural producers in designing the most profitable cropping systems for the northern Great Plains region.	The CSC is also an educational resource in university agronomy classes and crop advisor workshops, and is used as a teaching tool at Colorado State University, Iowa State University, Montana State University, South Dakota State University, and North Dakota State University. The target audience for the CSC includes agricultural producers, private consultants, commodity representatives, bankers, NRCS personnel, and agricultural researchers.	Since release of version 2.2.5 of the CSC in August 2003, over 12,000 copies (in CD-ROM format) have been distributed. The CSC has contributed to increased diversification of cropping systems in semiarid regions, and has furthered the application of a 'dynamic' approach to crop sequencing, which is used by over 70% of agricultural producers in the northern Great Plains.
4. Cover crop management system for U.S. potato production.	Technical information based on research that has been adopted by users.	Potato growers in the irrigated Pacific Northwest.	Within three years of implementing the cover cropping system, plantings of mustard cover crops by potato growers

increased from 400 to 20,000 acre in Washington State. At the same time, production costs were reduced by \$130 per acre due to savings on fumigation costs and an additional \$20-30 acre for nitrogen fertilizers. In addition, this technology has been extended to the neighboring states of Idaho and Oregon with similar results.

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 2007, ARS will identify underlying genetic and physiologic mechanisms impacting reproductive efficiency, nutrient conversion, and growth in food animals.

FY 2007 Accomplishments:

1. Genetic, environmental and economic factors influencing the incidence of bovine respiratory disease (BRD) in feedlot calves were characterized in nine breeds and three composite lines of beef cattle over a 15 yr period at the U.S. Meat Animal Research Center, Clay Center, NE. Epidemiological patterns for BRD infection were described and significant economic loss associated with BRD infection in a feedlot was estimated at \$13.90 per animal. Estimates of heritability for resistance to BRD were low to moderate suggesting resistance to BRD could be improved over time from genetic selection programs. Phenotypic, environmental, and

genetic correlations of carcass and palatability traits with BRD were low or negligible; inferring that selection to reduce BRD would not have a significant effect on those traits.

Impact: These results indicate that genetic variation exists and may be exploited to reduce incidence of this economically devastating disease complex.

2. Improving the fertilization and hatching rates of eggs is important for the trout industry. Research conducted at the National Center for Cool and Cold Water Aquaculture examined the localization and time course of gene expression of a suite of genes thought to regulate oocyte development in the stages just prior to spawning. This work has shown differences in the location of expression of several key genes, some growth factors are expressed in the follicle cells surrounding the oocytes whereas other key growth factors are predominantly expressed in the oocyte.
Impact: This work has revealed the time course of events leading up to spawning, and suggest that these peptide dynamics may be critical to the process of oocyte development and therefore may be important for egg quality.
3. The use of plant proteins in aquafeeds is growing. Although rainbow trout have some capacity for taurine biosynthesis from sulfur amino acid precursors, taurine has been identified as a potential limiting nutrient in plant-based diets for rainbow trout. Methionine is a precursor sulfur amino acid that can be supplemented to animal feeds more cost effectively than taurine. Research conducted by ARS scientists in collaboration with the University of Idaho at the Hagerman Fish Culture Experiment Station tested the efficacy of supplementing methionine and taurine separately and in combination on production performance of rainbow trout. Using metabolite profiling technologies this experiment determined that bioconversion of methionine to taurine was limiting and supplementing taurine was necessary.
Impact: The impact of this research is to verify the need for taurine supplementation in plant-based diets for rainbow trout and continue to refine plant-based aquafeeds to reduce dependence on fish meals.

Indicator 2

During FY 2007, ARS will develop technologies leading to improved marketability of animal products.

1. As corn prices and ethanol production increases, distillers grains are gaining widespread use in the beef industry, yet the effects of various levels of distillers grains in cattle diets on eating quality of meat are largely unknown. U.S. Meat Animal Research Center (Clay Center, NE) scientists evaluated the eating quality of meat from cattle fed 0, 15, 25, 40% distillers grains on an as-fed basis. There was no effect of any level of distillers grains on tenderness, juiciness, or beef flavor intensity.
Impact: These results indicate cattle feeders can take advantage of the economic benefits of feeding distillers grains without detrimental effects on eating quality of beef.
2. Beak trimming in the poultry industry typically involves the removal of 33 to 50% of the upper and lower mandibles using a heated blade that both cuts and cauterizes the beak tissue. There is a considerable body of morphological, neurophysiological, behavioral, and production research demonstrating the emergence of several markers of acute and chronic pain (e.g., persistent lethargy and guarding behaviors, reduced feed intake, and development of neuromas) as a result of beak trimming. ARS scientists in the Livestock Behavior Research Unit at West Lafayette, IN have shown that: 1) genetic selection of kind, gentle birds is a suitable approach for controlling cannibalism in poultry, and 2) infrared beak treatment causes less beak re-growth and fewer bill morphological changes compared to hot blade cutting.
Impact: These results will aid producers and scientists in managing layers most efficiently by reducing beak trimming associated damage and losses due to cannibalism before non-cannibalistic egg-laying strains are commercially available.

3. Pathogens and other microbial populations can accumulate and compromise fish health in fish culture systems that recirculate water. Scientists at The Conservation Fund's Freshwater Institute (Shepherdstown, WV) determined the process requirements necessary to achieve full-flow disinfection of recycled water using ozonation followed immediately by ultraviolet irradiation. The entire recirculating flow could be effectively disinfected when the ozone dose was controlled in a feed-back loop using probes that measured either dissolved ozone concentration or oxidation reduction potential. Thus, combining ozone with ultraviolet irradiation in a recirculating system can prevent the accumulation of most fish pathogens and significantly reduce the risk of spreading fish disease.
Impact: These findings will be used to produce more biosecure aquatic production systems that sustain healthier and more growth promoting environments.

4. Low-salinity recirculating systems can eliminate the need for marine aquaculture to be located near limited and expensive coastal land thereby expanding opportunities for marine aquaculture; however, little information exists regarding efficient operation of low-salinity recirculating systems. Juvenile Florida pompano were raised to market-size in a low salinity production-scale recirculating system by scientists at the ARS Sustainable Marine Aquaculture Project in Fort Pierce, FL. Pompano were reared for 300 days from 30 g to 620 g, and the efficiency of ammonia removal, feed and waste particle removal, and oxygen, water, and energy use were monitored on the system components as increasing amount of feed inputs were used to maximize fish growth.
Impact: The accomplishment provides culturists and engineers baseline performance and design criteria over a complete growout cycle for the construction of production-scale recirculating systems to produce market-size marine fish in low salinity.

Indicator 3

During FY 2007, ARS will identify genes and their function leading to DNA tests for use in food animal genetic improvement programs.

FY 2007 Accomplishments:

1. Consumers of beef desire a palatable and healthful product at a reasonable price and are increasingly concerned about relative levels of saturated and unsaturated fats in their diet. Genetically modifying lipid profiles can help cattle producers produce beef that more consistently meets consumer expectations. ARS scientists at the Fort Keogh Livestock and Range Research Laboratory at Miles City, MT identified seven quantitative trait loci (QTL) on five chromosomes involved in lipid metabolism, beef tenderness, and beef flavor. These QTL were independent of genes encoding major enzymes involved in fatty acid metabolism.
Impact: These results guide future research to provide a richer understanding of genetic mechanisms controlling palatability and healthfulness of beef and may ultimately lead to tools for producing beef of greater value to consumers.

2. Broiler breeders in the poultry industry are feed restricted to reduce the occurrence of reproductive problems associated with obesity. Skip-a-day feed restriction programs are commonly used in preference to everyday programs even though there is a potential for excess fat accumulation by using the skip-a-day regimen. A project was conducted by ARS scientists in the Animal Biosciences Lab, Beltsville, MD, to determine the effects of certain management regimens and metabolism of the broiler breeder candidate. Skip-a-day feeding increased the expression of certain genes implicated in the regulation of lipid metabolism. An increase in hepatic lipid accompanied the increase in gene expression, which could be deleterious to the long-term health of the birds.
Impact: These results show the potentially significant impact of feeding regimens on gene expression in breeder pullets.

3. Infectious disease is a significant factor hindering aquaculture and a better understanding of the fish immune system is required to improve health and disease resistance. Studies at the National Center for Cool and Cold Water Aquaculture identified a family of forty-four new tumor necrosis factor (an important group of immune system genes) gene sequences from rainbow trout and other fish species. Comparison of the protein sequences and chromosomal locations allowed us to identify which genes were related to those found in mammals and which were unique to fish. We developed methods for measuring gene expression in rainbow trout tissues.
Impact: These studies have led to a better understanding of how the fish immune system functions and how it differs from that of mammals. The newly developed gene detection methods will advance studies on gene expression and functional analyses in fish.

Indicator 4

During FY 2007, 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 2007 Accomplishments:

1. The recent release of the bovine genome sequence assembly by the International Bovine Genome Sequencing Consortium has developed a platform for the development of highly applied genomic tools for use in beef and dairy cattle research programs. ARS scientists at the U.S. Meat Animal Research Center at Clay Center, NE and the Beltsville Agricultural Research Center at Beltsville, MD have provided principal leadership for the bovine community in this area. Results of these efforts include: 1) A genotyping platform was produced through Reduced Representation Libraries for use in genome-wide assessment of association of genotype with production phenotypes. "Next generation" sequence technology was implemented create the DNA marker resources for generation of a "50K SNP chip" that was made commercially available in 2007. 2) Developed an integrated genome map for cattle in cooperation with international collaborators, providing an important resource for assembling and evaluating the genomic sequence, identifying quantitative trait loci, and supporting functional genomics. 3) Deposited over 500 full length gene sequences in the GenBank public database. Partial gene sequence and comparative information were used to identify clones containing complete genes. Genes containing clones were fully sequenced and 100 of these sequences were used to assist in the annotation of the bovine genome sequence.
Impact: Collectively these genomic resources will allow rapid, efficient, and full exploitation of the bovine sequence for genome-enabled animal improvement and precision animal management applications.
2. The swine industry required a panel of single nucleotide polymorphism (SNP) markers for parentage and animal identification to reduce the cost and improve the reliability of these DNA tests. Highly informative genetic markers developed at the U.S. Meat Animal Research Center, Clay Center, NE, were selected and tested in a large group of pigs selected from the industry by the National Swine Registry to represent purebred Duroc, Hampshire, Landrace and Yorkshire germplasm populations. Sixty markers that were sufficient for these industry applications remained in the final panel.
Impact: In cooperation with Sequenom, Inc. these markers were then grouped together so that the information could be obtained in an economical manner using the Sequenom MassArray system. This panel has been provided to the U.S. swine industry.

Indicator 5

During FY 2007, ARS continue to characterize germplasm of food animals for traits of importance.

FY 2007 Accomplishments:

1. Following decades of intense selection primarily for meat or egg production, and competition that has reduced the poultry industry to a few multinational companies, concern exists whether sufficient genetic diversity is available to address future needs. To survey biodiversity of commercial poultry, 2,580 unique individuals of commercial pure lines, experimental chickens, and standard breeds were assembled, genotyped with 3,072 genetic markers equally spaced throughout the chicken genome, and analyzed for loss of alleles by ARS scientists at East Lansing, MI.
Impact: Results revealed that individual commercial breeding lines have lost 70% or more genetic diversity of which only 25% can be recovered by combining all stocks of commercial poultry. These results emphasize the need for concerted national and international efforts to preserve chicken biodiversity.
2. Two important goals of the sheep industry are to increase reproductive rate and to decrease costs of labor. Hair breeds of sheep evolved to express “easy-care” attributes and are widely perceived to perform well with minimum labor requirements due to hardiness, parasite tolerance, and shedding of hair/wool. To investigate these issues, scientists at the U.S. Meat Animal Research Center (Clay Center, NE) mated rams of two wool breeds and three hair breeds with Romanov ewes and evaluated the resulting crossbred daughters for productivity in both high- and low-input production systems. The relative performance of the five types of crossbred ewes was similar in both production systems, with White Dorper x Romanov crossbred ewes being the most productive in each system.
Impact: Experimental results documented that prolific sheep and low inputs can be successfully combined to increase profitability for sheep producers.
3. Estimation of phenotypic and genetic (co)variances for economically important traits are required for development of a breeding program to produce superior catfish germplasm for release to catfish producers. Data were collected for growth, resistance to enteric septicemia of catfish (ESC, the most devastating disease for catfish production), and processing yield and resulted in heritability estimates of approximately 0.35, 0.10 and 0.25, respectively. The best performing animals from families of the third generation of selection of a channel catfish line were selected as future broodstock based on an index for these traits. Selected broodstock were mated to produce another generation of families which are currently being evaluated for growth, resistance to ESC, and processing yield.
Impact: This information is being used in a continued selection program to develop superior germplasm for release which will benefit producers, processors, and consumers.

Indicator 6

During FY 2007, ARS will develop improve cryopreservation technology for storage of animal germplasm and continue to increase the stocks of germplasm stored within the National Animal Germplasm Program repository.

FY 2007 Accomplishment:

1. The security of U.S. animal genetic resources was significantly increased in the past year. Samples in the National Animal Germplasm Program collection at Fort Collins, CO increased from 297,758 to 355,000, a 19.2% increase. The collection contains germplasm and tissue samples from 8,263 (a 12.8% increase) animals from 26 livestock, poultry and aquatic species, 119 breeds, and 110 unique within breed lines.
Impact: The repository released 1,866 samples for research on quantitative trait loci, genetic distancing of cattle and sheep breeds, and live animal generation. Sufficient germplasm has been collected on 28 (a 12% increase) livestock or fish populations so that the populations could be reconstituted if necessary.

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 2007, 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, and flower supply that is competitive in the global marketplace.

FY 2007 Accomplishments:

1. Sorghum plants compete with weeds by releasing chemicals that inhibit the growth of surrounding plants. The root hairs of sorghum can release a substantial amount of a natural herbicide called sorgoleone. ARS researchers at Oxford, Mississippi, have determined that the key enzymes required for sorgoleone biosynthesis are localized in the root hairs.
Impact: This new information can be used by plant scientists to manipulate and enhance the production of natural herbicides in other crop plants. [302]
2. Fusarium head blight (FHB) is a major disease of wheat and barley in several small grain production areas in the United States that is managed by application of fungicides. Although aerial application of fungicides provides a rapid method of response to a FHB outbreak, optimized methods are needed to maximize spray deposition on wheat heads. ARS scientists in College Station, Texas, conducted definitive aircraft spray-deposition trials using conventional hydraulic nozzles, electrostatic nozzles, and rotary atomizers and determined that hydraulic nozzles set at the lowest spray rate and largest droplet size, along with electrostatic spray nozzles, resulted in maximum spray deposits on wheat heads.
Impact: This research provides recommendations for optimal aerial fungicide application methods that will increase deposition on wheat heads to maximize disease control efficiency, while minimizing off-target deposition and potential adverse environmental impacts. [305]
3. In the mid-Atlantic coastal region short-day type strawberry plants do not produce fruit in the year they are planted. ARS scientists at Kearneysville, West Virginia, determined that young 'Carmine' and 'Camarosa' strawberry transplants prepared in July and held in small containers until field planting in early September resulted in flowering by mid-October. This evaluation indicates that it is possible to produce transplants with high fall-fruiting potential without the need to expose transplants to artificial short-days and chilling temperatures.
Impact: This new approach to strawberry will allow strawberry growers in the mid-Atlantic area to extend their production season and enhance their annual income. [305]
4. The extent of native bee declines is of national concern. However, as a major roadblock, there are no means to readily and accurately identify all the bees collected from large

surveys. Currently, only a handful of bee taxonomists are competent to provide identifications. To reduce this bottleneck, ARS scientists in Logan, Utah, developed, in collaboration with Patuxent Wildlife Refuge, a Web-accessible guide to bees of the Eastern United States that allows non-specialists to accurately identify bees. ARS researchers also created a guide to the genera of *Megachilidae*, a family of bees that includes the alfalfa leafcutting bee and the blue orchard bee, and that shows the most promise for additional crop pollinators.

Impact: These Web products will expand the capability of a great number of people to conduct pollination research. [305]

Indicator 2

During FY 2007, ARS will maintain genetic and genomic databases and make information accessible via standard software from the Internet.

FY 2007 Accomplishment:

1. Fire blight, a destructive disease of apple and pear trees, is estimated to cost the U.S. fruit industry over \$100 million a year in crop losses and disease control. ARS researchers at Kearneysville, West Virginia, have applied DNA technology to identify more than 450 apple genes that respond in apple between 1 and 72 hours after challenge with the fire blight pathogen.

Impact: The DNA sequence of these genes was deposited in a publicly accessible database to enable horticulturalists and plant breeders to develop new strategies for protecting apple and pear trees from fire blight disease. [302]

Indicator 3

During FY 2007, 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 2007 Accomplishments:

1. All aspects of plant biology hinge on the plant's ability to perceive light. Because the phytochrome (phy) family (phyA to phyE) are the major light receptors for plants, understanding how they function in regulating gene expression, is crucial for crop improvement. ARS researchers at Albany, California, and at the University of California, Berkeley, have found, contrary to expectation based on previous data, that phyA is the dominant photoreceptor regulating rapidly-induced genes in response to red-light signals. *Impact:* This finding represents a major shift in thinking about the molecular basis of phytochrome-regulated gene expression and opens up new opportunities for manipulating this system for agronomic improvement of crop species. [302]
2. In acid soils, toxic forms of aluminum (Al) are solubilized from clay minerals that damage root systems, greatly reducing crop yields. ARS researchers at Ithaca, New York, have isolated a novel aluminum tolerance gene. The gene encodes a citrate efflux transporter that mediates release of citric acid into the soil where it binds and detoxifies aluminum, so it does not damage the growing root tip. *Impact:* The significance of this discovery, also supported by the National Science Foundation, is that this aluminum tolerance gene can be exploited by plant breeders to improve crop yields on acid soils. [302]
3. All plants require nitrogen for growth. While many plants obtain nitrogen from fertilizer, legumes have bacteria in their root system that can make use of nitrogen from the air. Symbiotic nitrogen fixation within the root nodules is critical for legume crop growth but little is known about the genes affecting this process. ARS researchers at St. Paul, Minnesota, have

assessed the expression of more than 500 genes in the nodules of a model legume, *Medicago truncatula*. Results revealed that more than 80 genes had enhanced expression in root nodules including one putative plant disease resistance gene (R).

Impact: Identifying the genes involved is the first step in developing new strategies to improve nitrogen fixation and nitrogen assimilation in crop plants. [302]

4. With an ever-increasing interest in sugarcane as an energy crop, sugarcane breeders around the world are being called on to develop so-called energy cane cultivars to be used primarily as a fuel source, while continuing to genetically improve sugarcane primarily as a sucrose source. Commercially-released high-fiber canes for energy crop purposes have not heretofore been available in the United States. Together with the Louisiana State University AgCenter, St. Gabriel, Louisiana, ARS scientists in Houma, Louisiana, released three high-fiber sugarcane varieties that excel in total solids accumulation.

Impact: This will enable an emerging energy crop industry to have a choice of varieties – namely a very high-fiber, low-sugar variety; a high-fiber, moderate-sugar variety; and a traditional moderate-fiber, high-sucrose sugarcane – available to satisfy individual interests and regional constraints. [301]

5. The rate of photosynthesis declines at moderately high temperatures in temperate plants including the model plant, Arabidopsis. The decline is due to deactivation of the enzyme, RUBISCO (ribulose-1,5-biphosphate carboxylase/oxygenase), the enzyme that catalyzes the first major step in photosynthesis. At warmer temperatures there is reduced ability of an activase enzyme to activate RUBISCO. ARS researchers at Urbana, IL, have developed a more thermostable activase for Arabidopsis by inserting a portion of a more thermostable activase from tobacco. The initial results indicate that the rate of photosynthesis as measured by gas exchange is improved in the transgenic lines at moderately high temperatures and the recovery of photosynthesis is also better when the plants are returned to lower temperature.

Impact: This new information can be used by plant scientists to enhance the efficiency of photosynthesis to increase yields for food, feed, and bioenergy (302).

Indicator 4

During FY 2007, ARS will improve plant genetic transformation systems to expand their usefulness and improve exploitation of genome sequence information to identify valuable genes in raw germplasm collections.

FY 2007 Accomplishment:

1. Methods for gene expression profiling, such as microarrays, have the potential to revolutionize fruit tree genomic research, but no cost-effective microarrays are publicly available for Rosaceous crops such as apple, pear, stone fruits, strawberry, blackberry, and raspberry. A peach microarray of 5,000 DNA fragments was constructed, printed, and validated by ARS scientists at Kearneysville, West Virginia, and the arrays were tested on RNA of developing peach fruit. This study showed that genes active during peach stone hardening were genes for lignin (woody tissue).

Impact: This work showed that microarray analyses are effective for identifying important genes in stonefruit development and ultimately manipulating them to improve fruit quality. [301]

Indicator 5

During FY 2007, ARS will develop new genetic methods and tools to identify specific genes that affect end-product traits desired by consumers, such as oil and grain quality, disease resistance, and stress tolerance in agricultural crops.

FY 2007 Accomplishments:

1. Iron deficiency chlorosis (IDC) causes millions of dollars in losses in soybean production in the upper Midwest, reducing yields even after the plants seem to have recovered from IDC.

- ARS researchers applied global gene expression analyses to identify genes whose expression is altered even after plants seem to recover from IDC.
- Impact:* This information may provide clues as to why soybean yield is depressed long after the symptoms of IDC disappear, and may help breeders select soybeans that yield better on IDC-sensitive soils. [301]
2. Depending on the cultivar, papaya fruit may be the yellow color of carotenoids or it may be the red color of lycopenes. Since carotenoids are the source of human vitamin A and lycopenes are antioxidants, there are nutritional and health benefits related to the color of papaya fruit flesh. ARS scientists in Hilo, Hawaii, in collaboration with researchers from the Hawaii Agricultural Research Center, the University of Hawaii, and the University of Illinois isolated and characterized a key gene regulating the carotenoid biosynthetic pathway. *Impact:* This discovery can be exploited to better understand the genetic linkage between fruit color and fruit flesh firmness, a post-harvest characteristic important for shipping and handling. The gene can also be potentially used to improve the nutritional quality of papaya. [302]
 3. The most damaging and prevalent rice disease in the southern United States is rice blast. ARS researchers at Stuttgart, Arkansas, have identified resistance genes by screening the U.S. rice germplasm collection. Rice lines with resistance to all strains of blast found in the United States have been identified. Genes for resistance to rice sheath blight have also been identified. At Beaumont, Texas, ARS researchers have developed genetic markers associated with two significant milling yield component traits, grain chalkiness and greenness. *Impact:* The new genes and markers can be exploited by rice breeders to develop new varieties with enhanced disease protection and higher milling rice yield. [301]

Indicator 6

During FY 2007, ARS will construct and maintain physical, genetic, and transcript maps to facilitate comparative analyses among plant genomes.

FY 2007 Accomplishments:

1. Corn, the most widely grown crop in the United States, has a narrow genetic base. An expanded genetic base is needed to provide protection to new diseases and pests. ARS scientists at Ithaca, New York; Raleigh, North Carolina; and Columbia, Missouri, have produced more than 5,000 diverse maize lines, which are the largest set of mapping lines for complex trait dissection in any species. The researchers have DNA genotyped the lines to produce basic genetic maps with a total of 18 million data points in this effort that was also supported by the National Science Foundation. Developmental and agronomic traits have been determined for the lines in 6 environments. The seed have been increased for deposit with the ARS Maize Genetic Stock Center for use by plant breeders and geneticists. *Impact:* This project will provide unparalleled understanding of the number, location, and positive alleles of genes that can be mined for crop improvement. [301]
2. There is little or no knowledge of the location of genes that control important apple rootstock traits in the apple genome. To overcome this void, ARS scientists at Geneva, New York, created a genetic map, incorporating diverse molecular markers, from one of the most successful crosses in the breeding program (Ottawa 3 X Robusta 5), which segregates for several important traits including disease resistance, cold hardiness, dwarfing, and precocity. *Impact:* Knowledge of the genomic location and genetic inheritance of these traits will enable ARS researchers to streamline their breeding program and enable more efficient selection and delivery of improved apple rootstocks to the industry. [301]

3. The genetic architecture of beet can be visualized with a genetic map, constructed with molecular markers that are densely spaced and distributed across all beet chromosomes. However, there are limitations of current genetic maps of beet in that only sugar beet has been examined, and few molecular markers are in the public domain. A new genetic map was constructed from a cross between sugar beet and table beet, both representatives of all types of markers available in the public domain, and named according to a standard nomenclature.

Impact: A series of easily deployable molecular markers is now available for orienting maps with the same nomenclature, enabling scientists to better compare results from different breeding and genetic materials. [301]

Indicator 7

During FY 2007, ARS will identify, acquire, and expand the genetic base of crops through acquiring new accessions to enhance the diversity of plant germplasm collections.

FY 2007 Accomplishments:

1. Genetic resources are critical for continued progress in plant breeding, and are increasingly important for plant genomics research. During fiscal year 2007, the 20-plus genebanks in the ARS National Plant Germplasm System (NPGS) added more than 8,000 new samples — including several hundred new species — to their collections, so that the NPGS now conserves more than 484,000 samples of more than 12,500 plant species. Some of these new samples were acquired via successful collecting trips conducted in 12 nations.

Impact: Demand for these samples continues to increase, with more than 150,000 samples distributed during this period. These materials furnished key genes for advancing research and improving cultivars worldwide. [301]

2. To date over 5,000 accessions of cocoa germplasm in Trinidad and Costa Rica have been genotyped, cross-checked with the cooperating institutions and the data placed in international cocoa databases, as well as in Genbank. In addition, interesting sub-collections of wild materials and farmers' selections have been made in Peru. The entire collection of about 600 accessions in French Guiana, comprising both cultivated and wild materials, has also been evaluated and genotyped.

Impact: Interesting discoveries include the diverse origins of the 'Nacional' cocoa varieties in Ecuador, prized by industry because of their quality traits, as well as detailing the unusual diversity of material found in Nicaragua, which does not completely match the 'Criollo' varieties found in the rest of Mesoamerica, including Mexico. [301]

Indicator 8

During FY 2007, ARS will strengthen breeding and evaluating of specialty crops that have increasing economic importance.

FY 2007 Accomplishments:

1. A complex disease and insect problem, the Phytophthora-Diaprepes disease complex (PDC), has destroyed thousands of acres of Florida citrus. Two promising new hybrid citrus rootstocks with field tolerance to PDC and good fruit productivity were developed by the USDA citrus breeding program and released in 2007 for commercial use. These new rootstocks exhibit dramatic differences in their effects on fruit tree size, and thereby provide a wide range of management options for commercial producers.

Impact: The rootstocks, US-802 and US-897, fill valuable niches for vigorous and dwarfing rootstocks, respectively, with field tolerance to PDC. There is large commercial interest in these new citrus rootstocks in Florida. [301]

2. The lack of genetic diversity in current commercially grown pear cultivars for the Pacific Coast limits opportunities to capitalize on specialty markets and consumer demand for

new-high quality fruit. Working with collaborators in California and Oregon, ARS scientists at Kearneysville, West Virginia, developed cultivars, 'Blake's Pride' and 'Sunrise', and an unnamed selection that were rated very highly in consumer preference tests. The unnamed selection, which also has quality traits of benefit to growers and packers, will be submitted for cultivar release.

Impact: The new cultivars have the potential to increase consumption of pears. In addition, the newest selection will provide growers and packers with an attractive new cultivar which can be stored for long periods and handled with minimal damage. [301]

3. Nut production in pecans requires several-to-many years from tree planting to commercial nut production. Breeding improved cultivars is a slow, but necessary, process if new cultivars resistant to pests and diseases, with superior nut yield and quality traits, are to be made available to producers. ARS scientists at College Station, Texas, in cooperation with scientists at Kansas State University, developed a superior pecan clone and determined that it merited naming and release as a new USDA cultivar.

Impact: This important accomplishment provides growers with a new and productive pecan cultivar that fills a market niche and should increase production efficiency and grower profits. The cultivar also has disease resistance characteristics that will lessen the need for pesticide applications which are expensive to the grower and potentially harmful to the environment. [301]

2.2.3 Summary of the Major Technologies Developed, Transferred, and Used in FY 2007:

During FY 2007, ARS reported on five new technologies, summarized in the table below, 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.

1	Describe the Technology	For decades, soybean cultivars have been identified via morphological, pigmentation, biochemical, and physiological traits. But, as the number of public and proprietary cultivars has increased, the preceding traits sometimes are insufficient for accurate varietal identification. ARS researchers in Beltsville, MD developed a suite of 23 new DNA genetic markers, called "SNPs" (single nucleotide polymorphisms), which accurately identify cultivars, and are less expensive and more rapid than earlier DNA genetic markers.
	Describe the Transfer	The DNA sequences and analytical protocol for the SNP markers have been published in a peer-reviewed journal with an international scope, and presented at several scientific conferences.
	Identify the Customer	Soybean researchers, breeders, seed company quality control personnel, State, national, and international seed certification agencies, and varietal registration organizations are likely adopters of this new soybean genetic marker technology.
	Describe the Impact	These new genetic markers may increase the efficiency and effectiveness of seed production quality control and varietal identity testing/assurance programs in both the public and private sector. Testing costs may be reduced, accuracy enhanced, and decision-making (both in terms of scientific research and commercial enterprise) may be accelerated.
2	Describe the Technology	Organic farmers have suffered production limitations because of inadequate supplies of organic heirloom and new publicly bred vegetable varieties. Cornell University researchers and ARS Geneva, NY genebank curators have conducted training sessions for organic producers so as to expand their capacity to produce high-quality seedstock.
	Describe the Transfer	ARS and Cornell staff conducted 11 workshops, demonstrations, and/or community seed days in 10 different locations throughout the northeastern

		United States that taught more than 750 participants effective methods of small-scale seed production for heirloom and organic vegetables.
	Identify the Customer	The preceding workshops and training courses focused on heirloom and organic seed producers and farmers in the northeastern United States.
	Describe the Impact	These workshops provided critical training in small-scale seed production to growers and organic farmers who wish to incorporate seed production into their current farming systems. As a result, heirloom and new publicly bred vegetable germplasm is increasingly available to small-scale and/or organic farmers in the northeastern United States.
3	Describe the Technology	The root knot nematode causes severe yield losses in U.S. peanut production. Selecting nematode-resistant peanut via standard screening is extremely time-consuming and expensive, so genetic markers linked to genes conferring resistance would accelerate the development of resistant varieties. ARS researchers at Tifton, GA developed a DNA genetic marker that is highly correlated with host-plant resistance to root knot nematode in peanut, is economical, and is compatible with high-throughput DNA extraction methods.
	Describe the Transfer	The DNA sequence and analytical protocol for the genetic marker have been published in a peer-reviewed journal with an international scope, and presented at several scientific conferences.
	Identify the Customer	Public and private sector peanut researchers and breeders are likely adopters of this new genetic marker technology.
	Describe the Impact	Peanut breeders will apply this new genetic marker to accelerating efforts to combine host-plant resistance to root knot nematode with other important agronomic traits and breed superior, higher-yielding cultivars.
4	Describe the Technology	ARS researchers in Lincoln, NE, bred and released "Mace," a new winter wheat cultivar with genetic protection to wheat streak mosaic virus (WSMV). The new wheat harbors a gene that conferring resistance to the virus, which is spread by the wheat curl mite. Previously, growers typically sprayed pesticide to prevent the mite from feeding and transmitting the virus. However, outbreaks of the virus still occurred, causing million dollar yield losses in the Great Plains.
	Describe the Transfer	ARS publicly released the new cultivar after 10 years of research, breeding, and field evaluation. Seed is being made available to growers and other wheat breeders by the University of Nebraska Seed Foundation.
	Identify the Customer	Winter wheat producers in the Midwest will be users. Other wheat breeders will be able to incorporate the virus resistance gene into regionally adapted varieties and different market classes.
	Describe the Impact	Millers, bakers, food processors, and exporters will benefit from a more consistent wheat supply due to reduced viral damage. The need for pesticide application will also be reduced.
5	Describe the Technology	The profitability of nursery and floriculture production in greenhouses is very dependent on the rising cost of inputs, especially energy costs. Virtual Grower is a computer program that permits a user to assess greenhouse design, energy use and conservation related to factors such as growing conditions and geographical location. Users custom "build" a greenhouse, heat it using a variety of fuels, and schedule when different greenhouse sections will be used.
	Describe the Transfer	It is available as a download for free from an ARS Website, though the program can be made available on a CD, upon request. The program has received many positive reviews and press releases, so doing an internet search will result in many links to the ARS Web site from commercial sites, university Web pages, and greenhouse-management course descriptions.
	Identify the Customer	The software was designed for growers as the end user. The interface is user-friendly, and was developed based on interactions with the grower-component of the greenhouse production industry. Because of its ease-of-use, many high school and undergraduate-level courses have incorporated Virtual Grower into their curriculum.
	Describe the Impact	Since its release in January 2006, an average of three copies per day have been downloaded or distributed, totaling nearly 2,500 copies (as of Feb. 1, 2008) in every continent (except Antarctica) and to at least two dozen countries. This software has helped users identify areas for saving energy through better facility management, construction, sizing of heaters,

STRATEGIC GOAL 5

scheduling crops, and equipment upgrades.

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

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 2007, 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 2007 Accomplishments:

1. Trading partners require testing of pork, game, and horsemeat products for Trichinella infection prior to export. ARS scientists in Beltsville, MD developed a tissue digestion assay for the detection of Trichinella larvae in horsemeat using a double separatory funnel (DSF) procedure was validated for application in food safety programs and trade. The assay, with defined critical control points, was conducted within a quality assurance system compliant with ISO 17025 guidelines, and was found reliable, efficient, and fit for its intended use in food safety and trade.
Impact: The DSF is the only validated digestion assay for trichinellosis demonstrating consistency and effectiveness at critical levels of sensitivity required by trading partners for exported pork, game, and horsemeat, and has been accepted by EU trading partners for use in inspection of meat products destined for export.
2. Pathogen-contaminated manure accumulates at the feedlot pen surface and can serve as a source of pathogens for additional contamination in the cattle production environment. ARS scientists at Clay Center, NE evaluated if any essential oils and related compounds could control pathogens on cattle feedlot pen surfaces. Field studies showed that the prevalence of E. coli O157:H7 prevalence in pen surface could be reduced by 99.9% with linalool containing thymol.
Impact: This indicates that pen feedlot surfaces can be treated to reduce the pathogen load in the cattle production environment, thereby removing pathogens for contamination of additional cattle, cattle hides, and runoff

3. The U.S. imports lean boneless beef trim from Australia, New Zealand, and Uruguay to meet demand for ground beef production. The reported incidence of and the bacteria responsible for foodborne disease differs between these countries and the U.S. ARS scientists at Clay Center, NE determined if current U.S. microbiological profiling adequately addresses the potential differences in the foreign and domestic beef trim, by comparing the hygienic status of imported and domestic beef trim.
Impact: The results showed that the current pathogen monitoring procedures in the USA do not need to be changed for imported material.
4. Salmonella has been isolated throughout all stages of the pork production cycle and has received considerable attention, not only from a food safety standpoint, but also because Salmonella can cause clinical infection in swine. There needs to be increased understanding of the environmental factors that affect Salmonella colonization in farm animals, particularly as related to Salmonella transmission from animal to animal. ARS scientists at College Station, TX showed that by varying the level of light exposure, the animal-to-animal transmission of Salmonella in weaned pigs could be significantly reduced. This has important food safety and animal health implications since virtually all swine production in the U.S. occurs indoors with controlled lighting regimes.
Impact: This work will allow producers to control lighting parameters to minimize the colonization and spread of Salmonella, resulting in less contamination of pork meat products reaching the consumer.
5. Public health agencies are concerned that the agricultural use of antibiotics is contributing to the emergence of antibiotic-resistant bacterial populations in farm animals. Studies are needed to assess the nature of antibiotic-resistant genetic factors (plasmids) that may occur in bacteria that colonize the gastrointestinal tracts of livestock. ARS scientists at College Station, TX, isolated Salmonella enterica from beef and dairy cattle from different areas of the U.S., and determined their antibiotic resistance characteristics. Studies showed that the resistance factor "plasmid replicon IncA/C" was the predominant in all the isolates, and that this plasmid was not transmissible from animal to animal unless aided by a second plasmid which was absent in most of the serovars.
Impact: This suggests that antibiotic resistance elements are not likely to move easily from one bacterium to another; rather resistance spreads from animal to animal by movement of the bacteria themselves. Implementation of manure management practices that minimize bacterial spread from animal to animal could help avoid the spread of antibiotic-resistant bacteria. This would ensure microbiologically safer dairy and beef products for the American consumer.

Indicator 2:

During 2007, 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 2007 Accomplishments:

1. Zearalenone (ZEN) an estrogenic mycotoxin produced by Fusarium fungi has broad potential to contaminate many cereal crops. ARS scientists at Peoria, IL developed a capillary electrophoresis (CE) method for detecting ZEN using cyclodextrins. The cyclic

oligosaccharide enhanced the fluorescence of ZEN, which permitted the development of the assay with vastly improved sensitivity.

Impact: The new technology permits the detection of ZEN at 5 parts per billion (ppb), a level well-suited for testing by both industry and regulatory agencies for compliance with the European Union guideline of 50 ppb.

2. The California almond industry, which is the largest supplier of almonds in the world, has been affected by two international and one national outbreak of salmonellosis linked to raw almonds. Propylene oxide (PPO) is the only effective dry treatment to decontaminate raw kernels, but these treated kernels cannot be exported to foreign countries due to a lack of standards about PPO residue levels in the product. ARS scientists at Albany, CA developed an infrared heat-based technology that is at least as efficacious as fumigation in decontamination of raw kernels and involves a one-hour instead of a five-day process, to achieve a reduction of over 99.99999% in Salmonella levels per kernel.
Impact: The Almond Board of California presently mandates a 99.99% reduction and consequently has shown considerable interest to commercially develop this non-chemical intervention process
3. Fungal infection of crop plants poses a major problem to agricultural productivity, quality of agricultural products and food safety resulting from toxins that certain fungi produce. Additionally, certain fungi are significant human pathogens, whose infection can lead to serious debilitation or death. ARS scientists at Albany, CA have identified a number of safe, natural products that can significantly enhance the effectiveness of commercial fungicides, such as strobilurin and fludioxonil. These compounds weaken the ability of the fungi to build their cell walls or to respire normally. Once weakened by this "chemo-sensitization" the commercial products can be 1000 fold more effective. In collaboration with scientists at the University of Texas and the Institute of Hygiene and Tropical Medicine, Lisbon, Portugal, chemo-sensitization was also found to be effective against a number of human pathogenic fungi, when using the antifungal drugs, itraconazole or fluconazole
Impact: Chemo-sensitization has significant potential in agriculture and medicine to help reduce environmental impact and costs of using fungicides and preventing or overcoming resistance.

Indicator 3:

During 2007, 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 2007 Accomplishments:

1. A prerequisite to the use of microbial biosensors is the development of a microbiological medium that enhances and allows selective growth of each targeted pathogen. ARS scientists in collaboration with Purdue University developed a selective broth for the simultaneous enrichment of Salmonella spp., E. coli O157:H7 and L. monocytogenes (SEL). SEL was evaluated for its suitability to recover pathogens from inoculated ready-to-eat (RTE) meats. The performance of SEL was comparable with the Universal Pre-enrichment Broth (UPB, a commercial multiplex medium. Moreover, SEL was able to inhibit the growth of food associated spoilage or natural contaminants while UPB failed to do so.
Impact: These results indicate that SEL can be used as a single selective enrichment medium for the growth of multiple target pathogens critical to industry and regulatory agencies.

2. There is a need for rapid, sensitive assays for biothreat agents that can be used to detect intentionally contaminated foods, without the use of animal bioassay. ARS scientists at Albany, CA designed new monoclonal antibodies for type A botulinum neurotoxin and ricin, and then used them to develop new immunoassay with sufficient sensitivity to detect subtoxic levels of these toxins in various food matrices. The new antibodies have very high sensitivity, equivalent to the mouse bioassay, while others were found to protect mice from the effects of the toxins.
Impact: The availability of new test-tube assays with sufficient sensitivity to detect subtoxic levels in food matrices will help maintain the security and safety of the U.S. food supply. New protective antibodies could prove useful in treating victims exposed to these toxins.
3. Bones in boneless poultry filets are still one of the largest food safety issues affecting the poultry industry. ARS scientists in Athens, GA developed an on-line imaging system to detect bones in breast filets. The technology requires images of both sides of the filets and for the filet to be compressed to a uniform thickness, which can be accomplished with a forming machine.
Impact: This technology which can be readily implemented has a critical impact for processors providing filets for the USDA school lunch program.
4. Fluoroquinolones have recently been banned for use in chickens in the United States. The regulatory tolerance level, which had been set for enrofloxacin in chicken muscle, no longer applies, thus analytical methods for fluoroquinolones need to achieve lower detection limits. Further, the marker matrix for analysis of chicken is no longer limited to muscle. Using animal serum, ARS scientists at Wyndmoor, PA developed a liquid chromatography-fluorescence-tandem mass spectrometry method to easily detect 8 fluoroquinolones with good recoveries and low limits of detection. Enrofloxacin and its metabolite, ciprofloxacin were also detected in enrofloxacin-dosed animals for at least 2 days after withdrawal from dosing.
Impact: Serum is a much easier matrix to work with than muscle and the success of this method indicates a significant potential savings of time and effort in monitoring chickens for fluoroquinolones by the USDA Food Safety Inspection Service in their regulatory role.
5. The impact of contaminated animal feed ingredients on food safety and animal health has recently become a major public concern. Scientists at the Food Safety Laboratory, Beltsville, MD developed a rapid and nondestructive detection/identification method for melamine contamination based on Raman spectroscopic techniques. Dominant Raman peaks (676 and 702 cm⁻¹) in the melamine-tainted feed/food mixtures originate from the specific triazine ring of melamine (2,4,6-triamino-1,3,5-triazine). The methods also allow the detection of other triazine derivatives (such as cyanuric acid, 2,4,6-trihydroxy-1,3,5-triazine) purposely added into feed and foods.
Impact: The characteristic Raman peaks can be used to screen for the presence of melamine and its derivatives, in food and feed by industry and regulatory agencies in particular the FDA.

Indicator 4:

During 2007, 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 2007 Accomplishments:

1. The presence of *L. monocytogenes* in food products is strictly regulated by Federal agencies. ARS scientists at Wyndmoor, PA evaluated the effectiveness of the Sprayed Lethality in Container method in combination with the antimicrobial lauric arginate (LAE) to lower the levels of *L. monocytogenes* on the surface of frankfurters, roast beef and turkey breast logs. The results showed the intervention significantly reduced pathogen levels within 24 h at 4°C.
Impact: The application of LAE as a post-process intervention should assist ready-to-eat food manufacturers in achieving the USDA/FSIS alternative 2 status.
2. Studies in mammals have shown that tissues such as adipose and skin are major depots for persistent polybrominated diphenyl ethers (PBDE's). Cooked chicken skin is a commonly consumed product. ARS conducted an adsorption, tissue disposition, metabolism and excretion study with the most persistent PBDE found in the environment, that is, 2,2',4,4'-tetrabromodiphenyl ether (BDE-47). Results demonstrated that BDE-47 was well absorbed by the chicken, was not readily metabolized (<1% of the dose), and was mainly distributed to adipose tissue and skin. The data showed that the behavior of BDE-47 in chickens was similar to that observed in mammals.
Impact: Reduce human exposure to PBDEs from chicken consumption, by trimming the skin and fat before cooking.
3. Broilers are traditionally chilled using chlorinated ice-water. This is a significant trade issue especially with countries in the European Union who do not allow importation of chicken meat processed in this manner. Air chilled meats are however allowed to be imported. ARS scientists at Athens, GA conducted comparative studies to determine the efficacy of dry air versus traditional immersion chilling of broiler carcasses. Studies indicated that the numbers of bacteria found on dry air and immersion chilled chickens were the same, with a reduction of pathogen levels by over 90%. Chilling method did not affect prevalence, or the number of *Campylobacter* or *Salmonella* positive carcasses.
Impact: Implementation of air chilling by industry would provide increased opportunity for trade with equivalent control of pathogen levels to immersion chilling.
4. Breaches to the security of our Nation's food supply may arise due to the addition of threat agents such as *Bacillus anthracis* (BA) to high risk foods such as milk. ARS scientists at Wyndmoor, PA developed an intervention strategy using microfiltration technology to eliminate BA spores in bulk, fluid milk. The research established that microfiltration of milk prior to pasteurization had the ability to remove greater than 99.9999% of BA spores while maintaining the quality of milk.
Impact: The addition of a microfiltration step by industry, in conjunction with an ultrapasteurization step for the retentate, will lessen the likelihood that pathogenic bacteria and/or their spores will contaminate the milk supply
5. Internalized human pathogens are protected from surface treatments such as chlorine-based washes. To test a more penetrating process (irradiation), *E. coli* O157:H7 was inoculated to the interior leaf tissues of baby spinach and five different types of lettuce (Romaine, Green leaf, Red leaf, Iceberg and Boston). Chlorine wash treatments applied to these leaves were minimally effective, with 600ppm treatment yielding only a 90% reduction.
Impact: Depending on the type of leafy green examined, irradiation reduced pathogen populations by 99.9 to 99.999% at the highest dose tested (1.5kGy). Irradiation is shown to be effective in reducing risk associated with human pathogens on leafy greens, even when these pathogens are internalized.

Indicator 5:

During 2007, 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 2007 Accomplishments:

1. The CDC PulseNet Task Force requested the development and validation of DNA sequence-based methods for subtyping *L. monocytogenes* for use in outbreak detection and epidemiological investigations. In addition, the recent *L. monocytogenes* risk assessment completed by the FDA, FSIS, and CDC identified significant gaps in knowledge regarding subtype prevalence and cited as critical, the need for methods to determine the virulence potential of individual strains as FSIS transitions to a risk-based monitoring program. In response, ARS scientists at Peoria, IL developed and validated the first single-nucleotide-polymorphism-based subtyping assay for the group of *L. monocytogenes* strains most commonly associated with human illness. Studies demonstrated that the multi-locus genotyping (MLGT) assay provided high discriminatory power and differentiated groups relevant to epidemiological investigations. In addition, the technology provided for the identification of specific virulence-attenuated subtypes, and could be used to document epidemic and virulence-attenuated subtypes in ready-to-eat meat products.
Impact: Implementation of this technology by regulatory agencies will have significant impact on monitoring public health and development of threat-based risk assessment programs.
2. The whole genome sequencing of the aflatoxin producing fungus *A. flavus* has been completed, and has opened up many avenues for defining the role of specific fungal genes in aflatoxin production, particularly the ones that are activated during the exposure of the fungus to stress conditions leading to aflatoxin contamination of the host plant. Successfully microarray studies identified many genes that may play a critical role in the fungal response to, for example, antioxidants from walnut shells. In addition, defining the expression profile of genes related to aflatoxin biosynthesis in *A. flavus*, the involvement of antioxidant enzymes has been shown. The yeast system of *Saccharomyces cerevisiae* has been used as a model organism for understanding the cellular responses to treatment with oxidant and antioxidant compounds, attempting to establish a relationship of these reactions and secondary metabolism.
Impact: The specific role of the genes of interest is currently being determined using gene knockout techniques. The ultimate goal is to develop breeds of crops with traits that interfere with the processes that induce aflatoxin formation, such as oxidative stress.
3. Identification of differential gene content and protein expression of *C. jejuni* isolates demonstrated to differentially colonize chickens. The identification of genes and gene products involved in *Campylobacter* spp. colonization of chickens is necessary for the development of intervention strategies aimed at the reduction or elimination of *Campylobacter* spp. in poultry. Therefore, suppressive subtractive hybridization and microarray hybridization were used to determine gene content of two *C. jejuni* isolates with different abilities for chicken colonization. Additionally, differences in protein expression was investigated using 2-dimensional gel electrophoresis. It was determined that a variety of genes and proteins expressed by the good chicken colonizing *C. jejuni* isolate were not present in the poor colonizing isolate. A majority of these genes were located in areas of the *C. jejuni* genome previously determined to be hyper-variable
Impact: Interventions can be developed that disrupt specific biological functions of *C. jejuni*, such as attachment of the bacteria to chicken gastrointestinal cells, these bacteria could be reduced in chickens prior to processing for human consumption.
4. The use of raw meat in the manufacturing of fermented dry and semidry sausage may introduce *L. monocytogenes* and *Salmonella* spp into the finished product. Understanding the survivability of both pathogens in sausage during the manufacturing processes allows processing/product parameters be selected to minimize the presence of both pathogens in finished products. Studies conducted to collect the inactivation data of *L. monocytogenes*

and *S. typhimurium* in sausage were completed. Models were developed to describe the rates of inactivation of both pathogens during sausage manufacturing.

Impact: The results will be used by the manufacturers to determine the process/product parameters to meet the food safety requirement.

5. Food safety managers currently lack the ability to predict the microbial pathogen transfer in slicing operation for ready-to-eat foods. Models were developed for pathogen transfer prediction during mechanical slicing for RTE deli meats. Predictive models will be useful in developing HACCP plans and in risk assessment development for ready-to-eat meats.

Impact: Understanding the surface transfer, the production or retail (Franchise) equipment and operations for RTE deli meat may be further improved and therefore, reduce the possibility of outbreaks.

4.1.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2007:

During FY 2007, ARS reported on five 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.

1	Describe the Technology	Clostridium botulinum neurotoxins are the most toxic molecules known. Although the toxins are produced as a result of spoilage of certain food products, they have also been associated with use as a biological weapon for mass destruction.
	Describe the Transfer	Developed and validated a new test immunological based assay for the detection of Clostridium botulinum neurotoxin contamination in the food supply.
	Identify the Customer	FSIS, FDA, DHS, FBI, industry, public health and defense agencies in other countries.
	Describe the Impact	Determined that the new test is rapid, cost effective, and has a sensitivity and specificity greater than the currently used non-biological and biological (mouse) assays for the detection of Clostridium botulinum Type A neurotoxin. The antibodies produced could also be used in the treatment of exposed victims.
2	Describe the Technology	Ricin is a plant toxin produced by castor oil trees. The toxin has also been used as a biological weapon of mass destruction, and is a focus of major concern by security agencies worldwide due to its easy purification.
	Describe the Transfer	Developed and validated a new test immunological based assay for the detection of Ricin contamination in the food supply.
	Identify the Customer	FSIS., FDA, DHS, FBI, CIA, defense agencies in other countries.
	Describe the Impact	Determined that the new test is rapid, cost effective, and has a sensitivity and specificity greater than the currently used non-biological and biological (mouse) assays for the detection of Ricin. The antibodies produced could also be used in the treatment of exposed victims.
3	Describe the Technology	Zearalenone (ZEN) an estrogenic mycotoxin produced by Fusarium fungi has broad potential to contaminate many cereal crops.
	Describe the Transfer	Developed a capillary electrophoresis (CE) method for detecting ZEN using cyclodextrins.
	Identify the Customer	Industry and Federal regulatory agencies in particular the FDA and USDA.

STRATEGIC GOAL 5

	Describe the Impact	The new technology using cyclic oligosaccharide to enhance the fluorescence of ZEN permitted the development of the assay with vastly improved sensitivity to a detection level of 5 ppb. This will greatly assist with compliance guidelines for trading partners such as the European Union.
4	Describe the Technology	Developed and validated a decontamination technology for the reduction of Salmonella in raw almonds.
	Describe the Transfer	Developed an infrared heat-based technology that is at least as efficacious as fumigation in decontamination of raw kernels and involves a one-hour instead of a five-day process, to achieve a reduction of over 99.99999% in Salmonella levels per kernel.
	Identify the Customer	Producers of tree nuts, particularly almonds, and the associated commodity organizations for example the Almond Board of California.
	Describe the Impact	The California almond industry, which is the largest supplier of almonds in the world, has been affected by two international and one national outbreak of salmonellosis linked to raw almonds. Propylene oxide (PPO) is the only effective dry treatment to decontaminate raw kernels, but these treated kernels cannot be exported to foreign countries due to a lack of standards about PPO residue levels in the product. This new technology will decontaminate almonds better and more efficiently without leaving chemical residues.
5	Describe the Technology	Development and validation of a technology to determine if foods and feeds are contaminated with melamine and/or its derivatives.
	Describe the Transfer	Developed a rapid and nondestructive detection/identification method for melamine contamination based on Raman spectroscopic techniques. Dominant Raman peaks (676 and 702 cm^{-1}) in the melamine-tainted feed/food mixtures originate from the specific triazine ring of melamine (2,4,6-triamino-1,3,5-triazine). Hence, the method also allows detection and identification of other triazine derivatives (such as cyanuric acid, 2,4,6-trihydroxy-1,3,5-triazine).
	Identify the Customer	Food and feed producers, industry, and Federal agencies in particular the FDA and FSIS that regulate the international importation of food and feed.
	Describe the Impact	Rapid identification of melamine and/or its derivatives is critical. The practice of adding "melamine scrap" to animal feed is reported to be widespread in China in order to give the appearance of increased protein content in animal feed. Melamine has also been purposely added as a binder to fish and livestock feed manufactured in the United States and traced to suppliers in Ohio and Colorado. The European Food Safety Authority suggests possible synergistic effects and combined toxicity of melamine and cyanuric acid especially in relation to the recently observed toxicity linked to the acute renal failure and death of pet animals.

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

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

Baseline 2005

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 2007, 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 2007 Accomplishments:

1. Marek's disease (MD) is perhaps the most insidious virus affecting the poultry industry. Significant success in the control of MD has been achieved through the use of vaccines that prevent tumor development (The first cancer vaccine ever developed). However, current vaccines do not block viral infection and spread. It is speculated that vaccine selection pressures have resulted in new highly virulent viral strains that have been reported to cause greater than 50 percent mortality in certain flocks. Continued reports of periodic MD outbreaks in vaccinated flocks all point to the need for new strategies to control this re-emerging viral disease. ARS scientists at the Southeast Poultry Research Laboratory (SEPRL) in Athens, Georgia, and the Avian Disease Oncology Lab (ADOL) in East Lansing, Michigan, completed a comparative genomic project involving 13 virus strains from five MD virus (MDV) pathotypes (very virulent plus, very virulent, virulent, mildly virulent and attenuated). It was discovered that attenuated strains (e.g., strains limited in their disease causing capacity and often used as vaccines) contain altered DNA structure and those specific changes in the DNA likely contribute to their inability to cause disease.

Impact: The identification and characterization of genetic changes (i.e., polymorphisms) within the viral genome of the 5 pathotypes increases our understanding of virulence, pathogenesis, and will lead to the development of improved vaccines.
2. The threat of an avian influenza outbreak is significant. Highly pathogenic avian influenza (HPAI) can result in up to 90 percent mortality in infected flocks. HPAI viruses impact international trade by inhibiting exports from an infected country. An outbreak of AI in the United States would devastate our poultry industry and curtail the availability of poultry meat. HPAI is also a potential zoonotic agent. The continued reports of H5N1 infections in humans in Asia has the public health community concerned that a worldwide pandemic is impending. The most effective way of controlling many zoonotic diseases is at the source (the so called host reservoir). Therefore, expending resources to control and eradicate an outbreak at this level is the best strategy for safeguarding public health and preventing a potential pandemic. ARS scientists at the Southeast Poultry Research Laboratory have been conducting studies in chickens to understand the mechanisms the virus uses to escape the immune protective responses of the host. The interferon response in chickens plays an important role in the control of avian influenza virus. Two variants of influenza, one that had a full length NS1 protein and the other with only a partial length NS1 protein, were compared and it was demonstrated that the virus with a short NS1 protein induced higher levels of interferon that

resulted in poor growth of the virus in chickens. The NS1 protein had previously been shown to be an important interferon blocker in mammals, but this study showed it has the same role in chickens and has expanded our understanding of the pathogenesis of the virus.

Impact: Understanding the immune response of chickens to avian influenza virus is important to help us better target vaccines for control of the disease.

3. The use of reverse genetics to make avian influenza viruses with a specific sequence has proven to be a valuable tool to examine how these viruses cause disease in poultry. From 1994 to 2006 low pathogenic H7N2 avian influenza viruses circulated in the live bird markets of the Northeast United States, and there has been considerable concern that these viruses might change or mutate to the virulent form of the virus. Using reverse genetics techniques, ARS scientists at the Southeast Poultry Research Laboratory have taken a representative H7N2 virus and genetically changed the virus to try and understand the minimum number of nucleotide changes needed for the virus to become virulent. The results of this study showed that the virus needed insertions of amino acids at a key site in the virus, the cleavage site, to become virulent, and simple mutations at the cleavage site by themselves would not make the virus virulent.

Impact: This study has improved our understanding of how avian influenza viruses become virulent and will help us understand risks of low pathogenic viruses changing to the highly pathogenic form in the future.

4. Paratuberculosis (Johne's disease) is a chronic wasting enteric disease of ruminants caused by infection with a bacterial pathogen designated as *Mycobacterium avium* subsp. *paratuberculosis*. Economic losses are estimated to be \$200/infected cow/year and are the result of animal culling, reduced milk production, poor reproductive performance, and reduced carcass value. Prevalence of Johne's disease in the U.S dairy cattle population is estimated to be 22-40 percent. This past year ARS scientists at the National Animal Disease Center in Ames, Iowa, have produced several novel monoclonal antibodies (highly specific antibodies engineered to bind to a very precise mark or "epitope" on an antigen) against *Mycobacterium avium* subsp. *paratuberculosis*. These antibodies have enabled scientist to follow disease progression as this bacterial pathogen infects its host and have opened up new areas of research in pathogenesis and diagnostic studies. Importantly, ARS have also identified antibodies produced in sheep infected with Johne's Disease that react to both a sheep protein and a protein produced by *Mycobacterium avium* subsp. *paratuberculosis*. This finding suggests that the host immune response may not be able to distinguish between self proteins and this bacterial pathogen.

Impact: This new information provides the first clues to the immunopathology observed in Johne's Disease, and suggest an autoimmune component to this disease.

5. In a collaborative project between an entomologist from the Mosquito and Fly Research Unit, Gainesville, FL, and an ARS research immunologist at the Southeast Regional Poultry Laboratory, Athens, GA, determined that house flies became infected with *Salmonella enterica* within 24 hours of being released into a room with infected chickens. Dissection of flies revealed presence of the pathogen on the surface and in the midgut but not in the crop or salivary glands. Healthy birds became infected by ingesting as few as five of these naturally-infected flies. The results provide evidence that flies may play a significant role in the movement and transmission of this important pathogen of poultry and humans.

Impact: Integrated pest management of flies at poultry houses is an important part of assuring food safety of poultry.

Indicator 2:

During 2007, 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 to improve risk assessment, surveillance, prevention, and control by veterinarians and entomologists.

FY 2007 Accomplishments:

1. Since 2002, H5N1 HPAI viruses have caused mortality in numerous species of wild aquatic birds in Asia and Europe. Some HPAI viruses cause severe disease in several species of wild ducks in experimental infections. In collaboration with the Southeastern Cooperative Wildlife Disease Center (University of Georgia), ARS scientists at the Southeast Poultry Research Laboratory evaluated five species of wild ducks intranasally inoculated with an Asian strain of H5N1 HPAI virus. The wood duck was from 2-4 times more susceptible to infection than chickens, the latter being highly susceptible to the virus. Mallards (*Anas platyrhynchos*), northern pintails (*Anas acuta*), blue-wing teals (*Anas crecca*), and redheads (*Aythya americana*) were less sensitive to infection, produced virus in low concentrations for short periods of time, and did not exhibit clinical signs.
Impact: These data suggest that the wood duck would represent a sensitive indicator species for H5N1 HPAI should it enter North America.

2. Wild birds, especially ducks and shorebirds, are reservoirs of Avian Influenza (AI) viruses. Excrement and respiratory fluids from infected birds are the most important source of Avian Influenza virus. Virus shedding can be detected as early as 1 day post infection in poultry and may continue for up to 4 weeks in a population of birds. Comparison of the innate immune response in chickens and ducks to H5N1 avian influenza show a markedly different response between species. The innate immune response is responsible for detecting invading microorganisms during the initial stages of infection, which is a crucial determinant of disease resistance or susceptibility. ARS scientists at the Southeast Poultry Research Laboratory have been conducting studies to examine the role of the innate immune response in protection from disease by measuring cytokine (factors that modulate the immune response) expression immediately following infection. The results indicate differential cytokine expression between chickens and ducks following exposure with H5N1 viruses recovered from Southeast Asia. Ducks generally displayed increased cytokine expression and resistance to challenge, while chickens exhibit decreased cytokine expression.
Impact: These studies emphasize the importance of innate immunity in birds and correlate increased pathogenicity of recent H5N1 viruses for wild waterfowl with an enhanced suppression of the host immune response.

3. The cattle fever tick, *Rhipicephalus (Boophilus) microplus* was eradicated from the United States by systematically dipping cattle and placing quarantines on infested pastures. Eradication is important because this tick is the sole vector of bovine babesiosis in the U.S.; therefore, elimination of the tick eliminates the threat of this important disease of cattle. One of the threats to programs designed to prevent the tick from being reintroduced on infested cattle from Mexico is the development of resistance to acaricides. The Knippling-Bushland U.S. Livestock Insects Research Laboratory (KBUSLIRL), Kerrville, Texas, made significant progress in understanding the origins of resistance and how to detect it. They found that the tick produces three kinds of acetylcholinesterase, the first such discovery in any arthropod. This implies that organophosphate acaricides have three potential enzymes to attack and also that the tick has some redundancy in its response to those acaricides. The KBUSLIRL also developed a rapid DNA-based assay to detect gene mutations that change octopamine receptors, which are the targets of formamidine acaricides. Finally, ARS scientists examined the sensitivity of commonly used bioassays to show that some do not provide useful information for documentation of resistance or susceptibility.
Impact: Cattle producers in southern Texas will be able to determine whether or not cattle fever ticks are resistant to acaricides, informing them whether the infestation is due to reintroduction, inadequate dipping procedures, or acaricide resistance.

4. The Mosquito and Fly Research Unit, Gainesville, FL, has made progress in developing general guidelines for detection of mosquitoes in the U.S. One of the challenges is to know whether or not a mosquito has expanded its range. Another is simply to understand where mosquito species occur and how abundant they are at each location. Unbiased estimators

are needed to acquire data that can be used to understand and forecast mosquito distributions in time and space and to reliably predict mosquito-borne disease transmission risk. The mechanical traps presently used to monitor mosquito populations for this purpose provide biased estimates of mosquito density. We have developed a family of preliminary statistical models that explain the relationship between capture rates of adult mosquitoes by mechanical traps and the rate of landing by adult mosquitoes on a human subject. The models allow us to infer mosquito attack rates from mechanical trap data. This capacity is critical to the development of reliable methods for assessing disease transmission risk and for the timely implementation of vector controls that would allow preemption of epizootics/epidemics of mosquito-transmitted disease. Another approach is to use indirect indicators of mosquito abundance to estimate regional susceptibility to infestation and to predict abundance. MFRU has worked identified correlation of indicators from remote sensing (satellite imagery) with actual trap counts in the U.S. This work has been applied more specifically to the problem of detection at seaports. With the assistance of local, state, and federal officials, a pilot study site has been identified at the Ports of Charleston, SC and historical mosquito activity data for the Port area are being analyzed. The required permissions necessary to sample arriving vessels, berth areas, and the dockside environment for exotic mosquito vectors and the pathogens they may be carrying are being obtained.

Impact: The methods and techniques developed in this study will enable surveillance for exotic mosquito species in seaport environments throughout the continental U.S. and will facilitate the detection, containment, and local eradication of exotic and/or invasive mosquito vectors upon arrival in the USA.

5. The Biological Control of Pests Research Unit, Stoneville, MS, examined the shape and infrared signature of fire ant mounds in detail in order to be able to detect them from aerial photographs. They also developed a new and simpler method for distinguishing red and black imported fire ants, as well as their hybrids.

Impact: Nurserymen, ranchers, and growers in the south central U.S. will be able to determine the extent of their fire ant problems, allowing them to budget for the right amount of insecticide and other control measures.

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 2007, ARS will form new partnerships and continue old partnerships with industry, universities, and other government agencies in order to promote production and marketing of new methods for detection and identification of animal pathogens, arthropods that transmit pathogens, and arthropods that destroy property; including genetic markers, new methods of detecting gene sequences or antibodies or proteins, and comprehensive guides to morphological identification.

FY 2007 Accomplishments:

1. Newcastle disease (ND) is an infection of birds caused by a virulent Newcastle disease virus (vNDV) and is a worldwide problem for poultry production. The virulent form of the disease, called exotic ND (END) in the U.S, has been eradicated from U.S poultry. Recent analysis of genomic sequences has revealed the existence of two distinct clades: class I and II. Class I isolates have primarily been recovered from waterfowl and are generally attenuated in poultry. The class II NDV comprise the vast majority of vNDV and include isolates recovered from poultry, pet, and wild bird viruses. Current weaknesses in the USDA standard real time (r) reverse transcriptase polymerase chain reaction (RT-PCR) assay to detect class I viruses, suggests that viral transmission could occur unnoticed among wild birds and poultry. While it is impossible to predict which genotypes represent the most significant threat to the U.S poultry industry, the geographic proximity of vNDV and the large volume of commerce and travel with Mexico and countries of Southeast Asia, suggest that further evaluation of the efficacy of current U.S vaccines and diagnostic assays on emerging viruses are needed. ARS scientists at the Southeast Poultry Research Laboratory have developed an alternative rRT-PCR test. Phylogenetic analysis and preliminary rRT-PCR tests suggest that the newly developed assay can detect a majority of class I isolates from the U.S.
Impact: This test will enable the surveillance of Class I viruses and help identify the genotypes of viruses with the potential to acquire virulence upon replication in poultry, an important step in improving our capacity to prevent future outbreaks.

2. Research progress continues at the Arthropod-Borne Animal Diseases Research Laboratory, Laramie, WY, on the development of improved diagnostics for arboviruses. Scientists optimized a method for measuring the amount of bluetongue virus (BTV) in *Culicoides* cell culture, a capability that will improve the chances for early detection of exotic serotypes of BTV. A very sensitive method for detection of BTV RNA using markers that fluoresce in the infrared light range was applied to detection of epizootic hemorrhagic disease virus (EHDV), an important pathogen on deer farms. Solid phase detection of RNA developed in collaboration with an industrial partner may provide even more sensitive and quick methods for detection of these viruses. Sequencing of the genomes of BTV and EHDV is providing new targets for viral detection.
Impact: Ranchers will be able to determine whether or not their herds include infected animals and also evaluate the risk of infection from measurements of biting flies.

3. In response to a request by U.S. Navy personnel, a comparison was made by the Mosquito and Fly Research Unit, Gainesville, FL, of nine commercial fly traps, including the only trap ("Flies-be-gone") that currently has a national stock number (NSN). The "Flies-be-gone" trap only collected 7% as many house flies and 16% as many blow flies as the most attractive commercial trap (Farnam's "Terminator") studied. In a follow-up study in July 2007 that evaluated the relative contributions of trap geometry and attractants to fly collection, the "Flies-be-gone" trap did not collect as many flies as the "Terminator," regardless of the attractant used.
Impact: Results of this study will help guide future decisions as to which traps are most effective in collecting flies and provide the best value for the US military.

Indicator 2:

During 2007, 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 2007 Accomplishment:

1. Mosquito-borne diseases pose a significant threat to the health of animals and people. One of these diseases, Rift Valley fever (RVF), causes high mortality and abortion in domestic animals, and significant fever, meningoencephalitis, hemorrhage and mortality in humans. To prevent potential introduction of this disease into the United States, it is important that we detect and respond to outbreaks in natural settings in Africa and the Middle East. Scientists at the Mosquito and Fly Research Unit, Center for Medical, Agricultural and Veterinary Entomology in Gainesville, FL, have discovered a method, using global and local climate and vegetation development information, to forecast this disease well before it occurs. In late-2006, an early warning of an impending RVF outbreak was issued to national and international agricultural and public health officials 3 months before a large outbreak occurred in four countries in the Horn of Africa. This outbreak affected thousands of people and hundreds of thousands of domestic animals; dramatically impacting the economy of these countries. This alert resulted in increased national and international surveillance and dramatically enhanced the RVF control response for the first time in history; reducing the impact of the disease and protecting other countries from becoming affected by the disease.
Impact: This research product will become the standard model for predicting RVF and will be used as a template for new research to develop similar models for the United States for other important mosquito-borne diseases

Indicator 3:

During 2007, ARS will form new partnerships and continue old partnerships with industry, universities, and other government agencies in order to promote production and marketing of inventions that protect animals from pathogens or manage arthropods that transmit pathogens or damage property.

FY 2007 Accomplishments:

1. Classical Swine Fever Virus (CSFV) is a highly infectious disease of pigs that results in high rates of mortality and morbidity. CSFV is a significant foreign animal disease threat to the U.S national pork industry. Recent outbreaks in Western Europe have shown that there are critical gaps in the countermeasures available to control this disease. Critical needs include highly effective vaccines that can provide rapid protection, stop the transmission of the virus, and engineered so that infected pigs can be differentiated from vaccinated pigs. ARS scientists at the Plum Island Animal Disease Center are conducting molecular virology studies in secure biocontainment facilities to understand the mechanisms of CSF viral pathogenesis, which is a vital step on the path to vaccine discovery. The results of these studies have shown that CSFV contains in its envelope three heavily glycosylated (sugar-coated) proteins (E0, E1 and E2), which play a critical role in virulence and immune response. The major accomplishment of this project is the discovery, mapping and characterization of viral genetic determinants of virulence and the development of new vaccine strains. Specifically, the basic knowledge of the glycosylation patterns of CSFV structural proteins E0 and E2 has been determined along with their role in virus replication *in vitro* (in the test tube) and *in vivo* (in pigs).
Impact: Manipulation of the E2 glycosylation site has allowed the development of an experiment vaccine strain that has been shown to induce protection as early as 3-days post vaccination. The manipulation of the glycosylation sites also presents opportunities for developing negative marker attenuated vaccines able to induce early protection.
2. HPAI viruses can be present in the meat of infected poultry and poses a potential health risk. Research at the Southeast Poultry Research Laboratory previously showed that cooking was effective in killing an H5N1 HPAI virus. Two additional HPAI viruses (H5N2 Pennsylvania/83 and H5N2 Texas/04) were tested for thermal inactivation in naturally or artificially infected meat. Cooking at 70°C or 73.9°C (165°F) were effective at killing the viruses in less than 1 minute.
Impact: This study further demonstrates that proper cooking of poultry using the USDA Food Safety Inspection Service (FSIS) salmonella standards would be effective at killing HPAI viruses.

3. The emergence of bacteria resistant to antibiotics poses a significant threat to animal and human health. There is growing concern that the use of antibiotics in animal production can result in the emergence of resistant bacteria that cause human infections that are difficult to treat. With the continued concern over the use of antibiotics in poultry production, there is a real need to find safe and practical alternatives in poultry production to both prevent and treat poultry diseases. ARS scientists at the Poultry Production and Product Safety Research Unit, Fayetteville, AR, are evaluating the efficacy of bacteriophage to be used as an alternative to antibiotics to prevent and treat bacterial respiratory diseases of poultry. Bacteriophage therapy has the potential as a safe and environmentally benign alternative to antibiotics. One of the concerns with using bacteriophage to treat bacterial infections in animals and humans is that the animal could respond to the bacteriophage treatment by producing antibodies to the bacteriophage, which would limit the efficacy of repeated treatment of chronic bacterial infections. ARS scientists have determined that poultry mount an immunological response to bacteriophage that reduces bacteriophage efficacy by approximately 50 percent. However, ARS scientists have developed an *in vitro* assay to determine if bacteriophage will induce an immune response that will compromise bacteriophage efficacy.

Impact: Development of an assay that can be used in both animal and human clinical laboratories to customize bacteriophage treatment of bacterial infections.

4. Scientists at the Knippling-Bushland U.S. Livestock Insect Research Laboratory, Kerrville, TX, showed that cattle fever ticks resistant to either permethrin (a pyrethroid acaricide) or amitraz (a formamidine acaricide) were sensitive to a combination of the two chemicals. Use of a mixture of acaricides on cattle may provide the means to control tick populations that are currently resistant. What is more, mixtures may have the effect of reversing resistance in the population.

The mixture of acaricides is a tool for managing acaricide resistance in the cattle fever tick.

5. The Coordination of National Termite Management Program, New Orleans, LA, was started to address the problem of Formosan subterranean termite (FST) infestation in the French Quarter of New Orleans. This historical area of the U.S. contains many 18th and 19th century buildings of considerable cultural importance, but the importation of the invasive FST threatened them with destruction. The program has used a combination of monitoring and gradual, systematic expansion to target control efforts effectively. Some of the control and surveillance techniques have been developed as a part of this project. As of July 2007, 95% of the original colonies of FST in the treated portion of the French Quarter had been destroyed. The program has developed an extensive system of communication with the public, pest control operators, and municipal authorities in order to implement the trial control plan. Unfortunately, the FST continues to spread throughout the southeastern U.S.

Impact: As a model, the New Orleans program has produced lessons for expansion of area-wide pest management of the FST anywhere in the nation.

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

Baseline 2006

control. Biorationals have been studied and improvements explored that will provide additional protection for agriculturally important plants from pests and pathogens.

Target 2011

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

Indicator 1:

During 2007, ARS will develop methods to reduce emissions of harmful gases from crop production systems and post-harvest/quarantine treatments.

FY 2007 Accomplishments:

1. Minimizing fumigant emissions from strawberry fields becomes mandatory in California because strawberry production depends heavily on pre-plant soil fumigation that contributes to volatile organic compound (VOC) emissions. ARS scientists in Parlier, California conducted two large field trials in September-October 2006 on strawberry fields with raised beds in coastal areas of California to compare efficiency of plastic tarps. While results indicate that semi-impermeable films or virtually impermeable film films may reduce fumigant emissions, large variations were observed under field conditions.
Impact: The information is useful for identifying effective field methods to minimize fumigant emissions from strawberry production in non-attainment areas of California. [308]
2. Effective, economic, and environmentally safe field methods are needed to minimize fumigant emissions. Various surface seal, soil amendment with chemical (thiosulfate) or organic materials, and irrigation methods were compared to minimize fumigant emissions from shank-injection under field conditions. During studies conducted by ARS scientists in Parlier, California, the range of soil water content that most likely reduce emissions, but not affect efficacy, was determined in soil columns, and the effect of organic material incorporation in soils on fumigant degradation was tested in lab-incubation experiments. Results indicate that irrigation with sprinkler systems prior to fumigation can minimize emissions as effectively as post-fumigation water seals or tarp covers; and that soil amendment with organic materials may not necessarily reduce emissions depending on application methods.
Impact: The research provided essential information for evaluating soil and emission reduction methods currently considered in field experiments as well as for further research areas. [308]

Indicator 2:

During 2007, 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 2007 Accomplishment:

1. Cotton cultivars with host-plant resistance would provide the ideal means for controlling root-knot nematode, a major pest of cotton. But breeders require germplasm incorporating not only host-plant resistance, but also superior agronomic and fiber qualities. ARS researchers at Starkville, Mississippi, released six germplasm lines combining high levels of resistance to root-knot nematode with good agronomic and fiber properties.

Impact: Most of the major cotton seed breeding companies have already requested and received seed of these lines for use in their breeding programs. [301]

Indicator 3:

During 2007, 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 2007 Accomplishments:

1. The impact of delayed mating on total offspring is an important aspect of the effectiveness of mating disruption for control of lepidopteran pests. ARS scientists in Parlier, California, in collaboration with Paramount Farming Co., Bakersfield, California, showed that most navel orangeworm moths required at least 3 nights after adult emergence to mate under actual and simulated spring conditions. In contrast, under summer-like colony conditions the majority of moths mated the first night after emergence. These data and others showing greater longevity at lower temperatures indicate that mating disruption may have a greater impact on summer than spring generations of this pest.

Impact: This finding will improve the cost-effectiveness of mating disruption for control of this field pest, which is carried from the field into storage and threatens almonds, pistachios, and walnuts worth over \$3 billion per year. Improved control of this pest in the field would reduce fumigations targeted against this pest in these commodities. [308]

2. The ability to predict which almond orchards will experience navel orangeworm damage is important to effective integrated management of this pest. ARS scientists in Parlier, California, in collaboration with the Paramount Farming Co. and the Almond Board of California, compared the total navel orangeworm males and eggs captured in each flight with subsequent damage in the almond varieties 'Nonpareil' and 'Monterey'. Damage in 'Nonpareil' was significantly associated with total males captured in flights 1 and 2, whereas damage in 'Monterey' was significantly associated with total males captured in flight 3 and total eggs captured in flights 1 and 3.

Impact: This finding may reduce use of broad-spectrum insecticides while improving the control of this field pest of phytosanitary importance which threatens almonds worth over \$2 billion per year. [308]

3. Huanglongbing (HLB), also known as citrus greening, is the most serious, insect-transmitted disease of citrus and has become established in Florida. Control of citrus psyllid vector populations is a vital component of disease management. ARS scientists at Frederick, Maryland, determined the effect of imidacloprid insecticide on transmission of HLB. Following incorporation of the insecticide into sweet orange seedlings, infectious psyllids were aspirated on the seedlings and monitored for survival and disease transmission. Although most psyllids died within the first 24 hours, strong symptoms of HLB infection were evident by 8 weeks in most plants, indicating the insects could transmit the causal HLB bacterium before dying.

Impact: This research will provide fundamental information on insect transmission of HLB and contribute to our management and control programs. [303]

4. ARS scientists at Weslaco, Texas, working with scientists at Texas A&M University-Kingsville, used olfactometry and behavioral assays to determine that foliar odors are used during host-plant location by adult and immature glassy-winged sharpshooters (GWSS). The results indicated that GWSS response to visual cues is enhanced by exposure to olfactory cues. A subsequent study indicated that immature GWSS could learn to associate novel odors with the presence of host plants. Prior to these studies, virtually nothing was known about the possible role of olfactory cues in the host-plant searching behavior of GWSS.

Impact: An enhanced understanding of host-plant-finding behavior in GWSS will help in the development of management strategies, such as trap-cropping. [304]

5. Mass releases of sterile males are a widely used means to control pest fruit flies, but the radiation that sterilizes males often damages their sexual performance as well. Conditional-Lethality, where a male's offspring die when certain environmental conditions prevail, is a promising substitute for traditional sterility. A new gene was generated through mutation and fixed in four separate lines of the Caribbean fruit fly by ARS scientists from the Center for Medical, Agricultural and Veterinary Entomology, Insect Behavior and Biocontrol Research Unit in Gainesville, Florida. Flies carrying this gene die when temperatures exceed 30°C, so that males could be reared and released at lower temperatures, but their offspring would perish as the weather warmed.

Impact: Such conditional systems could improve the efficacy of control programs that protect US agriculture from the Mediterranean fruit fly and other potentially invasive pests. [304]

Indicator 4:

During 2007, 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.

1. ARS identified ecological systems most susceptible to invasion by the weed white sweetclover (*Melilotus alba*). Researchers demonstrated that white sweetclover in Alaska colonizes roadsides, other disturbed sites, and the floodplains of three glacially fed rivers. Through soil sample analysis, they showed that sweetclover prefers neutral to basic soils, upland soils are resistant to colonization by sweetclover, and river floodplains are highly susceptible. Further research indicated that sweetclover is negatively associated with several native species, suggesting that it may be affecting successional sequences on river floodplains.

Impact: Resource managers will be able to more efficiently control populations of sweetclover that could otherwise move into susceptible wetland habitats.

2. ARS conducted a preemptive assessment of the likelihood of successful introductions, probable pathways, and feasibility for detection and eradication of two aquatic weeds, water chestnut (*Trapa natans*), and oxygen weed (*Lagarosiphon major*), which are not yet in the Western United States, but are major weeds in other areas. The assessment revealed several potential points for blocking introduction pathways of the two target weeds.

Impact: This work was used by the California Department of Food and Agriculture to place these weeds in its highest priority ("A") category for monitoring and eradication. As a result, a pool of State, Federal, local agency, and expert contacts were identified to compose a Rapid Response Network Team in the event either species is detected. [304]

Indicator 5:

During 2007, 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.

1. Soybean rust, caused by *Phakopsora pachyrhizi*, is a devastating foliar disease of soybeans that has spread from Asia to Africa, South America, and the United States. Available genomic sequence data were mined by scientists at Frederick, Maryland, for simple sequence repeats, called microsatellites, to develop a set of molecular markers which could be used to distinguish individual isolates of the pathogen. Twenty-eight *P. pachyrhizi* isolates from 13 countries were surveyed using 24 microsatellite markers. Nineteen of these microsatellite markers were useful for assessing genetic variation and for distinguishing the isolates. Six *P. pachyrhizi* isolates collected from the initial outbreak of soybean rust in

Louisiana and Alabama, in November 2004, were included in the study and were shown to be genetically diverse. These six U.S. isolates also showed different levels of virulence when inoculated onto soybean accessions containing the four rust resistance genes Rpp1-4.

Impact: The microsatellite markers developed from this project can detect differences between *P. pachyrhizi* isolates and will be useful for population and genetic studies on this economically important pathogen. [303]

2. Yellow dwarf virus disease is caused by a collection of viruses, one of which is *Cereal Yellow Dwarf Virus* (CYDV). ARS researchers at West Lafayette, Indiana, have derived resistance to this virus from wheatgrass, a grassy relative of wheat. Working in partnership with Purdue University researchers, they have integrated a very high level of resistance to CYDV into commercial wheat varieties. Recent results have proven that this resistance is primarily due to a block in movement and also a reduced feeding ability of the aphid insect that carries this virus from plant to plant.

Impact: This combined resistance to the virus and the insect vector is extremely effective in the field. This resistance is now being used by wheat breeders worldwide because it is so effective and potentially durable. [303]

3. A new wheat stem rust mutant, called Ug99, has appeared in East Africa that threatens global production. Virulence of the disease-causing ability of stem rust strains collected in East Africa has been assessed. ARS researchers at the Cereal Disease Laboratory, St. Paul, Minnesota, determined that the Ug99 rust mutant can now overcome the wheat resistance gene, Sr24. The detection of Sr24 virulence is significant because this resistance gene is widely used in breeding of U.S. wheat, as well as many other major wheat production regions.

Impact: Accurate assessment of Ug99 virulence is critical for cereal breeders who are developing genetic resistance to the new African stem rust mutant. [303]

4.2.3 Summary of the Major Technologies Developed, Transferred, and Used in FY 2007:

During FY 2007, ARS reported two 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.

1	Describe the Technology	Combination treatments of pyrethrins or pyrethroids combined with an insect growth regulator, which are being applied as aerosols to control insect pests in flour mills and food warehouses, were shown to be active for 2-3 months.
	Describe the Transfer	Results of field trials were transferred to mill and warehouse managers through industry training sessions and industry meetings.
	Identify the Customer	The primary users of the technology are grain milling, storage, and processing industries.
	Describe the Impact	Results demonstrated that aerosols can be used in pest management programs to control stored-product insects pests, and can reduce the number and scope of fumigations with methyl bromide in grain milling, processing, and storage facilities.
2	Describe the Technology	A new reduced-risk insecticide, chlorfenapyr (Phantom®), which is registered for termites, was evaluated for control of stored-product beetles.
	Describe the Transfer	Efficacy data were transferred to BASF Corp. who petitioned the EPA to add stored-product beetles to the insecticide label.

Identify the Customer	The primary users of the technology are grain milling, storage, and processing industries.
Describe the Impact	Pest management professionals were provided with a new insecticide with minimal risk to mammals that could control stored-product beetles.

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 2007, 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 2007 Accomplishments:

1. Powdery mildew of hop is an economically limiting disease for producers. Fungicides commonly used for powdery mildew management increases populations of and damage by spider mites in numerous crops including hop, leading to increased use of pesticides. ARS scientists at Corvallis, Oregon, in collaboration with Washington State University researchers, identified powdery mildew management programs that enhance biological control of spider mite by natural enemies.
Impact: This discovery may allow growers to minimize pesticide use by enhancing the reliability of conservation biological control of spider mites, and result in optimized fungicide use, reduced input costs for producers, and enhanced environmental protection. [303]
2. The delivery of fungal biocontrol agents for Formosan subterranean termite (FST) control requires the use of a foaming agent that fills the termite feeding galleries without killing the fungal biocontrol agent. A biocompatible foaming agent composed of keratin, a major component of cattle hooves and chicken feathers, was identified by ARS Scientists in Peoria,

Illinois, and found to have foaming characteristics very similar to the chemical-based foam currently used to deliver chemicals to control termites.

Impact: This biocompatible foaming agent will allow the non-chemical, bioinsecticidal fungus *Paecilomyces fumosoroseus* to be effectively used for FST control in living trees and has the potential for use in other biocontrol situations where a biocompatible carrier is needed. [304]

3. The black vine weevil, *Otiorhynchus sulcatus* (Coleoptera: Curculionidae), is the most severe insect pest of the ornamental nursery industry in the Pacific Northwest. ARS scientists at Corvallis, Oregon, determined the long-term efficacy of the insect killing fungus, *Metarhizium anisopliae*, for control of *O. sulcatus* was determined. A granular formulation of the fungus was incorporated into media at potting and successfully persisted over two growing seasons providing high levels of insect control. This research was performed in collaboration with numerous nursery growers who currently struggle to manage this insect.
Impact: This microbial control agent will be available to the nursery industry in the spring of 2008. These data demonstrate to the Pacific Northwest nursery industry that this product can be expected to provide at least two growing seasons of effective *O. sulcatus* control when incorporated into media at potting. [304]

Indicator 2:

During 2007, 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 2007 Accomplishments:

1. Land managers are often reluctant to revegetate weed-infested rangeland because of the high costs and risk of failure. ARS developed two new methods for rehabilitating and restoring invasive weed-infested rangeland. The first is called "the one-pass system" which simultaneously applies all necessary treatments in a single entry for revegetating invasive plant infested rangeland. The second is called "island seeding" which attempts to establish small islands of seed sources throughout the landscape, from which managers promote their spread. Desired plants were successfully established in weed-infested rangeland each time island seeding has been tested. In the island seeding experiments, desired species became more abundant across the landscape within 3 years of creating the islands.
Impact: These two methods of rehabilitation are more cost-efficient than traditional multi-entry, multi-attempt strategies. Commercial "one-pass system" technology is being used in the field. Several land management agencies are establishing "islands" of desired vegetation across their weed infested landscapes. [304]
2. ARS discovered three species of Mediterranean insects affecting growth of giant cane, *Arundo donax*, a serious weed that chokes waterways, crowds out native plants, interferes with flood control, increases fire potential, and reduces habitat for wildlife in the Southwest. Insect colonies were shipped to the United States for evaluation in quarantine. Additional potential biological control agents for *A. donax* have been discovered from its native range in Europe. Two of these herbivore species have been imported to the United States established in culture at quarantine facilities in Texas where they are undergoing risk assessment.
Impact: Once established, these beneficial organisms will decrease weed biomass, allowing increased water availability, increased wildlife habitat, while decreasing illegal cross-border traffic as well as pesticide use. The Department of Homeland Security and border-enforcement agencies will benefit via reduction in illegal human and drug trafficking, and increased safety of officers. Enhanced habitat for native plants and wildlife will benefit local communities and organizations involved in restoration projects. Reduction in the use of

herbicides to manage giant cane will provide local communities with cleaner, safer water. [304]

Indicator 3:

During 2007, 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 2007 Accomplishments:

1. Squash vein yellowing virus (SqVYV), a novel pathogen was shown to be the cause of watermelon vine decline by scientists at Fort Pierce, Florida. Improved diagnostics for detection of SqVYV were developed during the current year's research.
Impact: This technology has been transferred to state regulatory and university diagnostic laboratories to facilitate SqVYV detection, and was used by ARS in the first report of SqVYV outside of Florida (in Indiana). [303]

2. By the time Botrytis fruit infections are detected visually, fruit quality has already suffered. ARS scientists in Geneva, New York, developed an early detection technology based on quantitative PCR to detect and monitor Botrytis infections up to 2 months prior to visual detection.
Impact: This ability to detect fungal infection prior to damage and secondary spread will enable growers to reduce the frequency of fungicide applications and specifically target applications when needed. [303]

4.2.4 Summary of the Major Technologies Developed, Transferred, and Used in FY 2007:

During FY 2007, ARS reported improved knowledge and understanding of the ecology, physiology, epidemiology, and molecular biology and genomics of endemic and emerging diseases and pest. Incorporate this knowledge into at least 2 management strategies that were developed and implemented to minimize chemical inputs and increase production.

1	Describe the Technology	In Spring 2005, blackberry rust (<i>Phragmidium violaceum</i>) was discovered on the Oregon coast and subsequently found distributed from Santa Cruz, California, into British Columbia, Canada, west of the Cascade and Sierra Nevada mountains. Several hundred acres of Evergreen blackberries suffered significant or complete crops loss in 2005. Knowledge on the epidemiology of Blackberry Rust was developed through collaborative research with Ken Johnson, Oregon State University. This information consisted of assessing the distribution of this introduced disease in the United States, understanding of the environmental conditions favorable for disease development, developing and testing various control strategies, and understanding the population diversity and relationship to potential sources of the introduced pathogen. This information was used to develop recommendations on when and what types of control should be used.
	Describe the Transfer	These recommendations were then transferred through numerous presentations to growers, consultants, and extension agents, and by helping consultants and extension agents develop Web sites and extension bulletins.
	Identify the Customer	The direct users of this information are blackberry growers within the Pacific Northwest, regulatory officials with APHIS, California, Oregon, and Washington Departments of Agriculture. Other users consist of land managers, nature conservatories, national parks, and the general public.
	Describe the	This research has resulted in reducing pesticide from four to six

STRATEGIC GOAL 5

Impact	recommended applications to one to two in most years. This research will also result in a disease forecasting model once testing of the model is complete.
2 Describe the Technology	ARS developed two new methods for rehabilitating and restoring invasive weed-infested rangeland. The first is called “the one-pass system” which simultaneously applies all necessary treatments in a single entry for revegetating invasive plant infested rangeland. The second is called “island seeding,” which attempts to establish small islands of seed sources throughout the landscape from which managers promote their spread.
Describe the Transfer	In cooperation with land management agencies, desired plants were successfully established in weed-infested rangeland.
Identify the Customer	Federal and state land managers and citizens.
Describe the Impact	In the island-seeding experiments, desired species became more abundant across the landscape within 3 years of creating the islands. These two methods of rehabilitation are more cost-efficient than traditional multi-entry, multi-attempt strategies. Commercial “one-pass system” technology is being used in the field. Several land management agencies are establishing “islands” of desired vegetation across their weed infested landscapes.

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 2007, ARS will continue to develop diagnostic assays to detect and differentiate existing, new and/or emerging quarantine arthropod pests, weeds, nematodes, and pathogens.

FY 2007 Accomplishment:

1. ARS completed the first studies explaining how the parasitic weeds known as dodders draw water and carbohydrate from the host and produce anatomical and biochemical changes. Using microscopic and immunocytochemical protocols, ARS showed that dodder hyphae (highly modified trichomes) detect host phloem and xylem cells and develop complementary structures that allow the parasite to draw both water and polysaccharides. Research showed that this is one of the few instances in higher plants where there is a cell-cell recognition phenomenon: the dodder is able to sense that a cell is xylem or phloem and then respond by producing the appropriate structure to draw nutrients from the host.
Impact: This information provides applied weed scientists with a potential avenue to disrupt cell-cell connections or to stop their formation, opening new potential avenues for control. [304]

Indicator 2:

During 2007, ARS will continue to expand interdisciplinary research to include means of excluding, managing and/or eradicating quarantine arthropod pests, weeds, nematodes and pathogens.

FY 2007 Accomplishments:

1. One of the disadvantages in employing baculoviruses as biological control agents for economically important pests is that it takes several days before it is known whether or not the insect is infected and by this time considerable crop damage could have occurred. This is due to the normally slow replication of most viruses in their hosts. A baculovirus was developed by ARS scientists in Columbia, Missouri, that fluoresces after the virus infects its host. Infection could be monitored by examining the caterpillar under UV light.
Impact: Detection of infected larvae could be demonstrated within 24 hours, providing a useful tool for pest managers to determine whether the virus application is effective. [304]
2. ARS identified management options and evaluated the potential yield losses associated with various weedy and weed-free intervals in cotton and peanut, including tropical spiderwort, yellow nutsedge, and Texas panicum, *Panicum texanum*. ARS used knowledge of the seasonality of spiderwort emergence to devise cropping systems that leverage the cotton canopy to suppress spiderwort growth. Researchers also quantified the losses in peanut caused by interference from yellow nutsedge, *Cyperus esculentus*, and Texas panicum, and developed treatment thresholds for both species.
Impact: Growers now plant cotton earlier in the season to minimize interference from late-emerging weed populations, which saves at least 30 percent in cotton yield losses at no additional cost.

Indicator 3:

During 2007, 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 2007 Accomplishment:

1. ARS identified the plant pathogenic fungi associated with root disease arising from herbivory of spotted and diffuse knapweed, *Centaurea maculosa* and *C. diffusa* by several root herbivores, and *Lepidium draba* by the candidate biological control agent *Ceutorhynchus assimilis*.
Impact: Based on the discovery of soilborne plant pathogens on foreign populations of the two knapweed species, scientists were provided with the means to investigate the enemy-release hypothesis by testing their susceptibility to the foreign pathogens. This research will permit the study of the microbial mechanisms that underlie the biological control potential of *C. assimilis* and exotic plant invasiveness. [304]

Indicator 4:

During 2007, 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.

1. The structurally conserved products of plant disease resistance genes can collectively mediate resistance to a diverse range of pathogens and suggest that plants may have evolved common resistance mechanisms. Scientists in the ARS Plant Gene Expression Center, Albany, California, used classical genetic and reverse genetic: virus induced gene-silencing (VIGS) approaches and identified several genes encoding components of the resistance signaling pathway. A caspase-like protease and a predicted lipase-domain containing protein were also identified.
Impact: These experiments will lead to an understanding of how a limited number of structural classes of resistance (R) proteins that cope with the potentially large array of diverse pathogens encountered by plants. [303]
2. While the infection process of the Fusarium head blight (FHB) pathogen on wheat heads has been studied under conditions of artificial inoculation and controlled conditions, little is known regarding whether results obtained under these conditions accurately reflect the field infection process. Colonization of wheat heads by an FHB antagonist patented by ARS scientists at Peoria, Illinois, *Cryptococcus flavescens* OH 182.9, under field conditions is also poorly understood. In a 2-year collaborative study between Peoria and researchers in Wooster, Ohio, irrigated, field-grown wheat infected by ascospore inoculum of *F. graminearum* naturally released within the field was studied using scanning electron microscopy to demonstrate that germ tubes from ascospores can enter stomates of the wheat head glume and lemma tissues within 3 days of flowering under field conditions. On irrigated and non-irrigated wheat grown under field conditions, the populations of *Cryptococcus flavescens* increased several orders of magnitude on wheat heads or recovered dramatically after natural rainfall events, respectively, indicating the high level of colonization competence of the antagonist.
Impact: These results clarify the infection process of the *F. graminearum* under field conditions and will assist the directed development of formulations that improved the effectiveness and consistency of biocontrol agents active against the pathogen. [303]

Indicator 5:

During 2007, ARS will support interagency collaboration for tracking successful exclusion, eradication where possible, and management of quarantine arthropods, weeds, nematodes, and pathogens

1. Pesticide manufacturers have little economic incentive to pursue pest control product registrations for specialty crops due to their low-acreage and the potential for liability due to the high crop value. The IR-4 program, a cooperative Federal-State-industry effort, designs and coordinates field-based research to generate the data needed to extend existing pesticide registrations to include one or more specialty crop. ARS established field trials to test 101 pesticide-food crop combinations and 275 pesticide-nursery and floral crop combinations in field trials at 7 locations. ARS also analyzed 175 pesticide/crop combinations in the laboratory for pesticide residues.
Impact: Using data from the field trials and laboratory analysis, ARS determined tolerances on 37 food crops and 23 pesticides, and contributed data toward the registration of uses for 73 floral and nursery crops and 33 pesticides that can be used by registrants to label for those uses. [304]

2. The potential and actual breeding hosts for tropical fruit flies determine the need for quarantine actions in both international and domestic trade. Currently, there are no international standards for correcting host lists or determining host status. ARS researchers at Weslaco, Texas, reviewed factors contributing to host specificity and host selection by fruit flies and compiled into an Annual Review of Entomology chapter. This review served as a guideline for studies of citrus (oranges, grapefruit), native *Sapotaceae*, and for reviews of experiments by trading partners to derive a standard method for examining resistance factors and how they affect infestation of commercial and wild fruit.
- Impact:** An experimental procedure with a supporting example for determining resistance factors was completed and a summary was presented to USDA Animal and Plant Health Inspection Service, Plant Protection and Quarantine, and International Services for establishing internationally standards for host lists and experimental determination of host status. [308]

4.2.5 Summary of the Major Technologies Developed, Transferred, and Used in FY 2007:

*During FY 2007, **During FY 2007**, ARS reported improved knowledge and understanding of quarantine pest and pathogen biology and epidemiology, leading to six 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.*

1	Describe the Technology	Pepino mosaic virus (PepMV) is an emerging disease in greenhouse tomato. The seed-borne nature of PepMV, coupled with easy mechanical transmission, make tomato seed a potential inoculum source. A sensitive molecular detection technique was developed, Real-time reverse transcription-polymerase chain reaction (RT-PCR), which would allow for an efficient detection of genetically diverse PepMV strains that exist. The Real-time RT-PCR was able to detect PepMV in one infested seed in 1,000. This level of sensitivity showed that the Real-time RT-PCR developed in the present study is useful for routine seed health assays. A major tomato germplasm core collection (109 accessions) was evaluated for its resistance against PepMV-US, a major type of PepMV in the United States, since there is no source of resistance available in tomato cultivars. Wild Solanum accessions were identified with tolerance and resistance to PepMV. A source of broad spectrum resistance to two major PepMV strains was identified that might provide a durable resistance that can be introgressed into tomato cultivars.
	Describe the Transfer	This information was provided to the scientific community, diagnostic clinics, and the greenhouse tomato industry through publications and personal communications.
	Identify the Customer	Diagnosticians, greenhouse tomato industry personnel, research scientists, breeders, and geneticists.
	Describe the Impact	This technology provides a highly sensitive method to detect and manage this important tomato virus, and prevent economic losses due to this disease.
2	Describe the Technology	Powdery mildew of hop is an economically limiting disease for producers. Fungicides commonly used for powdery mildew management increases populations of and damage by spider mites in numerous crops including hop, leading to increased use of pesticides. ARS scientists in Corvallis, Oregon, in collaboration with Washington State University, identified

STRATEGIC GOAL 5

		powdery mildew management programs that enhance biological control of spider mite by natural enemies. Management of spider mites on hops and other perennial crops were modified, and miticide usage can be reduced as a result of this research. New knowledge of processes associated with disruption of biological control of arthropod pests was developed. Integrated management strategies for powdery mildew that enhance conservation biological control were identified.
	Describe the Transfer	Preparation of a submitted peer-reviewed manuscript, face-to-face meetings with industry partners, and popular journal articles.
	Identify the Customer	Members of the hops industry, agrichemical companies, and farmers.
	Describe the Impact	This management strategy allows growers to minimize pesticide use by enhancing the reliability of conservation biological control of spider mites, and results in optimized fungicide use, reduced input costs for producers, and enhanced environmental protection.
3	Describe the Technology	ARS identified ecological systems most susceptible to invasion by the weed white sweetclover (<i>Melilotus alba</i>).
	Describe the Transfer	Researchers demonstrated that white sweetclover in Alaska colonizes roadsides, other disturbed sites, and the floodplains of three glacially fed rivers. Through soil sample analysis, they showed that sweetclover prefers neutral to basic soils, upland soils are resistant to colonization by sweetclover, and river floodplains are highly susceptible. Further research indicated that sweetclover is negatively associated with several native species, suggesting that it may be affecting successional sequences on river floodplains. These results were used by land managers to control and limit the spread of white sweetclover.
	Identify the Customer	Federal and State land managers and citizens.
	Describe the Impact	Resource managers more efficiently control populations of sweetclover that could otherwise move into susceptible wetland habitats.
4	Describe the Technology	A complex disease and insect problem, the <i>Phytophthora-Diaprepes</i> disease complex (PDC), has destroyed thousands of acres of Florida citrus. Two promising new hybrid citrus rootstocks with field tolerance to PDC and good fruit productivity were developed by the ARS citrus breeding program and released in 2007 for commercial use. These new rootstocks exhibit dramatic differences in their effects on fruit tree size, and thereby provide a wide range of management options for commercial producers.
	Describe the Transfer	Propagative material was released through the ARS plant variety release system. Field days were held for members of the citrus industry to evaluate the ARS breeding program.
	Identify the Customer	The Florida citrus industry members are in need of new resistant materials for production, in light of several new disease problems. Other citrus growing states will also have an interest in these rootstocks for their horticultural characteristics as well.
	Describe the Impact	The rootstocks US-802 and US-897 fill much-needed niches for vigorous and dwarfing rootstocks, respectively, with field tolerance to PDC. There is large commercial interest in these new citrus

		rootstocks in Florida.
5	Describe the Technology	Sclerotinia white mold disease results in \$10-15 million in lost revenue to pinto bean growers on an annual basis. Currently no commercial cultivars are resistant to white mold, and the application of foliar fungicides is cost-prohibitive. Thirty-four pea germplasm lines with resistance to white mold disease were identified from screening more than 500 accessions through ARS Prosser, Washington, in collaboration with researchers from Michigan State University and North Dakota State University, and with support from the ARS Sclerotinia Initiative. Those lines were bred the first pinto beans with partial resistance to white mold disease. Two high-yielding pinto bean lines were released with the first partial resistance to Sclerotinia.
	Describe the Transfer	The lines have been distributed to bean breeders across the United States for use in reducing the susceptibility of pinto bean cultivars to white mold. Release notices have been generated to the public.
	Identify the Customer	The new lines are being used by bean breeders across the United States to reduce susceptibility of pinto beans to white mold.
	Describe the Impact	Significantly fewer pesticides will be used, generating a cost savings for the producer and reduced environmental impact. The scientific community will benefit from this advance in breeding, since there is a national initiative aimed at basic and applied knowledge in the fungus Sclerotinia.
6	Describe the Technology	ARS conducted a preemptive assessment of the likelihood of successful introductions, probable pathways, and feasibility for detection and eradication of two aquatic weeds, water chestnut (<i>Trapa natans</i>) and oxygen weed (<i>Lagarosiphon major</i>), which are not yet in the Western United States, but are major weeds in other areas.
	Describe the Transfer	The assessment identified several potential points for blocking introduction pathways of the two target weeds.
	Identify the Customer	California Department of Food and Agriculture (CDFA)
	Describe the Impact	This work was used by CDFA to place these weeds in its highest priority ("A") category for monitoring and eradication. As a result, a pool of State, Federal, local agency, and expert contacts were identified to compose a Rapid Response Network Team in the event either species is detected.

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

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 2007, ARS will survey, release data on, and analyze national food consumption patterns of Americans.

FY 2007 Accomplishments:

1. Scientists at the ARS Center in Little Rock, Arkansas, found that children who skipped breakfast were less attentive and had slower visual cue response times than children who ate breakfast.
Impact: These findings suggest that breakfast facilitates brain and motor processes that are important for learning in school.
2. The *USDA/DHHS Dietary Guidelines for Americans* recommends 60 minutes of physical activity most days of the week for children. Scientists at the ARS Center in Houston, Texas, demonstrated that a controlled, moderate exercise training program without weight loss resulted in increased fitness, reduced fat accumulation in the abdomen and surrounding vital organs, and improved insulin sensitivity in obese adolescents.
Impact: This program can be adapted for use in schools and obesity clinics as a strategy to delay or reduce the risk of type-2 diabetes in children and adolescents.

3. Using data from the USDA “What We Eat in America/NHANES” national dietary survey, ARS scientists in Beltsville, Maryland, found that 80% of Americans consume breakfast on any given day.
Impact: On average breakfast was found to be proportionately lower in calories and higher in vitamins and minerals than other meals, demonstrating the importance of breakfast to the overall quality of American diets.

4. Scientists at the ARS Center in Houston, Texas, tracked the dietary intakes of middle-school children before and after enactment of the Texas Public School Nutrition Policy in 2004 that was designed to improve the nutrition of school children. Children consuming mostly foods from the National School Lunch Program (NSLP) had higher intakes of most nutrients, milk, fruit and vegetables, and lower intakes of sweetened beverages, snack chips, candy than students eating non-NSLP foods.
Impact: It is essential to document changes in eating behaviors in schools in order to support beneficial changes in the NSLP as well as a la carte food choices. Additionally, parents of minority students, at greater risk of obesity, were surveyed and found more likely to change dietary habits at home as a result of the altered school lunch policy.

Indicator 2:

During 2007, ARS will develop new methods, conduct food composition analyses, and compile databases for known, emerging, and new classes of nutrients.

FY 2007 Accomplishment:

1. Four new databases on nutrient content and dietary intake were released by ARS. These are summarized below as major technologies.
Impact: The primary product of this research is the unique, nationally representative information on nutrient content of the food supply and what Americans are eating in order to assess their food consumption in relation to dietary recommendations designed to maintain health and prevent chronic diseases.

5.2.1 Summary of the Major Technologies Developed, Transferred, and Used in FY 2007:

During FY 2007, ARS reported four 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.

1	Describe the Technology	Release 20 of the USDA National Nutrient Database for Standard Reference was compiled and released to the public. Up to 160 nutrients in over 7,500 foods are included.
	Describe the Transfer	The database is freely available and searchable on the ARS Web site. Downloadable versions are also available for use on personal computers and handheld personal digital assistants.
	Identify the Customer	This database is widely used by USDA’s REE and FNS agencies and by other Federal agencies such as FDA’s food labeling program. Individuals and health professionals make use of this information.
	Describe the Impact	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.

STRATEGIC GOAL 5

2	Describe the Technology	A Nutrient Data Set for Fresh Pork was released
	Describe the Transfer	This dataset was made freely available via the Internet.
	Identify the Customer	The primary user of this dataset is the pork industry.
	Describe the Impact	This dataset was updated both to reflect leaner cuts of pork now in commerce for labeling purposes and to assist the industry in preparing for proposed new labeling regulations issued by FSIS.
3	Describe the Technology	Release 2.1 of the USDA Flavonoid Content of Selected Foods database was compiled and released. A number of values were updated and 168 new foods were added.
	Describe the Transfer	This dataset was made freely available via the Internet.
	Identify the Customer	The primary users of this dataset are academic researchers. In addition, individuals interested in consuming more healthful diets can use this to select foods high in flavonoids.
	Describe the Impact	Research on health outcomes of consuming flavonoids has increased dramatically and having reference values is essential in relating consumption of fruit and vegetable sources of these compounds to health endpoints.
4	Describe the Technology	The MyPyramid Equivalent Database was compiled and released.
	Describe the Transfer	This dataset was made freely available via the Internet.
	Identify the Customer	The primary user of this database is the USDA Center for Nutrition Policy and Promotion.
	Describe the Impact	The database enables the conversion of USDA reference values to standardized servings of common foods on the MyPyramid Web site, enabling users to more accurately plan and analyze their diets.

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 2007, ARS will identify dietary and lifestyle intervention strategies to prevent obesity and promote healthy food choices and eating behaviors.

FY 2007 Accomplishments:

1. ARS Scientists in Boston, Massachusetts, reported on 6 and 12 month weight loss studies using diets high or low in glycemic load (rapidly digestible and absorbed carbohydrates) in overweight adults. Both groups lost similar amounts of weight and improved their risk factors for type 2 diabetes.
Impact: These results highlight the importance of preventing overweight or additional weight gain. Absolute weight loss was more important than the composition of the diet used to achieve that.
2. ARS researchers in Little Rock, Arkansas, used an animal model to find that obese females gave birth to normal weight offspring but the progeny were much more susceptible to becoming overweight in later life than offspring from normal weight mothers.
Impact: These results may partially explain the rapid increase in obesity seen in the U.S. over the last 30 years and afford the ability to test biological mechanisms and dietary interventions relatively quickly.
3. Scientists in Boston, Massachusetts, found in a study of more than 3,900 adults that eating a diet lower in glycemic index, or refined carbohydrate, was associated with lower risk of developing age-related macular degeneration, the leading cause of vision loss among the elderly.
Impact: These data contribute to the knowledge base upon which the dietary guideline to consume half of grains as whole (low glycemic index) grains is based.

Indicator 2:

During 2007, ARS will determine the functions, bioavailability, interactions, and requirements for known, emerging, and new classes of nutrients across the lifecycles.

FY 2007 Accomplishments:

1. ARS scientists in Boston, Massachusetts, noted a rise in colorectal cancer that coincided with the mandatory addition of folic acid to the food supply. This reversed a prolonged, slow decline in incidence of this type of cancer.
Impact: This observation is being followed up with folic acid analysis of 1,000 colon biopsies in people with or without cancer to determine if this association is truly cause and effect. Confirmation would cause a reassessment of federally-mandated fortification of wheat flour with folate.
2. A study of 617 people over 65 years old living in 33 nursing homes was conducted to determine if vitamin E supplements prevented pneumonia, one of the leading causes of death in this population. While vitamin E had small effects, subjects with normal blood zinc levels had decreased incidence (by almost half) and duration of pneumonia, needed fewer antibiotics, and had reduced total mortality. All of these reductions were statistically significant.
Impact: This study suggests that many elderly could benefit from diets higher in zinc and/or zinc supplements. This simple change could improve the health of many elderly.

STRATEGIC GOAL 5

3. Probiotics are helpful bacteria that live in the intestine. ARS scientists in Beltsville, Maryland, found that ingestion of these bacteria improved both intestinal immune function and the barrier function that keeps harmful bacteria from entering the body.
Impact: This research has potential to provide healthier dairy products that naturally contain probiotic bacteria. This product line is the fastest growing in the dairy segment.
4. ARS researchers in Houston, Texas, discovered that underweight women produced more arginine and more nitric oxide early in pregnancy compared with normal weight women but did not respond with the expected expansion of blood volume. These two compounds are regulators of many metabolic processes, including blood volume in the circulation.
Impact: These findings suggest that underweight women need more arginine and nitric oxide than normal weight women to maintain increased blood volume during pregnancy and this may be achieved by alterations in dietary precursors.

5.2.2. Summary of the Major Technologies Developed, Transferred, and Used in FY 2007:

During FY 2007, ARS reported three 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.

1	Describe the Technology	The IOM convened a workshop to engage research scientists and nutrition practitioners from government, academia, and industry, and others in discussion on issues related to knowledge gaps and research needs in developing and advancing the Dietary Reference Intakes (DRIs). Subsequent to the workshop, a report and a database of priority research questions on the DRIs were released.
	Describe the Transfer	The report and the database are available free via the Web or for purchase in hard copy from the National Academy Press.
	Identify the Customer	Primary users are federal agencies that rely on the DRIs, such as the USDA food assistance programs and the National School Lunch Program. Secondly, researchers at academic institutions will use this database to prioritize research on nutrients covered by the DRIs.
	Describe the Impact	Given the broad use of the DRIs, it is important that knowledge gaps and research needs be clearly articulated so that research addressing these gaps be proposed and funded.
2	Describe the Technology	The Institute of Medicine sponsored a workshop and report on Nutritional Risk Assessment. This approach is being promoted for the next revisions of Dietary Reference Intakes (DRIs) in contrast to previous versions of the DRIs.
	Describe the Transfer	The report was published by National Academy Press (NAP) and is available on the NAP Web site.
	Identify the Customer	Federal policy makers and academic nutritional researchers are the targets of this report.
	Describe the Impact	Since risk assessment is a new approach for nutrition, this workshop and report mark a turning point in the process of determining DRIs. This report framed the types of approaches needed if this will become the framework for future DRI

		assessments.
3	Describe the Technology	Modified MyPyramid for Older Adults was released by the ARS Human Nutrition Research Center on Aging at Tufts University.
	Describe the Transfer	The modified food guide pyramid was updated to reflect changes in the USDA MyPyramid and newer research on nutrition in older Americans. This was published in a peer-reviewed academic journal and is freely available on the Web.
	Identify the Customer	This will be used both by individuals wanting to improve their diets and by health professionals and researchers.
	Describe the Impact	The revised pyramid emphasizes physical activity and adequate fluid intake for older Americans as the basic recommendations. Nutrient dense food choices are stressed to provide nutrients that older Americans do not consume adequately, such as calcium, vitamin D and vitamin B12

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

Baseline 2003
Six research studies published in peer reviewed biomedical literature with the potential to strongly influence the field of human nutrition or have demonstrated impact through high citation rates.
Target 2011
Cumulatively, 30 new scientific papers will be published that generate high impact among the research community.

Indicator 1:

During FY 2007, ARS will publish new findings on metabolic processes that are affected by nutrient intake.

FY 2007 Accomplishments:

1. Although soy protein is allowed to carry an FDA-approved health claim for reducing risk of heart disease, the mechanism by which this occurs remains unknown. ARS scientists in Little Rock, Arkansas, discovered that components of soy protein reduced the circulating level of a normal protein, monocyte chemoattractant protein-1, in the blood of mice fed soy. This reduced the number of white blood cells attracted to blood vessels and atherosclerotic lesions in those animals.
Impact: These data suggest that soy foods inhibit an early event in development of vascular damage. In a climate in which the FDA is being criticized for allowing a health claim for soy, these data explain the plausibility of its healthy effect.

STRATEGIC GOAL 5

2. ARS scientists at Beltsville, Maryland, demonstrated that consuming a single meal per day, in contrast to several meals per day, adversely influences risk for diabetes and cardiovascular disease.

Impact: Such meal pattern information has broad implications for Federal and State nutrition policy and programs that encourage three meals daily.

Indicator 2:

During FY 2007, ARS will discover genetic or epigenetic factors that influence physiologic responses to diet or changes in gene expression in response to dietary intake.

FY 2007 Accomplishments:

1. Over 800 children from 300 Hispanic families in Texas were studied. It was discovered that overweight children ate more calories at dinner and consumed more calories in the absence of hunger than normal weight children. In addition, the overweight children had significant heritability for the hormones insulin, leptin, ghrelin and amylin. Genetic correlations were seen between eating behavior and fasting hormones, suggesting common underlying genes affecting their expression.

Impact: This research provides new evidence that overweight Hispanic children exhibit elevated levels of overeating behaviors that are influenced by genetic endowment, which should lead to better targeted interventions.

2. A three generation study in mice was used to determine that epigenetic changes in a particular gene were not inherited transgenerationally.

Impact: These results challenge the current dogma that genetic and epigenetic changes occurring during fetal development are permanent. This has particular importance in the field of obesity research, since it has been generally assumed that permanent signals acquired during gestation would cause normal weight offspring to become obese adults. This work indicates that assumption is not true for all genes related to obesity.

5.2.3: Summary of the Major Technologies Developed, Transferred, and Used in FY 2007

During FY 2007, ARS reported four 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.

1	Describe the Technology	A review of studies using omega-3 fatty acids to reduce the risk of cardiovascular disease compared benefits of those derived from fish with omega-3 fatty acids from plants.
	Describe the Transfer	Publication in peer-reviewed biomedical literature.
	Identify the Customer	The primary users are other researchers who will cite this work and build upon it. Secondary users will be federal agencies that promulgate dietary guidelines.
	Describe the Impact	While fish and fish oils provided health benefits, consumption of plant-based omega-3 fatty acids was without significant health benefit. This paper has already been cited 52 times by other researchers. Therefore, it has had a major influence on the field of diet and health.
2	Describe the Technology	A study of almost 1500 older adult participants in the NHANES survey found that in seniors with low vitamin B-12 status, high serum folate was associated with anemia and cognitive

STRATEGIC GOAL 5

		impairment. When vitamin B-12 status was normal, however, high serum folate was associated with protection against cognitive impairment.
	Describe the Transfer	Publication in peer-reviewed biomedical literature.
	Identify the Customer	The primary users are other researchers who will cite this work and build upon it. Secondary users will be federal agencies that promulgate dietary guidelines and the FDA which sets vitamin fortification regulations.
	Describe the Impact	These results will be considered when the Dietary Reference Values for these vitamins are re-evaluated. In addition, FDA will use this information to evaluate the safety of folate fortification of the food supply and decide whether vitamin B12 should also be added. This article has been cited 22 times by other academic researchers and is expected to accrue many more.
3	Describe the Technology	A new rodent model of nonalcoholic steatohepatitis (NASH) was developed by ARS scientists. NASH represents increased fat in the liver, is more common with obesity and affects many liver functions and metabolic processes.
	Describe the Transfer	Publication in peer-reviewed biomedical literature.
	Identify the Customer	The users are other researchers who will cite this work and build upon it.
	Describe the Impact	Methods in biomedical research become the most highly cited type of literature and help explain biological processes. Because of the extreme increase of NASH in adults and children and a lack of adequate experimental models to study prevention and treatment, this model will likely become widely used by researchers.
4	Describe the Technology	Characterization of the genes changed by exposure of prostate cancer cells to soy-derived phytochemicals. A molecular signature of gene expression for each phytochemical was developed which will help elucidate the biological mechanism by which it maintains health.
	Describe the Transfer	Publication in peer-reviewed biomedical literature.
	Identify the Customer	The users are other researchers who will cite this work and build upon it.
	Describe the Impact	The senior author's previous articles on related work showing soy interaction with estrogen receptors in breast cancer cells have been very heavily cited, with an average of more than 200 citations. It is anticipated the current work will likewise greatly influence researchers.

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

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.

Baseline 2005

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 2007, ARS will develop and demonstrate the use of innovative water management practices that improve water conservation, and/or reduces nutrient and pesticide losses to ground waters, streams, and lakes.

FY 2007 Accomplishments:

1. ARS researchers at the Hydrology and Remote Sensing Laboratory in Beltsville, MD, have developed a remote sensing technique to estimate the amount of N sequestered in cover crop biomass on farms enrolled in State cover crop cost share programs. The pilot study was conducted in the Choptank River watershed in MD, part of ARS' watershed research network associated with the Conservation Effects Assessment Project (CEAP). The strength of the technique is its synthesis of remote sensing data, on-farm sampling, and producer information derived from cost share program records (e.g., species, planting date, planting method). Biomass is estimated from satellite data using a Normalized Difference Vegetation Index (NDVI), which calculates a ratio of red vs. near infra-red reflectance. The use of remote sensing allows estimation of biomass and nutrient uptake for every cover crop field within each 60km x 60km satellite image. On-farm sampling of a small subset of the fields is necessary to calibrate the NDVI-to-biomass relationship, and also to estimate the nitrogen concentration of the vegetation. Future 'hyperspectral' satellites could make remote sensing of plant nitrogen content possible as well.

Impact: The technique allows managers to optimize and efficiently monitor this important best management practice at both watershed and regional scales with the aid of non-invasive remote sensing techniques. Nitrogen captured by winter cover crops reduces nitrogen losses to receiving waters (Chesapeake Bay in this example). Through the use of this new remote sensing technique, it is now possible to accurately quantify this reduction at the landscape scale. Accurately quantifying actual cover crop nutrient reduction at the landscape scale reduces uncertainty and increases the value of associated nutrient trading credits. The technology can also be used to verify cover crop implementation.
2. ARS scientists in Lincoln, NE, finalized the development of the Crop Circle active sensor system for N management, through a CRADA with Holland Scientific (Lincoln, NE), and developed procedures for its effective use. Sensor readings provide rapid, accurate assessments of plant canopy greenness.

Impact: Use of this sensor system to guide variable rate N applications has the potential to improve N use efficiency, enhancing both the environmental and economic quality of corn production, while reducing nitrogen losses from agricultural fields that contribute to the eutrophication of aquatic ecosystems.

Indicator 2:

During FY 2007, ARS will develop and validate field, watershed, and basin scale watershed assessment tools for the NRCS that quantify the economic and environmental impacts of conservation practices in improving water, soil, and air quality.

FY 2007 Accomplishments:

1. ARS researchers at Ames, IA, and Tucson, AZ, collaborated to develop a prototype spreadsheet tool capable of estimating N lost to surface waters from tile-drained agriculture. The tool uses statistical relationships from values measured in field experiments combined with a simulation model, providing a simple way to calculate the expected reduction in N loading from potential management changes.

Impact: Nitrogen losses from tile-drained agricultural systems in the upper Mississippi River basin have been identified as a major factor contributing to the annual development of the hypoxic zone in the Gulf of Mexico. This prototype has the potential to become an operational N management tool for use by farmers, growers, and natural resource managers, that will help maintain the sustainability of US agricultural practices while minimizing nitrogen losses from tile-drained agricultural systems in the upper Mississippi River basin.
2. Simulation models are critical to the accurate assessment of water quality concerns and the effects of conservation practices aimed at improving water quality. ARS scientists at the Grassland, Soil and Water Research Laboratory, Temple, TX, have developed a river basin scale model called SWAT (Soil and Water Assessment Tool) that integrates hydrology, soil erosion, plant growth, and nutrient cycling, with off-site processes such as channel erosion/deposition, pond and reservoir processes, groundwater flow, and climate variability. Numerous interfaces have been developed for the model to assist users in obtaining model inputs and interpreting model outputs. The model was calibrated and validated, and uncertainty in its output was analyzed, based on observations from ARS' CEAP Benchmark Watersheds and other watersheds around the world. In general, the model compared well with observed stream flow and sediment and nutrient loads and concentrations.

Impact: This model is being used across the country by US EPA to assess water quality concerns, and by USDA to assess the environmental impact of conservation programs on water quality and quantity. Scientists around the world are contributing to model development; over 350 scientific papers have been published in the open literature on the development and application of SWAT.
3. Agricultural pollutants in drainage waters have the potential to degrade the quality of waters used for municipal water supplies. ARS scientists in West Lafayette, IN, successfully calibrated and validated SWAT for modeling stream flow and atrazine concentrations in the Cedar Creek Watershed (CCW).

Impact: This research is necessary for further use of SWAT as an assessment tool to evaluate the long-term effects of different management practices on chemical transport in large, tile-drained agricultural watersheds in the Midwest. The results are significant in that Cedar Creek is the main tributary to the St. Joseph River, the source of the water supply for Ft. Wayne, IN, where concentrations of atrazine and other agricultural pollutants have been a major concern.
4. ARS scientists at Beltsville, MD, and Tifton, GA, tested the Riparian Ecosystem Management Model (REMM) using a GA riparian database. The sensitivity of REMM nutrient and sediment output was quantified with respect to changes in key riparian buffer parameters (e.g., vegetation; soil characteristics). Parameters associated with vegetation (e.g., rooting depth; plant height) moderately affected nutrient and sediment yields, but outputs were highly sensitive to changes in physical parameters (e.g., slope; Manning's surface roughness coefficient). Scientists at Beltsville are developing a similar evaluation of REMM for the Choptank Special Emphasis Watershed.

Impact: Accurate modeling of water movement through riparian buffers is critical for watershed-scale water quality assessments. This new model will assist farmers and policy makers in quantifying the effectiveness of specific riparian buffers in reducing pollutant loads to streams and other surface waters.

Indicator 3:

During FY 2007, ARS will develop at least one design and analysis tool for minimizing the impact of salinity on crops, soils, and water quality.

FY 2007 Accomplishments:

1. High salinity levels prohibit the reuse of irrigation drainage waters from agricultural fields in the western US. ARS researchers at Parlier, CA, identified plant species and poplar tree clones adapted to these high salinity waters. As an example, oil plants adapted to high salinity drainage waters can be used for bio-based products that have economic value for the grower (e.g., biofuel and Se-enriched feed products).
Impact: These findings improve our ability to sustain an agronomic-based system for drainage water reuse and encourage widespread use of degraded water for non-human consumptive uses, reducing competition for high quality water in the western U.S.
2. ARS scientists at the US Salinity Laboratory, Riverside, CA, in collaboration with researchers at the University of California Davis, developed a **Salt Management Guide**. The Guide and accompanying CD include an extensive list of plant species suitable for water reuse systems, ranging from relatively non-saline settings to salt-affected problem sites.
Impact: The product provides: 1) information on public health aspects, and regulations on use, of Title 22 waters, and their suitability for landscape irrigation relative to plants, soil properties, and irrigation application systems; and 2) information to educate the public about safe use of recycled water and its value in helping to address current and future shortfalls in potable waters. The product will assist landscape professionals, growers, and home gardeners in managing salinity in recycled irrigation waters.

6.1.1: Summary of the Major Technologies Developed, Transferred, and Used in FY 2007

During FY 2007, ARS reported two agricultural practices and technologies developed and used by customers to enhance water quality and availability.

1	Describe the Technology	Cover crops have been shown to be an effective way to reduce nitrogen losses from agricultural fields, but are difficult to monitor at the watershed/landscape scale. ARS researchers in Beltsville, MD, developed a remote sensing technique to estimate the amount of N sequestered in cover crop biomass on farms enrolled in State cover crop cost share programs. The pilot study was conducted in the Choptank River watershed in MD, part of ARS' watershed research network associated with the Conservation Effects Assessment Project (CEAP). The technique will allow managers to optimize and efficiently monitor this important best management practice at watershed and regional scales with the aid of remote sensing that is non-invasive.
	Describe the Transfer	ARS scientists developed a collaboration with the Maryland Department of Agriculture (MDA) to test this new technology under field conditions. The technique was used to evaluate the effects of cover crop implementation on nitrogen uptake and sequestration in the Choptank River watershed, MD, over 3 years—2005-6, 2006-7, and 2007-8. During this period, the MDA invested \$4.7-8.5 per year in cover crop programs statewide.
	Identify the Customer	The customer/user was the Maryland Department of Agriculture.

Strategic Goal 6

Describe the Impact	Application of this technique has the potential to provide real-time measurements of cover crop growth on all farms enrolled in state cost share programs. Output provides the Chesapeake Bay Program with cover crop efficiency calculations that feed back to MDA cover crop implementation. The technique also provides verification of cover crop implementation.
2 Describe the Technology	A significant proportion of the nitrogen losses from agricultural lands are associated with nitrogen fertilizers added in excess of crop nitrogen requirements. ARS scientists in Lincoln, NE, have developed the Crop Circle active sensor system for N management. Sensor readings provided rapid, accurate assessments of plant canopy greenness.
Describe the Transfer	The sensor system, and procedures for its effective use, were developed through a CRADA with Holland Scientific (Lincoln, NE).
Identify the Customer	Holland Scientific, Lincoln, NE.
Describe the Impact	This sensor system can be used to guide variable rate N applications. This gives it the potential to improve N use efficiency, enhancing both the environmental and economic quality of corn production, while reducing nitrogen losses from agricultural fields that contribute to the eutrophication of aquatic ecosystems

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

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 2007, 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 2007 Accomplishments:

1. Invasive plants are a major threat to the Earth's biodiversity and are estimated to cost U.S. agricultural and forest producers 34 billion dollars each year. There is a need to understand how increased atmospheric carbon dioxide may alter establishment, spread, and control of invasive weeds. The response of numerous invasive plants important to the southeastern U.S. to elevated carbon dioxide was examined by ARS scientists from Auburn, Alabama. Invasive plants, in almost all cases, had significantly more biomass when grown under elevated carbon dioxide.
Impact: The results suggest that invasive weeds will present agricultural producers with even greater challenges as atmospheric carbon dioxide continues to rise, and need to be taken into account when formulating future management strategies.
2. Increased atmospheric carbon dioxide has been implicated in the degradation of grasslands from encroachment of woody plants over the past two centuries, however research providing definitive support of this hypothesis has been lacking. It was shown by ARS scientists in Cheyenne, Wyoming in a northern Colorado native shortgrass steppe that doubling carbon dioxide over five years resulted in an 84% increase in productivity of a perennial native grass, and a 40-fold increase in aboveground biomass of a common sub-shrub of some North American and Asian grasslands. These results illustrate that rising atmospheric carbon dioxide can affect grassland species changes due to differential species sensitivities to carbon dioxide.
Impact: This is the first direct evidence implicating rising atmospheric carbon dioxide as a factor in rangeland woody plant invasions and degradation of grasslands. It is now firmly established that ecologists, land managers, and policy makers will need to consider the impact of rising atmospheric carbon dioxide on rangeland plant community shifts when formulating management practices and greenhouse gas emissions policy.
3. Precipitation patterns for North America are expected to be characterized by larger precipitation events separated by longer dry periods. These changes may differentially affect

the processes controlling uptake and release of carbon from terrestrial ecosystems and alter carbon sequestration on grasslands and other ecosystems. More extreme precipitation patterns (longer intervals between events combined with larger events) were shown by ARS scientists in Temple, Texas to shift grasslands towards greater net uptake of carbon and made carbon fluxes less responsive to variation of event size. More extreme precipitation regimes thus may reinforce increases in grassland carbon-sequestration expected to result from increasing atmospheric carbon dioxide, but may also lower plant water status and productivity. Benefits of greater carbon storage on grasslands likely will be offset by reductions in forage quantity and quality.

Impact: This information will benefit conservation planners and policy makers seeking to understand and enhance carbon sequestration by agroecosystems.

Indicator 2:

During FY 2007, 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 2007 Accomplishments:

1. Reducing agricultural contributions of carbon dioxide while maintaining profitability mandate identification of farming systems that favor retention and buildup of soil carbon. Deep soil sampling (60 cm depth) of long-term tillage trials by ARS scientists from St. Paul, Minnesota determined that biennial tillage (chisel plowing in the fall following corn harvest, with no-tillage following soybeans) results in greatest soil carbon storage and highest overall yields in corn/soybean systems of the upper Midwest. These results demonstrated that a tillage practice of intermediate intensity was able to accumulate more soil carbon compared to both more intensive and less intensive tillage.

Impact: The results provide information needed to develop strategies for minimizing the contribution of upper Midwest agriculture to increasing atmospheric carbon dioxide levels while maintaining acceptable yield levels, and are thus of interest to scientists, producers and policy-makers.
2. Carbon credit programs have the potential to realize multiple benefits for agricultural producers, including increased farm income and improvements in soil quality, while concurrently mitigating global climate change. Market-based carbon credit programs require scientifically sound estimates of soil carbon offset rates for agricultural management systems. ARS scientists from Mandan, North Dakota used data from a review article by the ARS Greenhouse Gas Reduction through Agricultural Carbon Enhancement Network (GRACEnet) to determine appropriate soil carbon offset rates for continuous conservation tillage (no-till) and seeded grassland for a carbon credit program developed by the North Dakota Farmers Union (NDFU) and the Chicago Climate Exchange (CCX).

Impact: During the 2006 contract year, over 830,000 acres in North Dakota were enrolled in the NDFU program, resulting in net payments to farmers and ranchers of \$2.07m. The program will be expanded nationwide for the 2007 contract year using soil carbon offset estimates from additional GRACEnet review articles.
3. Information is needed about the impact of management practices on emissions of greenhouse gases such as nitrous oxides. ARS scientists from Fort Collins, Colorado measured Greenhouse gas emissions in 12 different cropping systems representing different rotations, tillage intensities, types of nitrogen (N) fertilizer, and N fertilization levels. No-till cropping systems had significantly lower carbon dioxide and slightly lower nitrous oxide emissions than conventional till systems. Nitrous oxide emissions from plots fertilized with polycoated urea had lower emissions than plots fertilized with urea ammonium nitrate.

Impact: Results suggest that nitrification inhibitors and time-released fertilizers have strong potential to reduce nitrous oxide emissions while maintaining high grain yields. These results

are of interest to the Natural Resources Conservation Service because they will lead to management practices that make more efficient use of fertilizer N and reduce greenhouse gas emissions.

Indicator 3:

During FY 2007, ARS will develop practices which remediate degraded soils.

FY 2007 Accomplishments:

1. Degraded soils result in reduced crop yields; require greater inputs of fertilizer, water and energy; and pose a greater threat to the environment than high quality soils. Many agricultural, industrial and municipal wastes are generated each year and may be appropriate soil amendments to improve degraded soils. ARS scientists from several locations (West Lafayette, IN; Oxford, MS; Tifton, GA; and University Park, PA) have demonstrated that flue gas desulfurization (FGD) gypsum, generated by removal of sulfur dioxide from the flue gases of coal-fired power plants can improve soil chemical and physical properties. They have demonstrated that application of FGD gypsum to soil improves soil structure resulting in greater infiltration and storage of rainwater. Since water moves into the soil, more is available for subsequent use by crops and less water runs over the soil surface reducing erosion and movement of sediment, nutrients and trace elements to surface water.
Impact: These results show that a low-cost material like FGD gypsum can allow farmers to increase crop production while improving soil and water quality. This research supports conservation goals of the Natural Resources Conservation Service. Additionally, the research supports the goals of the Coal Combustion Products Partnership (ARS, Environmental Protection Agency, Department of Energy, Department of Transportation) to promote recycling and beneficial uses of industrial products.
2. Many of the processes affecting the behavior of herbicides in the environment are mediated by microorganisms, but information about the impact of environmental conditions or management practices on microbial degradation of herbicides is limited. ARS scientists from Urbana, Illinois found that soil nitrogen controls microbial degradation of herbicides. Soil nitrogen levels required for crop production are not conducive for degradation of herbicides such as atrazine and cloransulam-methyl. These herbicides undergo optimal degradation when the microbial community is starved for nitrogen. ARS scientists from Stoneville, Mississippi found that atrazine was degraded more rapidly in soils with a history of atrazine application compared to atrazine degradation in soils with limited previous atrazine application. They demonstrated that rapid degradation of atrazine reduced control of broadleaf weeds such as pitted morning glory and prickly sida. ARS scientists from Urbana, Illinois in cooperation with personnel from the University of Illinois and the Army Corps of Engineers found that under anaerobic conditions, organisms that degrade explosives also can degrade herbicides called dinitroanilines
Impact: This information can be used to predict the persistence of herbicides in soil and to develop management practices that allow appropriate weed control, but do not lead to excessive herbicide persistence. This information will be useful to the EPA Office of Pesticide Programs.
3. Many soils in the United States suffer from excessive soil compaction and have to be tilled annually to eliminate deep compacted layers that limit water movement and root growth. New spatial technologies that control in-row subsoiling to disrupt compacted layers may reduce fuel consumption while promoting increased yields. ARS scientists from Auburn, Alabama conducted a four-year experiment to compare the impact of site-specific subsoiling and uniform deep subsoiling on corn yield and energy requirements for tillage. Soils were mapped to determine the depth of the compacted layer, then tilled to that depth using site-specific subsoiling. The site-specific subsoiling treatment resulted in the same corn yields as uniform deep subsoiling, but reduced fuel requirements by 24 percent to 43 percent.

Impact: Site-specific subsoiling should help producers increase profits by reducing fuel costs while maintaining crop yields. This technology will contribute to conservation goals of the Natural Resources Conservation Service.

Indicator 4:

During FY 2007, ARS will develop methods to reduce emissions of harmful gases from crop and animal production systems.

FY 2007 Accomplishments:

1. Decreasing ammonia losses from the surface of beef cattle feedlots would improve air quality and increase the value of manure collected from the pens. ARS scientists from Bushland, Texas evaluated a number of materials for their ability to decrease ammonia emissions from a mixture of beef cattle feces and urine. Several of the materials including alum, zeolite, urease inhibitor and corn oil decreased ammonia emissions by 50 percent or more. In a related investigation, ARS scientists from Clay Center, Nebraska added antimicrobial plant oils (thymol, carvacol and eugenol) to cattle and swine manure. These oils inhibited essentially all microbial metabolism in manure slurries resulting in no production of volatile fatty acids or other gaseous products. Results from the eugenol addition to cattle and swine manure were unique because eugenol stopped production of volatile fatty acids associated with odor, yet allowed lactate accumulation. This effect rapidly lowered pH thereby reducing ammonia emissions.

Impact: Development of commercial uses of these natural plant oils in livestock production systems is currently being undertaken by an industry partner since these materials can be used to control both pathogens and emissions.

2. ARS scientists from Florence, South Carolina are developing a cost-effective, large-scale method of removing ammonia from livestock wastewater using an innovative bacterial process, anammox. The anammox process involves using anaerobic bacteria to convert nitrite and ammonia to harmless dinitrogen gas. The scientists have isolated the bacteria, Planctomycetes, used in the anammox process from livestock wastewater. They have demonstrated anammox's commercial potential to remove nitrogen from wastewater at higher rates and at a lower cost than conventional methods.

Impact: This finding can be of significant importance in modern livestock production because excess ammonia is a global problem, and the use of conventional biological nitrogen removal methods is usually limited by operational cost, which can be lowered four-fold with the anammox process. This technique is currently being tested with cooperators in the United States and Brazil.

Indicator 5:

During FY 2007, ARS will develop practices and approaches which mitigate the detrimental effects of tropospheric ozone on agricultural crops.

FY 2007 Accomplishments:

1. Screening techniques are needed to assess the impact of elevated ozone levels on crop production. Ozone-induced foliar injury is often used as a predictor of germplasm tolerance to ozone exposure. Studies by ARS scientists from Raleigh, North Carolina, were conducted to determine the response of selected soybean ancestors to season-long treatments of low ozone or elevated ozone. Specific ancestors exhibited low foliar injury with 25-30% yield loss whereas others were extensively injured with only 10% yield loss.

Impact: Ozone effects on yield components are complex and include combinations of reduced seed size and reduced pod/seed number. The development of ozone tolerant germplasm based on foliar injury alone may not take into account the full range of ozone effects.

2. Prediction of impacts of global climate change and the interactions of environmental pollutants on plant growth is still not resolved due to a number of confounding interactions in the response to environmental variables such as temperature and atmospheric vapor pressure deficit. The interactive influence of vapor pressure deficit and temperature on the long term growth of tall fescue, a cool season grass was examined by ARS scientists at Raleigh, North Carolina. At a constant vapor pressure deficit, contrary to expectations, the growth of this grass markedly increased with temperature. Increasing vapor pressure deficit at constant temperature, which is a common consequence of most temperature-increase experiments, actually caused growth to decrease.
Impact: Changes in atmospheric vapor pressure deficit caused by increased global temperatures may affect the susceptibility of plants to ozone damage

Indicator 6:

During FY 2007, ARS will develop management practices and decision tools to improve soil quality and protect the environment.

FY 2007 Accomplishments:

1. Water flowing in irrigation furrows can erode soil and transport sediment and associated nutrients from the field. Polyacrylamide (PAM) has been the standard treatment to improve infiltration and control erosion in furrow irrigation, but lower-cost natural product substitutes are being sought. A new treatment containing polysaccharide and PAM was compared with PAM treatment alone and untreated furrows in a field test to determine effects on infiltration and soil erosion by ARS scientists in Kimberly, ID. The new amendment, which is a blend of potato starch and PAM, increased infiltration 20% and reduced soil erosion 65% compared to untreated furrows. PAM treatment alone increased infiltration 13% and reduced erosion 98% compared to untreated furrows.
Impact: The new polysaccharide/PAM amendment can be used as an alternative to PAM for improving infiltration on furrow irrigated fields, although greater application rates will be needed to provide similar erosion control as PAM.
2. Knowledge of interactions between rainfall and different soils found across a landscape and managed under contrasting cropping systems is needed for understanding and modeling water movement in watersheds. The depth of the claypan horizon in the soil profile was found by ARS scientists from Columbia, Missouri to be the main factor controlling all sub-soil hydraulic properties. Cropping practices also affected soil hydraulic properties, but mostly affects the top 4 inches of soil and not equally for all landscape positions. An improvement of infiltration was achieved in backslope positions managed in permanent grass. Thus, landscape position and management practices interact, and both are important for characterizing hydraulic properties and developing targeted soil-water conservation practices.
Impact: This information contributes to the development of conservation practices and systems that will support long-term sustainability of crop production and water quality protection.
3. Crop residue has been identified as a near-term source of biomass, but additional research is needed to develop sustainable management practices for this activity. ARS scientists from Ames, Iowa studied four harvest scenarios using a single-pass grain and residue combine. Leaving the lower 40 to 50 cm of each plant and collecting only the cobs and upper plant parts provided the best biofuels feedstock in terms of water content and mineral ash. This technique left a reasonable amount of surface cover to protect the soil against wind and water erosion. Replacement value of the macro-nutrients (nitrogen, phosphorus, potassium) removed in the stover was estimated at \$5 per ton. Harvesting the lower portion of the plant added very little dry matter, slowed harvest efficiency, increased nutrient replacement costs, increased transportation and storage costs, and decreased surface soil protection.

Impact: This information will contribute to the development of a decision tool to predict appropriate stover harvest for bioenergy production and maintenance of soil productivity. These findings support Natural Resource Conservation Service efforts to sustain the productive capacity of US soils.

4. Sustainable production of cotton, peanut and other crops in the southern Atlantic Coastal Plain requires that growers minimize negative environmental impacts and reduce costs. To this end, conservation practices such as strip-tillage, may offer significant benefit. Seven years of data from a comprehensive tillage study in south-central Georgia was compiled. Strip-till provided equivalent crop yields and resulted in 2 times less surface runoff and erosion than conventional-tillage. Strip-till reduced herbicide losses by up to 10-fold compared to conventional-tillage.

Impact: This research will likely promote increased adoption of strip tillage since benefits have been documented and data has been provided that will allow direct cost-benefit analysis. This information can be used to make funding decisions in Conservation Programs run by the Natural Resources Conservation Service.

Indicator 7:

During FY 2007, 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 2007 Accomplishment:

1. New legislation in North Carolina promotes replacement of old lagoon technology with new Environmentally Superior Technology. ARS scientists from Florence, SC and industry cooperators have designed and demonstrated a second generation system for swine wastewater treatment that is more economical than earlier versions. The system, installed at a 5,150 head finishing operation, removed 97.7% of total suspended solids, 99.6% of biological oxygen demand, 96.1% of total nitrogen, 97.4% of ammonia, 94.0% of total phosphorus, 99.9% of odor causing compounds, and 99.9% of pathogen indicators. Animal health and productivity was improved compared to traditional lagoon management; mortality decreased 57%, daily weight gain increased 11% and feed conversion improved by 5.4%.
Impact: These results show that this alternative wastewater treatment technology can have significant positive impacts on livestock production and the environment. This information should allow this wastewater treatment technology to be eligible for funding through USDA Conservation Programs.

Indicator 8:

During FY 2007, 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 2007 Accomplishment:

1. Reducing the survival of bacterial enteric pathogens in manure and hence their ability to disseminate via air was evaluated. Scientists from Beltsville, MD prepared and inoculated a series of manure stacks with two important pathogenic bacteria, *E. coli* O157:H7 and *Salmonella typhimurium*, contained in specially designed tubes. These sample tubes were assayed for viable pathogens during composting. With very minor additions of on-farm materials like straw and careful attention to the construction and geometric shape of manure piles, the pathogenic bacteria were reduced to undetectable concentrations within a matter of weeks. In another experiment nearly complete pathogen destruction was obtained by composting solids and multi-stage treatment of liquids separated in a swine wastewater treatment system developed at Florence, SC.

Impact: This information will allow producers to rapidly and thoroughly reduce the number of pathogenic bacteria in manure to levels that will minimize the risk of off-site pathogen transport during manure handling and land application.

16.2.1: Summary of the Major Technologies Developed, Transferred, and Used in FY 2007
During FY 2007, ARS reported three agricultural practices and technologies to enhance soil and air natural resources will be developed and used by customers and partners.

1	Describe the Technology	A system of swine wastewater treatment technologies that reduces ammonia emissions, captures phosphorus, kills pathogens and reduces odor was developed by ARS scientists from Florence, SC and their cooperators.
	Describe the Transfer	A patent was received for the technology and the technology was licensed to Supersoil Systems Inc. The technology was judged to be “Environmentally Superior” to anaerobic lagoons in tests conducted through the North Carolina Attorney General-Smithfield Foods Consent Agreement.
	Identify the Customer	The systems are currently in use on swine and dairy operations in North Carolina.
	Describe the Impact	This system gives producers a wastewater treatment technology that provides environmental and economic benefits.
2	Describe the Technology	ARS scientists from Mandan, North ND used data from the ARS Greenhouse Gas Reduction through Agricultural Carbon Enhance Network (GRACEnet) to determine appropriate soil carbon offset rates for conservation tillage (no-till) and seeded grassland for a carbon credit program.
	Describe the Transfer	Estimates of soil carbon sequestration under conservation tillage and seeded grassland were made available to the North Dakota Farmers Union. The Farmers Union used this information to develop a carbon credit trading program in cooperation with the Chicago Climate Exchange.
	Identify the Customer	Farmers and ranchers in North Dakota enrolled in the program and received credit payments.
	Describe the Impact	Approximately 830,000 acres in North Dakota were enrolled in the carbon credit trading program and the participating farmers and ranchers received \$2.07 million. The program will be expanded into other states using data developed by the ARS GRACEnet program.
3	Describe the Technology	ARS scientists from Fort Collins, CO defined the concept of reduced losses of nitrogen (N) at the field level based on management practices that reduce N inputs, make more efficient use of N and prevent N losses.
	Describe the Transfer	ARS scientists generated and transferred to the Natural Resources Conservation Service (NRCS) data sets of predicted N losses for thousands of soil and management practice combinations using the Nitrogen loss and Environmental Assessment Package (NLEAP) model and field data from Colorado, Ohio and Virginia.
	Identify the Customer	The initial customer is NRCS. They have worked with ARS to develop a prototype Nitrogen Trading Tool that can predict N losses across a range of soils, climate, crops and management

Strategic Goal 6

	practices.
Describe the Impact	With further refinement the Nitrogen Trading Tool will be used by producers and their advisors to select the most appropriate management practice(s) for N loss reduction for a specific situation and to provide the scientific basis for N credit trading.

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

6.3.1 Improved management practices and technologies for managing pasture and range lands 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 2007, 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 2007 Accomplishments:

1. With global climate change, varieties of wheat and other grasses are needed that are better adapted to high soil and air temperatures and use water more efficiently. ARS scientists at Corvallis, OR studied grasses that are adapted to geothermal areas in Yellowstone Park.

Microscopic analysis of these plants revealed they had many more of a structure called trichomes that helps maintain water in the plant in hot environments. The trichomes of the adapted plants were also thicker in structure.

Impact: This information will help plant breeders develop more heat-tolerant wheat varieties and grasses. Increased heat tolerance will improve our ability to adapt to climate change and reduce the risk of drought to help maintain the production of grains and grasses essential to food, forage and bioenergy production.

2. Profitability of livestock production is increased when forages have high yield per acre and low non-digestible fiber content. Low fiber content increases forage consumption and digestible energy content and this results in improved animal performance. Unfortunately, some key forage grasses have shown a positive genetic correlation between higher yield and higher fiber concentration so opportunities to breed higher yielding, lower fiber varieties have appeared to be limited. ARS scientists at Madison, WI, found that breeding work to improve smooth bromegrass, an important harvested forage, resulted in a 1% decrease in non-digestible fiber but was accompanied by a 5% decrease in yield. However, in follow-on research they have been able to partially break this correlation by studying hybrids of smooth bromegrass and identifying a few genes that improve yield but are not linked to fiber content and vice versa.

Impact: Based on this knowledge work is proceeding to develop forages with both increased yield and lower fiber. More forage of higher quality per acre with improved increase livestock performance and overall profitability. Higher yielding, lower fiber grasses will also produce better feedstocks for bioenergy production.

3. Indian ricegrass is an important native grass in rangeland restoration. Following the 2007 fire season, the Bureau of Land Management bought over 116,000 pounds of seed of two commonly available varieties (Nezpar and Rimrock) of Indian ricegrass for approximately \$1.6 million. These two widely available varieties of Indian ricegrass were developed for the northern Great Basin but not other ecological zones in the West. In screening and genetically manipulating a large numbers of wildland-collected populations, ARS scientists at Logan, Utah, working with Utah State University and the Natural Resources Conservation Service, developed White River Indian ricegrass. White River performed better than the currently available varieties in a field tests conducted in Wyoming. White River provides a better Indian ricegrass option for rangeland restoration in the Upper Colorado Plateau. Because of its high germinability and seed yield, White River may also prove useful in the Northern Great Basin.

Impact: Having new commercially available Indian ricegrass adapted to other ecological regions provides land managers with better options for establishing this important grass on public and private land following fires and other causes of degradation.

Indicator 2:

During FY 2007, ARS will provide forage and pasture management technologies and strategies that reduce inputs while improving livestock performance and sustaining the environment.

FY 2007 Accomplishments:

1. An important step in developing the nation's bioenergy potential is determining the economics and net energy balance for perennial-grass feedstock production systems. Until now, previous estimates have been based on smallplot data or estimates. ARS scientists at Lincoln, NE planted and managed switchgrass as a biomass energy crop for five years on 10 cooperating farms in the northern Great Plains. Biomass yields and farmer inputs were used to determine the net energy balance. Net energy averaged 60 GJ ha⁻¹ y⁻¹ and switchgrass produced 540% more renewable energy than nonrenewable energy consumed. Switchgrass

managed for high yield had equal or greater net energy than low input restored prairies and can produce twice as much liquid fuel per acre. This large scale study clearly demonstrates that perennial grass energy crops are net energy positive and improvements in genetics and management will enhance both total and net energy yields and the cost of production. The economics information that was reported last year from this research unit also indicated that biomass switchgrass production systems were economically viable.

Impact: Quantitative data on the net energy balance of switchgrass grown on farmer fields will aid policy makers and producers in making decisions on investments in grass-based bioenergy feedstock production systems to improve national energy security and manage greenhouse gas emissions.

2. Traditionally, Appalachian farmers have relied on grass pastures to finish their lamb crop, but in the late summer and early fall, forage production and nutritive quality of the grasses declined. As a result, costly supplements are often used to ensure the animals gain weight. ARS researchers at Beaver, WV found that using a mixture of prairiegrass, a highly productive and nutritious perennial grass, and forage turnips in pastures provided high quality forage throughout the grazing season and greatly reduced or eliminated the need for supplements. They found that lambs finished on the prairiegrass-turnip pastures nearly double their rate of gain over lambs finished on the traditional grass-clover mixture.

Impact: The rapid growth in the demand for sheep on the East coast creates an opportunity for new markets and greater profits if the region's limited-resource producers have reliable, affordable options for finishing lambs without using high-cost supplements. This research provides pasture management tools that can increase the profitability of small Appalachian farms and provide customers with the meat products they desire at affordable prices.

3. An important avenue for new farmers to enter agriculture is pasture-based dairy systems because these systems require a much lower initial investment than confinement dairy systems. However extreme weather events appear to be more common and pasture-based dairy producers in the Northeastern U.S. need better strategies for managing the risk of drought. ARS scientists at University Park, PA evaluated the use of more complex mixtures of forage plants in pastures instead of the traditional grass monoculture or mixture of just two species (a grass and a clover). They found that combinations of six species produced the most forage in good years and increased economic returns per cow by more than \$100 per year during dry years. They also found that alternate six-species combinations of using different forage species responded differently to local variations in climate, soils and other conditions.

Impact: This information provides new and established farmers with pasture management options based on alternative forage combinations that are better adapted to the local climatic variations and thereby improve risk management by maintaining farm productivity and profitability during droughts.

Indicator 3:

During FY 2007, 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 2007 Accomplishments:

1. Shifts in precipitation patterns accompanying global climate change are predicted to affect rangeland ecosystems significantly. Most research has focused on how vegetative communities will change but little work has been done on soil processes. At Burns, OR, ARS scientists observed that shifts in precipitation timing from winter to spring in cold desert ecosystems resulted in lower carbon inputs into the soil by plants while increased microbial

- activity increased decomposition of organic matter. This shift resulted in as high as a 14% increase in carbon loss from the soil.
- Impact:** This information on the relationships between rainfall variation and soil carbon sequestration on rangelands will help scientists develop regional and global models of the carbon cycle and aid policy makers in developing standards for carbon trading which may provide a new marketing opportunity for land owners while aiding in reducing greenhouse gas emissions.
2. Many individuals moving into the Western States own horses for work and recreation and are concerned about the risk to horses from grazing locoweed. ARS scientists at Logan, UT determined that horses are more sensitive to locoweed poisoning than other domesticated large animals. Sheep and cattle require 0.30mg of swainsonine (the toxin in locoweed) per kg of animal weight per day over a period of 21 days before clinical poisoning symptoms occur. In contrast, horses develop clinical symptoms in 14 days with a daily dose of 0.25mg/kg. Among other things, locoweed poisoning affects the reproductive process of mares with clearly identifiable symptoms. These symptoms are reversible if further exposure is avoided. While the recovered mares can be used for breeding, they should not be used for work or riding.

Impact: This information will help veterinarians in advising clients on avoiding locoweed poisoning and in diagnosing and treating poisoning. Knowing that poisoned mares can still be used for breeding will result in significant economic savings.
 3. Prairie dog colony areas increased 6-fold in Colorado between 1999 and 2004 and now cover over 630,000 acres. ARS scientists at Cheyenne, WY working with scientists at Colorado State University as part of the Shortgrass Steppe Long-term Ecological research project studied the impact of blacktailed prairie dogs on livestock gains. They found that grazing livestock's seasonal gains decreased with an increasing percentage of the pasture was colonized by prairie dogs. Economic reductions were \$14.95 per steer and \$0.90 per acre with 20% of the pasture colonized. When colonization increased to 60% reductions in earnings increased to \$37.92 per steer and \$2.26 per acre. Gains per steer can be increased by reducing the number of grazing animals per acre but this practice results in reduced gains per acre.

Impact: This information on trade off between land-use alternatives will help policy makers and land managers develop better land-management strategies for balancing competing natural resource values on the shortgrass prairie.
 4. Wildfires are becoming increasingly frequent across the vast sagebrush steppes of the Intermountain West and the lack of information on the impacts of grazing on post-fire environments has limited the development of post-fire management strategies. ARS researchers at Burns, OR evaluated plant community recovery after combined with and without combinations of spring and summer grazing. They found that moderate grazing after fire did not limit recovery and productivity of herbaceous plants when compared to ungrazed treatments.

Impact: This information will enhance the ability of public and private land managers to prescribe post-fire grazing levels that will not slow the recovery of the plant community while reducing the loss of income for livestock producers who depend on rangeland grazing.

6.3.1: Summary of the Major Technologies Developed, Transferred, and Used in FY 2007

During FY 2007, ARS reported five new technologies or strategies provided to pasture, forage and range land managers and used to conserve and restore natural resources while supporting profitable production.

1	Describe the	Indian ricegrass is an important native grass in rangeland restoration.
---	--------------	---

Strategic Goal 6

Technology	<p>Following the 2007 fire season, the Bureau of Land Management bought over 116,000 pounds of seed of two commonly available Indian ricegrass varieties (Nezpar and Rimrock) for approximately \$1.6 million. These two available varieties of Indian ricegrass are well adapted to the northern Great Basin but not as adapted to other regions. To provide a better adapted variety for some of these other regions, ARS scientists at Logan, Utah, working with Utah State University and the Natural Resources Conservation Service, screened and genetically manipulated a large number of wildland-collected populations to develop White River Indian ricegrass. White River performed better than the currently available varieties in a field test conducted in near Pinedale, Wyoming demonstrating that White River provides a better Indian ricegrass option for rangeland restoration in the Upper Colorado Plateau. Because of its high germinability and seed yield, White River may also prove useful in the Northern Great Basin.</p>	
Describe the Transfer	<p>White River germplasm was released as a selected-class genetically manipulated germplasm without plant variety protection to promote widespread availability to meet urgent conservation needs. Seed is currently being increased by the Uncompahgre Plateau Project.</p>	
Identify the Customer	<p>The initial customer is the Uncompahgre Plateau Project, which is a consortium of public agencies, and NGOs conducting rangeland restoration in the Upper Colorado Plateau. As seeds become more plentiful, ranchers and the oil & gas industry will also benefit by having suitable germplasm for conserving and restoring their lands. Seed growers and seed companies benefit from the production and sale of seed.</p>	
Describe the Impact	<p>Initially, the anticipated area of use for White River is the Upper Colorado Plateau, which encompasses portions of eastern Utah and western Colorado. However, if seed production of White River is found to be competitive with Nezpar and Rimrock, its area of use would be expected to expand across much of the Intermountain Region, including northern Nevada, western Utah, and southern Idaho.</p>	
2	Describe the Technology	<p>Developing the nation's bioenergy potential requires data on the net energy balance for perennial-grass feedstock production systems. Until now, net energy estimates have been based on smallplot data and extrapolations. ARS scientists at Lincoln, NE planted and managed switchgrass as a biomass energy crop for five years on 10 cooperating farms in the northern Great Plains. Biomass yields and farmer inputs were used to determine the net energy balance. Net energy averaged 60 GJ ha⁻¹ y⁻¹ and switchgrass produced 540% more renewable energy than nonrenewable energy consumed. Switchgrass managed for high yield had equal or greater net energy than low input restored prairies and can produce twice as much liquid fuel per acre.</p>
Describe the Transfer	<p>Field demonstration, publications, technical presentations, and the popular press (a news release of the results of the research was distributed by Associated Press Service.)</p>	
Identify the Customer	<p>Quantitative data on the net energy balance of switchgrass grown on farmer fields will aid policy makers and producers in making decisions on investments in grass-based bioenergy feedstock production systems to improve national energy security and manage greenhouse gas emissions.</p>	
Describe the Impact	<p>This large scale study clearly demonstrates that perennial grass energy crops that can be grown on millions of acres are net energy positive and improvements in genetics and management will enhance both total and net energy yields and the cost of production.</p>	

Strategic Goal 6

3	Describe the Technology	Wildfires are becoming increasingly frequent across the vast sagebrush steppes of the Intermountain West and the lack of information on the impacts of grazing on post-fire environments has limited the development of post-fire management strategies. ARS researchers at Burns, OR evaluated plant community recovery after combined with and without combinations of spring and summer grazing. They found that moderate grazing after fire did not limit recovery and productivity of herbaceous plants when compared to ungrazed treatments.
	Describe the Transfer	Presentations, publications, and demonstrations for public and private land managers. Transfer is greatly facilitated by ARS scientists working closely for many years with private land owners and agency personnel in the process of developing research projects and then being regularly informed of the results of alternative grazing trials in a post-fire environment.
	Identify the Customer	Public land managers and private producers are the most immediate users. The information is also useful to public policy makers and private consultants advising land managers on grazing strategies.
	Describe the Impact	This information will enhance the ability of public and private land managers to prescribe post-fire grazing levels that will not slow the recovery of the plant community while significantly reducing the loss of income for livestock producers who depend on rangeland grazing.
4		One option for new farmers to enter agriculture is pasture-based dairy systems because these systems require a much lower initial investment than confinement dairy systems. However extreme weather events appear to be more common and pasture-based dairy producers in the Northeastern U.S. need better strategies for managing the risk of drought. ARS scientists at University Park, PA evaluated the use of more complex mixtures of forage plants in pastures instead of the traditional grass monoculture or mixture of just two species (e.g., a grass and a clover). They found that combinations of six species produced the most forage in good years and increased economic returns per cow by more than \$100 per year during dry years. They also found that alternate six-species combinations of using different forage species responded differently to local variations in climate, soils and other conditions.
		Presentations to producers groups, publications targeting educators, extension workers and producers, and field days and demonstrations.
		Producers, extension and other technical advisors, and scientists and the seed industry involved in providing the appropriate plant varieties for alternative pasture management strategies.
		This information provides farmers with pasture management options based on alternative forage combinations that are better adapted to the local climatic variations and thereby improve risk management by maintaining farm productivity and profitability during droughts.
		Many individuals moving into the Western States own horses for work and recreation and are concerned about the risk to horses from grazing locoweed. ARS scientists at Logan, UT determined that horses are more sensitive to locoweed poisoning than other domesticated large animals. Sheep and cattle require 0.30mg of

swainsonine (the toxin in locoweed) per kg of animal weight per day over a period of 21 days before clinical poisoning symptoms occur. In contrast, horses develop clinical symptoms in 14 days with a daily dose of 0.25mg/kg. Among other things, locoweed poisoning affects the reproductive process of mares with clearly identifiable symptoms. These symptoms are reversible if further exposure is avoided. While the recovered mares can be used for breeding, they should not be used for work or riding.

Presentations and publications targeting veterinarians, extension workers, owners of stabling facilities, hay growers, pasture and range managers, and horse owners and managers.

Horse owners, stable operators, veterinarians, extension workers, pasture and range managers, and hay producers.

This information will help veterinarians in advising clients on avoiding locoweed poisoning and in diagnosing and treating poisoning. Knowing that poisoned mares can still be used for breeding will result in significant economic savings plus allow owners to keep companion animals longer.

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 2007 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.

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.

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 2007 Accomplishments:

1. The Agricultural Research Service (ARS) continued to conduct outreach activities in K-12 schools, 1862 universities and colleges, 1890 land-grant universities, 1994 tribal colleges and universities, Historically Black Colleges, Hispanic Serving Institutions. In addition, the agency continued to conduct outreach activities with minority serving organizations, such as the Society for Advancement of Chicanos/Latinos and Native Americans in Science (SACNAS), Minorities in Agriculture Natural Resources and Related Sciences (MANRRS), American Indian Science and Engineering Society (AISES), Workforce Recruitment Program (WRP), and the Department of Defense's Operation War-fighter.
2. The Office of Outreach, Diversity, and Equal Opportunity (ODEO) continued funding two specific cooperative agreements between University of Arizona and United Tribes Technical College. ARS continues to encourage Native American students to pursue disciplines related to agriculture and related sciences while providing educational and employment opportunities for future generations. ARS continued to support the specific cooperative agreements, which are administered by the ARS Northern Plains Area. During FY 2007, nine Native American students received summer employment, which included salary, housing, and transportation, for eight weeks. Students, who were enrolled at either the University of Arizona or United Tribes Technical College, were assigned internships at five locations in the Northern Plains Area (Mandan, Fargo and Grand Forks, North Dakota; Brookings, South Dakota; and Sidney, Montana). During FY 2005, funding for both agreements totaled \$7,100. The funding for the Native American Internship Program has increased each year. During FY 2007, the funding exceeded \$64,000.
3. The ODEO continued to support two USDA/1890 National Scholars by providing funding for tuition, fees, books, and the use of laptop computers. Having completed a Bachelor's Degree and a Dietetic Internship, one African American female student is currently enrolled in graduate school pursuing a Master's Degree in Nutrition. The student is employed with ARS Delta Nutrition Intervention Research Initiative (NIRI) as a Biological Science Trainee. The other African American female student is enrolled at Tuskegee University majoring in Accounting. The student is employed as a Student Trainee Accountant with the Financial Management Division.
4. The Delta Nutrition Intervention Research Initiative (NIRI) partners with several universities (University of Arkansas, Alcorn State University, and University of Southern Mississippi) to conduct community-based participatory research in addressing health and nutrition needs of residents in the southern Mississippi Delta regions.
5. Professional and Science-Based Organizations/Federal Outreach Opportunities: Exhibits were set up and hosted at the following scientific professional society events and Federally sponsored programs for the purpose of showcasing ARS careers and employment opportunities:

- National FFA Organization (formerly known as Future Farmers of America until 1988)
 - Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS) Conference
 - American Chemical Society Meeting and Expo
 - American Dairy Science Association- Asociación Mexicana de Producción Animal-Poultry Science Association-American Society of Animal Science Joint Annual Meeting
 - Congressional Hispanic Caucus Institute 2007 Public Policy Conference
 - American Society of Agronomy/Crop Science Society of American/Soil Science Society of America Annual Meeting
 - Association for Career and Technical Education (ACTE) Convention and Career Expo
 - Entomological Society Meeting
 - Experimental Biology 2007
 - American Dietetic Association
 - National Institute of Health Post Doc Job Fair
 - American Association for the Advancement of Science (AAAS) Annual Meeting
 - 29th Symposium on Biotechnology for Fuels and Chemicals
 - World Coal Ash Conference
 - Southern Plains Technical Prep Career Expo, Texas
 - Landowners Association of Texas 22nd Annual Farmers and Ranchers Conference
 - North Carolina PhD Career Fair
 - Hispanic Engineering, Science, and Technology Conference (HESTEC) 2007
 - Hispanic Association of Colleges and Universities (HACU) Annual Conference
 - Youth Motivation Task Force (Alabama A&M University, University of Arkansas at Pine Bluff)
 - National Association of Agricultural Educators
 - New York State Agricultural Experiment Station 125 year Anniversary Celebration Open House
 - Empire Farm Days, New York
 - 2007 College and Career Fair, Mississippi 2nd Congressional District
 - National Council of Negro Women, Inc, Mitchellville-Bowie (MD) Section's, 4th Annual College Expo
 - Maine Agricultural Trade Show
 - Rural Small Business Conference, Alaska
 - Mayor's Career and Education Expo, Fresno, California
 - Public Service Recognition Week, District of Columbia and West Virginia State Fair
 - American Legion/DLLR Veterans Job Fair, Ft. Meade, Maryland
 - Job Fair, 913th Airlift Wing, Willow Grove Air Reserve Station, Pennsylvania
 - Confederated Tribes of Grande Ronde Reservation, College and Career Fair
 - USDA Sponsored Job Fairs – University of California-Davis, George Washington University, and University of Wisconsin-Madison
 - USDA Community Outreach Day at the Oaks Mission Indian School
 - OPM Sponsored Federal Career Fairs – Ohio State University, Carnegie Mellon University, New Mexico State University, and Louisiana State University
 - Federally Employed Women Conference
6. Colleges/Universities and K-12 Events: ARS staff participated in career fairs and career day events hosted by the following K-12 schools, colleges, and universities for the purpose of promoting careers in agriculture and science.

- Pennsylvania State University
- University of Idaho
- Washington State University
- Colorado State University
- University of California-Riverside
- University of Alaska-Fairbanks
- University of Maryland-Eastern Shore
- Delaware State University
- Lincoln University
- Heritage University
- Purdue University
- University of Nebraska
- University of the Sciences
- Temple University
- University of Minnesota
- California State University-Bakersfield
- Iowa State University
- Rochester Institute of Technology, National Technical Institute for the Deaf
- North Carolina State University
- Delta State University
- Wilberforce University
- Alcorn State University
- Indiana University
- Southeastern Louisiana University
- University of North Carolina – Chapel Hill
- University of Mississippi
- Xavier University
- Dillard University
- Southern University of New Orleans
- Tulane University
- Loyola University of New Orleans
- University of New Orleans
- College of Southern Idaho
- University of Kentucky
- Central State University
- South Dakota State University
- West Virginia University
- South Carolina State University
- Bradley University
- Falk Middle School, Pennsylvania
- Career Day, High Bridge Elementary School, Maryland
- Madison Elementary School
- Olympia High School
- High School Career Fair and Expo, DC (District of Columbia) Armory
- Ft. Pierce High School Career Day

7. The agency established or continued the following Outreach partnerships:

- *Partnership with The Confederated Tribes of the Colville Reservation* – the ARS Root Disease and Biological Control Research Unit, Pacific West Area, Pullman, Washington, leads and coordinates a major science outreach program, *Pumping-Up the Math & Science Pipeline: Grade School to College*. Co-participants in the project include: all ARS Research Units at Pullman, Washington; USDA, Natural Resources Conservation Service; Washington State University Cooperative Extension and Department of Plant Pathology; and Bellevue Community College. The program is intended to enhance and promote math and science education and expertise among Native American students from grade school through college. It also pairs high school and college students with ARS research mentors. The project has five components: (1) energy independence on the Colville Reservation by development of a science infrastructure and production of biofuels; (2) hands-on and face-to-face science education in Reservation schools by world-class scientists; (3) organization of and participation in on-Reservation summer science camps; (4) administration of the ARS Pullman Location High School and College Summer Research Internship Program; and (5) promotion of employment opportunities for Native American undergraduate and graduate students in ARS laboratories. Three students were hired at the location for summer positions and over 50 students were exposed to ARS research as part of the programs conducted.
- *Penobscot Nation, Old Town, Maine* – for the past 11 years, the Research Leader of the ARS North Atlantic Area, New England Plant, Soil, and Water Laboratory, Orono, Maine, has worked with the Director of Education, Penobscot Nation and others to identify and successfully employ a Native American Research Apprentice each year. The students selected work alongside Ph.D. scientists and technicians conducting research on biological controls of plant diseases and are exposed to the principles and practices of scientific research, as well as to USDA and ARS. The current student who was hired for the summer of 2007 was introduced (after learning of the student's interest in hunting and fishing) to the Chair of the Wildlife Ecology Department of the University of Maine and based on this introduction now has plans to pursue a bachelor's degree in wildlife ecology at the University of Maine.

- *Tribal College Librarians Professional Development Institute* – a staff member from the National Agricultural Library works closely with the Institute and is active in the Tribal College and University Library Association. In 2007, this staff member arranged for 995 books to be donated to twenty of the Tribal College libraries. From 2005-2007 some 5,664 volumes have been provided for the library collections through his efforts. This staff member has also worked with American Indian Higher Education Consortium (AIHEC) officials and Tribal College library staff to develop strategies to provide electronic information resources to faculty and students at the colleges.
- *USDA Outreach Event at Oaks Mission School Career and Information Fair* – scientific and administrative personnel from the ARS Southern Plains Area Dale Bumpers Small Farms Research Center in Booneville, Arkansas, South Central Agricultural Research Center in Lane, Oklahoma, and the Poultry Production and Product Safety Research Unit in Fayetteville, Arkansas represented ARS at this annual event. Over 850 elementary and high school students from all over eastern Oklahoma, Oaks Mission School staff and sponsors, six college/universities, two Tribal agencies, college students, parents, farmers, other community members, as well as ten other USDA agencies participated. Outreach to this underserved community of Native Americans included staffing an exhibit booth, providing a “Science in the Classroom” hands-on demonstration for 152 elementary students and their teachers, giving a seminar with hands-on activity on how to make paper for high school students, and conducting interviews to recruit and hire two high school students to work as summer interns at the Poultry Production and Product Safety Research Unit in Fayetteville, Arkansas. Outcome – two Native American students were recruited and hired for the summer and excess computer equipment has been donated.
- *Pioneers in Education, Pioneers Student Leadership Academy* – the Mid South Area ODEO Program Manager assisted the Pioneers in Education in recruiting three Tribal College students to attend the Leadership Academy. This program provides leadership development and mentoring opportunities for the underserved under-represented college students in non-traditional career fields. The focus is to expose the students to agricultural related studies and career opportunities. The students attending were from Oglala Lakota College (Kyle, South Dakota), Institute of American Indian Arts (Santa Fe, New Mexico), and Comanche Nation College (Lawton, Oklahoma).
- *Society for the Advancement of Chicanos and Native Americans in Science (SACNAS)* – for many years, ARS has participated in the annual conference of SACNAS. The ARS representatives conducted a scientific symposium titled “The Application of Genomics for Food, Feed, and Fiber Improvement” and also conducted a professional development workshop jointly with the Department of State titled “Navigating the Maze: Getting a Job with the Federal Government”; and hosted an exhibit to showcase the many career opportunities available with ARS and USDA. In addition, several ARS scientists from the Southern Plains Area participated on the SACNAS 2007 Abstract Selection Committee as student abstract reviewers.
- *American Indian Science and Engineering Society (AISES)* – for many years, ARS has participated in the annual conference of AISES by hosting exhibits to promote careers with ARS and USDA. Several ARS staff members have served on the Government Relations Council for AISES over the past years. The Associate Area Director for the ARS Mid South Area is an active participant in activities with AISES including chairing and serving as a poster competition judge, serving on the Government Relations Board, and implementing an extramural agreement grant annually for the AISES Graduate Student Poster competition.
- *SFWorks* – The Western Regional Research Center (WRRRC), Pacific West Area, has been participating since 2003 in this program established by the San Francisco Chamber of Commerce, the Committee on Jobs, and the United Way of the Bay Area. The purpose of the program is to facilitate hands-on outreach to female and minority students, providing opportunities for practical training and careers in science. The WRRRC SFWorks cooperation was strengthened in 2006 under the guidelines of a Memorandum of Understanding (MOU) executed between USDA/WRRRC and SFWorks. This MOU was prepared and implemented, and the program continued to be coordinated by staff at WRRRC in cooperation with the VP of Program Development and Operations at SFWorks. Five WRRRC Research Units have participated in the program. A total of 15 different supervisors have served as mentors and

teachers reaching out to a total of 50 interns. The majority of interns have been women, including those of African American, Hispanic, Asian, and Caucasian decent, as well as one Native American. This year marks the fifth anniversary of this unique USDA outreach effort. The impact extends beyond just the intern training, as six of these interns continued on at WRRRC in STEP and term positions. Other interns help fulfill the goal to create a vibrant, motivated and self-sufficient entry-level workforce in scientific career paths. From a total of approximately 50 interns employed at WRRRC and the Albany location, 42 have successfully graduated, pursued bioscience educations and are currently employed with firms such as T&B Systems Environmental Research Firm; California Pacific Medical Center; the University of California-San Francisco in departments such as the Gladstone Institute, Cancer Center, Diabetes Center, the National AIDS/HIV Clinicians Counseling Center, and the Cell Culture Center. Four graduates were hired by the University of California-San Francisco Laboratory Animal Resource Center. One successful graduate who completed the program at WRRRC was hired by ARS and has since transferred to Yulex Corp. (a USDA CRADA partner) in Arizona. Also, one graduate is employed in a legal firm specializing in patents for the biotechnology industry. The WRRRC Plant Mycotoxin Research Unit currently has one SFWorks student hired as a temporary, full-time laboratory technician. The WRRRC employees in this partnership were the recipients of the Administrator's Outreach, Diversity, and Equal Opportunity Award (non-supervisory category) for their accomplishments.

- *Future Scientist – Student Outreach Initiative* – FY 2007 was the 14th year that the Southern Plains Area (SPA), along with the Center for Mathematics Education and Science Education at Texas A&M University in College Station, Texas, sponsored a program for grades 4-12 science teachers to gain research skills, to increase science content, and to establish ARS laboratories as “Science Learning Centers” for teachers and students within their locale (with an emphasis on grades 5-9). The project addresses long-term needs for agricultural scientists and workforce diversity by providing middle school science teachers opportunities to enhance the science curricula of their schools with the help of ARS scientists as resource persons and ARS facilities as learning centers outside the classroom. Participating teachers have the support of their school districts and are working with their peers to reform science education in their school districts to include agricultural disciplines. In addition, the Project Director co-shared outreach booths with ARS at several major conferences; e.g., Community Day at the Hispanic Engineering, Science and Technology Conference, USDA Outreach at Oaks Mission School Career and Information Fair, Minorities in Natural Resources and Related Science National Conference, etc. The initiative was expanded to support an undergraduate initiative where the student is expected to work in a laboratory under the supervision/mentorship of an ARS research scientist and/or post-doc while receiving eight credit hours in biological research. The following are results of the initiative:
 - (1) 2,249 students (grades 4-10) from participating schools, as well as administrators and other science teachers obtained knowledge (train-the trainer) about ARS science, accomplishments, and employment opportunities; (2) Science Texas Assessment of Knowledge and Skills (TAKS) test scores increased by 6% (74% in 2006 to 80% in 2007) at a participating intermediate school; (3) Science TAKS scores were 18% and 10% above the state average at a participating elementary and high school, respectively; and (4) several elementary students, who were low science class performers and scored low on the 2006 Science TAKS test, passed the science TAKS test with commended performance. In addition, interactions on a one-on-one basis occurred with 3,497 students (36.3% minorities – 21.8% Hispanics and 14.5% Blacks). The SPA scientists in this initiative were the recipients of the Administrator's Outreach, Diversity, and Equal Opportunity Award (supervisory category) for their accomplishments.

8. Other Outreach Activities:

- The MWA initiated communications with Northeastern Illinois University (the only 4-year Hispanic Serving Institution in the Midwest States), Lincoln University (an 1890 Institution), and Haskell Indian Nations University (the only 4-year Tribal College/University in the Midwest) in order to post vacancy announcements promoting Federal employment as well as the Agency's electronic vacancy listing. This ongoing initiative promotes awareness of applicable opportunities in the Area. Applicant data from vacancy announcements will be analyzed to determine the impact of applicants from these institutions.

- Developed and published the Spanish-language version of the National Agricultural Library Agricultural Thesaurus and Glossary of Agricultural Terms, which increased Spanish language access to agricultural information throughout the United States and the world, accommodating the complexity of the Spanish language from a Western Hemisphere perspective.
- Hired three minority students from the University of Maryland Eastern Shore to work in the ARS/1890 Center of Excellence (CoE) in Poultry Food Safety Research. Four minority alumni of the ARS/1890 CoE at UMES now work for USDA.
- Partnered with the University of Washington Yakima Valley Gear Up Program which serves an area in Central Washington that is marked by extreme poverty and by low educational attainment. This program is the largest rural Gear Up partnership in the nation connecting seven school districts and a Tribal school, three community-based partners, a major research university and a community college over an area of 500 miles. This program is in its fourth year of a five-year grant and serves 6,200 students from eight Yakima Valley Schools.
- Hired a graduate of Tuskegee University, School of Veterinary Medicine into the Agency's DVM/PhD Program at the Animal Disease Research Unit, Pullman, WA.
- Participated in the First Joint Conference of Librarians of Color which was attended by over 1,100 African-American, Asian-American, Hispanic-American and Native American librarians and information professionals from across the nation who came together to celebrate and promote diversity in librarianship. Following the conference, the National Agricultural Library mailed additional information resources to a library school for a class on government resources and a high school library and media center in New Orleans that was devastated by hurricane Katrina.
- Provided guidance in establishing the "Louisiana Agricultural-Research Apprenticeship Program (LA-RAP), a program to develop and prepare minority youth for scientific experimental training. The project will give a long term presence for stimulating research interest by youth. The Mid South Area ODEO Program Manager will serve as the ARS collaborator providing technical assistance and research guidance. Southern University applied for a Capacity Building grant to fund the project. This project was funded for \$199,920 for 2007 to 2010.
- Continued the ARS partnership with Alcorn State University in an Intergovernmental Personnel Act (IPA) Agreement under Title IV of the IPA of 1970 (5 U.S.C.3371-3376) for a second year. This agreement provides an opportunity to develop an active liaison with a prominent 1890 Institution to enhance outreach activities, assist in improving the education opportunities of minority populations, prepare them to be competitive in the future workforce and to be able to solve agricultural problems of small farmers. The IPA was established and will assist Alcorn State University in developing and administering its agricultural science programs, including cooperative with and complementary to ARS' future onsite presence in the planned new ARS Biotechnology Research facility on the campus.
- Continued to support and promote the Workforce Recruitment Program for College Students with Disabilities. One individual completed recruiter training and served as a recruiter at three Hispanic Serving Institutions in the Rio Grande Valley, the only college in Texas classified as a Historically Black College/University and Hispanic Serving Institution, and at a university in southeast Texas. ARS employed four students from this program during Fiscal Year 2007.
- Continued a partnership with the University of Puerto Rico-Mayaguez and the Southern Plains Area, Cropping System Research Laboratory, Lubbock, Texas, to recruit, hire and train two Hispanic students enrolled in agriculture and agriculture-related disciplines to work as interns during the summer of 2007.
- ARS research scientists at the Southern Plains Area Children's Nutrition Research Center hosted and served as mentors for two minority students working as Unpaid Student Trainees through a USDA grant (titled "Agriculture Plant Genetics Research Project") with the Houston Community System.
- ARS research scientists at the Southern Plains Area, Grazinglands Research Laboratory, El Reno, OK, hosted and served as mentors to four minority undergraduate students who worked as Unpaid Student Trainees through a National Institute of Health grant entitled "Bridges to the Baccalaureate."
- ARS research scientists at the Beltsville Agricultural Research Center mentored over 40 Science and Technology students from three of the Science and Technology schools in Prince George's County, Maryland. This figure has more than doubled from the total in 2006. The

schools are Oxon Hill High School, Flowers High School, and Eleanor Roosevelt High School. This initiative is a result of advisory board participation and several visits to two of the schools to address the potential candidates that were seeking fall internships.

- 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 2007 Accomplishments:

1. ARS continued to review the Student Temporary Employment Program (STEP), Student Career Experience Program (SCEP), and Postdoctoral Research Program. Managers were encouraged to convert students from the STEP to the SCEP. This initiative is one of ARS' goals to improve diversity in the workforce.
 2. During FY 2007, 20 students were hired under the SCEP authority which included two African American males, two African American females, five Hispanic males, two Hispanic females, two White females, and seven White males. During FY 2007, seven SCEP students were non-competitively converted to permanent or temporary positions after graduation. The seven students included two African American females, one Hispanic female, two White females, and two White males.
 3. During FY 2007, 20 Postdoctoral Research Associates were converted to permanent positions, which included one African American male, one Asian/Pacific Islander female, two Asian/Pacific Islander males, one Hispanic male, four White females, and eleven White males.
 4. The ODEO Outreach and Recruitment Branch continued to track the participants in the ARS SCEP and Postdoctoral Research Associate Program, as a recruitment initiative. Due to the high quantity, ARS has no similar mechanism to track STEPs.
 5. ARS currently has 70 SCEP students and 974 STEP students on the roles. While both programs receive wide publicity, reports show that the STEP program is utilized more often throughout the Agency.
- Ensure that all employees complete mandatory USDA and recommended training.

FY 2007 Accomplishments:

1. All ARS employees and contractors completed the No FEAR and Anti-Harassment training courses, which were approved by the USDA Assistant Secretary for Civil Rights, using AgLearn online training. All ARS supervisors and managers completed a 20 minute video regarding reasonable accommodation.
2. The ARS FY 2007 Civil Rights Training Plan included the EEO complaint process, Reasonable Accommodation Process, NoFEAR Act, Sexual Harassment, Anti-Harassment, "What is the Difference Between Affirmative Action and Diversity?," Accountability Policy (mandated by Departmental Regulation 4300-010, Civil Rights Accountability Policy and Procedure, which holds all employees accountable to maintain an environment free of discrimination), and Management Directive 715.
3. Training included, but was not limited to, utilization of educational videos, which were available through the ODEO website, participation in small group discussions (such as brown bag lunches, etc.), participation in interactive training classes via the internet, and reading of

pamphlets distributed by the Department/Agency. The above mentioned topics are also included in New Employee Orientation programs.

4. ODEO continued to conduct EEO training for Area locations, as well as “Lunch and Learn Series” at Headquarters. The initial topic discussed was “An Overview of the Reasonable Accommodation Process.”

- Introduce Multigenerational Training and sponsor a Multigenerational Diversity Day.

FY 2007 Accomplishments:

1. During FY 2007, the Deputy Administrator, Administrative and Financial Management (AFM), conducted Multigenerational Training in the following ARS Areas: Headquarters, North Atlantic, Northern Plains, Mid South, Midwest, and Southern Plains.
2. The Director, ODEO, presented information and data on Multigenerational Issues during site visits to all ARS Areas plus the National Agricultural Library.
3. The Northern Plains Area (NPA) ODEO Program Manager included a discussion on generations during the NPA Leadership Conference in April 2007. In lieu of on-site training, an article on the four (4) different generations and a generational quiz was included in the Northern Plains Area Diversity Task Force biannual publication, *Voices*. In an August 2007 article of the same publication, the NPA ODEO Program Manager wrote an article on employee turn-over that dealt directly with generations.
4. The Mid South Area ODEO Program Manager conducted Multigenerational Training during the New Scientists Orientation, which was held in November 2006.
5. The Hilo, Hawaii location, which is located in the Pacific West Area, sponsored formal training for supervisors on how to deal with different generational expectations for career choices.

- 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 2007 Accomplishments:

1. ODEO continues to research the right vehicle to use to begin formal pilot mentoring program to ensure the development of employees in the competencies needed to accomplish current and future goals. Area Mentoring Programs established in 2007 include:
 - The SPA Director established a Mentoring Advisory Committee, which consists of a diverse group of research leaders and scientists, and the Area ODEO Program Manager, to advise him of possible courses of action for improving/orienting Research Leaders, Laboratory Directors, and Center Directors toward mentoring scientists. They have developed the criteria, bylaws, etc., defined mentoring expectations, mentor/mentee roles, etc., for the program.
 - The NPA continued 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 in attaining standards of performance that will enhance their opportunity for success and to ensure fairness and equity in evaluating professional scientific development.
2. The NASPDP provides a three-year period to enhance a newly appointed scientist’s transition into an ARS scientific position and to carefully monitor and evaluate their progress. This program covers all newly appointed Category 1 and 4 scientists, thereafter referred to as new scientists [including research leaders (RL)] within the Northern Plains Area (NPA). It includes all individuals hired under either merit or demonstration program authority and

irrespective of their probationary status. Currently there are 30 mentors and 30 protégés in the program.

3. The Pacific West Area (PWA) Workforce Diversity Committee created a mentoring program for both scientists and other employees in PWA entitled, "New Scientist Mentoring Program." It provides a formal network designed to enhance orientation, training programs, and promotion processes for scientific positions which are least reflective of the populations served in this geographic area.

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

FY 2007 Accomplishment:

1. 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, such as the Aspiring Leader Program (GS-5-7 administrative assistants), New Leader Program (GS-7-11, administrative assistants, technician, and support scientists), Leadership Evaluation and Development Program (GS-11 and above administrative employees), Executive Leadership Program for Mid-level employees (GS-11-13 scientists, managers, team leaders, and project leaders), ARS Path to Leadership Program (GS-12 and above scientists, managers, team leaders, and project leaders), Executive Potential Program (GS-13-15 scientists, managers, and supervisors), and the Executive Professional Excellence and Knowledge (GS-14 and above).

- Create, implement, and maintain a secure and confidential electronic exit interview process to determine why employees choose to leave ARS. Develop a plan to overcome any obstacles in the workforce.

FY 2007 Accomplishments:

1. In response to the barrier "Do not know why employees are leaving ARS", which was identified in the Management Directive 715 (MD-715), the Human Resources Division (HRD) and the Office of Outreach, Diversity, and Equal Opportunity (ODEO) collaborated to develop a draft electronic exit interview survey that will be provided to employees for voluntarily completion before or after departing the Agency. The coordinated process by the HRD and Office of ODEO (including the Area ODEO Program Managers) will be completed by the end of FY 2008. Implementation of the survey is tentatively planned for FY 2009.
2. As part of the MD-715 process, a barrier analyses and elimination planning process was conducted to identify problems and barriers to create a model EEO workforce. The MD-715 Report and plans to eliminate the identified barriers were developed through close collaboration and input from the Area ODEO Program Managers, Special Emphasis Program Managers, Human Resources Division, and the ODEO staff (EEO and Compliance Branch and the Outreach and Recruitment Branch) by first conducting self-assessment checklists to identify any barriers in ARS policies and procedures, followed by a workforce analysis to ensure equal employment for all groups. Other management tools used to determine obstacles in the workforce include the Federal Equal Opportunity Recruitment (FEORP) Plan and the Disabled Veterans Affirmative Action Plan.

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

FY 2007 Accomplishments:

1. 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, such as the Aspiring Leader Program (GS-5-7 administrative assistants), New Leader Program (GS-7-11, administrative assistants, technician, and support scientists), Leadership Evaluation and Development Program (GS-11 and above administrative employees), Executive Leadership Program for Mid-level employees (GS-11-13 scientists, managers, team leaders, and project leaders), ARS Path to Leadership Program (GS-12 and above scientists, managers, team leaders, and project leaders), Executive Potential Program (GS-13-15 scientists, managers, and supervisors), and the Executive Professional Excellence and Knowledge (GS-14 and above).
2. ARS continued to sponsor the AFM Leadership Evaluation and Development (LEAD) Program during FY 2007. The LEAD Program is a competitive program for employees who want to expand their leadership skills and broaden their experiences. Each participant is required to develop an individual development plan that serves as a roadmap for their developmental journey. Each LEAD Program participant experiences a combination of formal training, mentoring, details, Headquarters and field assignments, shadowing of senior executives, and self-development activities. The program assists the Agency in developing a pool of potential leaders for the future to ensure strong support for the research mission. Seven new candidates were chosen to participate in the LEAD Program during 2007, plus two others still in the program from the 2006 class. Those currently in the program include one Black female, four White females, and White males.
3. To increase Asian and Pacific Islander employee representation, ARS continued its participation in the USDA Development Opportunity Placement Program (DOPP). The DOPP provided employees with an opportunity to develop or enhance specific competencies and abilities, as well as, provide opportunities for all eligible and qualified employees to serve on details, receive temporary promotions, or participate in developmental assignments where there may be staffing shortages in headquarters and field office locations. ARS provided three (3) temporary details under the DOPP in which priority consideration was given to eligible and qualified Class Agents under the Basu Settlement Agreement. Two details were filled. One at NPA and one at the South Atlantic Area (SAA). The details completed ARS' FY 2007 requirement under the Basu Settlement Agreement
4. Each ARS Area has established Area EEO/Diversity Advisory Committees, which serve as management tools and advisors to ensure that the targeted groups are appropriately represented throughout the workforce. The EEO/Diversity Advisory Committees sponsor special activities designed to enhance diversity awareness. Special Emphasis Program (SEP) observances approved by the Office of Personnel Management or supported by the USDA Office of Civil Rights were sponsored by the Area EEO/Diversity Committees and available to all ARS employees. The ARS SEP Manager was involved in the planning of nearly all of the Departmental SEP observances. Employees are encouraged to participate in SEP observances, which are designed to raise awareness and educate employees on the cultural differences, similarities, and historical contributions.
5. The AFM Diversity Committee observed a number of special emphasis observances, including but not limited to, National Disability Employment Awareness Month, Martin Luther King Jr.'s Birthday, Black History Month, and Women's History Month.
6. The following items are a result of the various career development, leadership, and mentoring programs:

- Nine ARS employees were selected for the USDA Senior Executive Service Candidate Development Program (SESCDP). They include 1 Hispanic female, 1 Black female, 1 Black male, and 5 White males.
- Established career guides for all leadership positions as a principal component of the draft Succession Plan. These guides include critical development paths, competency requirements, and recommended online and instructor-led courses.
- Conducted the New Research Leader Training Program for 14 new research leaders.
- Initiated participation of 46 Agency employees in external career and leadership development programs. USDA Graduate School Programs: Aspiring Leaders Program - 1, New Leader Program - 5, Executive Leadership Program - 1, and the Executive Potential Program – 1; OPM Management Development Centers – 37; and OPM Federal Executive Institute: Leadership for a Democratic Society – 1.
- Trained 20 members of the Headquarters Advisory Council for Administrative Professionals (HACAP) on Resume and KSA Development. This training provided current administrative employees an opportunity to learn how to use the USAJOBS system to search for career development opportunities, develop their personal resume, as well as to submit applications for vacancy announcements.
- Minorities (24.17%) and White females (37.04%) represented 61.21% of the promotions within ARS (increase of 5.73% since FY 2006).

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

FY 2007 Accomplishment:

1. ODEO coordinated with the Human Resources Division 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: EEO Complaint Process, Reasonable Accommodation Process, No FEAR Act, Sexual Harassment, Anti-Harassment, “What is the Difference between Affirmative Action and Diversity?”, and the Accountability Policy. During FY 2007, the ODEO Director, and/or his representative, participated in each of the New Employee, New Research Leader, and Scientist Orientation programs. In addition, Area ODEO Program Managers were encouraged to participate in each of the programs in their Area as well.

- Identify barriers to parity among minorities and women in Agency award recognition programs; increase award recognition parity among minorities and women.

FY 2007 Accomplishments:

1. The ARS Human Resources Division is currently running reports to analyze the distribution of awards among Scientists, Biological Science Technicians, and Administrative Support positions to determine if distribution is equitable. Data will be run for each Area and shared with each Area Director. Similar data will be gathered and shared with Area Directors based on race, national origin, gender, and disability codes.

- 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 2007 Accomplishments:

1. The Director of the Office of Outreach, Diversity, and Equal Opportunity visited each Area Office and met with employees to explain how ODEO can assist in matters pertaining to Outreach, Diversity, and Equal Opportunity and conducted a question and answer segment.

Other ODEO staff members continue to serve ARS employees with technical support and guidance.

2. The ODEO continued to maintain visibility throughout the Agency by participating in various programs and activities listed herein.
3. The 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 2007 Accomplishments:

1. The Acquisition and Property Division deployed the Acquisition Tracking System (ATS) Customer Access/Inquiry and the Customer Notification features. Customers can access status of their procurement requests and also receive an electronic notification of the procurement offices receipt of their requisition and another notice at the time of award.
2. ARS has sustained a clean audit opinion of their Audited Financial Statements, has no material weaknesses, and has supported all Departmental efforts to design and promote the Financial Management Modernization Initiative (FMMI) through serving on multiple Pre-Implementation teams and task forces and actively participating in all Department FMMI planning meetings.

3. ARS recently completed a comprehensive review of the 90 Administrative Officer (AO) positions which are assigned to the various ARS locations. The primary purposes for the review were to: (1) reflect the evolution of the position over the past 20 years; (2) better align the positions with the current/future goals of the agency; and (3) to relieve some of the administrative burdens on the Research Leader positions.

As a result of this review, the agency issued new position descriptions, performance standards, and recruitment strategies for the AO positions. The documents reflect the AO role as “business manager” for the assigned location and as an integral member of the agency’s overall administrative and financial management community.

Based on the enhanced technical and leadership expectations associated with the updated AO positions, all selection and promotion decisions are now being made through a rigorous competency assessment. The AO must demonstrate possession of the requisite competencies prior to progression to the next level.

4. The Facilities Division developed and implemented a capital planning process, Asset Management Review Boards (AMRB), for real property acquisition, maintenance, and recapitalization. This provides a consistent and auditable method for the ARS real property portfolio management. Performance Measures are used throughout the AMRB review and approval process. All approved projects must be listed on the ARS 3-Year Capital Projects and Repair Plan in order to be considered for funding through the Agency’s annual budget process.
5. An ARS business process re-engineering team initiated actions to streamline the extramural agreements business process. The basis of the new process is the seamless integration of the Agricultural Research Information System (ARIS) and Agreements Information Management System (AIMS) into a single data base. Information previously entered in two systems at multiple steps in the process are now entered into a single interface and primarily collected up-front, at the inception of the agreement. The data gathered is used to generate all necessary documents for both incoming and outgoing agreements in a totally electronic environment.

Based on the type of agreement being entered into ARIS/AIMS, the system references all applicable laws, regulations and Agency policies via a link to the Extramural Agreements Division’s (EAD) website. This ensures Cooperators and ARS employees alike have access to up-to-date information on compliance requirements. EAD has also provided ARS employees with templates for use in establishing financial information for incoming and outgoing agreements.

Streamlining the extramural agreement process has shortened process time by approximately 50% (from 60+ days to 15-30 days). ARS Headquarters, Area, and Location offices have experienced a 50% reduction in the time needed to complete data entry and acquire the number of programmatic approvals. AIMS provides a consistent, timely and efficient process for awarding and administering ARS extramural agreements.

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.