Fiscal Year 2009 Annual Report for National Program 306,
Quality and Utilization of Agricultural Products

This National Program focuses on post-harvest quality and utilization of agricultural commodities and products. It addresses Strategic Goal 2, Objective 1, Performance 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) of the ARS FY 2006-2011 Strategic Plan.

Following an external peer review of the research in this program, a workshop that included national stakeholders and ARS scientists and management, and subsequent internal planning meetings, a new 5-year action plan was finalized in November 2008. The development of new project plans, their peer review, and implementation in 2010 will launch the second cycle for this program.

Selected accomplishments in this national program for FY 2009 are shown below under the two program components.

1. Quality Characterization, Preservation, and Enhancement

Commercialization of hidden stored grain insect detection system. Grain kernels infested by insects may show no indication on their exterior, but they often contain hidden larvae. Although grain is always inspected for insect infestations upon shipping and receiving, many infested samples go undetected. Many methods for detecting infested wheat have been developed, but none has seen widespread use due to expense or inadequate accuracy or both. 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 of them. Furthermore, the apparatus is low cost (about $1,500 for parts) and can inspect a 1-kilogram sample in less than 1 minute. A CRADA was formed with Total Manufacturing Company to produce and market commercial versions of the roller mill, and the first salable version is complete. The technology is currently being adopted by General Mills, Inc. More widespread adoption of this technology is expected in the next few years.

Joint release of new soft winter wheat cultivars. Scientists at Wooster, Ohio, joined in the release notices of the soft white wheat cultivars Ambassador and Coral from Michigan State University, the soft red winter wheat cultivar Red Amber from Michigan State University, and the soft red winter wheat cultivars Shirley, 3434, 5205, and Jamestown from Virginia Polytechnic Institute. All seven represent improvements in disease resistance and grain yield over the cultivars they are targeted to replace. All are similar in quality to the existing cultivars they are replacing or are significant improvements in quality relative to the best cultivars presently available in the target growing areas. These cultivars, which are the result of cooperative research between university-based breeding programs and the Wooster scientists, will improve the overall quality of the eastern U.S. wheat crop through improved flour yield.

More accurate assessment of flour quality. Occasionally, methods contain errors that become entrenched over the years. Researchers at Pullman, Washington, in cooperation with collaborators, identified an error in the "Solvent Retention Capacity (SRC)" method that is used extensively in both variety development work and in industry to define the potential utility of flour in baking. The official method was corrected and communicated to users, and the implications of the correction were also evaluated. The corrected method will allow more accurate and reliable assessment of flour quality.

Development of a new apparatus for cotton color measurement on color spectrophotometers. An improved pressurized fiber sampling system that can precisely measure cotton fiber samples is needed. Scientists at New Orleans, Louisiana, developed and fabricated a large sample pressure system for measuring cotton samples for use on multiple types of bench-top color spectrophotometers. The optimal pressure for measurement was established. The new fiber sampling system yielded significant improvements in color measurement consistency and variability over the present manual sampling systems for large fiber samples. Protocols for measuring large samples were established and implemented. Two additional systems were fabricated and installed for use at Agricultural Marketing Service and Cotton Incorporated.

Sugar snap cookie method revision. Scientists at Wooster, Ohio, in cooperation with researchers at Pullman, Washington, led the method development and coordinated the approval tests for the American Association of Cereal Chemistry revision of the sugar-snap cookie method, the most widely used bake test for soft wheat quality. The revised test is more uniform and reliable than the previous method for a wider range of soft wheat types in the U.S., Europe, Latin America and China. This will improve the progress in selecting wheat for the U.S. It also will allow researchers to better assess germplasm from other countries for its breeding value to improve U.S. wheat.

Microplate method for analysis of beta-glucan in malted and unmalted cereal grains, including barley and oats. Due to the recent cardiac health claim extended to both barley and oats for their beta-glucans content, there is a need for simple and efficient test methods using standard laboratory instrumentation to quantify this phytonutrient in grains. A method developed by scientists at Madison, Wisconsin, uses microplate fluorometers commonly available in research laboratories and simple, inexpensive reagents to measure this important plant constituent, making the analysis much more widely available than was previously the case using traditional flow-injection-analysis methodology. The publication describing the grain and malt beta-glucan analysis method has been highlighted by the American Association of Cereal Chemists in a listing of highly downloaded articles from the journal *Cereal Chemistry*.

Preserving cotton bale quality through safe microwave moisture measurements. Cotton is the only commodity that is sold on a wet basis. Of critical need to the industry is the development of a sensor that is capable of providing an absolute measurement of the moisture content of cotton bales because cotton quality can be significantly

degraded if stored at improper moisture contents. Researchers at Lubbock, Texas, found that existing commercial microwave moisture sensors will provide a dry reading when cotton bales are dangerously wet. When these moisture sensors were coupled with moisture restoration systems, the result was the production of extremely high-moisture-content bales that then underwent significant degradation in long-term storage. During the study, the number of dangerously wet bales that were placed into the U.S. cotton loan program was found to be in excess of 220,000. For many of these bales, the cotton was placed into the loan program or sold at one quality grade and then later, after long term storage, was found to have undergone significant degradation, and the U.S. AMS classing quality value was no longer accurate. Results of the study revealed the main issues responsible for the large errors, which led to the development of a method to eliminate those errors and provide a method for accurately measuring wet cotton bales. These findings help ensure the future integrity of the U.S. cotton industry's reputation for selling into the $4+ billion annual cotton export market by identifying problem areas with current moisture measurement techniques.

Inexpensive microwave sensor for instantaneous, nondestructive bulk density and moisture content determination in grain and seed. Rapid and nondestructive measurement of moisture content of grain and seed is crucial for determining optimum harvest time, safe handling and storage, and fair trade. A microwave sensor made with off-the-shelf components for predicting bulk density and moisture content of wheat, corn, soybeans, and peanuts was assembled, tested, and calibrated by engineers at Athens, Georgia. This new development in microwave sensing technology has generated interest from two major U.S. farm equipment companies, which filed licensing applications for the two patents on this technology; one license has already been awarded. Routine use of this technology by American farmers will allow them to improve the quality of grain and seed, avoid spoilage and waste, and augment the overall competitiveness of American agricultural products in the global market.

Presence of beneficial compound verified in California-grown mandarin oranges. Mandarin orange growers have been looking for ways to increase consumer utilization by identifying value-added biomolecules present in their products. ARS researchers at Albany, California, determined that mandarin oranges contain significant levels of dietary synephrine. Synephrine is a bioactive molecule that has been shown to have some promise as an aid to weight management and to also possess decongestant properties. The researchers also determined intragrove and intergrove variability and the effect of storage on synephrine concentrations. Results from this study were distributed through a peer-reviewed article and were picked up by the popular press. Growers indicated that these outputs were instrumental in generating increased consumer demand and ultimately contributed to the growers selling out their crop for the 2008 and 2009 seasons.

Identification of volatile compounds produced by *Aspergillus flavus* on corn. Extensive testing determined the predominant volatile compounds produced by toxigenic and non-toxigenic isolates of *Aspergillus flavus*. This work is being performed by scientists at New Orleans, Louisiana, in cooperation with Sensor Development

Corporation (SDC), which is developing a real-time electronic sensor to detect *A. flavus* growth and subsequent aflatoxin production in stored corn. SDC will patent this instrument and sell it to companies concerned with aflatoxin contamination of stored grains. The ARS researchers plan similar work in future years to detect *Fusarium* growth on stored grain. These data could lead to the development by SDC of an instrument for the detection of fungal pulmonary infections, which have a high mortality (80 percent or greater). If successful, these instruments installed in grain storage facilities and hospitals will save many millions of dollars of stored grains, help ensure the safety of the grain supply from fungal rot and toxins formation, and save many lives as well as millions of dollars for treatment of patients with pulmonary mycoses.

2. New Processes, New Uses, and Value-Added Foods and Biobased Products

Biobased fertilizers. Fertilizer costs have risen dramatically, a problem that has affected food production costs and, ultimately, food prices. Researchers at Albany, California, developed a fertilizer encapsulation matrix that, in lieu of petroleum-derived chemicals, contains entrapped functional microbes that fix nitrogen and releases nutrients, growth promoters, and insecticides into the soil for extended periods of time. The biobased fertilizer reduces the number of fertilizer applications that are required, saving labor, energy, and the environment. Such biobased fertilizer could benefit farmers in the U.S. and in developing countries that have more limited resources.

Microfilter process developed to remove spores from liquid egg white. Pasteurization, a food processing operation that is used to reduce or eliminate the natural microflora in foods such as fluid milk or liquid egg whites (LEW), is ineffective against threat agents such as spores of *Bacillus anthracis* (BA) if they were to be intentionally added to these foods through a terrorist act. In a study conducted by scientists at Wyndmoor, Pennsylvania, a cross-flow microfiltration membrane process was designed as an intervention strategy to filter spores of BA from LEW. Because LEW is a viscous material, new techniques were developed to alter the viscosity and the properties of the proteins so that only the LEW would pass through the membrane. The optimum operating conditions that preserved the delicate functional properties of LEW, such as foaming, and ensured that the constituent egg white proteins permeated through the membrane were also determined. Greater than 99.9999% of BA spores were intercepted when a 30-gallon-capacity pilot scale microfiltration unit was used to filter LEW inoculated with the surrogate strain of BA (Sterne) spores. These studies demonstrate that the addition of a microfiltration step followed by pasteurization will ensure the safety of LEW while preserving its nutrients and quality.

Apple- and tomato-based natural antimicrobial-containing edible films. Americans are increasingly concerned about the safety of their foods. Researchers at Albany, California, with support from a USDA, CSREES-funded NRI grant, are developing novel, natural antimicrobial-containing films from apples and tomatoes. Incorporation of natural essential oils from oregano, thyme, cinnamon, allspice, clove, and lemon grass into apple- and tomato-based films and coatings were found to be active against *E. coli*

0157:H7, *Salmonella enterica* and *Listeria monocytogenes*. Films have been applied to hams and chicken, and their effectiveness has been verified on these foods. In addition, tests are underway on the effectiveness of films against *E. coli* 0157:H7 in spinach. Concurrent sensory evaluations of films on foods are being performed to confirm sensory acceptability of these novel films. Continuous production methods have been developed to support future commercialization of the technology.

New antimicrobial packaging materials made from crop processing residues. Biobased products can utilize abundant crop processing residues and reduce dependence on foreign petroleum. Antimicrobial packaging materials were developed from citrus processing residues by scientists at Wyndmoor, Pennsylvania. Pectin/polylactic acid films possess mechanical properties similar to those of petroleum-derived thermoplastics, plus they can absorb antimicrobial agents and control their release, serving as an active barrier for the inhibition of growth of all classes of bacterial pathogens. In comparison with other methods, the present patented method is simpler, more efficient, and environmentally friendly (no organic solvents), and it can be easily scaled up.

New value-added lentil products. In the U.S., 1 in 133 consumers is considered to be allergic to gluten (Celiac disease). According to the USDA, the gluten-free market is currently valued at approximately $700 million and is expected to increase to $1.7 billion by 2010. Using extrusion technology, novel, lentil-based snacks rich in gluten-free dietary fiber and protein were developed by researchers at Albany, California, in collaboration with the Departments of Food Science and Human Nutrition and Biological Systems Engineering at Washington State University and in support of growers represented by the U.S. Dry Pea and Lentil Council. The value-added, lentil-based snacks had a high acceptance rating by a sensory panel. The products and technology developed under this accomplishment will be submitted as part of an invention entitled "Extruded Legumes." The commercialization of value-added, lentil-based, gluten-free products will benefit a large number of consumers who are allergic to gluten and will increase demand for this commodity.

Economical fabrication of fire-retardant/fire-barrier cotton-rich fabrics/pads for mattresses and furniture. A low-cost, cotton-rich, nonwoven pad was developed by scientists at New Orleans, Louisiana, using commercially available fire-retardant chemicals and fibers. The pad passed the California-legislated standard flammability tests for mattresses. An Agreement of Confidentiality with a U.S. firm has been signed to explore its application. Adoption of this technology will expand utilization of cotton in products that currently use synthetic fabrics.

Formulation of soybean-, corn-, and sorghum-based plywood adhesives. More protein co-products from soybean and cereal processing are expected to be generated as a result of increased demands for biofuels. Soybean meal, corn germ, and sorghum flour contain proteins with desirable functional properties that were exploited by researchers at Peoria, Illinois, to produce plywood glues. The glues with the alternative protein extenders had mixing properties and bonding strength that equaled those of the

industry adhesive and are viable protein extenders in plywood glues. Efforts underway to transfer this technology to industry will result in a beneficial economic impact for the plywood industry and soybean and corn farmers.

Leather finishing with natural antioxidants for enhancing leather durability. Durability of automotive leather is compromised by exposure to ultra-violet (UV) light and heat. Researchers at Wyndmoor, Pennsylvania, developed an environmentally friendly finishing process to counteract UV and heat degradation of leather. The process involves application of mixtures of humectants and tocopherols (Vitamin E) to the grain layer of chrome-free leather. Leather treated with glycerol/tocopherol mixtures had significant improvement in strength retention and color fading resistance against UV radiation and heat. This research program strengthens the competitiveness of the U.S. hides and leather industries by encouraging environmentally friendly production, while imparting better quality to the finished product.

Bio-based soil flocculant derived from poultry blood. Unlike the blood generated in beef and pork processing, the blood from poultry processing often is not collected and becomes part of the processing plant's wastewater stream. Treating the blood in this way adds significantly to the cost of poultry processing, while failing to capture its value. Researchers at Wyndmoor, Pennsylvania, discovered that if the blood is collected and processed correctly, it can be turned into a stable product that is very effective at flocculating clay particles from water. This biobased flocculant compares favorably with fossil fuel-based commercial flocculants in terms of both price and performance. This accomplishment will benefit poultry processors by transforming a costly waste product into to new, revenue-generating product. It will also benefit those with a need to control erosion and protect surface water quality, which includes growers practicing furrow irrigation.