

## Produce Quality and New Uses (NP 306) 2020 Annual Report

### Introduction

The USDA-ARS National Program for Product Quality and New Uses (NP306) in 2019 completed the fifth year of its 5-year research plans for the various research projects. Scientists in NP306 continue to demonstrate impact in numerous and diverse areas of research that enhance marketability of agricultural products, increase the availability of healthful foods, develop value-added food/nonfood products, and enable commercially-preferred technologies for post-harvest processing. National Program 306: Product Quality and New Uses (including biorefining), Vision & Relevance can be found at: <https://www.ars.usda.gov/nutrition-food-safetyquality/product-quality-and-new-uses/> and includes: the FY2020-2024 Action Plan for NP306.

The overarching goal of NP 306 is to conduct research that develops knowledge and enables commercially-viable technologies to: (1) Measure and maintain/enhance post-harvest product quality, (2) Harvest and process agricultural materials, and (3) Create new value-added bio-based products.

By developing commercially viable technologies that maintain/enhance postharvest product quality and create new products, ARS Product Quality and New Uses research increases the demand for agricultural products and, therefore, benefits both agricultural producers and rural communities.

This National Program is organized into three problem areas:

(1) Foods – Problem Areas of research are: 1a. Define, measure, and preserve/enhance/reduce attributes that impact quality and marketability; 1b. New bioactive Ingredients and health-promoting foods; and 1c. New and improved food processing and packaging technologies;

(2) Non-Foods – Problem Areas of research are: 2a. Maintain/enhance fiber and hide quality; and 2b. Enable technologies to produce new and expand marketable nonfood biobased products derived from agricultural feedstock.

(3) Biorefining – Problem Areas of research are: 3a. Viable technologies for producing advanced biofuels (including biodiesel), or other marketable biobased products; 3b. Technologies that reduce risks and increase profitability in existing industrial biorefineries; and 3c. Accurately estimate the economic value of biochemical, thermolysis conversion technologies.

## NP 306 accomplishments for FY20

During FY 2020, National Program 306 had 219 full-time scientists and 48 vacancies working at 21 locations across the U.S. actively engaged in 62 ARS-base Projects. Number of graduate students and postdoctoral students (89). The quality and impact of NP 306 research was further evidenced in 2020 by the following:

- 318 refereed journal articles published
- 14 new patents
- 28 new patent applications
- 27 new invention disclosures submitted
- 7 current cooperative research and development agreements with stakeholders
- 8 new material transfer agreements with stakeholders.

In 2020, NP 306 scientists participated in research collaborations with scientists in 39 different countries: Argentina (1), Australia (10), Austria (2), Belgium (3), Brazil (32), Canada (9), Chile (2), China (37), Colombia (4), Denmark (2), Egypt (1), Ethiopia (1), France (3), Germany (4), Ghana (2), Greece (6), India (2), Israel (4), Italy (7), Japan (7), Kenya (2), Malaysia (3), Mexico (6), Netherlands (4), New Zealand (2), Panama (2), Philippines (5), Singapore (1), Slovakia (2), South Africa (2), South Korea (17), Spain (12), Sweden (2), Taiwan (1), Tajikistan (3), Thailand (1), Turkey (6), Uganda (2), and United Kingdom (15).

This section summarizes significant and high impact research results that address specific components of the FY 2015 – 2019 action plan for NP 306. Each section summarizes accomplishments of individual research projects in NP 306. Many of the programs summarized for FY 2020 include significant domestic and international collaborations with both industry and academia. These collaborations provide extraordinary opportunities to leverage funding and scientific expertise for USDA-ARS research by rapidly disseminating technology, which enhances the impact of ARS research programs.

### **Significant Accomplishments for FY 2020 – NP306**

COVID antiviral cotton facemasks. During the COVID-19 enforced maximal telework period ARS researchers at New Orleans, LA, in collaboration with a medical trauma wound dressing company, revealed that a jointly developed cotton nonwoven product exhibited antiviral activity. The natural compound in cotton (hydrogen peroxide) was discovered by ARS and tested by a contract company and was found to have antiviral activity based on a molecular model of SARS-CoV-2 virus. The product exhibited 99.999 percent antiviral activity after 1 hour of contact with the fabric. Nonwoven cotton will be studied with collaborators to determine its ability to inhibit COVID-19, which is caused by the current SARS-CoV-2 virus. Following testing by a secondary company to obtain a Food and Drug Administration-approved ISO test for antiviral textiles, the company plans to develop a prototype for use in facemasks. (NP306, C2, PS2a, Project No. 6054-41430-007-00D)

Removing plastic contamination and increasing cotton's value. Plastic contamination is the single biggest threat to the U.S. cotton industry to date. According to the USDA Agricultural Marketing Service, most of the plastic contamination in test samples from ginned cotton in the United States originates from plastic material used to wrap the harvested cotton modules formed by state-of-the-art cotton harvesters. Plastic contamination is the major reason for the loss of the premium grade status. U.S. grown cotton was once well received on the international market for its reputation as the world's reliable source of contaminant-free natural fiber. On an annual basis the loss is more than \$750 million. ARS researchers in Lubbock, TX (with assistance from ARS researchers in Las Cruces, NM), developed a low-cost system that identifies and removes plastic and other contaminants in harvested cotton before being ginned. This system, commercially known as VIPR (for Visual Inspection and Plastic Removal), uses imaging sensors

from the cell phone industry with low-cost embedded microcontrollers to identify contaminants. When a contaminant is detected, a pneumatic system blows the contaminant out of the cotton and onto the floor. Commercial testing shows that the system can operate with detection/removal efficiency of more than 90 percent. This technology was developed, tested, and successfully transferred to a commercial partner and is now being sold domestically and internationally. This system will return “premium grade” status to U.S. cotton and over the next decade is expected to earn the industry more than \$7 billion. (NP306, C2, PS2a, Project Nos. 3096-21410-008-00D and 3050-41000-009-00D)

Discovery of a standard reference for wheat “falling number” quality determination. Falling number is an 80-year-old method used the world over to measure the quality of harvested wheat. There has long been a need to identify a stable reference material to standardize the precision and accuracy of machines that calculate falling numbers. ARS engineers in Beltsville, MD, determined that corn starch is an excellent material to serve as a substitute for harvested wheat because of its high precision in falling number tests, long shelf life, and low cost. Government regulatory agencies in Canada, the USDA Agricultural Marketing Service, and private grain-handling and milling companies are, for the first time, developing the acceptable limits for a worldwide standard chart, based on this standard reference, to reliably determine wheat falling number. (NP306, C1, PS1a, Project No. 8042-44000-001-00D)

Biobased cat litters made from renewable low-value plant fibers. ARS scientists in Peoria, IL, using low-value, invasive Eastern red cedar (ERC) wood chips, developed new absorbents and pest control products. ERC lumber and sawdust were processed for optimal use as a biobased absorbent that contains essential oils shown to be repellent and/or toxic to fleas and ticks. An absorbent formulation consisting of 10 percent ERC biochar, 84 percent ERC wood fibers, 4 percent guar gum, and 2 percent mineral oil provided excellent suppression of odors, including the major cat urine odor compound, and had physical and chemical properties equal to or superior to the top three biobased cat litters currently on the market. A U.S.-based pet care company has signed a confidential agreement to work with ARS scientists on this cat litter and an invention disclosure has been approved by the ARS Chemical Patent Committee. (NP306, C1, PS1c, Project Nos. 5010-41000-167-00D and 5010-41000-169-00D)

Unlocking the genetic resistance of soft winter wheat preharvest sprouting (PHS). PHS is the germination of wheat grains in the field before harvest following 2 or more consecutive days of rain with cool temperatures. These weather conditions occur in the soft winter wheat growing region about once every 2 years and farmers can lose approximately 30 percent of their crop value, which translates into approximately \$420 million annually in the United States. Much is known about the biochemical process of PHS but little is understood about the genetics of PHS. Because its genetic nature is not well understood, few markers exist for breeders to use in developing resistant lines. ARS scientists in Wooster, OH, completed a survey of PHS resistance in a population of nearly 200 diverse soft wheat breeding lines over 3 years and over 2 years in a second, and a more diverse population of older varieties. Nine soft winter wheat varieties were identified as PHS-tolerant over multiple years under PHS-inducing conditions. These findings provide important information for breeders about varieties with tolerance to PHS and the potential for future breeding of PHS resistance. (NP306, C1, PS1a, Project No. 5082-43440-001-00D)

First ever control of blueberry fruit rot. Control of postharvest blueberry fruit rot is important to maintain domestic and international marketing and shelf life, and to reduce fruit loss and waste. To date no products have been registered specifically to control blueberry fruit rot. ARS researchers in Parlier, CA, tested reduced-risk fungicides as a preharvest treatment and a postharvest continuous ozone fumigation to control blueberry fruit rot. A mixture of the fungicides fludioxonil and cyprodinil was

## NP 306 accomplishments for FY20

found to significantly reduce gray mold and *Alternaria* rot, the two most important postharvest rot diseases of blueberries grown in California. Continuous ozone fumigation at low doses significantly reduced gray mold and its fruit-to-fruit spread. These treatments provide new tools for control of commercial postharvest fruit rot diseases of blueberries. (NP306, C1, PS1a, Project No. 2034-43000-039-00D)

ARS develops the first automated peanut sampling system. Every load of peanuts a farmer delivers for sale is sampled and graded by the USDA Agricultural Marketing Service (AMS) to determine its quality and value. Each load is parked beneath an overhead pneumatic sampler where human operators crawl through the truckload of peanuts to insert a probe up to 15 times in specified locations to obtain samples for testing. ARS engineers in Dawson, GA, designed and installed an instrumentation and control system that automatically senses the load of peanuts under the sampler, locates the trailer, and controls the sampler to probe the trailer according to the prescribed probe patterns. AMS personnel conducted tests for 2 years and have approved the control system for installation at commercial peanut facilities for official sampling. This device reduces the reliance on seasonal labor and improves the consistency and accuracy of the sample used for determining peanut quality and value. (NP306, C1, PS1a, Project No. 6044-41430-006-00D)

High-value gluten-free fiber from grapefruit citrus peel waste. When citrus fruits are processed into juice the waste material is usually converted into low-monetary-value animal feed and molasses in a process that is energy demanding and costly. This process destroys compounds within the residues that, if recovered, can be used to make high-value products such as gluten-free fiber. Low-cost and low-energy-use steam explosion systems have been used in the past to recover valuable compounds from orange juicing waste residues but never from grapefruit juicing residues. As part of a research agreement with an industry partner, ARS scientists in Fort Pierce, FL, conducted steam explosion on grapefruit processing residues and successfully recovered gluten-free fiber, high-value pectin, phytonutrients, and essential oils. These scientists continue to interact with stakeholders interested in using steam explosion on an industrial level for processing grapefruit peel waste residues at their facilities into high-value bioproducts. (NP306, C1&2, PS1a&2b, Project No. 6034-41000-017-00D)

Making pulses a novel, issue free, food ingredient. Pulses (dried beans) provide valuable health benefits in the diet but are a relatively minor component in the U.S. food economy due to issues such as long cooking time, beany taste, flatulence, and abdominal discomfort. New processing methods are needed to provide pulse-based functional food ingredients in a form that facilitates their incorporation into various food products while minimizing negative characteristics. ARS scientists in Peoria, IL, successfully used jet-cooking to separate navy bean flour into readily obtained water soluble and insoluble fractions while leaving behind almost all the flatulent sugars and the “beany” taste. The researchers discovered the insoluble fractions could serve as a fiber and protein ingredient to fortify bread or spreadable food products, while the soluble fraction has good emulsification and foam properties, making it a potential substitute for egg whites. Because the isolated fractions can be dried and reconstituted or used directly, food producers and consumers can readily adapt them into their manufacturing or food preparation processes. (NP306, C1, PS1b, Project No. 5010-41000-168-00D)

Potato postharvest quality evaluations and release of new potato cultivars. Acceptable processing quality after storage is an essential attribute of a successful potato variety. The standardized evaluation procedures developed and used by ARS scientists in East Grand Forks, MN, a worksite of the ARS research unit in Fargo, ND, have been an important component of the overall process for evaluation and release of new cultivars by Federal and State cooperators nationwide. In the past year, in support of

## NP 306 accomplishments for FY20

Federal and non-Federal public breeding/screening programs, 139 advanced breeding lines were analyzed for storage/processing quality at multiple storage temperatures and durations. Since 2015, 17 chip clones and 14 fry processing clones identified in East Grand Forks to have superior storage quality have advanced through rigorous national variety testing platforms aimed at providing potato industry stakeholders a high-quality processed potato product throughout storage. Data from these analyses have contributed to the national release of new potato varieties with superior processing quality throughout storage. (NP306, C1, PS1a, Project No. 3060-21430-007-00D)

ARS annual Hard Winter Wheat Crop Quality Survey. ARS scientists in Manhattan, KS, completed the annual Hard Winter Wheat Crop Quality Survey involving the evaluation of more than 600 individual and more than 100 composite, hard winter wheat samples for milling and baking quality. The resulting data were posted in real time to a web page managed by Plains Grain, Inc., as the harvest progressed; the data were also used by U.S. Wheat Associates in its final annual report for domestic and international export customers. (NP306, C1, PS1a, Project No. 3020-44000-026-00D)

Corn starch: It's an emulsifier and a pesticide. An emulsifier allows two normally insoluble materials to become a stable mixture. Many industrial emulsifiers use carcinogenic or highly hazardous ingredients. As a result, there is a constant need for improved industrial emulsifiers that provide biobased and safe alternatives. ARS scientists in Peoria, IL, have developed an economical emulsifier that uses corn starch and a vegetable oil. This new emulsifier (called an AIC) forms suspensions of oil in water, which are stable for months and makes water slicker, allowing the AIC-water solutions to lubricate parts and allowing for efficient cleaning. In addition, the AIC can control Gram-positive bacteria, yeast, mold, fungi, and some insects, including termites. The ability of corn starch to function as both an emulsifier and pesticide is highly attractive and has given it a higher value. This new technology allows for the replacement of imported emulsifiers or those that use hazardous ingredients or processes. These new products are being promoted by industry resulting in new applications for corn starch benefiting corn producers, processors, and consumers. (NP306, C1 & C2, PS1c, & PS2b, Project No. 5010-41000-166-00D)

Treatment of poison ivy dermatitis. ARS researchers in Oxford, MS, in collaboration with ElSohly Laboratories, Inc. and university researchers, are developing preventive treatments for poison ivy dermatitis. Development to date has shown that derivatives of urushiol, the oil in poison ivy that causes dermatitis, to be effective in animal models for desensitization to poison ivy dermatitis and to have desirable bioavailability and toxicological properties. This product has been given "investigational new drug" (IND) status by the Food and Drug Administration. (NP306, C2, PS2a, Project No. 6060-41000-012-00D)

Economically fermenting xylose into ethanol. Xylose is cheap, abundant sugar naturally present in biobased materials, and for the past 30 years scientists have been working to develop brewer's yeast that ferments this sugar into ethanol. Although the process has been successful, the rate of fermentation is still low by industrial standards. To speed up the fermentation process xylose needs to gain faster access into the yeast cells, which occurs via transporter proteins. ARS researchers in Peoria, IL, have developed a yeast that has two novel xylose transporter proteins, thus improving the rate of fermentation rate by 10 percent. Improving the rate of fermentation allows an ethanol plant that produces 40 million gallons per year to produce 4 million extra gallons, bringing down the cost of ethanol production. Increasing fuel ethanol production directly benefits farmers by creating demand for their unused agricultural residues through more efficient biorefining. (NP306, C3, PS3a, Project No. 5010-41000-178-00D)

A novel “green” process for germinated, brown rice beverage. The functional beverage market offers a consumer-friendly mechanism to rapidly ingest healthy alternates to dairy products. ARS researchers in New Orleans, LA, developed methods to deliver superior all-natural value-added rice beverages using green technologies. Green technologies for food processing was defined as being sustainable, less harmful to the environment, and entails the use of safe, natural chemical processes to transform raw products into value-added foods and ingredients. The researchers described a novel method for germinating and processing unstabilized raw brown rice that leads to a completely green process and free-flowing soluble matrix that renders a beverage. The “green” sprouted brown rice beverage has no additives, fortifications, added oils, or salts. The method has very low inputs, requires minimal equipment, and is applicable for both germinated brown and colored rice varieties. An invention disclosure was submitted, resulting in the transfer of this knowledge through publication. The global market for plant-based alternatives to dairy beverages is expected to surpass \$34 billion by 2024. This new plant-based, protein-rich functional beverage with proven health-beneficial attributes will have a positive economic impact on that market. (NP306, C1, PS1a, Project No. 6054-41000-107-00D)

Stopping the degradation of sugarcane during temporary storage. Microbial deterioration of sugarcane starts as soon as it is harvested. Harvested cane is commonly stored while awaiting processing, but significant sugar losses occur during storage because of microbial degradation. ARS researchers in New Orleans, LA, working with a private company tested liquid sodium permanganate application to the sugarcane during storage and compared its ability to prevent sugar loss via microbial degradation against other currently used products (bleach, biocide). Sodium permanganate was better than bleach at preventing sugar loss to microbial degradation. A preliminary economic analysis estimates an annual revenue increase for the average Louisiana sugarcane factory to be approximately \$1.95 million using sodium permanganate. Expanded to the entire Louisiana sugar industry, this early treatment system could increase the annual revenue of the industry by a net of 1.64 percent or \$44.4 million. (NP306, C1, PS1b, Project No. 6054-41000-111-00D)

A new starter culture accelerates the conversion of sugars to acids in the fermentation of commercial pickle production. Out of 243 bacterial isolates from commercial cucumber fermentations, ARS scientists in Raleigh, NC, identified 18 cultures that were able to ferment cucumbers under various conditions of temperature, pH, and salt content. Cultures that were unable to produce potentially carcinogenic biogenic amines in cucumber fermentation brines were selected for further study. These starter cultures produced exopolysaccharides (sugar chains that serve as prebiotics) that feed helpful bacteria that are naturally present in the human gut. Five of the 18 cultures were found to be suitable for use as starter cultures in low-salt fermentations currently undergoing commercial development. One starter culture was transferred to the private sector for commercial production and was used in the United States and in Germany, Mexico, and Turkey for the manufacture of cucumber pickles. The availability of these starter cultures enables the continued and expanded use of the technology to manufacture pickles with low salt and minimized environmental impact. (NP306, C1, PS1b, Project No. 6070-41000-008-00D)

Stevia has no negative effect on the gut. Stevia is a popular plant-based low-calorie sweetener loved by consumers who consume a low-carbohydrate diet. Stevia is a natural plant-based sweetener extracted from the leaves of the *Stevia rebaudiana* plant using water or ethanol, and then dried. Recently, questions have been raised about the safety of stevia and similar extracts. ARS scientist in Wyndmoor, PA, studied the effect of stevia on models of human gut bacteria and found that stevia has no adverse impact on the bacteria in the human gut models. (NP306, C1, PS1b, Project No. 8072-41000-102-00D)

Stopping the yellowing of wool. Wool is a major textile fiber obtained from agricultural animals. However, the long-term exposure of wool to sunlight often causes yellowing and reduces its commercial value. ARS scientists in Wyndmoor, PA, have developed a simple treatment that decreases yellowing by treating wool using a vitamin-like substance, para-aminobenzoic acid (PABA), in combination with high-absorbance ultraviolet (UV) light. The yellowing rate as measured using an absorption-metric colorimeter was greatly diminished when wool fabrics were treated with PABA and UV light. An invention disclosure patent has been submitted and ARS scientists are seeking an industrial partner to commercialize this new process to preserve wool. (NP306, C2, PS2a, Project No. 8072-41440-024-00D)

### **Biobased Accomplishments**

Improved packaging film made from renewable, inexpensive cotton waste materials. There is increasing concern about the environmental impact of nondegradable plastics accumulating in landfills and the oceans. One solution is to replace some of these fossil-fuel based nondegradable plastics with water-soluble, biodegradable plastics. Poly(vinyl alcohol) (PVOH), derived from plant sources, is water-soluble and biodegradable and the perfect candidate for this replacement. ARS scientists in Peoria, IL, discovered that when PVOH is blended with cotton gin trash (CGT, a waste material left over after cotton processing), it resulted in a low-cost biodegradable composite that is applicable for making composite films or plastics. When CGT is chemically modified, properties of the blended films were further improved for diverse applications. Using CGT in a higher-value product, like biodegradable plastics, increases the value of U.S. cotton coproducts, which benefits U.S. cotton farmers and helps mitigate plastic pollution. (NP306, C2, PS2a, Project No. 5010-41000-174-00D)

Green technique for producing cellulosic composites with improved structural properties. Wood is mainly composed of cellulose and lignin. To remove the lignin is a complex and expensive process that destroys the inherent structure of the wood. ARS scientists in Peoria, IL, have developed a unique green method for removing lignin from woody biomass that leaves the woody cellulosic structure intact. The removal of lignin from woody biomass is accomplished by using acetic acid and hydrogen peroxide. Novel composites can then be produced by infusing the lignin-free cellulosic with biobased polymers (such as corn starch or corn-derived polylactic acid), which have improved properties. A variety of cellulosic-based materials have been treated in this fashion, including pine and oak. Non-woody samples, such as soy hulls or alfalfa, can also be processed to provide cellulose composites. The wood composites produced using materials from corn will benefit corn growers and producers as well as tree processors by providing another product line for corn and woody products. ( NP306, C2, PS2a, Project No. 5010-41000-174-00D)

New renewable, plant-based engine oil additive. There is a great demand in the United States and the world to find new biobased engine additives to help improve lubricant issues found in fossil fuel-based oils. The purpose of an oil is to provide lubrication between two moving metal surfaces. The oil must be of low viscosity (water-like) to penetrate the contact areas yet be viscous enough to provide separation between the moving surfaces at all operating temperatures. As oil heats up in an engine, its viscosity changes and good separation of the moving parts is no longer maintained. ARS scientists in Peoria, IL, used ARS-created and commercialized estolides (made from sunflower and soybean oils) to develop a new type of engine oil additive that solves these engine lubrication problems. When small amounts of these materials are added to an engine oil, the oil's viscosity remains nearly constant over a broad range of temperatures. These new materials are beneficial to farmers, consumers, and retailers because they are environmentally friendly, improve utilization of soybean and sunflower production, and enhance economic security for rural communities. (NP306, C3, PS3b, Project No. 5010-41000-171-00D)

Novel high-value sorghum coproducts. An economic obstacle to producing cellulosic biofuels is the low market price of bioethanol relative to its operating and very high capital costs. ARS researchers in Peoria, IL, working with University of Illinois scientists in Urbana, solved this problem by developing a new process that allows glucose and xylose to be extracted separately from sorghum grain. Glucose is conveniently fermented to ethanol. The xylose syrup was concentrated and then converted to a nutritional product using an engineered brewer's yeast from the ARS microbial collection. The product was beta-carotene, which our bodies use to produce vitamin A. This research will be of interest to those who work on commercializing cellulosic biofuels and more generally to agriculturally based refiners and farmers looking to find new markets for their crops. (NP306, C3, PS3a, Project No. 5010-41000-176-00D)

New biorefinery-compatible oily yeast strain platform for synthetic biology. Over one billion tons of cellulosic biomass (the structural portion of plants), which can be converted into biofuels and biobased products, can be available throughout the United States without impinging on corn and other row crop production. ARS researchers in Peoria, IL, identified a yeast named *Candida phangngensis* that is suitable for commercial development and closely related to existing commercial yeast strains used in synthetic biology and generally regarded as safe. The new yeast strain produces a plant-like oil from cellulosic sugars and can be transformed to grow on all biomass sugars to produce even more oil. This new strain is expected to advance the economic feasibility of high-quality biodiesel and jet fuels from renewable herbaceous and woody biomass, reducing U.S. dependence on fossil fuels while supporting rural economies and conserving the environment. (NP306, C3, PS3a, Project No. 5010-41000-177-00D)

Identification of genes for degrading plant biomass. Renewable conversion of plants to products begins with breaking down the fibers in plant material. In nature, fungi do the heavy lifting in biomass breakdown. ARS scientists in Peoria, IL, collaborated with the Joint Genome Institute and scientists from Colombia and the Netherlands to decode the genome of a unique fungus for that natural process. This is the first in-depth genome/transcriptome analysis in an understudied group of fungi with powerful machinery for breaking down plant fibers. More than 50 new genes related to biomass breakdown were identified. This fungus has an arsenal of genes and enzymes needed to break down biomass fibers. The genes and enzymes can be "borrowed" to break down plant polymers and make value-added fuels and chemicals. This research and these results will benefit producers of renewable products who seek effective enzymes to deconstruct the fibers in plant biomass. (NP306, C3, PS3a, Project No. 5010-41000-178-00D)

### **Nano Technology Accomplishments**

Use of nano-proteins to provide an antifogging surface. Antifogging agents are chemicals that prevent the condensation of water in the form of small droplets on a surface. Without antifogging treatment, condensed water forms fog-like droplets on the surface of glass or plastics and scatters light, causing low visibility. ARS scientists in Peoria, IL, have improved on a previously patented ARS invention to produce protein nanoparticles that outperform commercial antifog solutions. These biodegradable nanoparticles are made using proteins (from wheat, soybean, or milk) combined with a petroleum-based material. Any surface that may have water fogging or beading on it will benefit. This includes surfaces such as windows on cars, boats, homes, and buildings. In addition, eyewear, such as eyeglasses, and medical and swim goggles, will also benefit. End consumers will benefit, and depending on the protein used, so will farmers and stakeholders in the wheat, soybean, and milk value chains. (NP306, C3, PS3a, Project No. 5010-44000-053-00D)

Improved products using nanocellulose derived from corn stover. Cellulose is the substance that is responsible for a plant's strength. If cellulose is reduced to a nano scale (one billionth of a meter) it is called nanocellulose (NC). NC produced from corn stover was developed by ARS scientists in Peoria, IL. NC has been shown to provide value in many end uses and products, including polymer blends, medical devices, cosmetics, and waste treatment. In all these applications, the NC must be pumped from one location to the next. For the full value of corn stover NC to be realized, its flow properties must be understood. The scientists used state-of-the-art techniques to determine the flow properties of NC suspensions, which will allow for the production of improved NC-based products. Corn producers and processors will benefit from developing a high-value use from what is normally left over on the corn field. (NP306, C3, PS 3a, Project No. 5010-44000-053-00D)

New analytical techniques to characterize silver nanoparticle-treated textiles. Silver nanoparticles are added to clothing for their powerful ability to kill bacteria and fungi and the odors they cause. To develop safe and reliable nanoparticle-enhanced products, it is essential to have proper analytical techniques that evaluate the resulting technologies and products. However, currently available techniques are complicated, destructive, expensive, and time consuming. ARS researchers in New Orleans, LA, developed two simple, cost-effective, fast, and accurate surface-enhanced Raman spectroscopic methods to quantify silver nanoparticles. The first method, which uses plasmonic hot spots of aggregated nanoparticles, measures silver nanoparticles in a (washing) solution. The second method, which uses a dye to generate a distinctive Raman signal, measures silver nanoparticles in a solid (textile) material. These methods are extremely sensitive, accurate, and better than conventional methods in distinguishing silver nanoparticles from other silver species and mapping the distribution of nanoparticles in textiles. ARS researchers verified the uniformity of the developed silver nanoparticle-embedded cottons and their washing durability. The first method was supported by the ARS Innovation Fund and the National Science Foundation, and its novelty was highlighted as a featured article on the front cover of the journal *Analytical Methods*. (NP306, C2, PS2a, Project No. 6054-41000-106-00D)