Produce Quality and New Uses (NP 306)
2021 Annual Report

Introduction

The USDA-ARS National Program for Product Quality and New Uses (NP306) in 2020 established the first year of its 5-year research plans for the various research projects. Scientists in NP306 will 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, reduce food loss, and waste, and enable commercially preferred technologies for post-harvest processing and biorefining. 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 factors 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-Food (fibers including hides) – 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 feedstocks.

(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.

During FY 2021, National Program 306 had 193 full-time scientists and 47 vacancies working at 21 locations across the United States actively engaged in 61 ARS-based Projects. Number of graduate students and postdoctoral students (61). The quality and impact of NP 306 research was further evidenced in 2021 bythe following:

- 298 refereed journal articles published
- 11 new patents
- 27 new patent applications
- 16 new invention disclosures submitted
- 4 current cooperative research and development agreements with stakeholders
- 28 new material transfer agreements with stakeholders.

In 2021, NP 306 scientists participated in research collaborations with scientists in 34 different countries: Argentina (1), Australia (6), Austria (1), Belgium (1), Brazil (14), Canada (4), Chile (1), China (15), Colombia (1), Denmark (1), France (2), Germany (1), Ghana (2), Greece (4), Israel (3), Italy (3), Japan (3), , Malaysia (1), Mexico (3), Mozambique (1),), New Zealand (1), Philippines (4), Singapore (1), Slovakia (1), South Africa (2), South Korea (5), Spain (7), Sweden (1), Switzerland (1), Tajikistan (1), Thailand (1), Turkey (4), Uganda (2), and United Kingdom (4).

This section summarizes significant and high impact research results that address specific components of the FY 2020 – 2024 action plan for NP 306. Each section summarizes accomplishments of individual research projects in NP 306. Many of the programs summarized for FY 2021 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 2021 – NP306

FOOD

Resistant starch (RS) pasta provides benefits to people with high blood sugar. Having low insulin sensitivity (insulin resistance, the responsiveness of the body's cells to insulin) is believed to be a major risk factor for several serious diseases, including metabolic syndrome, Type 2 diabetes, obesity, heart disease and Alzheimer's. Luckily, several studies have shown that resistant starch (RS) can improve insulin sensitivity. In addition, RS is very effective at lowering blood sugar levels after meals. By improving insulin sensitivity and lowering blood sugar, RS may help consumers avoid chronic disease and improve their quality of life. Chayotextle is a type of gourd native to Mexico and Central America and is a rich source of RS. ARS scientists in Albany, California, developed a healthy pasta (spaghetti) from novel formulations containing nonconventional and underutilized native and modified chayotextle with 31-36 % RS. The study demonstrated the possibility for producing spaghetti containing up to 40% modified chayotextle, with acceptable quality and functional properties. The healthy pasta could provide a healthy alternative to commercial pasta (which has a negligible content of RS), for people suffering from low insulin sensitivity and high blood sugar. (NP306, C1, PS1b, Project No. 2030-21410-022-000D)

Resilience CL+, a new soft white winter wheat delivering high yield and disease resistance. Soft white winter wheat is the leading type of wheat grown in the Northwest United States. New varieties are always needed to provide producers with higher yields and lower risks associated with diseases. ARS scientists in Pullman, Washington, in cooperation with scientists at Washington State University, developed and released 'Resilience CL+' a soft white winter wheat variety. Resilience CL+ has high grain yield potential, and resistance to stripe rust and foot rot, which can routinely reduce crop yields

by 40% or more. Resilience CL+ will provide producers an additional option for growing high yielding wheat in eastern Washington and similar areas. (NP-306, C1, PS1c, Project No. 2090-43440-008-000D)

Sorghum components shown to have value to inhibit spread of colon cancer in lab trials. Sorghum polyphenols have been shown to exert an anti-cancer effect in limited cell and animal studies. The mechanisms behind this anti-cancer effect are not well understood and at the same time these mechanisms are important to understand to design further studies including animal and human models. ARS scientists at Manhattan, Kansas in collaboration with researchers at the University of Maryland, College Park, Maryland tested sorghum polyphenol extracts on four different colon cancer cell lines and probed the mechanisms behind the anti-cancer effect. Sorghum polyphenols limited the ability of the cancer to spread to other cells. This study provides justification for further research using animal models and justifies sorghum to be researched as a health food. (NP-306, C1, PS1b, Project No. 3020-43440-002-000D)

Sorghum proteins improve functionality of wheat-free dough. While isolated corn proteins (zein) are known to be able to form a dough the resulting baked goods are deficient relative to wheat-based foods. To improve the quality of wheat-free dough made from corn proteins, ARS scientists at Manhattan, Kansas collaborated with scientists from South Africa to investigate the ability of sorghum proteins to improve the quality of dough made from zein. When sorghum proteins were added to zein, the dough formed from the mixed proteins was improved over dough made from zein alone. This research demonstrated that mixtures of corn and sorghum proteins work together to form a better dough which could lead to improved wheat-free baked food products and new commercial opportunities for isolated sorghum proteins. (NP-306, C1, PS1a, Project No. 3020-43440-002-000D)

Potato varieties with reduced acrylamide concentration identified. Acrylamide is an unwanted and potentially toxic by-product produced when carbohydrate-rich foods are processed at high temperatures. Several potato clones exhibiting excellent processing characteristics and very low acrylamide levels were identified among entries in the National Fry Processing Trials by ARS scientists at East Grand Forks, Minnesota. These clones will be evaluated in more detailed trials and may be candidates to replace currently used varieties in the commercial production of processed potato products. Eventual adoption of these varieties and consequent reduction in the acrylamide concentration of potato products will benefit both producers and consumers. (NP-306, C1, PS1a, Project No. 3060-21430-008-000D)

Innovative healthy noodle product using amaranth. Amaranth (Amaranthus sp.) is an under-utilized ancient grain that is known to be more resistant to drought than other major staple crops. Improved techniques to process it are needed to capture its full value as a gluten-free alternative. Thermo-mechanical processes such as roasting and jet-cooking have potential for developing nutritive noodles that are high in healthy nutrients, have a good protein profile, with a high proportion of unsaturated fatty acids and a low fraction of saturated fatty acid. This blend of fatty acids is known to have a cholesterol-lowering effect. ARS scientists at Peoria, Illinois, developed a process of thermo-mechanical treatment that includes roasting and steam jet cooking to increase the value of amaranth. Roasting, a simple dry heat process, and steam jet cooking, a wet heat process that generates high shear stress, were applied to improve the nutrition and digestibility of amaranth flour. Noodles made from the raw, and treated amaranth flours were compared to wheat flour noodles in terms of several important sensory properties. The results demonstrated that gluten-free amaranth flours produced using these processing methods improved the processability, textural, and sensory properties of the amaranth. These results facilitate the expanded utilization of amaranth and contribute to the sustainability of U.S. agriculture in the era of climate change. (NP-306, C1, PS1a, Project No. 5010-

41000-182-000D)

New highly efficient apple harvesting robotic arm. Automated harvesting technology is urgently needed to address U.S. labor shortages and increasing labor costs facing the multi-billion-dollar U.S. tree fruit industry. Although research into robotic harvesting has been reported in recent years, there did exist unresolved technical challenges of picking fruit from clusters, and seeing fruit obscured by leaves and branches. In collaboration with scientists at Michigan State University, an ARS engineer at East Lansing, Michigan, developed a new robotic apple harvesting technology. This novel approach utilizes an innovative concept of vacuum sucking and rotation, coupled with a simple and effective robot arm movement mechanism, for picking fruit from trees. The new harvesting robotic arm was tested in 2020 during multiple, commercial field trials and was effective and dexterous in picking fruit from clusters, as well as deep within the canopy obscured by leaves and branches. A patent application for this technology has been filed. (NP306, C1, PS1a, Project No. 2019 5050-43640-003-000D)

Definition of ideal wheat proteins for producing high quality biscuits. Baking powder biscuits are a type of quick bread commonly consumed in the United States. They are prepared from soft wheat flour of intermediate-to-high protein content; however, little is known about the gluten protein strength and composition of U.S. eastern soft wheat (ESW) suitable for making biscuits. This lack of knowledge makes the selection of biscuit wheat varieties difficult. ARS scientists at Wooster, Ohio, identified the preferred protein composition of ESW varieties required for producing good-quality biscuits with high height and large volume. Thirty-five ESW wheat varieties carrying differing proteins were tested for flour characteristics and biscuit quality. This allowed the determination of protein profiles ideal for biscuit baking. These results are crucial for breeders to select the appropriate wheat varieties, and development of new varieties, with the necessary protein characteristics to produce quality biscuits. The results have been shared with the scientific community, the milling and baking industry and wheat breeders. (NP306, C1, PS1c, Project No. 5082-43440-002-000D)

Select rice varieties reduces obesity. Health surveys suggest that an estimated 160 million Americans are either obese or overweight. This condition leads to an increased risk of type 2 diabetes, heart disease, and cancer. It is known that gut bacteria are altered with obesity. After eating rice, normal rice starch is rapidly digested and absorbed as glucose that can then result in low blood sugar levels. Newer rice varieties have been developed that contain higher amounts of resistant starch (RS) that are not rapidly digested. In collaborative research with ARS scientists at Stuttgart, Arkansas; and Beltsville, Maryland, ARS scientist at New Orleans, Louisiana, conducted an 8-week rodent feeding study with low and high fat diets utilizing cooked rice with low to high amounts of RS. The results showed the body fat mass gain with a high fat diet was reduced in the medium and high RS groups. Gut analysis determined that mice fed with higher RS levels had lower obesity risk and improved gut bacteria known to alleviate obesity. These results demonstrate a novel route to likely combat obesity and improve the health of overweight Americans. (NP306, C1, PS1b, Project No. 6054-41000-112-000D)

Improved cottonseed oil for frying. It has long been known that cottonseed oil has been considered the ‘gold’ standard of frying oil. However, the oil has lost parts of this market to other oils that are more stable at higher frying temperatures. ARS scientists at New Orleans, Louisiana, have identified cotton varieties having seed oil composition that should perform better for frying. Together with ARS scientists at Starkville, Mississippi, these traits are being bred into cotton plants that also have good fiber properties. Upon completion of the breeding process, these cottonseed oils will be better for high temperature cooking applications and help to regain cottonseed oil’s role as the preferred frying oil. (NP306, C1, PS1c, Project No. 6054-41000-113-000D)

AI: The future of food sensory evaluation is here today. Traditionally, food quality is evaluated by humans trained in physical (visual and textural) and chemical (taste and smell) analyses. This multi-dimensional and comprehensive approach is ideal; however, it is time-consuming, labor-intensive, and expensive. ARS scientists at Beltsville, Maryland, found through examining a well-constructed digital image of a fruit/vegetable, consumers could qualitatively determine the actual, authentic physical appearance of the same fruit with only a small quantitative score difference. This finding revealed a significant use of digital images for sensory panels. This new method uses artificial intelligence (AI) to generate a vast amount of data, enabling automation to predict consumers' choices and to guide the marketability of fresh produce sold online. To strengthen this work, across all fruits and vegetables, these ARS scientists have employed a 3-D Robotic image capture system, with photo/lightbox and image processing software, to promote deep learning and advance AI food sensory evaluations. (NP306, C1, PS1b, Project No. 8042-43440-006-000D)

Resolution of toxin-contaminated wheat. Gluten extraction from toxin-contaminated wheat by wet milling. Deoxynivalenol (DON) is a toxin that occurs in grain infected with the fungal disease, Fusarium head blight (FHB). The presence of DON is the main reason FHB contaminated grain cannot be used for human consumption. Wet milling using water is a common method for processing wheat grains. Because DON is soluble in water, a wet milling process can be a valuable method to remove DON in wheat flour. ARS scientists at Fargo, North Dakota, investigated the impact of various wet milling procedures on the removal of DON and the quality of the processed wheat products. Wet milling was identified to produce wheat products with very low DON levels. This result will be a valuable option to promote the utilization of DON-contaminated wheat. (NP306, C1, PS1c, Project No. 3060-43440-015-000D)

Production of a new food grade sweetener from a low value almond product. Almond hulls, the shell which encloses almonds, are rich in extractable free sugars which could be used in feed or even food applications if the sugars could be extracted effectively and safely. However, hulls carry phenolic compounds that render them too bitter for most foods. ARS scientists at Albany, California, tested a series of food-grade proteins to remove bitter-tasting phenolic compounds from almond hull sugar syrups. Fish gelatin proved to be the most effective protein for removing bitter phenolics (up to 85%) from almond syrups, compared to other proteins. The resulting unique natural sugar solution can now be further tested in tasting panels for human consumption. Creating food-grade sweeteners from almond hulls could add hundreds of millions of dollars to the value of hulls, a direct benefit to the nut industry. (NP306, C1, PS1c, Project No. 2030-41000-068-000D)

Extending the life of food ingredients. Encapsulation is a process to encase valued materials including drugs and food ingredients from degradation by air and heat. This results in longer shelf life of the encapsulated ingredients, reducing cost to the consumer. Encapsulation of drugs and food ingredients may also provide controlled release. New encapsulating (wall) materials and encapsulation methods are always desirable. Cashew gum, a co-product from cashew nut production, is a widely available agro-based raw material that is an eco-friendly and biodegradable polymer. ARS scientists at Peoria, Illinois, and collaborators from the Institute of Agrochemistry and Food Technology (IATA) at Spanish National Research Council, Valencia, Spain, used cashew gum to encapsulate carotene (a precursor to vitamin A) through a technique called electrospraying. The encapsulated carotene was shown to be significantly protected against degradation. (NP306, C1, PS1c, Project No. 5010-41000-188-000D)

Making healthier margarines with lower saturated fat. Margarines are traditionally prepared using mixtures of hard fats, such as palm oil or hydrogenated oils, liquid vegetable oils, water, and other ingredients. They are used as table spreads and for baking and cooking. Current recommendations call

for reducing saturated fats in the diet (such as those used in producing margarines) because their consumption increases the risk of high cholesterol, atherosclerosis, and heart disease. ARS scientists at Peoria, Illinois, are developing replacements for the high saturated fats that are used in margarines using 'oleogels' made from small amounts of natural waxes mixed with liquid oil. The scientists previously found that mixtures of oil with candelilla wax or beeswax provided oleogels with increased firmness but lower melting points. To improve on these mixtures, margarines made with oil and mixtures of candelilla wax and beeswax provided oleogels that had higher firmness and lower melting points than traditional margarines. Reducing the melting point will allow the margarine to melt in the mouth, which is preferred by consumers. This study showed that properties of oleogel-based margarines such as firmness and melting properties could be improved by mixing two waxes, and that these oleogels could be used to replace saturated fats to prepare improved margarines. (NP306, C1, PS1c, Project No. 5010-44000-054-000D)

A novel, water-conserving microgreen growing system. Feeding the increasing world's population with shrinking arable land and water resources requires novel alternatives to soil-based cultivation systems and creative solutions to minimize water usage. ARS scientists at Beltsville, Maryland, developed a biodegradable, hydrogel-based "artificial soil" that minimizes water use and labor. By improving water retention/delivery and root zone aeration, this new technology supports a full 14-day growth cycle for microgreens, which equals conventional production yields without the daily watering requirements. This current technology supports facilitating live plant shipping and user-friendly vegetable growth kits for health-conscious consumers and novice urban farmers. Early, enthusiastic feedback and adoption from test urban farmers indicates potential widespread adoption by the urban farming industry. In addition, NASA scientists are investigating the employment of this technology for use in the production of food during space travel. (NP306, C1, PS1b, Project No. 8042-43440-006-000D)

New postharvest treatments to control blueberry spoilage. Postharvest fruit rots are a key factor limiting the storage and shelf life of fresh blueberries. Control of postharvest fruit rot diseases are important to the domestic and international marketing of fresh blueberries. No products have been registered specifically for the control of postharvest fruit rots. ARS scientists at Parlier, California, tested natamycin (a food additive and biofungicide) for control of fruit rots on blueberries and found that natamycin applied as either a dipping or spraying treatment significantly reduced postharvest fruit rot disease of blueberries grown in California. Natamycin treatments provide new tools for control of postharvest fruit rot diseases and maintenance of fruit quality of blueberries which will result in increased shelf-life of blueberries. (NP306, C2, PS2b, Project No. 2034-43000-041-000D)

Microbes: a biocontrol disease solution for stored potatoes. Each year Americans consume 110 pounds of potatoes per person, and to supply this year-around demand, potatoes must be stored for up to a year. Fossil-fuel based chemicals are currently used to treat stored potatoes for disease control, but due to resistance the chemical treatments by the causative disease organisms these chemicals are becoming less and less effective. An alternative to fossil-fuel based chemicals are natural microbes (e.g., biological control agents) that, when applied to potatoes, prevent rot and even delay sprouting which improves marketability. One issue with the commercial use of the fresh microbes, for postharvest potato disease control, is microbe storage life. ARS scientists at Peoria, Illinois, in collaboration with the ARS-State Partnership Potato Research Program have developed strains of microbes (containing three Pseudomonas strains) that are able to survive the drying process. Additionally, they developed a special solution which boosts reactivation of the dried microbes, especially after they have been dried and stored over six months. This long shelf-life of potato disease controlling microbes simplifies supply logistics and enables commercialization. (NP306, C3, PS3b, Project No. 2019 5010-41000-189-000D)

NON-FOOD, FIBERS and LEATHER

A new field cleaner that makes the next generation of cotton harvesters more efficient. Stripper-type cotton harvesters are used to harvest about 10 million bales, or half of the annual U.S. cotton crop. Recent design changes to make cotton modules cleaner have increased the cost of harvesters from about $250,000 to around $800,000. In response, to enable greater harvest productivity and efficiency, ARS engineers at Lubbock, Texas, working with engineers at John Deere in a cooperative research and development agreement developed and evaluated the performance of a new field cleaner for use on stripper harvesters. This new machine increased material processing capacity by 25% while improving cleaning efficiency by 20%. In addition to meeting new processing capacity goals, the new machine increased the value of cotton harvested by over $5 per bale resulting in a $35 to $50 million of annual revenue increase for U.S. cotton growers. (NP306, C2, PS2a, Project No. 2019 3096-21410-009-000D)

Development of antiviral cotton fabrics. Developing new methods for combating the spread of viruses with improved facemasks is a high priority for public health. A study by ARS scientists at New Orleans, Louisiana, in collaboration with a medical trauma wound dressing company, revealed that a jointly developed cotton nonwoven product exhibited 90-99.99 percent antiviral (against polio or corona viruses) after three hours of contact with the fabric. The nonwoven fabrics were incorporated into cotton cloth facemasks and show promise in being adopted in the marketplace as a safe effective facemask to combat viral infection. (NP306, C2, PS2b, Project No. 6054-41430-008-000D)

Optimal processing factors for producing cotton nonwoven fabrics. Nonwoven fabrics are made from long and short fibers chemically or mechanically bound together and have a market value greater than $40 billion. Cotton fibers are used extensively in this market, being used in wipes, feminine hygiene products, and diapers. The use of high-pressure water jets to produce nonwoven fabrics directly from fibers, known as spunlacing, is widely used by manufactures to create these fabrics. Using a pilot-scale spunlacing line, ARS scientists at New Orleans, Louisiana, have determined detailed and optimal processing settings specifically for the spunlacing of cotton nonwoven fabrics that enables chemical-free production of high value cotton nonwovens. This technology has been transferred to cotton producers and nonwoven manufacturers to producer higher valued fabrics to better meet the demands of consumers for disposable cotton-based products increasing the demand for and consumption of United States cotton in the nonwovens industry. (NP306, C2, PS2b, Project No. 6054-41000-108-000D)

Germ-fighting, durable, nano-enhanced cotton. Current methods to produce germ-fighting activity to fabrics rely on surface coatings. These surface coatings typically have poor durability and lose their functionality after only a few uses. To resolve this shortcoming, ARS scientists in New Orleans, Louisiana, developed a new technology that produces permanent antimicrobial cotton products by synthesizing inexpensive copper oxide nanoparticles within the cotton fiber without the use of harsh chemicals. These metallic nanoparticles are powerful antimicrobial agents. This is the first known development of a nano-enhanced cotton having long-lasting antimicrobial performance (50 laundering cycles) that is easily transferrable to large-scale manufacturing. It is anticipated that these active fabrics will have a market value reaching $1.1 billion by 2026. (NP306, C2, PS2b, Project No. 6054-41000-108-000D)

Safe, environmentally friendly cotton fabrics using vitamin C to provide disinfectant activity. There is a continued need for improved, safe, and economical textile fabrics that prevent the spread of infectious diseases within the $18 billion annual market for active textiles. With the outbreak of COVID-19, this market demand has increased. To address the demand for improved microbe fighting textiles, ARS

scientists in New Orleans, Louisiana, developed a low-cost treatment of cotton fabrics. The new treatment uses small amounts of vitamin C (safe for human consumption) applied directly to the fabric. The treated fabric prevents growth of bacteria and viruses at the 99.99 percent level. The treatment is ideal for manufacturing lines and streamlines the production process that use domestic cotton. ARS scientists in New Orleans, Louisiana, are working with the cotton and textile manufacturing industry to transfer the process. The new cotton fabric will be applicable to a wide range of textile uses including facemasks, wound dressings, hygienic wipes, and fabrics used as barriers to the spread of microbes and viruses in hospitals. (NP306, C2, PS2b, Project No. 6054-41430-008-000D)

BIOPROCESSING

Green jet-fuel from yeast is now at commercial scale. U.S. airlines have committed to reducing carbon dioxide emissions by 50% in 2050. This has created pent up demand for renewable jet fuel to replace the fossil-fuel-based 23 billion gallon per year jet fuel market. ARS scientists at Peoria, Illinois, have assembled a collection of yeasts that convert agriculture waste into bio-oil, which is easily converted into biodiesel or renewable jet fuel. One of these yeasts (Rhorosporidium toruloides) was used in a pilot demonstration at a commercial development center, to convert sugarcane bagasse into bio-oil; the yeast produced 18 gram bio-oil/100 gram agricultural waste. Demonstrating that the yeast is robust enough to produce bio-oil in a commercial, large-scale operation. This accomplishment supports the President's mandate to reduce fossil fuels and convert underutilized agricultural residues into a value-added, green biofuels that support rural economies. (NP306, C3, PS3b, Project No. 2019 5010-41000-189-000D)

Environmentally friendly "green" plastics as packaging materials. Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) and polyhydroxyalkanoates (PHA) are considered as promising "green" alternatives to fossil fuel-based synthetic polymers like nylon, polyethylene, and polyester used to make plastics. Because PHBV and PHA are made by bacteria they are compatible with living tissues making them biodegradable unlike fossil-fuel based plastics. PHAs have similar properties as plastics with good moisture/aroma transport properties but they tend to be more brittle and stiffer. PHBV are less stiff and tougher compound making PHBV ideal for packaging materials. The properties of PHBV blends depends on its composition, which can be analyzed by nuclear magnetic resonance (NMR). ARS scientists at Peoria, Illinois, developed an improved NMR method for PHBV structure determination that provides enhanced informatics on PHBV structural accuracy. This knowledge helps determine the structural relationships used for making better PHBV plastics, especially for packaging, orthopedic devices, and in controlled release of drugs. (NP306, C2, PS2b, Project No. 2019 5010-41000-188-000D)

Antibiotic alternative to increase fuel ethanol production. Most fuel ethanol facilities use baker's yeast to ferment sugars from agricultural products to alcohol. Bacterial contamination in large-scale production plants is unavoidable, so efforts usually focus on controlling levels of these bacteria. Contaminating bacteria compete for the same sugars that are used by the yeast and they often synthesize by-products that inhibit the ability of the yeast to grow. Chronic and acute contamination problems significantly reduce the economic viability of the U.S. fuel ethanol industry. While antibiotics can be used to control the contamination, alternatives are preferred to avoid overuse of antibiotics to combat these infections and eliminate the presence of antibiotic residues in fuel ethanol coproducts. ARS scientists at Peoria, Illinois, developed technology to control contamination using enzymes found in viruses that target contaminating bacteria. Studies have shown that these novel enzymes are able to reduce contamination 1,000-fold in a typical corn mash fermentation and restore ethanol productivity back to normal. These findings will allow ethanol producers to improve the efficiency of their fermentation and reduce the use of antibiotics in their plants. (NP306, C2, PS2b, Project No. 5010-41000-191-000D)

Use of dredged waterway sediments for engineered soils for improved water management roadways. In order to keep waterways such as rivers and lakes navigable, the United States Army Corps of Engineers performs dredging operations in these bodies of water. However, storage space for the dredged material is limited, so value-added uses for it are needed. ARS scientists at Peoria, Illinois, and collaborators from the Greater Peoria Sanitary District, the U.S. Corps of Engineers, and LHF Compost, Inc. was established in 2018 to study beneficial uses of dredged sediments. The team has focused on the use of dredged material from the main channel of the Illinois River to produce engineered soils for use in water management including bioswales, and rain gardens along state highways. The grass species used by the Illinois Department of Transportation had excellent growth in engineered soils containing dredged material and locally produced treated compost (including Greater Peoria Sanitary District biosolids). The use of dredged material to replace the use of other soil sources for these remediation projects will provide a new use for an underutilized waste material and control water flow. (NP306, C2, PS2b, Project No. 5010-41000-183-000D)

Developing higher value products for sugarcane co-products. It has been determined that approximately 1 million tons of surplus sugarcane bagasse goes unused and an additional 2 million tons of field residue from sugarcane harvested are generated. These materials, termed 'bagasse' cost mills several million dollars annually to manage and maintain. ARS scientists in New Orleans, Louisiana, identified ways to convert this bagasse into value-added products. These products include high-density low ash fuel pellets, low density adsorption pellets, and biochar for soil amendment. Together with industrial partners, key processing parameters have been identified for optimization to ensure that these products will be competitive with current commercially available materials. These new sugarcane co-products provide additional revenue for all participants in the sugarcane value chain. (NP306, C2, PS2b, Project No. 6054-41000-114-000D)

Improved catalyst for biofuel production from vegetable oils. The transformation of vegetable oil into a material that can be directly used as a replacement for fossil-based oil is a difficult technical process. However, ARS scientists at Peoria, Illinois, have developed a new catalyst made from recycled iridium chloride, previously used in industrial and medical applications. Using this technique, a biofuel can be made from fatty acids naturally found in plants. This new biofuel produces a higher valued biofuel when compared to fuels made using other technologies. This new fuel provides value to meet standard specifications and keep seals in the fuel system pliable and elastic. This new vegetable-based, catalyst-derived biofuel is a sustainable replacement for fossil-fuels when used alone, or in combination with fossil-fuels to produce high value blends. ARS has patented this technology. (NP306, C3, PS3a, Project No. 2019 5010-41000-186-000D)

Biobased sanitizers from sugars and seed oil. Surfactants are the primary component of detergents and are used in a wide range of products including cosmetics, foods, paints, and agricultural herbicides. ARS scientists at Peoria, Illinois, created a new class of surfactant by combining two different proprietary ARS technologies that allow commonly used sugars to be chemically linked to a compound derived from the seed oil obtained from the new row crop cuphea. The sugars can include glucose and maltose, which are obtained from corn starch, and lactose, an under-valued sugar from the dairy industry. These new surfactants are low foaming and kill bacteria on contact making them suitable for use in cleansers and sanitizers and are being commercialized. New uses for cuphea oil make this alternative crop economically attractive to farmers with marginal lands where cuphea grows well. (NP306, C2, PS2b, Project No. 5010-41000-184-000D)

New safe renewable insect repellent. Biting or blood sucking insects (flies, mosquitos, ticks, and bed

bugs) can transmit various diseases such as Zika and yellow fever. Current control of mosquito species primarily relies on massive use of petroleum-based insecticides. Many of these have some degree of toxicity that require special handling. ARS scientists at Peoria, Illinois, and Lincoln, Nebraska, developed a new series of safe all-natural insect repellents and formulation packages designed to meet the challenges posed by these menacing insects. One variant of this technology uses coconut fatty acid; a very safe material which has food grade versions. ARS scientists used these new materials to test against mosquitos to show that they performed just as well as commercial standards. The estimated global mosquito repellent market was valued at $4.1 billion in 2020. This ARS advancement will help protect the public from mosquitos using materials developed from all-natural sources. (NP306, C2, PS2b, Project No. 5010-41000-185-000D)

New biobased litter using low value soyhulls. Cats are among the most popular pets in the U.S., and the majority are kept indoors where litter boxes contain some type of absorbent litter material. Multiple companies in the United States are marketing biobased cat litters made using a variety of materials. Biobased litters are attractive because many cat owners are concerned with disposal problems encountered with traditional inorganic clay-based litters. Pet owners fear that cats might harm themselves by ingesting clay litters or inhaling clay dust. ARS scientists at Peoria, Illinois, produced a biobased cat litter based on soybean hulls and soybean hull biochar that had superior odor suppression with much lower dust particle formation compared to the three top commercial biobased cat litters. The liquid absorption and clumping ability of this soy-based litter are similar to these commercial litters. A patent application was filed in September 2020 for this formulation to further commercialization of the invention. (NP306, C2, PS2b, Project No. 5010-41000-183-000D)